

**SDS 930 COMPUTER  
EXAMINER DIAGNOSTIC SYSTEM  
TECHNICAL MANUAL**

**SDS 900097A                      October 1964**

**(Volume II)**

**LOGIC BY INSTRUCTION NUMBER, PHASE, AND CLOCK**



**SCIENTIFIC DATA SYSTEMS/1649 Seventeenth Street/Santa Monica, California**



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## INTRODUCTION

The following equations show the complete logic flow for each instruction in terms of phase and clock. This logic breakdown per instruction indicates the logic terms involved during each clock time of every phase.

The right-hand columns contain remarks concerning an equation or group of equations.

The logical derivation of the B Register during Rsa, Br1, and A12, is illustrated in detail in Appendix A.

The last instructions have the heading "UDI". These are unassigned operator codes.



|    | HLT | Halt                                   |  | 4 Cycles                             |
|----|-----|--|--|--------------------------------------|
| 00 | T8  | rC24 = T8(TsTsr)                       |  |                                      |
|    |     | rCz = 00T8                             |  |                                      |
|    |     | sF1 = (00T8IaC2C5C8(C3+C4))            |  | 05 next (T7)                         |
|    |     | sF3 = ( " )                            |  |                                      |
|    |     | sHz = T8                               |  |                                      |
|    |     | sIa = 00T8IaC2C5C8(C3+C4)              |  | initiate P register increment        |
|    |     | Oxc = (00T8IaGO)C2                     |  |                                      |
|    |     | sO(1,3,4,5,6) = OxcC(3,5,6,7,8)        |  | C(3-8) → 0 instruction to 0 register |
|    |     | rO2 = OxcC4                            |  |                                      |
| 05 | T7  | Ar3 = (01020304)Q1                     |  |                                      |
|    |     | sA(0-2) = A(21-23)AnrAr3               |  |                                      |
|    |     | rA( " ) = A( " ) "                     |  |                                      |
|    |     | sA(3-23) = A(0-20)Ar3                  |  | Recirculate A T7 thru T0             |
|    |     | rA( " ) = A( " ) "                     |  |                                      |
|    |     | sB(0-2) = B(21-23)BnrAr3               |  |                                      |
|    |     | rB( " ) = B( " ) "                     |  | Recirculate B T7 thru T0             |
|    |     | sB(3-23) = B(0-20)Ar3                  |  |                                      |
|    |     | rB( " ) = B( " ) "                     |  |                                      |
|    |     | End = 05(A00+GO)                       |  | last cycle                           |
|    |     | Pr3 = (F1GO)Q2                         |  |                                      |
|    |     | sP0 = (F1GO(02040506))(P12⊕(P13P14Ia)) |  |                                      |
|    |     | rP0 = ( " ) (P12⊕(P13P14Ia))           |  |                                      |
|    |     | sP1 = ( " ) (P13⊕(P14Ia))              |  |                                      |
|    |     | rP1 = ( " ) (P13⊕(P14Ia))              |  | P+1 → P T7 thru T3                   |
|    |     | sP2 = ( " ) (P14⊕Ia)                   |  |                                      |
|    |     | rP2 = ( " ) (P14⊕Ia)                   |  |                                      |
|    |     | rIa = (P12P13P14)Q2F1                  |  |                                      |
|    |     | sP(3-14) = P(0-11)Pr3                  |  |                                      |
|    |     | rP( " ) = P( " ) "                     |  |                                      |
| T4 | Sc  | = T4(End+F1F2)Inr                      |  |                                      |
|    |     | rS(1-14) = Sc                          |  | Clear S                              |
| T3 | Sxp | = T3Int(End+JuEax)GO+T3Kmc             |  |                                      |
|    |     | sS1 = (F1GO(02040506))(P13⊕(P14Ia))Sxp |  |                                      |
|    |     | sS2 = ( " ) (P14⊕Ia)Sxp                |  | P → S                                |
|    |     | sS(3-14) = P(0-11)Sxp                  |  |                                      |
| T0 | sHt | = 05T0010205                           |  | initiate Halt (Set Halt light)       |
| Tr | Cxm | = EndGO $\overline{Tsm}$ (Tr+Tp)       |  |                                      |
|    |     | sC(0-23) = M(0-23)Cxm                  |  | M → C Tr + Tp                        |
|    |     | rC( " ) = M( " ) "                     |  |                                      |
|    |     | rIa = TrF1                             |  |                                      |
|    |     | rIx = Tr(F1F3)(GOHt)                   |  |                                      |
|    |     | rRc = Tr                               |  |                                      |
| Tp | rF1 | = TpEndSk                              |  | 00 next clock (T8)                   |
|    |     | rF3 = ( " )                            |  |                                      |
|    |     | rGO = ( " )Ht                          |  | Machine enters HALT Status           |
|    |     | rRf = Tp01(GOHt)                       |  |                                      |
|    |     | rJu = Tp                               |  |                                      |
|    |     | Oc = TpEndSk                           |  |                                      |
|    |     | rO(1,3,4,5,6) = Oc                     |  |                                      |
|    |     | sO2 = Oc                               |  | NOP (20) → 0                         |

|    |     |               |  |                            |            |
|----|-----|---------------|--|----------------------------|------------|
| ∅0 | T8  | rC24          | = T8( $\overline{\text{TsTsr}}$ )                            |                            |            |
|    |     | rCz           | = ∅0T8   |                            |            |
|    |     | sF1           | = T8G0   |                            |            |
|    |     | sF3           | = T8G0   | ∅5 next (T7)               |            |
|    |     | sHz           | = T8   |                            |            |
| ∅5 | T7  | Ar3           | = (01020304)Q1   |                            |            |
|    |     | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                        |                            |            |
|    |     | rA( " )       | = $\overline{\text{A( " )}}$ "                               | Recirculate A              | T7 thru T0 |
|    |     | sA(3-23)      | = A(0-20)Ar3   |                            |            |
|    |     | rA( " )       | = $\overline{\text{A( " )}}$ "                               |                            |            |
|    |     | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                        |                            |            |
|    |     | rB( " )       | = $\overline{\text{B( " )}}$ "                               | Recirculate B              | T7 thru T0 |
|    |     | sB(3-23)      | = B(0-20)Ar3   |                            |            |
|    |     | rB( " )       | = $\overline{\text{B( " )}}$ "                               |                            |            |
|    |     | End           | = ∅5( $\overline{\text{A00+G0}}$ )                           | last cycle                 |            |
| T4 | Sc  |               | = T4( $\overline{\text{End+F1F2}}$ ) $\overline{\text{Inr}}$ | Clear S                    |            |
|    |     | rS(1-14)      | = Sc   |                            |            |
| Tr | rIa |               | = TrF1   |                            |            |
|    |     | rRc           | = Tr   |                            |            |
| Tp | rF1 |               | = TpEnd $\overline{\text{Sk}}$                               | ∅0 next clock (T8)         |            |
|    |     | rF3           | = ( " )  | Machine enters HALT Status |            |
|    |     | rG0           | = ( " )Ht  |                            |            |
|    |     | rJu           | = Tp   |                            |            |
|    |     | Oc            | = TpEnd $\overline{\text{Sk}}$                               |                            |            |
|    |     | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0               |            |
|    |     | sO2           | = Oc   |                            |            |

The Computer is now in Halt status and will remain in this state until the mode switch is placed on "IDLE". The following shows what takes place in "IDLE".

|    |               |          |   |                    |                                       |
|----|---------------|----------|---|--------------------|---------------------------------------|
| ∅0 | T8            | rC24     | = T8( $\overline{T8Tsr}$ )                          |                    |                                       |
|    |               | rCz      | = $\overline{\emptyset 0T8}$                        |                    |                                       |
|    |               | sF1      | = T8 $\overline{GO}$                                |                    |                                       |
|    |               | sF3      | = T8 $\overline{GO}$                                | ∅5 next (T7)       |                                       |
|    |               | rHt      | = T8( $\overline{KskgCpGO}$ )                       |                    | initiate idle (also reset halt light) |
|    |               | sHz      | = T8  |                    |                                       |
| ∅5 | T7            | Ar3      | = (01020304)Q1                                      |                    |                                       |
|    |               | sA(0-2)  | = A(21-23) $\overline{ArAr3}$                       |                    |                                       |
|    |               | rA( " )  | = $\overline{A}$ ( " ) " "                          | Recirculate A      | T7 thru T0                            |
|    |               | sA(3-23) | = A(0-20)Ar3  |                    |                                       |
|    |               | rA( " )  | = $\overline{A}$ ( " ) " "                          |                    |                                       |
|    |               | sB(0-2)  | = B(21-23) $\overline{BnrAr3}$                      |                    |                                       |
|    |               | rB( " )  | = $\overline{B}$ ( " ) " "                          | Recirculate B      | T7 thru T0                            |
|    |               | sB(3-23) | = B(0-20)Ar3  |                    |                                       |
|    |               | rB( " )  | = $\overline{B}$ ( " ) " "                          |                    |                                       |
|    |               | End      | = $\emptyset 5(\overline{A00+GO})$                  |                    | last cycle                            |
| T4 | Sc            |          | = T4( $\overline{End+F1F2}$ ) $\overline{Inr}$      |                    | Clear S                               |
|    |               | rS(1-14) | = Sc  |                    |                                       |
| Tr | rIa           |          | = TrF1  |                    |                                       |
|    | rIx           |          | = Tr( $\overline{F1F3}$ ) ( $\overline{GOHt}$ )     |                    |                                       |
|    | rRc           |          | = Tr  |                    |                                       |
| Tp | rF1           |          | = TpEnd $\overline{Sk}$                             |                    |                                       |
|    | rF3           |          | = ( " )   | ∅0 next clock (T8) |                                       |
|    | rRf           |          | = Tp $\overline{\emptyset 1}$ ( $\overline{GOHt}$ ) |                    |                                       |
|    | rJu           |          | = Tp  |                    |                                       |
|    | Oc            |          | = TpEnd $\overline{Sk}$                             |                    |                                       |
|    | rO(1,3,4,5,6) |          | = Oc  |                    | NOF (20) → 0                          |
|    | sO2           |          | = Oc  |                    |                                       |

The Computer is now in Idle status and will remain in this state until the mode switch is placed on "RUN or STEP". The following shows what takes place when the mode switch is placed on "RUN".

|    |     |               |  |                                  |            |
|----|-----|---------------|--|----------------------------------|------------|
| ∅0 | T8  | rC24          | = T8( $\overline{\text{TsTsr}}$ )            |                                  |            |
|    |     | rCz           | = ∅0T8                                       |                                  |            |
|    |     | sF1           | = T8 $\overline{\text{G0}}$                  |                                  |            |
|    |     | sF3           | = T8 $\overline{\text{G0}}$                  | ∅5 next (T7)                     |            |
|    |     | sHz           | = T8   |                                  |            |
| ∅5 | T7  | Ar3           | = (01020304)Q1                               |                                  |            |
|    |     | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$        |                                  |            |
|    |     | rA( " )       | = $\overline{\text{A}}$ ( " ) "              |                                  |            |
|    |     | sA(3-23)      | = A(0-20)Ar3                                 | Recirculate A                    | T7 thru T0 |
|    |     | rA( " )       | = $\overline{\text{A}}$ ( " ) "              |                                  |            |
|    |     | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$        |                                  |            |
|    |     | rB( " )       | = $\overline{\text{B}}$ ( " ) "              |                                  |            |
|    |     | sB(3-23)      | = B(0-20)Ar3                                 | Recirculate B                    | T7 thru T0 |
|    |     | rB( " )       | = $\overline{\text{B}}$ ( " ) "              |                                  |            |
|    |     | End           | = ∅5(A00+G0)                                 | last cycle                       |            |
| T4 | Sc  |               | = T4(End+F1F2) $\overline{\text{Inr}}$       | Clear S                          |            |
|    |     | rS(1-14)      | = Sc   |                                  |            |
| Tr | rIa |               | = TrF1                                       |                                  |            |
|    |     | rRc           | = Tr   |                                  |            |
| Tp | rF1 |               | = TpEndSk                                    |                                  |            |
|    |     | rF3           | = ( " )                                      | ∅0 next clock (T8)               |            |
|    |     | sGO           | = $\overline{\text{A00B00TpHt}}$ (Ks+Kg) Tem | Machine enters normal run status |            |
|    |     | rRf           | = Tp $\overline{\text{01}}$ (GOHt)           |                                  |            |
|    |     | rJu           | = Tp   |                                  |            |
|    |     | Oc            | = TpEndSk                                    |                                  |            |
|    |     | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                     |            |
|    |     | sO2           | = Oc   |                                  |            |

The Computer is now in normal run status with the contents of the C register about to be executed.



|    | BRU                   | Unconditional Branch                          | M → P                     | 1 Cycle    |
|----|-----------------------|---|---------------------------|------------|
| 00 | T8                    | rCz = 00T8                                    |                           |            |
|    |                       | sHz = T8                                      |                           |            |
|    |                       | sIx = C1G000T8                                | Initialize indexing       |            |
|    |                       | sJu = $\overline{IaGOC4C5C8C9T8}$             |                           |            |
|    |                       | Oxc = $\overline{IaGOC200T8}$                 |                           |            |
|    |                       | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc               | Instruction to 0 register |            |
|    |                       | rO2 = $\overline{C4Oxc}$                      |                           |            |
| T7 | Ar3                   | = (01020304)Q1                                |                           |            |
|    | sA(0-2)               | = A(21-23) $\overline{AnrAr3}$                |                           |            |
|    | rA( " )               | = $\overline{A( " )}$ " "                     | Recirculate A             | T7 thru T0 |
|    | sA(3-23)              | = A(0-20)Ar3                                  |                           |            |
|    | rA( " )               | = $\overline{A( " )}$ " "                     |                           |            |
|    | sB(0-2)               | = B(21-23) $\overline{BnrAr3}$                |                           |            |
|    | rB( " )               | = $\overline{B( " )}$ " "                     | Recirculate B             | T7 thru T0 |
|    | sB(3-23)              | = B(0-20)Ar3                                  |                           |            |
|    | rB( " )               | = $\overline{B( " )}$ " "                     |                           |            |
|    | End                   | = JuEax01                                     | Last cycle                |            |
|    | Cr3                   | = $\overline{F1F2(TsQ1)}$                     |                           |            |
|    | sC0                   | = (P12)JuTsCr3Q6                              |                           |            |
|    | rC0                   | = ( " ) " "                                   |                           |            |
|    | sC(1,2)               | = P(13,14)JuTsCr3Q2                           |                           |            |
|    | rC( " )               | = $\overline{P( " )}$ " "                     | P(1-14) → C(10-23)        | T7 thru T3 |
|    | sC(3-23)              | = C(0-20)Cr3                                  |                           |            |
|    | rC( " )               | = $\overline{C( " )}$ " "                     |                           |            |
|    | sCp                   | = (C21 ⊕ C22 ⊕ C23) $\overline{CpTsHtQ1F1F2}$ |                           |            |
|    | rCp                   | = ( " ) Cp " "                                | Parity check              | T7 thru T0 |
|    | Pr3                   | = JuQ2  |                           |            |
|    | sP(0-2)               | = Add(1-3) (JuEax+02040506) Pr3               |                           |            |
|    | rP( " )               | = $\overline{Add( " )}$ ( " ) " "             | C + X·Ix → P              | T7 thru T3 |
|    | sP(3-14)              | = P(0-11)Pr3                                  |                           |            |
|    | rP( " )               | = $\overline{P( " )}$ " "                     |                           |            |
|    | Xz(1-3)               | = Xn(1-3)00Ix                                 |                           |            |
|    | $\overline{Xz}$ ( " ) | = $\overline{Xn( " )}$ 00Ix+ $\overline{Ix}$  | Input to adder (X·Ix)     | T7 thru T0 |
|    | Yz(1-3)               | = C(21-23)07                                  |                           |            |
|    | $\overline{Yz}$ ( " ) | = $\overline{C( " )}$ " "                     | Input to adder (C)        | T7 thru T0 |
|    | sCz                   | = KzQ1T0                                      |                           |            |
|    | rCz                   | = $\overline{KzQ1}$                           | Carry logic               | T7 thru T1 |
| T4 | Sc                    | = $\overline{InrF1F2T4}$                      |                           |            |
|    | rS(1-14)              | = Sc  | Clear S                   |            |
| T3 | rC0                   | = (JuTsCr3)Q4Q6                               | No input to C3, C6, C9    | T3 thru T1 |
|    | Sxp                   | = $\overline{IntEndGOT3}$                     |                           |            |
|    | sS(1,2)               | = Add(2,3) (JuEax+02040506) Sxp               |                           |            |
|    | sS(3-14)              | = P(0-11)Sxp                                  | P → S                     |            |
| T2 | rC(1,2)               | = (JuTsCr3)T2                                 | No input to C7, C8        |            |
| T1 | sC(1,2)               | = (JuTsCr3)Em(1,2)T1                          |                           |            |
|    | rC( " )               | = ( " ) $\overline{Em( " )}$ " "              | (C1,C2) is (C4,C5) at T1  |            |
| T0 | rCz                   | = F1T0  |                           |            |
|    | sC0                   | = Of(JuTsCr3)T0                               | Set C0 if overflow        |            |
|    | rC0                   | = $\overline{Of( " )}$ " "                    |                           |            |
|    | rC(1,2)               | = (JuTsCr3)T0                                 | No input to C1, C2        |            |

|    |               |                    |                                |
|----|---------------|--------------------|--------------------------------|
| Tr | Cxm           | = EndGOTsm(Tr+Tp)  |                                |
|    | sC(0-23)      | = M(0-23) Cxm      | M → C (Fetch next instruction) |
|    | rC( " )       | = CxmTr            | Tr thru Tp                     |
|    | sHt           | = CpTrKpK002       | Parity error                   |
|    | rIx           | = (FIF3) (GOHt)Tr  |                                |
|    | rRc           | = Tr               |                                |
| Tp | rA00          | = EndGOTp          |                                |
|    | rB00          | = ( " )            |                                |
|    | sCp           | = M24CxmHtTsTp     | Initiate parity                |
|    | rJu           | = Tp               |                                |
|    | Oc            | = (O1O3Ia+EndSk)Tp |                                |
|    | rO(1,3,4,5,6) | = Oc               |                                |
|    | sO2           | = Oc               | NOP (20) → 0                   |

|    |      |   |  |                          |
|----|------|---|--|--------------------------|
| 01 | BRU* | Uncock Active Interrupt<br>(Unconditional Branch, Indirectly Addressed)   | (M) → P  | 2 Cycles                 |
| 00 | T8   | rCz = 00T8<br>sHz = T8<br>sIa = $\overline{C2}C9(C5+C8+C3C4)00T8$<br>sIx = $\overline{C1}G000T8$<br>Oxc = $\overline{Ia}G0\overline{C2}00T8$<br>sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>rO2 = $\overline{Oxc}C4$   | Indirect addressing<br>Initialize indexing<br>C(3-8) → 0 instruction to 0 register   |                          |
| T7 | Ar3  | = $(05F1F2+(01020304))Q1$<br>sA(0-2) = $\overline{A}(21-23)\overline{Anr}Ar3$<br>rA( " ) = $\overline{A}( " ) " "$<br>sA(3-23) = $\overline{A}(0-20)Ar3$<br>rA( " ) = $\overline{A}( " ) " "$<br>sB(0-2) = $\overline{B}(21-23)\overline{Bnr}Ar3$<br>rB( " ) = $\overline{B}( " ) " "$<br>sB(3-23) = $\overline{B}(0-20)Ar3$<br>rB( " ) = $\overline{B}( " ) " "$<br>Cr3 = $\overline{Ts}00Q1$<br>sC(0-2) = $\overline{Add}(1-3)Cr3\overline{Ju}Ts$<br>rC( " ) = $\overline{Add}( " ) " "$<br>sC(3-23) = $\overline{C}(0-20)Cr3$<br>rC( " ) = $\overline{C}( " ) " "$<br>sCp = $(C21+C22+C23)\overline{Cp}Ts\overline{Ht}Q1F1F2$<br>rCp = ( " ) Cp " "<br>Xz(1-3) = $\overline{Xn}(1-3)00Ix$<br>XZ( " ) = $\overline{Xn}( " )00Ix+\overline{Ix}$<br>Yz(1-3) = $\overline{C}(21-23)07$<br>YZ( " ) = $\overline{C}( " ) " "$<br>sCz = $\overline{Kz}Q1\overline{T0}$<br>rCz = $\overline{Kz}Q1$ | (All instructions except 66 & 67)<br>Recirculate A<br>Recirculate B<br>C + X·Ix → C<br>Parity check<br>Xz input to adder<br>Yz input to adder<br>Carry logic | T7 thru T0<br>T7 thru T0 |
| T4 | Sc   | = $\overline{Inr}F1F2T4$  | Clear S  |                          |
| T3 | Ib   | = $\overline{Ia}0102040506\overline{Ts}Q5Q6$<br>Sxc = $\overline{Ju}T3$<br>sS(1,2) = $\overline{Add}(2,3)Sxc$<br>sS(3-14) = $\overline{C}(0-11)Sxc$   | Uncock active interrupt<br>C + X·Ix → S  | T3 thru Tr               |
| T0 | rCz  | = $\overline{F1}T0$   |  |                          |
| Tr | Cxm  | = $\overline{Ju}Ts\overline{m}(Tr+Tp)$<br>sC(0-23) = $\overline{M}(0-23)Cxm$<br>rC( " ) = $\overline{Cxm}Tr$<br>sHt = $\overline{Cp}Tr(\overline{Kp}K002)$<br>rIx = $(F1F3)(GOHt)Tr$<br>rRc = Tr  | M → C (Fetch effective add)<br>Parity error  | Tr thru Tp               |
| Tp | sCp  | = $\overline{M24}Cxm\overline{Ht}TsTp$  | Initiate parity  |                          |

|    |         |                       |  |                       |            |
|----|---------|-----------------------|--|-----------------------|------------|
| ∅0 | T8      | rCz                   | = ∅0T8                                       |                       |            |
|    |         | sHz                   | = T8   |                       |            |
|    |         | rIa                   | = $\overline{C9}Ia$                          |                       |            |
|    |         | sIx                   | = C1G0∅0T8                                   | Initialize indexing   |            |
|    |         | sJu                   | = $\overline{C90203}∅0T8$                    |                       |            |
| T7 | Ar3     |                       | = $\overline{05}∅0Q1$                        |                       |            |
|    |         | sA(0-2)               | = A(21-23) $\overline{Anr}Ar3$               |                       |            |
|    |         | rA( " )               | = $\overline{A}$ ( " ) "                     | Recirculate A         | T7 thru T0 |
|    |         | sA(3-23)              | = A(0-20)Ar3                                 |                       |            |
|    |         | rA( " )               | = $\overline{A}$ ( " ) "                     |                       |            |
|    |         | sB(0-2)               | = B(21-23) $\overline{Bnr}Ar3$               |                       |            |
|    |         | rB( " )               | = $\overline{B}$ ( " ) "                     | Recirculate B         | T7 thru T0 |
|    |         | sB(3-23)              | = B(0-20)Ar3                                 |                       |            |
|    |         | rB( " )               | = $\overline{B}$ ( " ) "                     |                       |            |
|    |         | End                   | = JuEax01                                    | Last cycle            |            |
|    |         | Cr3                   | = $\overline{Ts}∅0Q1$                        |                       |            |
|    |         | sC0                   | = (P12)JuTsCr3Q6                             |                       |            |
|    |         | rC0                   | = ( " ) "                                    |                       |            |
|    |         | sC(1,2)               | = P(13,14)JuTsCr3Q2                          | P(1-14) → C(10-23)    | T7 thru T3 |
|    |         | rC( " )               | = $\overline{P}$ ( " ) "                     |                       |            |
|    |         | sC(3-23)              | = C(0-20)Cr3                                 |                       |            |
|    |         | rC( " )               | = $\overline{C}$ ( " ) "                     |                       |            |
|    |         | sCp                   | = (C21⊕C22⊕C23)CpTsHtQ1F1F2                  | Parity check          | T7 thru T0 |
|    |         | rCp                   | = ( " ) Cp "                                 |                       |            |
|    |         | Pr3                   | = JuQ2                                       |                       |            |
|    |         | sP(0-2)               | = Add(1-3) $\overline{02040506}Pr3$          |                       |            |
|    |         | rP( " )               | = $\overline{Add}$ ( " ) "                   | C + X·Ix → P          | T7 thru T3 |
|    |         | sP(3-14)              | = P(0-11)Pr3                                 |                       |            |
|    |         | rP( " )               | = $\overline{P}$ ( " ) "                     |                       |            |
|    |         | Xz(1-3)               | = Xn(1-3) $\overline{00}Ix$                  | Input to adder (X·Ix) |            |
|    |         | $\overline{Xz}$ ( " ) | = $\overline{Xn}$ ( " ) $\overline{00}Ix+Ix$ |                       |            |
|    |         | Yz(1-3)               | = C(21-23) $\overline{07}$                   | Input to adder (C)    |            |
|    |         | $\overline{Yz}$ ( " ) | = $\overline{C}$ ( " ) "                     |                       |            |
|    |         | sCz                   | = KzQ1 $\overline{T0}$                       | Carry logic           | T7 thru T1 |
|    |         | rCz                   | = $\overline{Kz}Q1$                          |                       |            |
| T4 | Sc      |                       | = $\overline{Inr}F1F2T4$                     | Clear S               |            |
|    |         | rS(1-14)              | = Sc   |                       |            |
| T3 | rC0     |                       | = (JuTsCr3)Q4Q6                              | No input to C0        | T3 thru T1 |
|    |         | Sxp                   | = $\overline{Int}EndGOT3$                    |                       |            |
|    |         | sS(1,2)               | = Add(2,3)(JuEax+ $\overline{02040506}$ )Sxp |                       |            |
|    |         | sS(3-14)              | = P(0-11)Sxp                                 |                       |            |
| T2 | rC(1,2) |                       | = (JuTsCr3)T2                                | No input to C1, C2    |            |
| T1 | sC(1,2) |                       | = (JuTsCr3)Em(1,2)T1                         |                       |            |
|    |         | rC( " )               | = ( " ) $\overline{Em}$ ( " ) "              |                       |            |
| T0 | rCz     |                       | = $\overline{F}T0$                           |                       |            |
|    |         | sC0                   | = Of(JuTsCr3)T0                              |                       |            |
|    |         | rC0                   | = $\overline{Of}$ ( " ) "                    |                       |            |
|    |         | rC(1,2)               | = (JuTsCr3)T0                                |                       |            |

|    |               |                     |                                |
|----|---------------|---------------------|--------------------------------|
| Tr | Cxm           | = EndGOTsm(Tr+Tp)   |                                |
|    | sC(0-23)      | = M(0-23) Cxm       | M → C (Fetch next instruction) |
|    | rC( " )       | = CxmTr             | Tr thru Tp                     |
|    | sHt           | = CpTr(Kp)002       | Parity error                   |
|    | rIx           | = (FIF3) (GOHt) Tr  |                                |
|    | rRc           | = Tr                |                                |
| Tp | rA00          | = EndGOTp           |                                |
|    | rB00          | = ( " )             |                                |
|    | sCp           | = M24CxmHtTsTp      | Initiate parity                |
|    | rJu           | = Tp                |                                |
|    | Oc            | = (0103Ta+EndSK) Tp |                                |
|    | rO(1,3,4,5,6) | = Oc                |                                |
|    | sO2           | = Oc                | NOP (20) → 0                   |

|    |           |                |   |                                      |
|----|-----------|----------------|---|--------------------------------------|
| 02 | EOM 20001 | Reset Overflow |   | 1 Cycle                              |
| 00 | T8        | rC24           | = $T8(\overline{TsTsr})$  |                                      |
|    |           | rCz            | = $\overline{0}T8$  |                                      |
|    |           | sF1            | = $(\overline{0}T8\overline{Ia}\overline{C2}\overline{C5}\overline{C8}(\overline{C3}+\overline{C4}))$             |                                      |
|    |           | sF3            | = ( " )   | 05 next (T7)                         |
|    |           | sHz            | = T8  |                                      |
|    |           | sIa            | = $\overline{0}T8\overline{Ia}\overline{C2}\overline{C5}\overline{C8}(\overline{C3}+\overline{C4})$               | initiate P register increment        |
|    |           | Oxc            | = $(\overline{0}T8\overline{Ia}GO)\overline{C2}$  |                                      |
|    |           | sO(1,3,4,5,6)  | = $OxcC(3,5,6,7,8)$   | C(3-8) → 0 instruction to 0 register |
|    |           | rO2            | = $Oxc\overline{C4}$  |                                      |
| 05 | T7        | Ar3            | = $(\overline{0}1\overline{0}2\overline{0}3\overline{0}4)Q1$  |                                      |
|    |           | sA(0-2)        | = $A(21-23)\overline{AnrAr3}$   |                                      |
|    |           | rA( " )        | = $\overline{A}( " )$ "   | Recirculate A                        |
|    |           | sA(3-23)       | = $A(0-20)Ar3$  | T7 thru T0                           |
|    |           | rA( " )        | = $\overline{A}( " )$ "   |                                      |
|    |           | sB(0-2)        | = $B(21-23)\overline{BnrAr3}$   |                                      |
|    |           | rB( " )        | = $\overline{B}( " )$ "   | Recirculate B                        |
|    |           | sB(3-23)       | = $B(0-20)Ar3$  | T7 thru T0                           |
|    |           | rB( " )        | = $\overline{B}( " )$ "   |                                      |
|    |           | End            | = $\overline{0}5(A00+GO)$   | last cycle                           |
|    |           | Eom            | = $(\overline{0}5\overline{0}1\overline{0}5\overline{Ts}\overline{Q2}\overline{Q5})\overline{O4}$                 | T7 thru Tr                           |
|    |           | rOf            | = $(EomC10\overline{C11})\overline{C23}$  | Reset Overflow                       |
|    |           | Pr3            | = $(F1GO)Q2$  |                                      |
|    |           | sP0            | = $(F1GO(\overline{0}2\overline{0}4\overline{0}5\overline{O6}))(\overline{P12}+(\overline{P13}\overline{P14}Ia))$ |                                      |
|    |           | rP0            | = ( " ) $(\overline{P12}+(\overline{P13}\overline{P14}Ia))$   |                                      |
|    |           | sP1            | = ( " ) $(\overline{P13}+(\overline{P14}Ia))$   |                                      |
|    |           | rP1            | = ( " ) $(\overline{P13}+(\overline{P14}Ia))$   | P+1 → P                              |
|    |           | sP2            | = ( " ) $(\overline{P14}+Ia)$   | T7 thru T3                           |
|    |           | rP2            | = ( " ) $(\overline{P14}+Ia)$   |                                      |
|    |           | rIa            | = $(\overline{P12}\overline{P13}\overline{P14})Q2F1$  |                                      |
|    |           | sP(3-14)       | = $P(0-11)Pr3$  |                                      |
|    |           | rP( " )        | = $\overline{P}( " )$ "   |                                      |
| T4 | Sc        |                | = $T4(\overline{End}+\overline{F1}\overline{F2})\overline{Inr}$   | Clear S                              |
|    |           | rS(1-14)       | = Sc  |                                      |
| T3 | Sxp       |                | = $T3\overline{Int}(\overline{End}+\overline{Ju}\overline{Eax})GO+T3\overline{Kmd}$                               |                                      |
|    |           | sS1            | = $(F1GO(\overline{0}2\overline{0}4\overline{0}5\overline{O6}))(\overline{P13}+(\overline{P14}Ia))Sxp$            |                                      |
|    |           | sS2            | = ( " ) $(\overline{P14}+Ia)Sxp$  | P → S                                |
|    |           | sS(3-14)       | = $P(0-11)Sxp$  |                                      |
| Tr | Cxm       |                | = $\overline{End}GO\overline{Tsm}(\overline{Tr}+\overline{Tp})$   |                                      |
|    |           | sC(0-23)       | = $M(0-23)Cxm$  | M → C                                |
|    |           | rC( " )        | = $\overline{M}( " )$ "   | Tr + Tp                              |
|    |           | rIa            | = $\overline{Tr}F1$   |                                      |
|    |           | rIx            | = $\overline{Tr}(\overline{F1}\overline{F3})(\overline{GO}Ht)$  |                                      |
|    |           | rRc            | = Tr  |                                      |
| Tp | rF1       |                | = $\overline{Tp}\overline{End}\overline{Sk}$  | 00 next clock (T8)                   |
|    |           | rF3            | = ( " )   |                                      |
|    |           | rRf            | = $\overline{Tp}\overline{0}1(\overline{GO}Ht)$   |                                      |
|    |           | rJu            | = Tp  |                                      |
|    |           | Oc             | = $\overline{Tp}\overline{End}\overline{Sk}$  |                                      |
|    |           | rO(1,3,4,5,6)  | = Oc  | NOP (20) → 0                         |
|    |           | sO2            | = Oc  |                                      |

2

EOM 20002

Enable Interrupt

1 Cycle

|    |               |               |                                     |  |                                      |
|----|---------------|---------------|-------------------------------------|--|--------------------------------------|
| 00 | T8            | rC24          | = T8(TsTsr)                         |  |                                      |
|    |               | rCz           | = 0T8                               |  |                                      |
|    |               | sF1           | = (0T8IaC2C5C8(C3+C4))              |  |                                      |
|    |               | sF3           | = ( " )                             |  | 05 next (T7)                         |
|    |               | sHz           | = T8                                |  |                                      |
|    |               | sIa           | = 0T8IaC2C5C8(C3+C4)                |  | initiate P register increment        |
|    |               | Oxc           | = (0T8IaGO)C2                       |  |                                      |
|    |               | sO(1,3,4,5,6) | = OxcC(3,5,6,7,8)                   |  | C(3-8) → 0 instruction to 0 register |
|    |               | rO2           | = OxcC4                             |  |                                      |
| 05 | T7            | Ar3           | = (01020304)Q1                      |  |                                      |
|    |               | sA(0-2)       | = A(21-23)AnrAr3                    |  |                                      |
|    |               | rA( " )       | = A( " ) "                          |  | Recirculate A T7 thru T0             |
|    |               | sA(3-23)      | = A(0-20)Ar3                        |  |                                      |
|    |               | rA( " )       | = A( " ) "                          |  |                                      |
|    |               | sB(0-2)       | = B(21-23)BnrAr3                    |  |                                      |
|    |               | rB( " )       | = B( " ) "                          |  | Recirculate B T7 thru T0             |
|    |               | sB(3-23)      | = B(0-20)Ar3                        |  |                                      |
|    |               | rB( " )       | = B( " ) "                          |  |                                      |
|    |               | End           | = 05(A00+GO)                        |  | last cycle                           |
|    |               | Eom           | = (050105TsQ2Q5)Q4                  |  | T7 thru Tr                           |
|    |               | Pr3           | = (F1GO)Q2                          |  |                                      |
|    |               | sP0           | = (F1GO(02040506)) (P12⊕(P13P14Ia)) |  |                                      |
|    |               | rP0           | = ( " ) (P12⊕(P13P14Ia))            |  |                                      |
|    |               | sP1           | = ( " ) (P13⊕(P14Ia))               |  |                                      |
|    |               | rP1           | = ( " ) (P13⊕(P14Ia))               |  | P+1 → P T7 thru T3                   |
|    |               | sP2           | = ( " ) (P14⊕Ia)                    |  |                                      |
|    |               | rP2           | = ( " ) (P14⊕Ia)                    |  |                                      |
|    |               | rIa           | = (P12P13P14)Q2F1                   |  |                                      |
|    |               | sP(3-14)      | = P(0-11)Pr3                        |  |                                      |
|    |               | rP( " )       | = P( " ) "                          |  |                                      |
| T4 | Sc            |               | = T4(End+F1F2)Inr                   |  |                                      |
|    | rS(1-14)      |               | = Sc                                |  | Clear S                              |
| T3 | Sxp           |               | = T3Int(End+JuEax)GO+T3Kmc          |  |                                      |
|    | sS1           |               | = (F1GO(02040506)) (P13⊕(P14Ia))Sxp |  |                                      |
|    | sS2           |               | = ( " ) (P14⊕Ia)Sxp                 |  | P → S                                |
|    | sS(3-14)      |               | = P(0-11)Sxp                        |  |                                      |
| T0 | sEn           |               | = (EomC10C11)C22T0                  |  | Enable interrupt                     |
| Tr | Cxm           |               | = EndGO <del>Fsm</del> (Tr+Tp)      |  |                                      |
|    | sC(0-23)      |               | = M(0-23)Cxm                        |  | M → C Tr + Tp                        |
|    | rC( " )       |               | = M( " ) "                          |  |                                      |
|    | rIa           |               | = TrF1                              |  |                                      |
|    | rIx           |               | = Tr(F1F3)(GOHt)                    |  |                                      |
|    | rRc           |               | = Tr                                |  |                                      |
| Tp | rF1           |               | = TpEndSk                           |  | 00 next clock (T8)                   |
|    | rF3           |               | = ( " )                             |  |                                      |
|    | rRf           |               | = Tp01(GOht)                        |  |                                      |
|    | rJu           |               | = Tp                                |  |                                      |
|    | Oc            |               | = TpEndSk                           |  |                                      |
|    | rO(1,3,4,5,6) |               | = Oc                                |  | NOP (20) → 0                         |
|    | sO2           |               | = Oc                                |  |                                      |

| 02 | EOM 20004 | Disable Interrupt  | 1 Cycle                              |
|----|-----------|--|--------------------------------------|
| 00 | T8        | rC24 = T8( $\overline{\text{TsTsr}}$ )                                 |                                      |
|    |           | rCz = 0T8  |                                      |
|    |           | sF1 = (0T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )) |                                      |
|    |           | sF3 = ( " )  | 05 next (T7)                         |
|    |           | sHz = T8   |                                      |
|    |           | sIa = 0T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )   | initiate P register increment        |
|    |           | Oxc = (0T8 $\overline{\text{IaGO}}$ )C2                                |                                      |
|    |           | sO(1,3,4,5,6) = OxcC(3,5,6,7,8)  | C(3-8) → 0 instruction to 0 register |
|    |           | rO2 = OxcC4  |                                      |
| 05 | T7        | Ar3 = (01020304)Q1   |                                      |
|    |           | sA(0-2) = A(21-23)AnrAr3   |                                      |
|    |           | rA( " ) = A( " ) "   | Recirculate A                        |
|    |           | sA(3-23) = A(0-20)Ar3  | T7 thru T0                           |
|    |           | rA( " ) = A( " ) "   |                                      |
|    |           | sB(0-2) = B(21-23)BnrAr3   |                                      |
|    |           | rB( " ) = B( " ) "   | Recirculate B                        |
|    |           | sB(3-23) = B(0-20)Ar3  | T7 thru T0                           |
|    |           | rB( " ) = B( " ) "   |                                      |
|    |           | End = 05(A00+GO)   | last cycle                           |
|    |           | Eom = (050105TsQ2Q5)O4   | T7 thru Tr                           |
|    |           | Pr3 = (F1GO)Q2   |                                      |
|    |           | sP0 = (F1GO(02040506))(P12 $\oplus$ (P13P14Ia))                        |                                      |
|    |           | rP0 = ( " )(P12 $\oplus$ (P13P14Ia))                                   |                                      |
|    |           | sP1 = ( " )(P13 $\oplus$ (P14Ia))                                      |                                      |
|    |           | rP1 = ( " )(P13 $\oplus$ (P14Ia))                                      | P+1 → P                              |
|    |           | sP2 = ( " )(P14 $\oplus$ Ia)   | T7 thru T3                           |
|    |           | rP2 = ( " )(P14 $\oplus$ Ia)   |                                      |
|    |           | rIa = (P12P13P14)Q2F1  |                                      |
|    |           | sP(3-14) = P(0-11)Pr3  |                                      |
|    |           | rP( " ) = P( " ) "   |                                      |
| T4 | Sc        | = T4(End+F1F2) $\overline{\text{Inr}}$                                 | Clear S                              |
|    |           | rS(1-14) = Sc  |                                      |
| T3 | Sxp       | = T3 $\overline{\text{Int}}$ (End+JuEax)GO+T3Kmc                       |                                      |
|    |           | sS1 = (F1GO(02040506))(P13 $\oplus$ (P14Ia))Sxp                        |                                      |
|    |           | sS2 = ( " )(P14 $\oplus$ Ia)Sxp  | P → S                                |
|    |           | sS(3-14) = P(0-11)Sxp  |                                      |
| T0 | rEn       | = (EomC10C11)C21T0   | Disable interrupt                    |
| Tr | Cxm       | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)                                |                                      |
|    |           | sC(0-23) = M(0-23)Cxm  | M → C                                |
|    |           | rC( " ) = M( " ) "   | Tr + Tp                              |
|    |           | rIa = TrF1   |                                      |
|    |           | rIx = Tr(F1F3)(GOht)   |                                      |
|    |           | rRc = Tr   |                                      |
| Tp | rF1       | = TpEndSk  | 00 next clock (T8)                   |
|    |           | rF3 = ( " )  |                                      |
|    |           | rRf = Tp01(GOht)   |                                      |
|    |           | rJu = Tp   |                                      |
|    |           | Oc = TpEndSk   |                                      |
|    |           | rO(1,3,4,5,6) = Oc   | NOP (20) → 0                         |
|    |           | sO2 = Oc   |                                      |



02 EOM 20010 Set Overflow if X14 ≠ X15 1 Cycle

|    |    |               |                                    |                                      |            |
|----|----|---------------|------------------------------------|--------------------------------------|------------|
| 00 | T8 | rC24          | = T8(TsTsr)                        |                                      |            |
|    |    | rCs           | = 00T8                             |                                      |            |
|    |    | sF1           | = (00T8IaC2C5C8(C3+C4))            |                                      |            |
|    |    | sF3           | = ( " )                            | 05 next (T7)                         |            |
|    |    | sHa           | = T8                               |                                      |            |
|    |    | sIa           | = 00T8IaC2C5C8(C3+C4)              | initiate P register increment        |            |
|    |    | Oxc           | = (00T8IaGO)C2                     |                                      |            |
|    |    | sO(1,3,4,5,6) | = OxCC(3,5,6,7,8)                  | C(3-8) → 0 instruction to 0 register |            |
|    |    | rO2           | = OxCC4                            |                                      |            |
| 05 | T7 | Ar3           | = (01020304)Q1                     |                                      |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                   |                                      |            |
|    |    | rA( " )       | = A( " ) "                         | Recirculate A                        | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                       |                                      |            |
|    |    | rA( " )       | = A( " ) "                         |                                      |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                   |                                      |            |
|    |    | rB( " )       | = B( " ) "                         | Recirculate B                        | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                       |                                      |            |
|    |    | rB( " )       | = B( " ) "                         |                                      |            |
|    |    | End           | = 05(A00+GO)                       | last cycle                           |            |
|    |    | Eom           | = (050105TsQ205)04                 |                                      | T7 thru Tr |
|    |    | Pr3           | = (F1GO)Q2                         |                                      |            |
|    |    | sP0           | = (F1GO(02040506))(P12⊕(P13P14Ia)) |                                      |            |
|    |    | rP0           | = ( " ) (P12⊕(P13P14Ia))           |                                      |            |
|    |    | sP1           | = ( " ) (P13⊕(P14Ia))              |                                      |            |
|    |    | rP1           | = ( " ) (P13⊕(P14Ia))              | P+1 → P                              | T7 thru T3 |
|    |    | sP2           | = ( " ) (P14Ia)                    |                                      |            |
|    |    | rP2           | = ( " ) (P14Ia)                    |                                      |            |
|    |    | rIa           | = (P12P13P14)Q2F1                  |                                      |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                       |                                      |            |
|    |    | rP( " )       | = P( " ) "                         |                                      |            |
| T4 |    | sOf           | = (EomC10C11)C20T4(Xn3⊕Xw1)        | Set overflow if X14 ≠ X15            |            |
|    |    | Sc            | = T4(End+F1F2)Inr                  | Clear S                              |            |
|    |    | rS(1-14)      | = Sc                               |                                      |            |
| T3 |    | Sxp           | = T3Int(End+JuEax)GO+T3Kmc         |                                      |            |
|    |    | sS1           | = (F1GO(02040506))(P13⊕(P14Ia))Sxp |                                      |            |
|    |    | sS2           | = ( " ) (P14⊕Ia)Sxp                | P → S                                |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                       |                                      |            |
| Tr |    | Cxm           | = EndGO+am(Tr+Tp)                  | M → C                                | Tr + Tp    |
|    |    | sC(0-23)      | = M(0-23)Cxm                       |                                      |            |
|    |    | rC( " )       | = M( " ) "                         |                                      |            |
|    |    | rIa           | = TrF1                             |                                      |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)                   |                                      |            |
|    |    | rRc           | = Tr                               |                                      |            |
| Tp |    | rF1           | = TpEndSk                          |                                      |            |
|    |    | rF3           | = ( " )                            | 00 next clock (T8)                   |            |
|    |    | rRf           | = TpF1(GOht)                       |                                      |            |
|    |    | rJu           | = Tp                               |                                      |            |
|    |    | Oc            | = TpEndSk                          |                                      |            |
|    |    | rO(1,3,4,5,6) | = Oc                               | NOP (20) → 0                         |            |
|    |    | sO2           | = Oc                               |                                      |            |

|    |           |                         |   |                                      |
|----|-----------|-------------------------|---|--------------------------------------|
| 06 | EOD 2010X | Set Bank Register 2 = X |   | 1 Cycle                              |
| 00 | T8        | rC24                    | = T8( $\overline{TsTsr}$ )                                  |                                      |
|    |           | rCz                     | = $\overline{\emptyset}OT8$                                 |                                      |
|    |           | sF1                     | = ( $\overline{\emptyset}OT8IaC2C5C8(\overline{C3+C4})$ )   | $\emptyset 5$ next (T7)              |
|    |           | sF3                     | = ( " )   |                                      |
|    |           | sHz                     | = T8  |                                      |
|    |           | sIa                     | = $\overline{\emptyset}OT8IaC2C5C8(\overline{C3+C4})$       | initiate P register increment        |
|    |           | Oxc                     | = ( $\overline{\emptyset}OT8IaGO$ ) $\overline{C2}$         |                                      |
|    |           | sO(1,3,4,5,6)           | = Ox $\overline{C(3,5,6,7,8)}$                              | C(3-8) → 0 instruction to 0 register |
|    |           | rO2                     | = Ox $\overline{C4}$  |                                      |
| 05 | T7        | Ar3                     | = ( $\overline{01020304}$ )Q1                               |                                      |
|    |           | sA(0-2)                 | = A(21-23) $\overline{AnrAr3}$                              |                                      |
|    |           | rA( " )                 | = $\overline{A}$ ( " ) " "                                  | Recirculate A T7 thru T0             |
|    |           | sA(3-23)                | = A(0-20)Ar3  |                                      |
|    |           | rA( " )                 | = $\overline{A}$ ( " ) " "                                  |                                      |
|    |           | sB(0-2)                 | = B(21-23) $\overline{BnrAr3}$                              |                                      |
|    |           | rB( " )                 | = $\overline{B}$ ( " ) " "                                  | Recirculate B T7 thru T0             |
|    |           | sB(3-23)                | = B(0-20)Ar3  |                                      |
|    |           | rB( " )                 | = $\overline{B}$ ( " ) " "                                  |                                      |
|    |           | End                     | = $\overline{\emptyset 5(A00+GO)}$                          | last cycle                           |
|    |           | Eod                     | = ( $\overline{\emptyset 50105TsQ2Q5}$ )04                  | T7 thru Tr                           |
|    |           | Pr3                     | = ( $\overline{F1GO}$ )Q2                                   |                                      |
|    |           | sP0                     | = ( $\overline{F1GO(02040506)}$ ) (P12 $\oplus$ (P13P14Ia)) |                                      |
|    |           | rP0                     | = ( " ) (P12 $\oplus$ (P13P14Ia))                           |                                      |
|    |           | sP1                     | = ( " ) (P13 $\oplus$ (P14Ia))                              |                                      |
|    |           | rP1                     | = ( " ) (P13 $\oplus$ (P14Ia))                              | P+1 → P T7 thru T3                   |
|    |           | sP2                     | = ( " ) (P14 $\oplus$ Ia)                                   |                                      |
|    |           | rP2                     | = ( " ) (P14 $\oplus$ Ia)                                   |                                      |
|    |           | rIa                     | = ( $\overline{P12P13P14}$ )Q2F1                            |                                      |
|    |           | sP(3-14)                | = P(0-11)Pr3  |                                      |
|    |           | rP( " )                 | = $\overline{P}$ ( " ) " "                                  |                                      |
| T4 |           | sE2m(0-2)               | = C(21-23) (EodC10 $\overline{C11C17}$ )                    |                                      |
|    |           | rE2m( " )               | = $\overline{C}$ ( " ) ( " )                                | Set bank register 2                  |
|    |           | Sc                      | = T4(End+F1F2)Inr   |                                      |
|    |           | rS(1-14)                | = Sc  | Clear S                              |
| T3 |           | Sxp                     | = T3Int (End+Ju $\overline{Eax}$ )GO+T3(Kmc)                |                                      |
|    |           | sS1                     | = ( $\overline{F1GO(02040506)}$ ) (P13 $\oplus$ (P14Ia))Sxp |                                      |
|    |           | sS2                     | = ( " ) (P14 $\oplus$ Ia)Sxp                                | P → S                                |
|    |           | sS(3-14)                | = P(0-11)Sxp  |                                      |
| Tr |           | Cxm                     | = EndGO $\overline{Tam}$ (Tr+Tp)                            |                                      |
|    |           | sC(0-23)                | = M(0-23)Cxm  | M → C Tr + Tp                        |
|    |           | rC( " )                 | = $\overline{M}$ ( " ) " "                                  |                                      |
|    |           | rIa                     | = TrF1  |                                      |
|    |           | rIx                     | = Tr( $\overline{F1F3}$ ) (GOHt)                            |                                      |
|    |           | rRc                     | = Tr  |                                      |
| Tp |           | rF1                     | = TpEnd $\overline{Sk}$                                     | $\emptyset 0$ next clock (T8)        |
|    |           | rF3                     | = ( " )   |                                      |
|    |           | rRf                     | = Tp $\overline{01}$ (GOHt)                                 |                                      |
|    |           | rJu                     | = Tp  |                                      |
|    |           | Oc                      | = TpEnd $\overline{Sk}$                                     |                                      |
|    |           | rO(1,3,4,5,6)           | = Oc  | NOP (20) → 0                         |
|    |           | sO2                     | = Oc  |                                      |

06 EOD 202X0 Set Bank Register 3 = X 1 Cycle

|    |    |               |                                   |                                      |            |
|----|----|---------------|-----------------------------------|--------------------------------------|------------|
| 00 | T8 | rC24          | = T8(TsTsr)                       |                                      |            |
|    |    | rCz           | = 0T8                             |                                      |            |
|    |    | sF1           | = (0T8IaC2C5C8(C3+C4))            | 05 next (T7)                         |            |
|    |    | sF3           | = ( " )                           |                                      |            |
|    |    | sHz           | = T8                              |                                      |            |
|    |    | sIa           | = 0T8IaC2C5C8(C3+C4)              | initiate P register increment        |            |
|    |    | Oxc           | = (0T8IaGO)C2                     |                                      |            |
|    |    | sO(1,3,4,5,6) | = OxCC(3,5,6,7,8)                 | C(3-8) → 0 instruction to 0 register |            |
|    |    | rO2           | = OxCC4                           |                                      |            |
| 05 | T7 | Ar3           | = (01020304)Q1                    |                                      |            |
|    |    | sA(0-2)       | = A(21-23)ArAr3                   |                                      |            |
|    |    | rA( " )       | = A( " ) " "                      | Recirculate A                        | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                      |                                      |            |
|    |    | rA( " )       | = A( " ) " "                      |                                      |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                  |                                      |            |
|    |    | rB( " )       | = B( " ) " "                      | Recirculate B                        | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                      |                                      |            |
|    |    | rB( " )       | = B( " ) " "                      |                                      |            |
|    |    | End           | = 05(A00+GO)                      | last cycle                           |            |
|    |    | Eod           | = (050105TsQ2Q5)04                |                                      | T7 thru Tr |
|    |    | Pr3           | = (FIGO)Q2                        |                                      |            |
|    |    | sP0           | = (FIGO(02040506))(P12(P13P14Ia)) |                                      |            |
|    |    | rP0           | = ( " ) (P12(P13P14Ia))           |                                      |            |
|    |    | sP1           | = ( " ) (P13(P14Ia))              | P+1 → P                              | T7 thru T3 |
|    |    | rP1           | = ( " ) (P13(P14Ia))              |                                      |            |
|    |    | sP2           | = ( " ) (P14Ia)                   |                                      |            |
|    |    | rP2           | = ( " ) (P14Ia)                   |                                      |            |
|    |    | rIa           | = (P12P13P14)Q2P1                 |                                      |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                      |                                      |            |
|    |    | rP( " )       | = P( " ) " "                      |                                      |            |
| T4 |    | sE3m(0-2)     | = C(18-20)(EodC10C11C16)          | Set bank register 3                  |            |
|    |    | rE3m( " )     | = C( " ) ( " )                    |                                      |            |
|    |    | Sc            | = T4(End+P1P2)Inr                 | Clear 8                              |            |
|    |    | rS(1-14)      | = Sc                              |                                      |            |
| T3 |    | Sxp           | = T3Int(End+Julax)GO+T3mc         |                                      |            |
|    |    | sS1           | = (FIGO(02040506))(P13(P14Ia))Sxp | P → S                                |            |
|    |    | sS2           | = ( " ) (P14Ia)Sxp                |                                      |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                      |                                      |            |
| Tr |    | Cxm           | = EndGOIam(Tr+Tp)                 | M → C                                | Tr + Tp    |
|    |    | sC(0-23)      | = M(0-23)Cxm                      |                                      |            |
|    |    | rC( " )       | = M( " ) " "                      |                                      |            |
|    |    | rIa           | = TrP1                            |                                      |            |
|    |    | rIx           | = Tr(P1P3)(Cont)                  |                                      |            |
|    |    | rIc           | = Tr                              |                                      |            |
| Ip |    | rP1           | = TpEndIa                         | 00 next clock (T8)                   |            |
|    |    | rP3           | = ( " )                           |                                      |            |
|    |    | rRf           | = TpP1(Cont)                      |                                      |            |
|    |    | rJu           | = Tp                              |                                      |            |
|    |    | Op            | = TpEndIa                         |                                      |            |
|    |    | rO(1,3,4,5,6) | = Oc                              | NOP (20) → 0                         |            |
|    |    | sO2           | = Oc                              |                                      |            |

| 10 | MIY | Memory to Y Buffer When Ready   | (M) → Y                  | 2 Cycles<br>+ Wait |
|----|-----|---------------------------------|--------------------------|--------------------|
| ∅0 | T8  | rCz = ∅0T8                      |                          |                    |
|    |     | sIx = ∅0T8C1G0                  | Initialize indexing      |                    |
|    |     | Oxc = (∅0T8IaG0)C2              |                          |                    |
|    |     | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0          |                    |
|    |     | rO2 = C4Oxc                     |                          |                    |
|    | T7  | Ar3 = (01020304)Q1              |                          |                    |
|    |     | sA(0-2) = A(21-23)AnrAr3        |                          |                    |
|    |     | rA( " ) = A( " ) "              | Recirculate A            | T7 thru T0         |
|    |     | sA(3-23) = A(0-20)Ar3           |                          |                    |
|    |     | rA( " ) = A( " ) "              |                          |                    |
|    |     | sB(0-2) = B(21-23)BnrAr3        |                          |                    |
|    |     | rB( " ) = B( " ) "              | Recirculate B            | T7 thru T0         |
|    |     | sB(3-23) = B(0-20)Ar3           |                          |                    |
|    |     | rB( " ) = B( " ) "              |                          |                    |
|    |     | Cr3 = F1F2(TsQ1)                |                          |                    |
|    |     | sC(0-2) = Add(1-3)∅0JuTsCr3     |                          |                    |
|    |     | rC( " ) = Add( " ) "            | C+X•Ix → C (Add=Xz+Yz)   | T7 thru T0         |
|    |     | sC(3-23) = C(0-20)Cr3           |                          |                    |
|    |     | rC( " ) = C( " ) "              |                          |                    |
|    |     | Xz(1-3) = Xn(1-3)∅0•Ix          | Adder input (XIx)        | T7 thru T0         |
|    |     | Xz( " ) = Xn( " )∅0Ix+Ix        |                          |                    |
|    |     | Yz(1-3) = C(21-23)∅7            | Adder input (C)          | T7 thru T0         |
|    |     | Yz( " ) = C( " ) "              |                          |                    |
|    |     | sCz = KzQ1T0∅7                  | Carry logic              | T7 thru T1         |
|    |     | rCz = KzQ1                      |                          |                    |
|    |     | sCp = (C21⊕C22⊕C23)CpTsHtQ1F1F2 | Check parity             | T7 thru T0         |
|    |     | rCp = ( " )Cp "                 |                          |                    |
|    | T4  | Sc = T4F1F2Inr                  | Clear S                  |                    |
|    |     | rS(1-14) = Sc                   |                          |                    |
|    | T3  | Sxc = T3F1F2Ju                  |                          |                    |
|    |     | sS(1,2) = Add(2,3)Sxc           |                          |                    |
|    |     | sS(3-14) = C(0-11)Sxc           | C + X•Ix → S             |                    |
|    | T0  | rCz = F1T0                      |                          |                    |
|    |     | sRf = T0F305Yf(Y0+Y9)           | Set Rf if Y Buffer empty |                    |
|    | Tr  | Cxm = Ju∅0Tsm(Tr+Tp)            |                          |                    |
|    |     | sC(0-23) = M(0-23)Cxm           | M → C (Fetch operand)    | Tr thru Tp         |
|    |     | rC( " ) = TrCxm                 |                          |                    |
|    |     | sHt = CpTr(Kp)K0∅2              | Parity error             |                    |
|    |     | rIx = Tr(F1F3)(G0Ht)            |                          |                    |
|    |     | rK0 = G0TrF2                    |                          |                    |
|    | Tp  | sCp = M24CxmHtTsTp              | Initiate parity          |                    |
|    |     | sF1 = Tp(F1F3010304)IaRf        | ∅6 next clock (T8) if Rf |                    |
|    |     | sF2 = (TpIa∅0)0302              | ∅2 next clock (T8) if Rf |                    |
|    |     | rRf = Tp∅1(G0Ht)                |                          |                    |

If the Y Buffer is empty and ready to accept from C, ∅6 will follow; otherwise, ∅2, the waiting phase, will occur.

|    |    |          |  |                            |            |
|----|----|----------|--|----------------------------|------------|
| Ø2 | T7 | Ar3      | = $\overline{(01020304)}Q1$                  |                            |            |
|    |    | sA(0-2)  | = $A(21-23)\overline{Ar}Ar3$                 |                            |            |
|    |    | rA( " )  | = $\overline{A( " ) "}$                      |                            |            |
|    |    | sA(3-23) | = $A(0-20)Ar3$                               | Recirculate A              | T7 thru T0 |
|    |    | rA( " )  | = $\overline{A( " ) "}$                      |                            |            |
|    |    | sB(0-2)  | = $B(21-23)\overline{Br}Ar3$                 |                            |            |
|    |    | rB( " )  | = $\overline{B( " ) "}$                      |                            |            |
|    |    | sB(3-23) | = $B(0-20)Ar3$                               | Recirculate B              | T7 thru T0 |
|    |    | rB( " )  | = $\overline{B( " ) "}$                      |                            |            |
| T0 |    | rCz      | = $\overline{Fl}T0$                          |                            |            |
|    |    | sRf      | = $T0\overline{F305Yf}(Y0+\overline{Y9})$    | Set Rf if Y Buffer empty   |            |
| Tp |    | sFl      | = $Tp(\overline{FlF3010304})\overline{Ia}Rf$ | Ø6 next if Rf              |            |
|    |    | rRf      | = $Tp\overline{Ø1}(GOHt)$                    | Ø2 next if $\overline{Rf}$ |            |

The Computer will continue to repeat Ø2 until to Y Buffer becomes ready.

|    |    |          |  |                                    |            |
|----|----|----------|--|------------------------------------|------------|
| Ø6 | T8 | sIa      | = T8F1F3 <del>L</del> <del>Kr</del>                        | Initiate P register increment      |            |
|    |    | End      | = F1F2   | Last cycle                         |            |
|    |    | Rx       | = (Ø1030406F1F3Ts)   |                                    |            |
|    |    | Yxx      | = RxØ5   | Initiate transfer of C to Y buffer |            |
|    |    | sCpr     | = T8(C21 <del>C</del> 22 <del>C</del> 23)                  | Start parity generation for I/O    |            |
| T7 |    | Ar3      | = (Ø1020304)Q1   |                                    |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3   |                                    |            |
|    |    | rA( " )  | = A( " ) "   | Recirculate A                      | T7 thru TØ |
|    |    | sA(3-23) | = A(0-20)Ar3   |                                    |            |
|    |    | rA( " )  | = A( " ) "   |                                    |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3   |                                    |            |
|    |    | rB( " )  | = B( " ) "   | Recirculate B                      | T7 thru TØ |
|    |    | sB(3-23) | = B(0-20)Ar3   |                                    |            |
|    |    | rB( " )  | = B( " ) "   |                                    |            |
|    |    | Cr3      | = F1F3(TsQ1)   |                                    |            |
|    |    | sC(0-2)  | = Add(1-3)Ø6TsCr3  |                                    |            |
|    |    | rC( " )  | = Add( " ) "   | A + C → C                          | T7 thru TØ |
|    |    | sC(3-23) | = C(0-20)Cr3   |                                    |            |
|    |    | rC( " )  | = C( " ) "   |                                    |            |
|    |    | Xz(1-3)  | = A(21-23)Ø6Ø204   |                                    |            |
|    |    | Xz( " )  | = A( " ) "   |                                    |            |
|    |    | Yz(1-3)  | = C(21-23)Ø7   | Unused adder inputs                | T7 thru TØ |
|    |    | Yz( " )  | = C( " ) "   |                                    |            |
|    |    | sCz      | = KzQ1F1Ø7   |                                    |            |
|    |    | rCz      | = KzQ1   | Carry logic                        | T7 thru TØ |
|    |    | sCp      | = (C21 <del>C</del> 22 <del>C</del> 23)CpTsHtQ1Ø603        |                                    |            |
|    |    | rCp      | = ( " )Cp "  | Check parity                       | T7 thru TØ |
|    |    | Pr3      | = (F1GØ)Q2   |                                    |            |
|    |    | sPØ      | = (P12 <del>P</del> 13 <del>P</del> 14Ia)F1GØ(Ø2040506)Pr3 |                                    |            |
|    |    | rPØ      | = ( " ) "  |                                    |            |
|    |    | sP1      | = (P13 <del>P</del> 14Ia) "                                |                                    |            |
|    |    | rP1      | = ( " ) "  |                                    |            |
|    |    | sP2      | = (P14 <del>P</del> Ia) "                                  | P + 1 → P                          | T7 thru T3 |
|    |    | rP2      | = ( " ) "  |                                    |            |
|    |    | sP(3-14) | = P(0-11)Pr3   |                                    |            |
|    |    | rP( " )  | = P( " ) "   |                                    |            |
|    |    | rIa      | = (P12P13P14)Q2F1  |                                    |            |
|    |    | sYw(1-3) | = C(21-23)YxxQ1Y4  |                                    |            |
|    |    | rYw( " ) | = C( " ) " Y4  | C → Y buffer                       | T7 thru TØ |
|    |    | sCpr     | = (C18 <del>C</del> 19 <del>C</del> 20)Q1                  |                                    |            |
|    |    | rCpr     | = ( " )Q1  | Generate parity for I/O            |            |
| T4 |    | Sc       | = T4EndInr   |                                    |            |
|    |    | rS(1-14) | = Sc   | Clear S                            |            |
| T3 |    | Sxp      | = T3IntEndGØ   |                                    |            |
|    |    | sS1      | = (P13 <del>P</del> 14Ia)F1GØ(Ø2040506)Sxp                 |                                    |            |
|    |    | rS1      | = ( " ) "  |                                    |            |
|    |    | sS2      | = (P14 <del>P</del> Ia) "                                  | P + 1 → S                          |            |
|    |    | rS2      | = ( " ) "  |                                    |            |

|    |               |  |                                |
|----|---------------|--|--------------------------------|
|    | sS(3-14)      | = P(0-11)Sxp                                   |                                |
|    | rS( " )       | = $\overline{P}$ ( " ) "                       |                                |
| Tr | Cxm           | = EndGO $\overline{Tsm}$ (Tr+Tp)               |                                |
|    | sC(0-23)      | = M(0-23)Cxm                                   | M → C (Fetch next instruction) |
|    | rC( " )       | = TrCxm  | Tr thru Tp                     |
|    | sHt           | = CpTr $\overline{KpK002}$                     | Parity error                   |
|    | rIa           | = TrFl   |                                |
|    | rIx           | = Tr( $\overline{FlF3}$ )( $\overline{GOHt}$ ) |                                |
| Tp | rA00          | = TpEndGO                                      |                                |
|    | rB00          | = ( " )  |                                |
|    | sCp           | = M24Cxm $\overline{HtTsTp}$                   | Initiate parity                |
|    | rCpr          | = Tp   |                                |
|    | rF(1,2)       | = TpEnd $\overline{Sk}$                        | ∅0 next clock (T8)             |
|    | Oc            | = ( " )  |                                |
|    | sO2           | = Oc   |                                |
|    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                   |

| 12 | MIW      | Memory to W Buffer When Ready   | (M) → W                  | 2 Cycles<br>+ Wait |
|----|----------|---------------------------------|--------------------------|--------------------|
| ∅0 | T8       | rCz = ∅0T8                      |                          |                    |
|    |          | sIx = ∅0T8C1G0                  | Initialize Indexing      |                    |
|    |          | Oxc = (∅0T8IaG0)C2              |                          |                    |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0          |                    |
|    |          | rO2 = C4Oxc                     |                          |                    |
| T7 | Ar3      | = (O1O2O3O4)Q1                  |                          |                    |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                          |                    |
|    | rA( " )  | = A( " ) " "                    | Recirculate A            | T7 thru T0         |
|    | sA(3-23) | = A(0-20)Ar3                    |                          |                    |
|    | rA( " )  | = A( " ) " "                    |                          |                    |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                          |                    |
|    | rB( " )  | = B( " ) " "                    | Recirculate B            | T7 thru T0         |
|    | sB(3-23) | = B(0-20)Ar3                    |                          |                    |
|    | rB( " )  | = B( " ) " "                    |                          |                    |
|    | Cr3      | = F1F2(TsQ1)                    |                          |                    |
|    | sC(0-2)  | = Add(1-3)∅0JuTsCr3             |                          |                    |
|    | rC( " )  | = Add( " ) " "                  | C+X·Ix → C (Add=Xz+Yz)   | T7 thru T0         |
|    | sC(3-23) | = C(0-20)Cr3                    |                          |                    |
|    | rC( " )  | = C( " ) " "                    |                          |                    |
|    | Xz(1-3)  | = Xn(1-3)∅0·Ix                  | Adder input (XIx)        | T7 thru T0         |
|    | Xz( " )  | = Xn( " )∅0Ix+Ix                |                          |                    |
|    | Yz(1-3)  | = C(21-23)∅7                    | Adder input (C)          | T7 thru T0         |
|    | Yz( " )  | = C( " ) " "                    |                          |                    |
|    | sCz      | = KzQ1T0∅7                      | Carry logic              | T7 thru T1         |
|    | rCz      | = KzQ1                          |                          |                    |
|    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2     | Check parity             | T7 thru T0         |
|    | rCp      | = ( " ) Cp " "                  |                          |                    |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                  |                    |
|    | rS(1-14) | = Sc                            |                          |                    |
| T3 | Sxc      | = T3F1F2Ju                      |                          |                    |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                          |                    |
|    | sS(3-14) | = C(0-11)Sxc                    | C + X·Ix → S             |                    |
| T0 | rCz      | = F1T0                          |                          |                    |
|    | sRf      | = T0F3O5Wf(W0+W9)               | Set Rf if W buffer empty |                    |
| Tr | Cxm      | = Ju∅0Tsm(Tr+Tp)                |                          |                    |
|    | sC(0-23) | = M(0-23)Cxm                    | M → C (Fetch operand)    | Tr thru Tp         |
|    | rC( " )  | = TrCxm                         |                          |                    |
|    | sHt      | = CpTr(Kp)K0∅2                  | Parity error             |                    |
|    | rIx      | = Tr(F1F3)(GOHt)                |                          |                    |
|    | rK0      | = GOTrF2                        |                          |                    |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity          |                    |
|    | sF1      | = Tp(F1F3O1O3O4)IaRf            | ∅6 next if Rf            |                    |
|    | sF2      | = (TpIa∅0)O3O2                  | ∅2 next if Rf            |                    |
|    | rRf      | = Tp∅1(GOHt)                    |                          |                    |

If the W Buffer is empty and ready to accept from C, ∅6 will follow; otherwise, ∅2, the waiting phase, will occur.



|    |    |          |                      |                          |            |
|----|----|----------|----------------------|--------------------------|------------|
| Ø2 | T7 | Ar3      | = (01020304)Q1       |                          |            |
|    |    | sA(0-2)  | = A(21-23)ArAr3      |                          |            |
|    |    | rA( " )  | = A( " ) " "         |                          |            |
|    |    | sA(3-23) | = A(0-20)Ar3         | Recirculate A            | T7 thru T0 |
|    |    | rA( " )  | = A( " ) " "         |                          |            |
|    |    | sB(0-2)  | = B(21-23)BrAr3      |                          |            |
|    |    | rB( " )  | = B( " ) " "         |                          |            |
|    |    | sB(3-23) | = B(0-20)Ar3         | Recirculate B            | T7 thru T0 |
|    |    | rB( " )  | = B( " ) " "         |                          |            |
| T0 |    | rCz      | = FlT0               |                          |            |
|    |    | sRf      | = T0F305Wf(W0+W9)    | Set Rf if W Buffer empty |            |
| Tp |    | sFl      | = Tp(F1F3010304)IaRf | Ø6 next if Rf            |            |
|    |    | rRf      | = TpØ1(GØHt)         | Ø2 next if Rf            |            |

The Computer will continue to repeat Ø2 until the W Buffer becomes ready.

|    |    |          |                                   |                                    |            |
|----|----|----------|-----------------------------------|------------------------------------|------------|
| 06 | T8 | sIa      | = T8F1F3I <del>Kr</del>           | Initiate P register increment      |            |
|    |    | End      | = F1F2                            | Last cycle                         |            |
|    |    | Rx       | = 01030406F1F3Ts                  |                                    |            |
|    |    | Wxx      | = Rx05                            | Initiate transfer of C to W buffer |            |
|    |    | sCpr     | = T8(C21⊕C22⊕C23)                 | Start parity generation for I/O    |            |
| T7 |    | Ar3      | = (01020304)Q1                    |                                    |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                  |                                    |            |
|    |    | rA( " )  | = A( " ) " "                      |                                    |            |
|    |    | sA(3-23) | = A(0-20)Ar3                      | Recirculate A                      | T7 thru T0 |
|    |    | rA( " )  | = A( " ) " "                      |                                    |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                    |            |
|    |    | rB( " )  | = B( " ) " "                      |                                    |            |
|    |    | sB(3-23) | = B(0-20)Ar3                      | Recirculate B                      | T7 thru T0 |
|    |    | rB( " )  | = B( " ) " "                      |                                    |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |                                    |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                 |                                    |            |
|    |    | rC( " )  | = Add( " ) " "                    | A + C → C                          | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                    |            |
|    |    | rC( " )  | = C( " ) " "                      |                                    |            |
|    |    | Xz(1-3)  | = A(21-23)060204                  |                                    |            |
|    |    | Xz( " )  | = A( " ) " "                      |                                    |            |
|    |    | Yz(1-3)  | = C(21-23)07                      | Unused adder inputs                | T7 thru T0 |
|    |    | Yz( " )  | = C( " ) " "                      |                                    |            |
|    |    | sCz      | = KzQ1F107                        |                                    |            |
|    |    | rCz      | = KzQ1                            | Carry logic                        | T7 thru T0 |
|    |    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ10603       |                                    |            |
|    |    | rCp      | = ( " ) Cp " "                    | Check parity                       | T7 thru T0 |
|    |    | Pr3      | = (F1G0)Q2                        |                                    |            |
|    |    | sP0      | = (P12⊕P13P14Ia)F1G0(02040506)Pr3 |                                    |            |
|    |    | rP0      | = ( " ) " "                       |                                    |            |
|    |    | sP1      | = (P13⊕P14Ia) " "                 |                                    |            |
|    |    | rP1      | = ( " ) " "                       |                                    |            |
|    |    | sP2      | = (P14⊕Ia) " "                    | P + 1 → P                          | T7 thru T3 |
|    |    | rP2      | = ( " ) " "                       |                                    |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                    |            |
|    |    | rP( " )  | = P( " ) " "                      |                                    |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                    |            |
|    |    | sWn(1-3) | = C(21-23)WxxQ1                   |                                    |            |
|    |    | rWn( " ) | = C( " ) " "                      | C → W Buffer                       | T7 thru T0 |
|    |    | sCpr     | = (C18⊕C19⊕C20)Q1                 |                                    |            |
|    |    | rCpr     | = ( " ) Q1                        | Generate parity for I/O            | T7 thru T0 |
| T4 |    | Sc       | = T4EndInr                        |                                    |            |
|    |    | rS(1-14) | = Sc                              | Clear S                            |            |
| T3 |    | Sxp      | = T3IntEndGO                      |                                    |            |
|    |    | sS1      | = (P13⊕P14Ia)F1G0(02040506)Sxp    |                                    |            |
|    |    | rS1      | = ( " ) " "                       |                                    |            |
|    |    | sS2      | = (P14⊕Ia) " "                    | P + 1 → S                          |            |
|    |    | rS2      | = ( " ) " "                       |                                    |            |

|    |               |                                  |                                |
|----|---------------|----------------------------------|--------------------------------|
|    | sS(3-14)      | = P(0-11)Sxp                     |                                |
|    | rS( " )       | = P( " ) "                       |                                |
| Tr | Cxm           | = EndGO $\overline{Tsm}$ (Tr+Tp) |                                |
|    | sC(0-23)      | = M(0-23)Cxm                     | M → C (Fetch next instruction) |
|    | rC( " )       | = TrCxm                          | Tr thru Tp                     |
|    | sHt           | = CpTr $\overline{K002}$         | Parity error                   |
|    | rIa           | = TrF1                           |                                |
|    | rIx           | = Tr(F1F3)( $\overline{GOHt}$ )  |                                |
| Tp | rA00          | = TpEndGO                        |                                |
|    | rB00          | = ( " )                          |                                |
|    | sCp           | = M24Cxm $\overline{T}$ TsTp     | Initiate parity                |
|    | rCpr          | = Tp                             |                                |
|    | rF(1,2)       | = TpEndSk                        | ∅0 next clock (T8)             |
|    | Oc            | = ( " )                          |                                |
|    | sO2           | = Oc                             |                                |
|    | rO(1,3,4,5,6) | = Oc                             | NOP (20) → 0                   |

| 13 | POT      | Parallel Output When Ready      | (M) → Output Device    | 3 Cycles + Wait |
|----|----------|---------------------------------|------------------------|-----------------|
| ∅0 | T8       | rCz = ∅0T8                      |                        |                 |
|    |          | sIx = ∅0T8C1G0                  | Initialize indexing    |                 |
|    |          | Oxc = (∅0T8IaG0)C2              |                        |                 |
|    |          | s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |                 |
|    |          | r02 = C40xc                     |                        |                 |
| T7 | Ar3      | = (01020304)Q1                  |                        |                 |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |                 |
|    | rA( " )  | = A( " ) " "                    | Recirculate A          | T7 thru T0      |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |                 |
|    | rA( " )  | = A( " ) " "                    |                        |                 |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |                 |
|    | rB( " )  | = B( " ) " "                    | Recirculate B          | T7 thru T0      |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |                 |
|    | rB( " )  | = B( " ) " "                    |                        |                 |
|    | Cr3      | = F1F2(TsQ1)                    |                        |                 |
|    | sC(0-2)  | = Add(1-3)∅0JuTsCr3             |                        |                 |
|    | rC( " )  | = Add( " ) " "                  | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0      |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |                 |
|    | rC( " )  | = C( " ) " "                    |                        |                 |
|    | Xz(1-3)  | = Xn(1-3)∅0·Ix                  | Adder input (XIx)      | T7 thru T0      |
|    | Xz( " )  | = Xn( " )∅0Ix+Ix                |                        |                 |
|    | Yz(1-3)  | = C(21-23)∅7                    | Adder input (C)        | T7 thru T0      |
|    | Yz( " )  | = C( " ) " "                    |                        |                 |
|    | sCz      | = KzQ1T0∅7                      |                        |                 |
|    | rCz      | = KzQ1                          | Carry logic            | T7 thru T1      |
|    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2     |                        |                 |
|    | rCp      | = ( " )Cp " "                   | Check parity           | T7 thru T0      |
| T4 | Sc       | = T4F1F2Inr                     |                        |                 |
|    | rS(1-14) | = Sc                            | Clear S                |                 |
| T3 | Sxc      | = T3F1F2Ju                      |                        |                 |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                        |                 |
|    | sS(3-14) | = C(0-11)Sxc                    | C + X·Ix → S           |                 |
| T0 | rCz      | = F1T0                          |                        |                 |
| Tr | Cxm      | = Ju∅0Tsm(Tr+Tp)                |                        |                 |
|    | sC(0-23) | = M(0-23)Cxm                    | M → C (Fetch operand)  | Tr thru Tp      |
|    | rC( " )  | = TrCxm                         |                        |                 |
|    | sHt      | = CpTr(CpK0∅2)                  | Parity error           |                 |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |                 |
|    | rK0      | = GOTrF2                        |                        |                 |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |                 |
|    | sF2      | = (TpIa∅0)0302                  | ∅2 next clock (T8)     |                 |

|    |    |          |  |                               |                    |
|----|----|----------|--|-------------------------------|--------------------|
| Ø2 | T7 | Ar3      | = $\overline{(01020304)}Q1$                  |                               |                    |
|    |    | sA(0-2)  | = $A(21-23)\overline{Ar}Ar3$                 |                               |                    |
|    |    | rA( " )  | = $\overline{A( " ) "}$                      | Recirculate A                 | T7 thru T0         |
|    |    | sA(3-23) | = $A(0-20)Ar3$                               |                               |                    |
|    |    | rA( " )  | = $\overline{A( " ) "}$                      |                               |                    |
|    |    | sB(0-2)  | = $B(21-23)\overline{Br}Ar3$                 |                               |                    |
|    |    | rB( " )  | = $\overline{B( " ) "}$                      | Recirculate B                 | T7 thru T0         |
|    |    | sB(3-23) | = $B(0-20)Ar3$                               |                               |                    |
|    |    | rB( " )  | = $\overline{B( " ) "}$                      |                               |                    |
|    |    | sRf      | = $Q2\overline{F306}F2Rt$                    | External Device is ready (Rt) | T7 thru T3         |
|    |    |          |  | to receive information        | from the computer. |
| T0 |    | rCz      | = $\overline{F1}T0$                          |                               |                    |
| Tp |    | sF1      | = $Tp(\overline{F1F3010304})\overline{Ia}Rf$ | Ø6 next if Rf                 |                    |
|    |    |          |  | Ø2 next if $\overline{Rf}$    |                    |
|    |    | rRf      | = $Tp\overline{Ø1}(\overline{COHt})$         |                               |                    |

The Computer will continue to repeat Ø2 until the External Device becomes ready, at which time the data will be transferred in parallel from the C register to the device. At Tp time, following the transfer, Ø6 will occur.

|    |    |          |                                   |                                |            |
|----|----|----------|-----------------------------------|--------------------------------|------------|
| Ø6 | T8 | sIa      | = T8F1F3(1)K1                     | Initiate P register increment  |            |
|    |    | End      | = F1F2                            | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                    |                                |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                  |                                |            |
|    |    | rA( " )  | = A( " ) "                        | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |    | rA( " )  | = A( " ) "                        |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |    | rB( " )  | = B( " ) "                        | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |    | rB( " )  | = B( " ) "                        |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |    | sC(0-2)  | = Add(1-3)Ø6TsCr3                 | A + C → C                      | T7 thru T0 |
|    |    | rC( " )  | = Add( " ) "                      |                                |            |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |    | rC( " )  | = C( " ) "                        |                                |            |
|    |    | Xz(1-3)  | = Xz                              | Unused adder inputs            | T7 thru T0 |
|    |    | Yz(1-3)  | = C(21-23)Ø7                      |                                |            |
|    |    | Yz( " )  | = C( " ) "                        |                                |            |
|    |    | sCz      | = KzQ1F1Ø7                        | Carry logic                    | T7 thru T0 |
|    |    | rCz      | = KzQ1                            |                                |            |
|    |    | sCp      | = (C21ØC22ØC23)CpTsHQ1Ø603        | Check parity                   | T7 thru T0 |
|    |    | rCp      | = ( " )Cp "                       |                                |            |
|    |    | Pr3      | = (F1G0)Q2                        |                                |            |
|    |    | sP0      | = (P12ØP13P14Ia)F1G0(Ø2040506)Pr3 |                                |            |
|    |    | rP0      | = ( " ) "                         |                                |            |
|    |    | sP1      | = (P13ØP14Ia) "                   |                                |            |
|    |    | rP1      | = ( " ) "                         |                                |            |
|    |    | sP2      | = (P14ØIa) "                      | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) "                         |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |    | rP( " )  | = P( " ) "                        |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    | T4 | Sc       | = T4EndInr                        | Clear S                        |            |
|    |    | rS(1-14) | = Sc                              |                                |            |
|    | T3 | Sxp      | = T3IntEndG0                      |                                |            |
|    |    | sS1      | = (P13ØP14Ia)F1G0(Ø2040506)Sxp    |                                |            |
|    |    | rS1      | = ( " ) "                         | P + 1 → S                      |            |
|    |    | sS2      | = (P14ØIa) "                      |                                |            |
|    |    | rS2      | = ( " ) "                         |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |    | rS( " )  | = P( " ) "                        |                                |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                 | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23) | = M(0-23)Cxm                      |                                |            |
|    |    | rC( " )  | = TrCxm                           |                                |            |
|    |    | sHt      | = CpTrØKØØ2                       | Parity error                   |            |

|    |               |                  |                    |
|----|---------------|------------------|--------------------|
|    | rIa           | = TrF1           |                    |
|    | rIx           | = Tr(F1F3)(GOHt) |                    |
| Tp | rA00          | = TpEndGO        |                    |
|    | rB00          | = ( " )          |                    |
|    | sCp           | = M24CmHtTsTp    | Initiate parity    |
|    | rF(1,2)       | = TpEndSk        | 00 next clock (T8) |
|    | Oc            | = ( " )          |                    |
|    | sO2           | = Oc             |                    |
|    | rO(1,3,4,5,6) | = Oc             | NOP (20) → 0       |

|    |               |                   |                    |
|----|---------------|-------------------|--------------------|
|    | rIa           | = TrF1            |                    |
|    | rIx           | = Tr(F1F3) (GOHt) |                    |
| Tp | rA00          | = TpEndGO         |                    |
|    | rB00          | = ( " )           |                    |
|    | sCp           | = M24CxmHtTsTp    | Initiate parity    |
|    | rF(1,2)       | = TpEndSk         | Ø0 next clock (T8) |
|    | Oc            | = ( " )           |                    |
|    | sO2           | = Oc              |                    |
|    | rO(1,3,4,5,6) | = Oc              | NOP (20) → 0       |



| 14 | ETR      | Extract                         | Ai·Mi → Ai                   | 2 Cycles   |
|----|----------|---------------------------------|------------------------------|------------|
| 00 | T8       | rCz = 00T8                      | Initialize carry             |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing          |            |
|    |          | Oxc = (00T8IaG0)C2              |                              |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0              |            |
|    |          | rO2 = C4Oxc                     |                              |            |
| T7 | Ar3      | = (01020304)Q1                  |                              |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                | Recirculate A                | T7 thru T0 |
|    | rA( " )  | = A( " ) " "                    |                              |            |
|    | sA(3-23) | = A(0-20)Ar3                    |                              |            |
|    | rA( " )  | = A( " ) " "                    |                              |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                | Recirculate B                | T7 thru T0 |
|    | rB( " )  | = B( " ) " "                    |                              |            |
|    | sB(3-23) | = B(0-20)Ar3                    |                              |            |
|    | rB( " )  | = B( " ) " "                    |                              |            |
|    | Cr3      | = F1F2(TsQ1)                    |                              |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             | C+X·Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    | rC( " )  | = Add( " ) " "                  |                              |            |
|    | sC(3-23) | = C(0-20)Cr3                    |                              |            |
|    | rC( " )  | = C( " ) " "                    |                              |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input if Ix (indexing) |            |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                              | T7 thru T0 |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input C register       | T7 thru T0 |
|    | Yz( " )  | = C( " ) " "                    |                              |            |
|    | sCz      | = KzQ1T007                      | Carry for Adder              | T7 thru T1 |
|    | rCz      | = KzQ1                          |                              |            |
|    | sCp      | = (C21+C22+C23)CpTsHtQ1F1F2     | Check parity                 | T7 thru T0 |
|    | rCp      | = ( " )Cp " "                   |                              |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                      |            |
|    | rS(1-14) | = Sc                            |                              |            |
| T3 | Sxc      | = T3F1F2Ju                      |                              |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   | C+X·Ix → S                   |            |
|    | sS(3-14) | = C(0-11)Sxc                    |                              |            |
| T0 | rCz      | = F1T0                          |                              |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch Operand)        | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                              |            |
|    | rC( " )  | = TrCxm                         |                              |            |
|    | sCz      | = (Tr00)(040506)                | Parity error                 |            |
|    | sHt      | = CpTrCxm002                    |                              |            |
|    | rIx      | = Tr(F1F3)(G0Ht)                |                              |            |
|    | rK0      | = G0TrF2                        |                              |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity              |            |
|    | sF1      | = (TpIa00)0304                  | 06 next clock (T8)           |            |
|    | sF2      | = ( " )0302                     |                              |            |

|    |    |          |   |                                |            |
|----|----|----------|---|--------------------------------|------------|
| 06 | T8 | Anr      | = $\overline{0102040606}$   |                                |            |
|    |    | sIa      | = $T8F1F31K1K1$   | Initiate P register increment  |            |
|    |    | End      | = $F1F2$  | Last cycle                     |            |
|    | T7 | Ar3      | = $(01020304)Q1$  |                                |            |
|    |    | sA(0-2)  | = $(A \cdot C)(21-23)(\overline{0102040606})Ar3$                            |                                |            |
|    |    | rA( " )  | = $(\overline{A+C})( " ) ( " )$   | A * M → A                      | T7 thru T0 |
|    |    | sA(3-23) | = $A(0-20)Ar3$  |                                |            |
|    |    | rA( " )  | = $\overline{A}( " )$   |                                |            |
|    |    | sB(0-2)  | = $B(21-23)\overline{Bnr}Ar3$   |                                |            |
|    |    | rB( " )  | = $\overline{B}( " )$   | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = $B(0-20)Ar3$  |                                |            |
|    |    | rB( " )  | = $\overline{B}( " )$   |                                |            |
|    |    | Cr3      | = $F1F3(\overline{Ts}Q1)$   |                                |            |
|    |    | sC(0-2)  | = $Add(1-3)\overline{06Ts}Cr3$  |                                |            |
|    |    | rC( " )  | = $Add( " )$  | A + C + 1 → C                  | T7 thru T0 |
|    |    | sC(3-23) | = $C(0-20)Cr3$  |                                |            |
|    |    | rC( " )  | = $\overline{C}( " )$   |                                |            |
|    |    | Xz(1-3)  | = $A(21-23)\overline{060204}$   |                                |            |
|    |    | Xz( " )  | = $\overline{A}( " )$   | Unused adder inputs            | T7 thru T0 |
|    |    | Yz(1-3)  | = $C(21-23)\overline{07}$   |                                |            |
|    |    | Yz( " )  | = $\overline{C}( " )$   |                                |            |
|    |    | sCz      | = $KzQ1F1\overline{07}$   |                                |            |
|    |    | rCz      | = $KzQ1$  | Carry logic                    | T7 thru T0 |
|    |    | sCp      | = $(C21\overline{06}C22\overline{06}C23)\overline{CpTsHt}Q1\overline{0603}$ |                                |            |
|    |    | rCp      | = ( " ) Cp  | Check parity                   | T7 thru T0 |
|    |    | Pr3      | = $(F1G0)Q2$  |                                |            |
|    |    | sP0      | = $(P12\overline{06}P13P14Ia)F1G0(\overline{02040506})Pr3$                  |                                |            |
|    |    | rP0      | = ( " )   |                                |            |
|    |    | sP1      | = $(P13\overline{06}P14Ia)$   |                                |            |
|    |    | rP1      | = ( " )   |                                |            |
|    |    | sP2      | = $(P14\overline{06}Ia)$  |                                |            |
|    |    | rP2      | = ( " )   | P + 1 → P                      | T7 thru T3 |
|    |    | sP(3-14) | = $P(0-11)Pr3$  |                                |            |
|    |    | rP( " )  | = $\overline{P}( " )$   |                                |            |
|    |    | rIa      | = $(P12P13P14)Q2F1$   |                                |            |
|    | T4 | Sc       | = $T4\overline{End}Inr$   |                                |            |
|    |    | rS(1-14) | = $Sc$  | Clear S                        |            |
|    | T3 | Sxp      | = $T3\overline{Int}EndG0$   |                                |            |
|    |    | sS1      | = $(P13\overline{06}P14Ia)F1G0(\overline{02040506})Sxp$                     |                                |            |
|    |    | rS1      | = ( " )   |                                |            |
|    |    | sS2      | = $(P14\overline{06}Ia)$  |                                |            |
|    |    | rS2      | = ( " )   | P + 1 → S                      |            |
|    |    | sS(3-14) | = $P(0-11)Sxp$  |                                |            |
|    |    | rS( " )  | = $\overline{P}( " )$   |                                |            |
|    | Tr | Cxm      | = $EndG0\overline{Ts}m(Tr+Tp)$  |                                |            |
|    |    | sC(0-23) | = $M(0-23)Cxm$  | M → C (Fetch next instruction) |            |
|    |    | rC( " )  | = $TrCxm$   |                                | Tr thru Tp |
|    |    | sHt      | = $CpTr\overline{0607}$   | Parity error                   |            |

| 16 | MRG | Merge                           | $A_i + M_i \rightarrow A_i$                   | 2 Cycles   |
|----|-----|---------------------------------|---|------------|
| 00 | T8  | rCz = 00T8                      | Initialize carry                              |            |
|    |     | sIx = 00T8C1G0                  | Initialize indexing                           |            |
|    |     | Oxc = (00T8IaG0)C2              |   |            |
|    |     | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction $\rightarrow 0$                   |            |
|    |     | rO2 = C4Oxc                     |   |            |
|    | T7  | Ar3 = (01020304)Q1              |   |            |
|    |     | sA(0-2) = A(21-23)AnrAr3        |   |            |
|    |     | rA( " ) = A( " ) "              | Recirculate A                                 | T7 thru T0 |
|    |     | sA(3-23) = A(0-20)Ar3           |   |            |
|    |     | rA( " ) = A( " ) "              |   |            |
|    |     | sB(0-2) = B(21-23)BnrAr3        |   |            |
|    |     | rB( " ) = B( " ) "              | Recirculate B                                 | T7 thru T0 |
|    |     | sB(3-23) = B(0-20)Ar3           |   |            |
|    |     | rB( " ) = B( " ) "              |   |            |
|    |     | Cr3 = F1F2(TsQ1)                |   |            |
|    |     | sC(0-2) = Add(1-3)00JuTsCr3     |   |            |
|    |     | rC( " ) = Add( " ) "            | $C+X \cdot I_x \rightarrow C$ (Add= $Xz+Yz$ ) | T7 thru T0 |
|    |     | sC(3-23) = C(0-20)Cr3           |   |            |
|    |     | rC( " ) = C( " ) "              |   |            |
|    |     | Xz(1-3) = Xn(1-3)00Ix           | Adder input if Ix (indexing)                  |            |
|    |     | Xz( " ) = Xn( " )00Ix+Ix        |   | T7 thru T0 |
|    |     | Yz(1-3) = C(21-23)07            | Adder input C register                        | T7 thru T0 |
|    |     | Yz( " ) = C( " ) "              |   |            |
|    |     | sCz = KzQ1T007                  | Carry for Adder                               | T7 thru T1 |
|    |     | rCz = KzQ1                      |   |            |
|    |     | sCp = (C210C220C23)CpTsHtQ1F1F2 | Check parity                                  | T7 thru T0 |
|    |     | rCp = ( " )Cp "                 |   |            |
|    | T4  | Sc = T4F1F2Inr                  | Clear S                                       |            |
|    |     | rS(1-14) = Sc                   |   |            |
|    | T3  | Sxc = T3F1F2Ju                  |   |            |
|    |     | sS(1,2) = Add(2,3)Sxc           |   |            |
|    |     | sS(3-14) = C(0-11)Sxc           | $C+X \cdot I_x \rightarrow S$                 |            |
|    | T0  | rCz = F1T0                      |   |            |
|    | Tr  | Cxm = Ju00Tsm(Tr+Tp)            | M $\rightarrow$ C (Fetch Operand)             | Tr thru Tp |
|    |     | sC(0-23) = M(0-23)Cxm           |   |            |
|    |     | rC( " ) = TrCxm                 |   |            |
|    |     | sCz = (Tr0)0405Xw1              | Set carry if Xw1                              |            |
|    |     | sHt = CpTrCp002                 | Parity error                                  |            |
|    |     | rIx = Tr(F1F3)(GOHt)            |   |            |
|    |     | rK0 = GOTrF2                    |   |            |
|    | Tp  | sCp = M24CxmHtTsTp              | Initiate parity                               |            |
|    |     | sF1 = (TpIa0)0304               |   |            |
|    |     | sF2 = ( " )0302                 | 06 next clock (T8)                            |            |

|    |    |          |   |                                |            |
|----|----|----------|---|--------------------------------|------------|
| 06 | T8 | Anr      | = $\overline{0102040606}$                                       |                                |            |
|    |    | sIa      | = T8F1F3( <del>1</del> )K1                                      | Initiate P register increment  |            |
|    |    | End      | = F1F2  | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1  |                                |            |
|    |    | sA(0-2)  | = (A+C)(21-23)( $\overline{010204(05+06)06}$ )                  |                                |            |
|    |    | rA( " )  | = ( $\overline{A \cdot C}$ )( " )( " )                          | A + M → A                      | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3  |                                |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "  |                                |            |
|    |    | sB(0-2)  | = B(21-23) $\overline{BnrAr3}$                                  |                                |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "  | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3  |                                |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "  |                                |            |
|    |    | Cr3      | = F1F3( $\overline{TsQ1}$ )                                     |                                |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3   |                                |            |
|    |    | rC( " )  | = $\overline{Add}$ ( " ) "                                      | A + C + 1 → C                  | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3  |                                |            |
|    |    | rC( " )  | = $\overline{C}$ ( " ) "  |                                |            |
|    |    | Xz(1-3)  | = A(21-23)060204  |                                |            |
|    |    | Xz( " )  | = $\overline{A}$ ( " ) "  | Unused adder inputs            | T7 thru T0 |
|    |    | Yz(1-3)  | = C(21-23)07  |                                |            |
|    |    | Yz( " )  | = $\overline{C}$ ( " ) "  |                                |            |
|    |    | sCz      | = KzQ1F107  | Carry logic                    | T7 thru    |
|    |    | rCz      | = KzQ1  |                                |            |
|    |    | sCp      | = (C210C220C23)CpTsHtQ10603                                     | Check parity                   | T7 thru T0 |
|    |    | rCp      | = ( " )Cp "   |                                |            |
|    |    | Pr3      | = (F1G0)Q2  |                                |            |
|    |    | sP0      | = ( $\overline{P120P13P14Ia}$ )F1G0( $\overline{02040506}$ )Pr3 |                                |            |
|    |    | rP0      | = ( " ) "   |                                |            |
|    |    | sP1      | = ( $\overline{P130P14Ia}$ ) " "                                |                                |            |
|    |    | rP1      | = ( " ) "   |                                |            |
|    |    | sP2      | = ( $\overline{P140P1a}$ ) " "                                  | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) "   |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3  |                                |            |
|    |    | rP( " )  | = $\overline{P}$ ( " ) "  |                                |            |
|    |    | rIa      | = ( $\overline{P12P13P14}$ )Q2F1                                |                                |            |
|    | T4 | Sc       | = T4EndInr  | Clear S                        |            |
|    |    | rS(1-14) | = Sc  |                                |            |
|    | T3 | Sxp      | = T3IntEndG0  |                                |            |
|    |    | sS1      | = ( $\overline{P130P14Ia}$ )F1G0( $\overline{02040506}$ )Sxp    |                                |            |
|    |    | rS1      | = ( " ) "   | P + 1 → S                      |            |
|    |    | sS2      | = ( $\overline{P140P1a}$ ) " "                                  |                                |            |
|    |    | rS2      | = ( " ) "   |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp  |                                |            |
|    |    | rS( " )  | = $\overline{P}$ ( " ) "  |                                |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)   | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23) | = M(0-23)Cxm  |                                |            |
|    |    | rC( " )  | = TrCxm   |                                |            |
|    |    | sHt      | = CpTr( <del>0</del> )02  | Parity error                   |            |

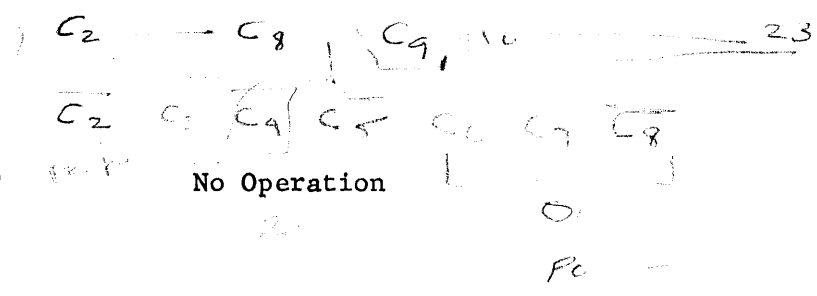
|    |               |                   |                    |
|----|---------------|-------------------|--------------------|
|    | rIa           | = TrF1            |                    |
|    | rIx           | = Tr(F1F3) (GOHt) |                    |
| Tp | rA00          | = TpEndGO         |                    |
|    | rB00          | = ( " )           |                    |
|    | sCp           | = M24CxmHtTsTp    | Initiate parity    |
|    | rF(1,2)       | = TpEndSk         | Ø0 next clock (T8) |
|    | Oc            | = ( " )           |                    |
|    | sO2           | = Oc              |                    |
|    | rO(1,3,4,5,6) | = Oc              | NOP (20) → 0       |

|               |     |   |  |  |
|---------------|-----|---|--|--|
| 17            | EOR | Exclusive "or"  | $\overline{A_i M_i} + \overline{A_i} M_i \rightarrow A_i$                                | 2 Cycles                               |
| $\emptyset 0$ | T8  | rCz = $\emptyset 0 T 8$<br>sIx = $\emptyset 0 T 8 C 1 G 0$<br>Oxc = $(\emptyset 0 T 8 \overline{I a G 0}) \overline{C 2}$<br>sO(1,3,4,5,6) = $\overline{C(3,5,6,7,8) Oxc}$<br>rO2 = $\overline{C 4 Oxc}$  | Initialize carry<br>Initialize indexing<br>Instruction $\rightarrow 0$                   |  |
|               | T7  | Ar3 = $(0 1 0 2 0 3 0 4) Q 1$<br>sA(0-2) = $\overline{A(21-23) A n r A r 3}$<br>rA( " ) = $\overline{A( " ) "}$<br>sA(3-23) = $\overline{A(0-20) A r 3}$<br>rA( " ) = $\overline{A( " ) "}$<br>sB(0-2) = $\overline{B(21-23) B n r A r 3}$<br>rB( " ) = $\overline{B( " ) "}$<br>sB(3-23) = $\overline{B(0-20) A r 3}$<br>rB( " ) = $\overline{B( " ) "}$<br>Cr3 = $\overline{F 1 F 2 (T s Q 1)}$<br>sC(0-2) = $\overline{A d d(1-3) \emptyset 0 J u T s C r 3}$<br>rC( " ) = $\overline{A d d( " ) "}$<br>sC(3-23) = $\overline{C(0-20) C r 3}$<br>rC( " ) = $\overline{C( " ) "}$<br>Xz(1-3) = $\overline{X n(1-3) \emptyset 0 \cdot I x}$<br>Xz( " ) = $\overline{X n( " ) \emptyset 0 I x + I x}$<br>Yz(1-3) = $\overline{C(21-23) \emptyset 7}$<br>Yz( " ) = $\overline{C( " ) "}$<br>sCz = $\overline{K z Q 1 T 0 \emptyset 7}$<br>rCz = $\overline{K z Q 1}$<br>sCp = $\overline{(C 2 1 \oplus C 2 2 \oplus C 2 3) C p T s H t Q 1 F 1 F 2}$<br>rCp = $\overline{( " ) C p "}$ | Recirculate A<br>Recirculate B<br>C+X·Ix $\rightarrow$ C (Add=Xz+Yz)                     | T7 thru T0<br>T7 thru T0<br>T7 thru T0 |
|               | T4  | Sc = $\overline{T 4 F 1 F 2 I n r}$   | Adder input if Ix (indexing)   | T7 thru T0                             |
|               | T3  | Sxc = $\overline{T 3 F 1 F 2 J u}$<br>sS(1,2) = $\overline{A d d(2,3) S x c}$<br>sS(3-14) = $\overline{C(0-11) S x c}$  | Adder input C register   | T7 thru T0                             |
|               | T0  | rCz = $\overline{F 1 T 0}$  | Carry for Adder  | T7 thru T1                             |
|               | Tr  | Cxm = $\overline{J u \emptyset 0 T s m (T r + T p)}$<br>sC(0-23) = $\overline{M(0-23) C x m}$<br>rC( " ) = $\overline{T r C x m}$<br>sHt = $\overline{C p T r (K p K 0 \emptyset 2)}$<br>rIx = $\overline{T r (F 1 F 3) (G O H t)}$<br>rK0 = $\overline{G O T r F 2}$   | Check parity   | T7 thru T0                             |
|               | Tp  | sCp = $\overline{M 2 4 C x m H t T s T p}$<br>sF1 = $\overline{(T p \overline{I a} \emptyset 0) 0 3 0 4}$<br>sF2 = $\overline{( " ) 0 3 0 2}$   | Clear S<br>C + X·Ix $\rightarrow$ S<br>M $\rightarrow$ C (Fetch operand)<br>Parity error | Tr thru Tp                             |
|               |     |   | Initiate parity<br>$\emptyset 6$ next clock (T8)   |  |

|    |    |                       |   |  |                               |
|----|----|-----------------------|---|--|-------------------------------|
| 06 | T8 | Anr                   | = $\overline{0102040506}$                   |  |                               |
|    |    | sIa                   | = T8F1F3(1)K1                               |  | Initiate P register increment |
|    |    | End                   | = F1F2                                      |  | Last cycle                    |
|    | T7 | Ar3                   | = (01020304)Q1                              |  |                               |
|    |    | sA(0-2)               | = (A)C(21-23)( $\overline{0102040506}$ )Ar3 |  |                               |
|    |    | rA( " )               | = (A)C( " )( " ) "                          |  |                               |
|    |    | sA(3-23)              | = A(0-20)Ar3                                | $A \cdot \overline{M} + \overline{A}M \rightarrow A$ | T7 thru T0                    |
|    |    | rA( " )               | = $\overline{A}$ ( " ) "                    |  |                               |
|    |    | sB(0-2)               | = B(21-23) $\overline{Bnr}$ Ar3             |  |                               |
|    |    | rB( " )               | = $\overline{B}$ ( " ) "                    | Recirculate B  | T7 thru T0                    |
|    |    | sB(3-23)              | = B(0-20)Ar3                                |  |                               |
|    |    | rB( " )               | = $\overline{B}$ ( " ) "                    |  |                               |
|    |    | Cr3                   | = F1F3(TsQ1)                                |  |                               |
|    |    | sC(0-2)               | = Add(1-3)06TsCr3                           |  |                               |
|    |    | rC( " )               | = $\overline{Add}$ ( " ) "                  | $A + C \rightarrow C$                                | T7 thru T0                    |
|    |    | sC(3-23)              | = C(0-20)Cr3                                |  |                               |
|    |    | rC( " )               | = $\overline{C}$ ( " ) "                    |  |                               |
|    |    | Xz(1-3)               | = A(21-23)060204                            |  |                               |
|    |    | $\overline{Xz}$ ( " ) | = $\overline{A}$ ( " ) "                    | Unused adder inputs                                  | T7 thru T0                    |
|    |    | Yz(1-3)               | = C(21-23)07                                |  |                               |
|    |    | $\overline{Yz}$ ( " ) | = $\overline{C}$ ( " ) "                    |  |                               |
|    |    | sCz                   | = KzQ1F107                                  |  |                               |
|    |    | rCz                   | = $\overline{Kz}$ Q1                        | Carry logic  | T7 thru T0                    |
|    |    | sCp                   | = (C21)C22(C23)CpTsHtQ10603                 |  |                               |
|    |    | rCp                   | = ( " )Cp "                                 | Check parity   | T7 thru T0                    |
|    |    | Pr3                   | = (F1G0)Q2                                  |  |                               |
|    |    | sP0                   | = (P12)P13P14(Ia)F1G0(02040506)Pr3          |  |                               |
|    |    | rP0                   | = ( " ) " "                                 |  |                               |
|    |    | sP1                   | = (P13)P14(Ia) " "                          |  |                               |
|    |    | rP1                   | = ( " ) " "                                 |  |                               |
|    |    | sP2                   | = (P14)P1(Ia) " "                           | $P + 1 \rightarrow P$                                | T7 thru T3                    |
|    |    | rP2                   | = ( " ) " "                                 |  |                               |
|    |    | sP(3-14)              | = P(0-11)Pr3                                |  |                               |
|    |    | rP( " )               | = $\overline{P}$ ( " ) "                    |  |                               |
|    |    | rIa                   | = (P12P13P14)Q2F1                           |  |                               |
|    | T4 | Sc                    | = T4EndInr                                  |  |                               |
|    |    | rS(1-14)              | = Sc  | Clear S  |                               |
|    | T3 | Sxp                   | = T3IntEndG0                                |  |                               |
|    |    | sS1                   | = (P13)P14(Ia)F1G0(02040506)Sxp             |  |                               |
|    |    | rS1                   | = ( " ) " "                                 |  |                               |
|    |    | sS2                   | = (P14)P1(Ia) " "                           | $P + 1 \rightarrow S$                                |                               |
|    |    | rS2                   | = ( " ) " "                                 |  |                               |
|    |    | sS(3-14)              | = P(0-11)Sxp                                |  |                               |
|    |    | rS( " )               | = $\overline{P}$ ( " ) "                    |  |                               |
|    | Tr | Com                   | = EndG0Fsm(Tr+Tp)                           |  |                               |
|    |    | sC(0-23)              | = M(0-23)Com                                | $M \rightarrow C$ (Fetch next instruction)           |                               |
|    |    | rC( " )               | = TrCom                                     |  | Tr thru Tp                    |
|    |    | sHt                   | = CpTrK002                                  | Parity error   |                               |

|    |               |                             |                    |
|----|---------------|-----------------------------|--------------------|
|    | rIa           | = TrF1                      |                    |
|    | rIx           | = Tr(FIF3)(GOHt)            |                    |
| Tp | rA00          | = TpEndGO                   |                    |
|    | rB00          | = ( " )                     |                    |
|    | sCp           | = M24C <del>om</del> HtTsTp | Initiate parity    |
|    | rF(1,2)       | = TpEndSk                   | 00 next clock,(T8) |
|    | Oc            | = ( " )                     |                    |
|    | sO2           | = Oc                        |                    |
|    | rO(1,3,4,5,6) | = Oc                        | NOP (20) → 0       |





|    |     |   |  |  |
|----|-----|---|--|--|
|    |     |   |  | NOP 1  |
| 20 | NOP | No Operation  |  | 1 Cycle  |
| Ø0 | T8  | $rC24 = T8(\overline{TsTsr})$<br>$rCz = \overline{\text{Ø}0T8}$<br>$sF1 = (\overline{\text{Ø}0T8IaC2C5C8}(\overline{C3+C4}))$<br>$sF3 = ( \quad " \quad )$<br>$sHz = T8$<br>$sIa = \overline{\text{Ø}0T8IaC2C5C8}(\overline{C3+C4})$<br>$Oxc = (\overline{\text{Ø}0T8IaGO})\overline{C2}$<br>$sO(1,3,4,5,6) = OxcC(3,5,6,7,8)$<br>$rO2 = Oxc\overline{C4}$  |  | Ø5 next (T7)<br><br>initiate P register increment<br><br>C(3-8) → 0 instruction to 0 register                        |
| Ø5 | T7  | $Ar3 = (\overline{01020304})Q1$<br>$sA(0-2) = A(21-23)\overline{ArAr3}$<br>$rA( \quad ) = \overline{A( \quad ) \quad "}$<br>$sA(3-23) = A(0-20)Ar3$<br>$rA( \quad ) = \overline{A( \quad ) \quad "}$<br>$sB(0-2) = B(21-23)\overline{BnrAr3}$<br>$rB( \quad ) = \overline{B( \quad ) \quad "}$<br>$sB(3-23) = B(0-20)Ar3$<br>$rB( \quad ) = \overline{B( \quad ) \quad "}$<br>$End = \overline{\text{Ø}5(A00+G0)}$<br>$Pr3 = (F1GO)Q2$<br>$sP0 = (F1GO(\overline{02040506})) (P12 \oplus (P13P14Ia))$<br>$rP0 = ( \quad " \quad ) (P12 \oplus (P13P14Ia))$<br>$sP1 = ( \quad " \quad ) (P13 \oplus (P14Ia))$<br>$rP1 = ( \quad " \quad ) (P13 \oplus (P14Ia))$<br>$sP2 = ( \quad " \quad ) (P14 \oplus Ia)$<br>$rP2 = ( \quad " \quad ) (P14 \oplus Ia)$<br>$rIa = (P12P13P14)Q2F1$<br>$sP(3-14) = P(0-11)Pr3$<br>$rP( \quad ) = \overline{P( \quad ) \quad "}$ |  | Recirculate A                      T7 thru T0<br><br>Recirculate B                      T7 thru T0<br><br>last cycle |
| T4 | Sc  | $rS(1-14) = T4(\overline{End+F1F2})\overline{Inr}$  |  | Clear S  |
| T3 | Sxp | $sS1 = (F1GO(\overline{02040506})) (P13 \oplus (P14Ia))Sxp$   |  | P → S  |
| Tr | Cxm | $sS(3-14) = P(0-11)Sxp$<br>$rC(0-23) = \overline{EndGOTsm(Tr+Tp)}$<br>$rC( \quad ) = \overline{M(0-23)Cxm}$<br>$rIa = TrF1$<br>$rIx = Tr(F1F3)(\overline{GOHt})$<br>$rRc = Tr$  |  | M → C                      Tr + Tp   |
| Ø0 | Ø0  | $rF = Tp\overline{EndSk}$<br>$rF3 = ( \quad " \quad )$<br>$rRf = Tp\overline{Ø1}(\overline{GOHt})$<br>$rJu = Tp$<br>$Oc = Tp\overline{EndSk}$<br>$rO(1,3,4,5,6) = Oc$<br>$sO2 = Oc$   |  | Ø0 next clock (T8)<br><br>NOP (20) → 0   |

| 23 | EXU           | Execute                          | M → P                        | 1 Cycle    |
|----|---------------|----------------------------------|------------------------------|------------|
| 00 | T8            | rCz = 00T8                       |                              |            |
|    |               | sHz = T8                         |                              |            |
|    |               | sIx = C1G000T8                   | Initialize indexing          |            |
|    |               | Oxc = IaGOC200T8                 |                              |            |
|    |               | s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc  | Instruction to 0 register    |            |
|    |               | r02 = C4Oxc                      |                              |            |
| T7 | Ar3           | = (01020304)Q1                   |                              |            |
|    | sA(0-2)       | = A(21-23)AnrAr3                 |                              |            |
|    | rA( " )       | = A( " ) " "                     | Recirculate A                | T7 thru T0 |
|    | sA(3-23)      | = A(0-20)Ar3                     |                              |            |
|    | rA( " )       | = A( " ) " "                     |                              |            |
|    | sB(0-2)       | = B(21-23)BnrAr3                 |                              |            |
|    | rB( " )       | = B( " ) " "                     | Recirculate B                | T7 thru T0 |
|    | sB(3-23)      | = B(0-20)Ar3                     |                              |            |
|    | rB( " )       | = B( " ) " "                     |                              |            |
|    | Cr3           | = Ts00Q1                         |                              |            |
|    | sC(0-2)       | = Add(1-3)Cr3JuTs                |                              |            |
|    | rC( " )       | = Add( " ) " "                   | C + X-Ix → C                 | T7 thru T0 |
|    | sC(3-23)      | = C(0-20)Cr3                     |                              |            |
|    | rC( " )       | = C( " ) " "                     |                              |            |
|    | sCp           | = (C21 ⊕ C22 ⊕ C23) CpTsHtQ1F1F2 | Parity error                 | T7 thru T0 |
|    | rCp           | = ( " ) Cp " "                   | Adder input if Ix (indexing) | T7 thru T0 |
|    | Xz(1-3)       | = Xn(1-3)00Ix                    |                              |            |
|    | Xz( " )       | = Xn( " )00Ix+Ix                 | Adder input C register       | T7 thru T0 |
|    | Yz(1-3)       | = C(21-23)07                     |                              |            |
|    | Yz( " )       | = C( " ) " "                     | Carry logic                  | T7 thru T1 |
|    | sCz           | = KzQ1T0                         |                              |            |
|    | rCz           | = KzQ1                           |                              |            |
| T4 | Sc            | = InrF1F2T4                      | Clear S                      |            |
|    | rS(1-14)      | = Sc                             |                              |            |
| T3 | Sxc           | = JuT3F1F2                       |                              |            |
|    | sS(1,2)       | = Add(2,3)Sxc                    | C(10-23) → S                 |            |
|    | sS(3-14)      | = C(0-11)Sxc                     |                              |            |
| T0 | rCz           | = F1T0                           |                              |            |
| Tr | Cxm           | = JuTsm(Tr+Tp)                   | M → C (Fetch instruction)    | Tr thru Tp |
|    | sC(0-23)      | = M(0-23)Cxm                     |                              |            |
|    | rC( " )       | = CxmTr                          | Parity error                 |            |
|    | sHt           | = CpTr(KpK002)                   |                              |            |
|    | rIx           | = (F1F3)(G0Ht)Tr                 |                              |            |
|    | rRc           | = Tr                             |                              |            |
| Tr | sCp           | = M24CxmHtTsTp                   | Initiate parity              |            |
|    | Oc            | = 0103Ia                         |                              |            |
|    | r0(1,3,4,5,6) | = Oc                             | NOP (20) → 0                 |            |
|    | s02           | = Oc                             |                              |            |

|    | YIM      | Y Buffer Into Memory When Ready | Y → (M)                | 3 Cycles<br>+ Wait |
|----|----------|---------------------------------|------------------------|--------------------|
| ∅0 | T8       | rCz = ∅0T8                      |                        |                    |
|    |          | sIx = ∅0T8C1G0                  | Initialize indexing    |                    |
|    |          | Oxc = (∅0T8IaG0)C2              |                        |                    |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |                    |
|    |          | rO2 = C4Oxc                     |                        |                    |
| T7 | Ar3      | = (O1O2O3O4)Q1                  |                        |                    |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |                    |
|    | rA( " )  | = A( " ) "                      | Recirculate A          | T7 thru T0         |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |                    |
|    | rA( " )  | = A( " ) "                      |                        |                    |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |                    |
|    | rB( " )  | = B( " ) "                      | Recirculate B          | T7 thru T0         |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |                    |
|    | rB( " )  | = B( " ) "                      |                        |                    |
|    | Cr3      | = F1F2(TsQ1)                    |                        |                    |
|    | sC(0-2)  | = Add(1-3)∅0JuTsCr3             |                        |                    |
|    | rC( " )  | = Add( " ) "                    | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0         |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |                    |
|    | rC( " )  | = C( " ) "                      |                        |                    |
|    | Xz(1-3)  | = Xn(1-3)∅0·Ix                  | Adder input (XIx)      | T7 thru T0         |
|    | Xz( " )  | = Xn( " )∅0Ix+Ix                |                        |                    |
|    | Yz(1-3)  | = C(21-23)∅7                    | Adder input (C)        | T7 thru T0         |
|    | Yz( " )  | = C( " ) "                      |                        |                    |
|    | sCz      | = KzQ1T0∅7                      | Carry logic            | T7 thru T1         |
|    | rCz      | = KzQ1                          |                        |                    |
|    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2     | Check parity           | T7 thru T0         |
|    | rCp      | = ( " )Cp "                     |                        |                    |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |                    |
|    | rS(1-14) | = Sc                            |                        |                    |
| T3 | Sxc      | = T3F1F2Ju                      |                        |                    |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                        |                    |
|    | sS(3-14) | = C(0-11)Sxc                    | C + X·Ix → S           |                    |
| T0 | rCz      | = F1T0                          |                        |                    |
|    | sRf      | = T0F3O5Yf(Y0+Y9)               | Y Buffer ready to send |                    |
| Tr | Cxm      | = Ju∅0Tsm(Tr+Tp)                |                        |                    |
|    | sC(0-23) | = M(0-23)Cxm                    | M → C (Fetch operand)  | Tr thru Tp         |
|    | rC( " )  | = TrCxm                         |                        |                    |
|    | sHt      | = CpTrKpK0∅2                    | Parity error           |                    |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |                    |
|    | rK0      | = GOTrF2                        |                        |                    |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |                    |
|    | sF1      | = Tp(F1F3O1O3O4)IaRf            | ∅4 next clock if Rf    |                    |
|    | sF2      | = TpIa∅0O3O4Rf                  | ∅2 next clock if Rf    |                    |
|    | rRf      | = Tp∅1(GOHT)                    |                        |                    |

If the Buffer is ready, ∅2 is ignored and ∅4 will occur.

|    |    |          |                        |                         |            |
|----|----|----------|------------------------|-------------------------|------------|
| Ø2 | T7 | Ar3      | = (01020304)Q1         |                         |            |
|    |    | sA(0-2)  | = A(21-23)ArAr3        |                         |            |
|    |    | rA( " )  | = A( " ) " "           | Recirculate A           | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3           |                         |            |
|    |    | rA( " )  | = A( " ) " "           |                         |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3       |                         |            |
|    |    | rB( " )  | = B( " ) " "           | Recirculate B           | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3           |                         |            |
|    |    | rB( " )  | = B( " ) " "           |                         |            |
| T0 |    | rCz      | = F1T0                 |                         |            |
|    |    | sRf      | = T0F305Yf(Y0+Y9)      | Set Rf if Y Buffer full |            |
| Tp |    | sF1      | = (Tp(F1F3010304)IaRf) | Ø4 next if Rf           |            |
|    |    | rF2      | = ( " )                | Ø2 next if Rf           |            |
|    |    | rRf      | = TpØ1(GØHt)           |                         |            |

The Computer will continue to repeat Ø2 until the Y Buffer becomes ready.

|    |    |          |   |                                 |            |
|----|----|----------|---|---------------------------------|------------|
| 04 | T8 | rC24     | = T8( $\overline{TsTsr}$ )  | Initialize parity generation    |            |
|    |    | sIa      | = F1F3( $\overline{K}$ )  | Initialize P register increment |            |
|    |    | Mxc      | = 04Tsm   |                                 | T8 thru Tp |
|    |    | Rx       | = 01030406F1F3Ts  |                                 |            |
|    |    | sRn(1-3) | = Rwy(1-3) $\overline{Tsr}$   |                                 |            |
|    |    | rRn( " ) | = $\overline{Rwy}$ ( " ) "  | Information from Y              | T8 thru Tp |
| T7 |    | Ar3      | = (01020304)Q1  |                                 |            |
|    |    | sA(0-2)  | = A(21-23) $\overline{AnrAr3}$  |                                 |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "  | Recirculate A                   | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3  |                                 |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "  |                                 |            |
|    |    | sB(0-2)  | = B(21-23) $\overline{BnrAr3}$  |                                 |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "  | Recirculate B                   | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3  |                                 |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "  |                                 |            |
|    |    | Cr3      | = F1F3(TsQ1)  |                                 |            |
|    |    | sC(0-2)  | = Rn(1-3)RxCr3  |                                 |            |
|    |    | rC( " )  | = $\overline{Rn}$ ( " ) "   | Y Buffer → C                    | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3  |                                 |            |
|    |    | rC( " )  | = $\overline{C}$ ( " ) "  |                                 |            |
|    |    | Pr3      | = (F1G0)Q2  |                                 |            |
|    |    | sP0      | = (P12 <del>P</del> P13P14Ia)F1G0(02040506)Pr3                                |                                 |            |
|    |    | rP0      | = ( " ) "   |                                 |            |
|    |    | sP1      | = (P13 <del>P</del> P14Ia) "  |                                 |            |
|    |    | rP1      | = ( " ) "   |                                 |            |
|    |    | sP2      | = (P14 <del>P</del> Ia) "   | P + 1 → P                       | T7 thru T3 |
|    |    | rP2      | = ( " ) "   |                                 |            |
|    |    | sP(3-14) | = P(0-11)Pr3  |                                 |            |
|    |    | rP( " )  | = $\overline{P}$ ( " ) "  |                                 |            |
|    |    | rIa      | = (P12P13P14)Q2F1   |                                 |            |
| T6 |    | sC24     | = (C0 <del>C</del> C1 <del>C</del> C2)C24( $\overline{TsTsr}$ )(Q3+Q5)        | Generate parity                 | T6 thru Tr |
|    |    | rC24     | = ( " )C24( " )( " )  |                                 |            |
| T3 |    | rM(0-24) | = T3  | Clear M                         |            |
| T0 |    | rCp      | = $\overline{TsT0HtK0}$ (F1 <del>0</del> 701 <del>0</del> 6) $\overline{0}$ 2 |                                 |            |
| Tr |    | sHt      | = CpTr( $\overline{K}$ ) $\overline{K0}$ $\overline{0}$ 2                     | Parity error                    |            |
|    |    | rIa      | = TrF1  |                                 |            |
|    |    | rK0      | = TrGOF2  |                                 |            |
| Tp |    | sF(1-3)  | = Tp $\overline{0}$ 4   | 07 next clock (T8)              |            |
|    |    | sM(0-24) | = C(0-24)MxcTp  |                                 |            |
|    |    | rM( " )  | = $\overline{C}$ ( " ) "  | C → M (Store operand)           |            |

|    |    |               |                               |                                |            |
|----|----|---------------|-------------------------------|--------------------------------|------------|
| 07 | T8 | End           | = F1F2                        | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3              | Recirculate A                  | T7 thru T0 |
|    |    | rA( " )       | = A( " ) "                    |                                |            |
|    |    | sA(3-23)      | = A(0-20)Ar3                  |                                |            |
|    |    | rA( " )       | = A( " ) "                    |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3              | Recirculate B                  | T7 thru T0 |
|    |    | rB( " )       | = B( " ) "                    |                                |            |
|    |    | sB(3-23)      | = B(0-20)Ar3                  |                                |            |
|    |    | rB( " )       | = B( " ) "                    |                                |            |
|    |    | Pr3           | = F1GOQ2                      |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3 | Recirculate P                  | T7 thru T3 |
|    |    | rP( " )       | = P( " ) " ( " ) "            |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                  |                                |            |
|    |    | rP( " )       | = P( " ) "                    |                                |            |
|    | T4 | Sc            | = T4EndInr                    | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                          |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                  | P(13,14) contains P(1,2) at T3 |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp | P → S                          |            |
|    |    | rS( " )       | = P( " ) " ( " ) "            |                                |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                  |                                |            |
|    |    | rS( " )       | = P( " ) "                    |                                |            |
|    | T0 | rSk           | = 07T0                        | M → C (Fetch next instruction) |            |
|    | Tr | Cxm           | = EndGOIsm(Tr+Tp)             | Tr thru Tp                     |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                  |                                |            |
|    |    | rC( " )       | = TrCxm                       |                                |            |
|    |    | rIa           | = F1Tr                        |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)              |                                |            |
|    | Tp | rA00          | = TpEndGO                     | Initiate parity                |            |
|    |    | rB00          | = TpEndGO                     | 00 next                        |            |
|    |    | sCp           | = M24CxmHtTsTp                |                                |            |
|    |    | rF(1-3)       | = TpEndSK                     |                                |            |
|    |    | Oc            | = TpEndSK                     |                                |            |
|    |    | s02           | = Oc                          |                                |            |
|    |    | r0(1,3,4,5,6) | = Oc                          | NOP (20) → 0                   |            |

| 32 | WIM      | W Buffer Into Memory When Ready | W → (M)                | 3 Cycles<br>+ Wait |
|----|----------|---------------------------------|------------------------|--------------------|
| ∅0 | T8       | rCz = ∅0T8                      |                        |                    |
|    |          | sIx = ∅0T8C1G0                  | Initialize indexing    |                    |
|    |          | Oxc = (∅0T8IaG0)C2              |                        |                    |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |                    |
|    |          | rO2 = C4Oxc                     |                        |                    |
| T7 | Ar3      | = (01020304)Q1                  |                        |                    |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |                    |
|    | rA( " )  | = A( " ) "                      | Recirculate A          | T7 thru T0         |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |                    |
|    | rA( " )  | = A( " ) "                      |                        |                    |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |                    |
|    | rB( " )  | = B( " ) "                      | Recirculate B          | T7 thru T0         |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |                    |
|    | rB( " )  | = B( " ) "                      |                        |                    |
|    | Cr3      | = F1F2(TsQ1)                    |                        |                    |
|    | sC(0-2)  | = Add(1-3)∅0JuTsCr3             |                        |                    |
|    | rC( " )  | = Add( " ) "                    | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0         |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |                    |
|    | rC( " )  | = C( " ) "                      |                        |                    |
|    | Xz(1-3)  | = Xn(1-3)∅0·Ix                  | Adder input (XIx)      | T7 thru T0         |
|    | Xz( " )  | = Xn( " )∅0Ix+Ix                |                        |                    |
|    | Yz(1-3)  | = C(21-23)∅7                    | Adder input (C)        | T7 thru T0         |
|    | Yz( " )  | = C( " ) "                      |                        |                    |
|    | sCz      | = KzQ1T0∅7                      | Carry logic            | T7 thru T1         |
|    | rCz      | = KzQ1                          |                        |                    |
|    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2     | Check parity           | T7 thru T0         |
|    | rCp      | = ( " )Cp "                     |                        |                    |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |                    |
|    | rS(1-14) | = Sc                            |                        |                    |
| T3 | Sxc      | = T3F1F2Ju                      |                        |                    |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                        |                    |
|    | sS(3-14) | = C(0-11)Sxc                    | C + X·Ix → S           |                    |
| T0 | rCz      | = F1T0                          |                        |                    |
|    | sRf      | = T0F305WF(W0+W9)06             | W Buffer ready to send |                    |
| Tr | Cxm      | = Ju∅0Tsm(Tr+Tp)                |                        |                    |
|    | sC(0-23) | = M(0-23)Cxm                    | M → C (Fetch operand)  | Tr thru Tp         |
|    | rC( " )  | = TrCxm                         |                        |                    |
|    | sHt      | = CpTrKpK0∅2                    | Parity error           |                    |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |                    |
|    | rK0      | = GOTrF2                        |                        |                    |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |                    |
|    | sF1      | = Tp(F1F3010304)IaRf            | ∅4 next if Rf          |                    |
|    | sF2      | = (TpIa∅0)0304Rf                | ∅2 next if Rf          |                    |
|    | rRf      | = Tp∅1(GOHt)                    |                        |                    |

If Buffer is ready ∅2 is ignored and ∅4 will occur.

|    |    |          |                        |                         |            |
|----|----|----------|------------------------|-------------------------|------------|
| Ø2 | T7 | Ar3      | = (01020304)Q1         |                         |            |
|    |    | sA(0-2)  | = A(21-23)ArAr3        |                         |            |
|    |    | rA( " )  | = A( " ) " "           |                         |            |
|    |    | sA(3-23) | = A(0-20)Ar3           | Recirculate A           | T7 thru T0 |
|    |    | rA( " )  | = A( " ) " "           |                         |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3       |                         |            |
|    |    | rB( " )  | = B( " ) " "           |                         |            |
|    |    | sB(3-23) | = B(0-20)Ar3           | Recirculate B           | T7 thru T0 |
|    |    | rB( " )  | = B( " ) " "           |                         |            |
| T0 |    | rCz      | = F1T0                 |                         |            |
|    |    | sRf      | = T0F305Wf(W0+W9)      | Set Rf if W Buffer full |            |
| Tp |    | sF1      | = (Tp(F1F3010304)IaRf) | Ø4 next if Rf           |            |
|    |    | sF2      | = ( " )02              | Ø2 next if Rf           |            |
|    |    | rRf      | = TpØ1(GØHt)           |                         |            |

The Computer will continue to repeat Ø2 until the W Buffer becomes ready.



|    |    |          |  |                                 |            |
|----|----|----------|--|---------------------------------|------------|
| 04 | T8 | rC24     | = $T8(\overline{TsTsr})$                                 | Initialize parity generation    |            |
|    |    | sIa      | = $F1F3(\overline{Ia})$                                  | Initialize P register increment |            |
|    |    | Mxc      | = $\overline{04Tsm}$                                     |                                 | T8 thru Tp |
|    |    | Rx       | = $\overline{01030406F1F3Ts}$                            |                                 |            |
|    |    | sRn(1-3) | = $\overline{Rwy(1-3)Tsr}$                               | Information from W              | T8 thru Tp |
|    |    | rRn( " ) | = $\overline{Rwy( " ) "}$                                |                                 |            |
| T7 |    | Ar3      | = $(\overline{01020304})Q1$                              |                                 |            |
|    |    | sA(0-2)  | = $\overline{A(21-23)AnrAr3}$                            | Recirculate A                   | T7 thru T0 |
|    |    | rA( " )  | = $\overline{A( " ) "}$                                  |                                 |            |
|    |    | sA(3-23) | = $\overline{A(0-20)Ar3}$                                |                                 |            |
|    |    | rA( " )  | = $\overline{A( " ) "}$                                  |                                 |            |
|    |    | sB(0-2)  | = $\overline{B(21-23)BnrAr3}$                            | Recirculate B                   | T7 thru T0 |
|    |    | rB( " )  | = $\overline{B( " ) "}$                                  |                                 |            |
|    |    | sB(3-23) | = $\overline{B(0-20)Ar3}$                                |                                 |            |
|    |    | rB( " )  | = $\overline{B( " ) "}$                                  |                                 |            |
|    |    | Cr3      | = $\overline{F1F3(TsQ1)}$                                |                                 |            |
|    |    | sC(0-2)  | = $\overline{Rn(1-3)RxCr3}$                              | W Buffer → C                    | T7 thru T0 |
|    |    | rC( " )  | = $\overline{Rn( " ) "}$                                 |                                 |            |
|    |    | sC(3-23) | = $\overline{C(0-20)Cr3}$                                |                                 |            |
|    |    | rC( " )  | = $\overline{C( " ) "}$                                  |                                 |            |
|    |    | Pr3      | = $(\overline{F1G0})Q2$                                  |                                 |            |
|    |    | sP0      | = $(\overline{P12P13P14Ia})F1G0(\overline{02040506})Pr3$ |                                 |            |
|    |    | rP0      | = $( " ) " " "$  |                                 |            |
|    |    | sP1      | = $(\overline{P13P14Ia}) " "$                            |                                 |            |
|    |    | rP1      | = $( " ) " " "$  |                                 |            |
|    |    | sP2      | = $(\overline{P14Ia}) " "$                               | P + 1 → P                       | T7 thru T3 |
|    |    | rP2      | = $( " ) " " "$  |                                 |            |
|    |    | sP(3-14) | = $\overline{P(0-11)Pr3}$                                |                                 |            |
|    |    | rP( " )  | = $\overline{P( " ) "}$                                  |                                 |            |
|    |    | rIa      | = $(\overline{P12P13P14})Q2F1$                           |                                 |            |
| T6 |    | sC24     | = $(\overline{C0C1C2})C24(\overline{TsTsr})(Q3+Q5)$      | Generate parity                 | T6 thru Tr |
|    |    | rC24     | = $( " )C24( " )( " )$                                   |                                 |            |
| T3 |    | rM(0-24) | = T3   | Clear M                         |            |
| T0 |    | rCp      | = $\overline{TsT0HtK0(F1070106)02}$                      |                                 |            |
| Tr |    | sHt      | = $\overline{CpTrK002}$                                  | Parity error                    |            |
|    |    | rIa      | = TrF1   |                                 |            |
|    |    | rK0      | = TrG0F2   |                                 |            |
| Tp |    | sF(1-3)  | = Tp04   | 07 next clock (T8)              |            |
|    |    | sM(0-24) | = $\overline{C(0-24)MxcTp}$                              | C → M (Store operand)           |            |
|    |    | rM( " )  | = $\overline{C( " ) "}$                                  |                                 |            |

|    |    |               |                                  |                                |            |
|----|----|---------------|----------------------------------|--------------------------------|------------|
| Ø7 | T8 | End           | = F1F2                           | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                   |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                 | Recirculate A                  | T7 thru T0 |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "         |                                |            |
|    |    | sA(3-23)      | = A(0-20)Ar3                     | Recirculate B                  | T7 thru T0 |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "         |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                 |                                |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "         | Recirculate P                  | T7 thru T3 |
|    |    | sB(3-23)      | = B(0-20)Ar3                     |                                |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "         |                                |            |
|    |    | Pr3           | = F1GOQ2                         |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3    | Recirculate P                  | T7 thru T3 |
|    |    | rP( " )       | = $\overline{P}$ ( " ) " ( " ) " |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                     |                                |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) "         |                                |            |
|    | T4 | Sc            | = T4EndInr                       | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                             |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                     | P(13,14) contains P(1,2) at T3 |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp    | P → S                          |            |
|    |    | rS( " )       | = $\overline{P}$ ( " ) " ( " ) " |                                |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                     |                                |            |
|    |    | rS( " )       | = $\overline{P}$ ( " ) "         |                                |            |
|    | T0 | rSk           | = Ø7T0                           | M → C (Fetch next instruction) |            |
|    | Tr | Cxm           | = EndGOIsm(Tr+Tp)                | Tr thru Tp                     |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                     |                                |            |
|    |    | rC( " )       | = TrCxm                          |                                |            |
|    |    | rIa           | = F1Tr                           |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)                 |                                |            |
|    | Tp | rA00          | = TpEndGO                        | Initiate parity                |            |
|    |    | rB00          | = TpEndGO                        | Ø0 next                        |            |
|    |    | sCp           | = M24CxmHtTsTp                   |                                |            |
|    |    | rF(1-3)       | = TpEndSK                        |                                |            |
|    |    | Oc            | = TpEndSK                        |                                |            |
|    |    | sO2           | = Oc                             | NOP (20) → 0                   |            |
|    |    | rO(1,3,4,5,6) | = Oc                             |                                |            |

| 33 | PIN | Parallel Input to Memory When Ready External Device → (M)  | 4 Cycles<br>+ Wait  |  |
|----|-----|--|---|--|
| ∅0 | T8  | rCz = ∅0T8<br>sIx = ∅0T8C1G0<br>Oxc = (∅0T8IaG0)C2<br>sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>rO2 = C4Oxc   | Initialize indexing<br>Instruction → 0  |  |
|    | T7  | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>Cr3 = F1F2(TsQ1)<br>sC(0-2) = Add(1-3)∅0JuTsCr3<br>rC( " ) = Add( " ) "<br>sC(3-23) = C(0-20)Cr3<br>rC( " ) = C( " ) "<br>Xz(1-3) = Xn(1-3)∅0·Ix<br>Xz( " ) = Xn( " )∅0Ix+Ix<br>Yz(1-3) = C(21-23)∅7<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T0∅7<br>rCz = KzQ1<br>sCp = (C21⊕C22⊕C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp " | Recirculate A<br>Recirculate B<br>C+X·Ix → C (Add=Xz+Yz)<br>Adder input (XIx)<br>Adder input (C)<br>Carry logic<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0 |
|    | T4  | Sc = T4F1F2Inr   | Clear S   |  |
|    | T3  | Sxc = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc   | C + X·Ix → S  |  |
|    | T0  | rCz = F1T0   |   |  |
| Tr | Cxm | = Ju∅0Tsm(Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = TrCxm<br>sHt = CpTrKpK0∅2<br>rIx = Tr(F1F3)(GOHt)<br>rK0 = G0TrF2   | M → C (Fetch operand)<br>Parity error   | Tr thru Tp   |
| Tp | sCp | = M24CxmHtTsTp   | Initiate parity   |  |
|    | sF2 | = (TpIa∅0)0304Rf   | ∅2 next clock (T8)  |  |

|    |    |          |   |  |                            |            |
|----|----|----------|---|--|----------------------------|------------|
| Ø2 | T7 | Ar3      | = | $(01020\overline{304})Q1$                    |                            |            |
|    |    | sA(0-2)  | = | $A(21-23)\overline{A}nrAr3$                  |                            |            |
|    |    | rA( " )  | = | $\overline{A}( " ) "$                        |                            |            |
|    |    | sA(3-23) | = | $A(0-20)Ar3$                                 | Recirculate A              | T7 thru T0 |
|    |    | rA( " )  | = | $\overline{A}( " ) "$                        |                            |            |
|    |    | sB(0-2)  | = | $B(21-23)\overline{B}nrAr3$                  |                            |            |
|    |    | rB( " )  | = | $\overline{B}( " ) "$                        |                            |            |
|    |    | sB(3-23) | = | $B(0-20)Ar3$                                 | Recirculate B              | T7 thru T0 |
|    |    | rB( " )  | = | $\overline{B}( " ) "$                        |                            |            |
|    |    | Cxi      | = | $(\overline{F1F2F306Ts})O2Q105$              |                            |            |
|    |    | sC(0-23) | = | $CxiCd0$                                     | External Device → C        | T7 thru T0 |
|    |    | rC( " )  | = | $CxiQ2$                                      |                            |            |
|    |    | sRf      | = | $Q2\overline{F306F2Rt}$                      | External Device ready (Rt) |            |
| T0 |    | rCz      | = | $\overline{F1T0}$                            |                            |            |
| Tp |    | sF1      | = | $(Tp(\overline{F1F3010304})\overline{IaRf})$ | Ø4 next if $\overline{Rf}$ |            |
|    |    | rF2      | = | $( " )O2$                                    | Ø2 next if $\overline{Rf}$ |            |
|    |    | rRf      | = | $Tp\overline{Ø1}(\overline{GOHt})$           |                            |            |

The Computer will continue to repeat Ø2 until the External Device transmits to C.

|    |          |      |                                  |                                 |            |
|----|----------|------|----------------------------------|---------------------------------|------------|
| 04 | T8       | rC24 | = T8( <u>TsTr</u> )              | Initialize parity generation    |            |
|    |          | s1a  | = F1F3( <u>Cr</u> )              | Initialize P register increment |            |
|    |          | Mxc  | = <u>04Tsm</u>                   |                                 | T8 thru Tp |
| T7 | Ar3      |      | = (01020304)Q1                   |                                 |            |
|    | sA(0-2)  |      | = A(21-23)AnrAr3                 | Recirculate A                   | T7 thru T0 |
|    | rA( " )  |      | = A( " ) "                       |                                 |            |
|    | sA(3-23) |      | = A(0-20)Ar3                     |                                 |            |
|    | rA( " )  |      | = A( " ) "                       |                                 |            |
|    | sB(0-2)  |      | = B(21-23)BnrAr3                 | Recirculate B                   | T7 thru T0 |
|    | rB( " )  |      | = B( " ) "                       |                                 |            |
|    | sB(3-23) |      | = B(0-20)Ar3                     |                                 |            |
|    | rB( " )  |      | = B( " ) "                       |                                 |            |
|    | Cr3      |      | = F1F3(TsQ1)                     |                                 |            |
|    | sC(0-2)  |      | = C(21-23)04010406TsCr3          | Recirculate C                   | T7 thru T0 |
|    | rC( " )  |      | = C( " ) "                       |                                 |            |
|    | sC(3-23) |      | = C(0-20)Cr3                     |                                 |            |
|    | rC( " )  |      | = C( " ) "                       |                                 |            |
|    | Pr3      |      | = (F1G0)Q2                       |                                 |            |
|    | sP0      |      | = (P12P13P14Ia)F1G0(02040506)Pr3 |                                 |            |
|    | rP0      |      | = ( " ) "                        |                                 |            |
|    | sP1      |      | = (P13P14Ia) "                   |                                 |            |
|    | rP1      |      | = ( " ) "                        |                                 |            |
|    | sP2      |      | = (P14Ia) "                      | P + 1 → P                       | T7 thru T3 |
|    | rP2      |      | = ( " ) "                        |                                 |            |
|    | sP(3-14) |      | = P(0-11)Pr3                     |                                 |            |
|    | rP( " )  |      | = P( " ) "                       |                                 |            |
|    | rIa      |      | = (P12P13P14)Q2F1                |                                 |            |
| T6 | sC24     |      | = (C0C1C2)C24(TsTr)(Q3+Q5)       | Generate parity                 | T6 thru Tr |
|    | rC24     |      | = ( " )C24( " )( " )             | Clear N                         |            |
| T3 | rM(0-24) |      | = T3                             | Parity error                    |            |
| T0 | rCp      |      | = TsT0HcK0(F1070106)02           |                                 |            |
| Tr | sHt      |      | = CpTr( <u>K002</u> )            |                                 |            |
|    | rIa      |      | = TrF1                           |                                 |            |
|    | rK0      |      | = TrGOF2                         |                                 |            |
| Tp | sF(1-3)  |      | = Tp04                           | 07 next clock (T8)              |            |
|    | sM(0-24) |      | = C(0-24)MxcTp                   | C → M (Store operand)           |            |
|    | rM( " )  |      | = C( " ) "                       |                                 |            |

|    |    |               |                               |                                |            |
|----|----|---------------|-------------------------------|--------------------------------|------------|
| 07 | T8 | End           | = F1F2                        | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3              | Recirculate A                  | T7 thru T0 |
|    |    | rA( " )       | = A( " ) " "                  |                                |            |
|    |    | sA(3-23)      | = A(0-20)Ar3                  |                                |            |
|    |    | rA( " )       | = A( " ) " "                  |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3              | Recirculate B                  | T7 thru T0 |
|    |    | rB( " )       | = B( " ) " "                  |                                |            |
|    |    | sB(3-23)      | = B(0-20)Ar3                  |                                |            |
|    |    | rB( " )       | = B( " ) " "                  |                                |            |
|    |    | Pr3           | = F1GOQ2                      |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3 | Recirculate P                  | T7 thru T3 |
|    |    | rP( " )       | = P( " ) " ( " ) "            |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                  |                                |            |
|    |    | rP( " )       | = P( " ) " "                  |                                |            |
|    | T4 | Sc            | = T4EndInr                    | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                          |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                  |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = P( " ) " ( " ) "            | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                  |                                |            |
|    |    | rS( " )       | = P( " ) " "                  |                                |            |
|    | T0 | rSk           | = 07T0                        |                                |            |
|    | Tr | Cxm           | = EndGOTsm(Tr+Tp)             | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23)      | = M(0-23)Cxm                  |                                |            |
|    |    | rC( " )       | = TrCxm                       |                                |            |
|    |    | rIa           | = F1Tr                        |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)              |                                |            |
|    | Tp | rA00          | = TpEndGO                     | Initiate parity                |            |
|    |    | rB00          | = TpEndGO                     | 00 next                        |            |
|    |    | sCp           | = M24CxmHtTsTp                |                                |            |
|    |    | rF(1-3)       | = TpEndSk                     |                                |            |
|    |    | Oc            | = TpEndSk                     |                                |            |
|    |    | sO2           | = Oc                          |                                |            |
|    |    | rO(1,3,4,5,6) | = Oc                          | NOP (20) → 0                   |            |

|    | STA      | Store A                         | A → (M)                | 3 Cycles   |
|----|----------|---------------------------------|------------------------|------------|
| 00 | T8       | rCz = 00T8                      |                        |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing    |            |
|    |          | Oxc = (00T8IaG0)C2              |                        |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |            |
|    |          | rO2 = C4Oxc                     |                        |            |
| T7 | Ar3      | = (01020304)Q1                  |                        |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |            |
|    | rA( " )  | = A( " ) "                      | Recirculate A          | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |            |
|    | rA( " )  | = A( " ) "                      |                        |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |            |
|    | rB( " )  | = B( " ) "                      | Recirculate B          | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |            |
|    | rB( " )  | = B( " ) "                      |                        |            |
|    | Cr3      | = F1F2(TsQ1)                    |                        |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             |                        |            |
|    | rC( " )  | = Add( " ) "                    | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |            |
|    | rC( " )  | = C( " ) "                      |                        |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input (XIx)      | T7 thru T0 |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                        |            |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input (C)        | T7 thru T0 |
|    | Yz( " )  | = C( " ) "                      |                        |            |
|    | sCz      | = KzQ1T007                      | Carry logic            | T7 thru T1 |
|    | rCz      | = KzQ1                          |                        |            |
|    | sCp      | = (C21C22C23)CpTsHtQ1F1F2       | Check parity           | T7 thru T0 |
|    | rCp      | = ( " )Cp "                     |                        |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |            |
|    | rS(1-14) | = Sc                            |                        |            |
| T3 | Sxc      | = T3F1F2Ju                      |                        |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   | C + X·Ix → S           |            |
|    | sS(3-14) | = C(0-11)Sxc                    |                        |            |
| T0 | rCz      | = F1T0                          |                        |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch operand)  | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                        |            |
|    | rC( " )  | = TrCxm                         |                        |            |
|    | sHt      | = CpTrKpK002                    | Parity error           |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |            |
|    | rK0      | = GOTrF2                        |                        |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |            |
|    | sF1      | = (TpIa00)0304                  | 04 next clock (T8)     |            |

|    |    |          |                                  |                                 |            |
|----|----|----------|----------------------------------|---------------------------------|------------|
| 04 | T8 | rC24     | = T8(TsTr)                       | Initialise parity generation    |            |
|    |    | sIa      | = F1F3(TTr)                      | Initialise P register increment |            |
|    |    | Mxc      | = 04Tsm                          |                                 | T8 thru Tp |
|    | T7 | Ar3      | = (01020304)Q1                   |                                 |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                 |                                 |            |
|    |    | rA( " )  | = A( " ) "                       | Recirculate A                   | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                     |                                 |            |
|    |    | rA( " )  | = A( " ) "                       |                                 |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                 |                                 |            |
|    |    | rB( " )  | = B( " ) "                       | Recirculate B                   | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                     |                                 |            |
|    |    | rB( " )  | = B( " ) "                       |                                 |            |
|    |    | Cr3      | = F1F3(TsQ1)                     |                                 |            |
|    |    | sC(0-2)  | = A(21-23)040405TsCr3            | A → C                           | T7 thru T0 |
|    |    | rC( " )  | = A( " ) "                       |                                 |            |
|    |    | sC(3-23) | = C(0-20)Cr3                     |                                 |            |
|    |    | rC( " )  | = C( " ) "                       |                                 |            |
|    |    | Pr3      | = (F1G0)Q2                       |                                 |            |
|    |    | sP0      | = (P12P13P14Ia)F1G0(02040506)Pr3 |                                 |            |
|    |    | rP0      | = ( " ) "                        |                                 |            |
|    |    | sP1      | = (P13P14Ia)                     |                                 |            |
|    |    | rP1      | = ( " ) "                        |                                 |            |
|    |    | sP2      | = (P14Ia)                        | P + 1 → P                       | T7 thru    |
|    |    | rP2      | = ( " ) "                        |                                 |            |
|    |    | sP(3-14) | = P(0-11)Pr3                     |                                 |            |
|    |    | rP( " )  | = P( " ) "                       |                                 |            |
|    |    | rIa      | = (P12P13P14)Q2F1                |                                 |            |
|    | T6 | sC24     | = (000102)C24(TsTr)(Q3+Q5)       | Generate parity                 | T6 thru Tr |
|    |    | rC24     | = ( " )C24( " )( " )             |                                 |            |
|    | T3 | rM(0-24) | = T3                             | Clear M                         |            |
|    | T0 | rCp      | = TsT0HtK0(F1070106)02           |                                 |            |
|    | Tr | sHt      | = CpTrK002                       | Parity error                    |            |
|    |    | rIa      | = TrF1                           |                                 |            |
|    |    | rK0      | = TrGOF2                         |                                 |            |
|    | Tp | sF(1-3)  | = Tp04                           | 07 next clock (T8)              |            |
|    |    | sM(0-24) | = C(0-24)MxcTp                   | C → M (Store operand)           |            |
|    |    | rM( " )  | = C( " ) "                       |                                 |            |



|    |    |               |                               |                                |            |
|----|----|---------------|-------------------------------|--------------------------------|------------|
| Ø7 | T8 | End           | = F1F2                        | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                |                                |            |
|    |    | sA(0-2)       | = A(21-23)ArAr3               |                                |            |
|    |    | rA( " )       | = A( " ) " "                  | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                  |                                |            |
|    |    | rA( " )       | = A( " ) " "                  |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3              | Recirculate B                  | T7 thru T0 |
|    |    | rB( " )       | = B( " ) " "                  |                                |            |
|    |    | sB(3-23)      | = B(0-20)Ar3                  |                                |            |
|    |    | rB( " )       | = B( " ) " "                  |                                |            |
|    |    | Pr3           | = F1GQ2                       |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GQ(02040506)Pr3 |                                |            |
|    |    | rP( " )       | = P( " ) " ( " ) "            | Recirculate P                  | T7 thru T3 |
|    |    | sP(3-14)      | = P(0-11)Pr3                  |                                |            |
|    |    | rP( " )       | = P( " ) " "                  |                                |            |
|    | T4 | Sc            | = T4EndInr                    | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                          |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                  |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GQ(02040506)Sxp | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = P( " ) " ( " ) "            | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                  |                                |            |
|    |    | rS( " )       | = P( " ) " "                  |                                |            |
|    | T0 | rSk           | = Ø7T0                        |                                |            |
|    | Tr | Cxm           | = EndGOIsm(Tr+Tp)             | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                  |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCxm                       |                                |            |
|    |    | rIa           | = F1Tr                        |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)              |                                |            |
|    | Tp | rA00          | = TpEndGO                     |                                |            |
|    |    | rB00          | = TpEndGO                     |                                |            |
|    |    | sCp           | = M24CxmHtTsTp                | Initiate parity                |            |
|    |    | rF(1-3)       | = TpEndSk                     | Ø0 next                        |            |
|    |    | Oc            | = TpEndSk                     |                                |            |
|    |    | sO2           | = Oc                          |                                |            |
|    |    | rO(1,3,4,5,6) | = Oc                          | NOP (20) → 0                   |            |

| 36 | STB      | Store B                         | B → (M)                | 3 Cycle    |
|----|----------|---------------------------------|------------------------|------------|
| 00 | T8       | rCz = 00T8                      |                        |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing    |            |
|    |          | Oxc = (00T8IaG0)C2              |                        |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |            |
|    |          | rO2 = C4Oxc                     |                        |            |
| T7 | Ar3      | = (01020304)Q1                  |                        |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |            |
|    | rA( " )  | = A( " ) "                      | Recirculate A          | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |            |
|    | rA( " )  | = A( " ) "                      |                        |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |            |
|    | rB( " )  | = B( " ) "                      | Recirculate B          | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |            |
|    | rB( " )  | = B( " ) "                      |                        |            |
|    | Cr3      | = F1F2(TsQ1)                    |                        |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             |                        |            |
|    | rC( " )  | = Add( " ) "                    | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |            |
|    | rC( " )  | = C( " ) "                      |                        |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input (XIx)      | T7 thru T0 |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                        |            |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input (C)        | T7 thru    |
|    | Yz( " )  | = C( " ) "                      |                        |            |
|    | sCz      | = KzQ1T007                      | Carry logic            | T7 thru T1 |
|    | rCz      | = KzQ1                          |                        |            |
|    | sCp      | = (C21C22C23)CpTsHtQ1F1F2       | Check parity           | T7 thru T0 |
|    | rCp      | = ( " )Cp "                     |                        |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |            |
|    | rS(1-14) | = Sc                            |                        |            |
| T3 | Sxc      | = T3F1F2Ju                      |                        |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   | C + X·Ix → S           |            |
|    | sS(3-14) | = C(0-11)Sxc                    |                        |            |
| T0 | rCz      | = F1T0                          |                        |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch operand)  | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                        |            |
|    | rC( " )  | = TrCxm                         |                        |            |
|    | sHt      | = CpTrK002                      | Parity error           |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |            |
|    | rK0      | = GOTrF2                        |                        |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |            |
|    | sFl      | = (TpIa00)0304                  | 04 next clock (T8)     |            |

|    |          |                             |                                  |                                 |            |
|----|----------|-----------------------------|----------------------------------|---------------------------------|------------|
| 04 | T8       | rC24                        | = T8(TsTsr)                      | Initialize parity generation    |            |
|    |          | sIa                         | = F1F3(TsTsr)                    | Initialize P register increment |            |
|    |          | Mxc                         | = <del>04</del> Tsm              |                                 | T8 thru Tp |
|    | T7       | Ar3                         | = (01020304)Q1                   |                                 |            |
|    |          | sA(0-2)                     | = A(21-23)AnrAr3                 |                                 |            |
|    |          | rA( " )                     | = A( " ) " "                     | Recirculate A                   | T7 thru T0 |
|    |          | sA(3-23)                    | = A(0-20)Ar3                     |                                 |            |
|    |          | rA( " )                     | = A( " ) " "                     |                                 |            |
|    |          | sB(0-2)                     | = B(21-23)BnrAr3                 |                                 |            |
|    |          | rB( " )                     | = B( " ) " "                     | Recirculate B                   | T7 thru T0 |
|    |          | sB(3-23)                    | = B(0-20)Ar3                     |                                 |            |
|    |          | rB( " )                     | = B( " ) " "                     |                                 |            |
|    |          | Cr3                         | = F1F3(TsQ1)                     |                                 |            |
|    |          | sC(0-2)                     | = B(21-23)040406TsCr3            | B → C                           | T7 thru TC |
|    |          | rC( " )                     | = B( " ) " "                     |                                 |            |
|    |          | sC(3-23)                    | = C(0-20)Cr3                     |                                 |            |
|    |          | rC( " )                     | = C( " ) " "                     |                                 |            |
|    |          | Pr3                         | = (F1G0)Q2                       |                                 |            |
|    |          | sP0                         | = (P12P13P14Ia)F1G0(02040506)Pr3 |                                 |            |
|    |          | rP0                         | = ( " ) " "                      |                                 |            |
|    |          | sP1                         | = (P13P14Ia) " "                 |                                 |            |
|    |          | rP1                         | = ( " ) " "                      |                                 |            |
|    |          | sP2                         | = (P14Ia) " "                    | P + 1 → R                       | T7 thru T3 |
|    |          | rP2                         | = ( " ) " "                      |                                 |            |
|    |          | sP(3-14)                    | = P(0-11)Pr3                     |                                 |            |
|    |          | rP( " )                     | = P( " ) " "                     |                                 |            |
|    |          | rIa                         | = (P12P13P14)Q2F1                |                                 |            |
| T6 | sC24     | = (000102)C24(TsTsr)(Q3+Q5) | Generate parity                  | T6 thru T                       |            |
|    | rC24     | = ( " )C24( " )( " )        |                                  |                                 |            |
| T3 | rM(0-24) | = T3                        | Clear M                          |                                 |            |
| T0 | rCp      | = TsTOHtK0(F1070106)02      |                                  |                                 |            |
| Tr | sHt      | = CpTrK002                  | Parity error                     |                                 |            |
|    | rIa      | = TrF1                      |                                  |                                 |            |
|    | rK0      | = TrGOF2                    |                                  |                                 |            |
| Tp | sF(1-3)  | = Tp04                      | 07 next clock (T8)               |                                 |            |
|    | sM(0-24) | = C(0-24)MxcTp              | C → M (Store operand)            |                                 |            |
|    | rM( " )  | = C( " ) " "                |                                  |                                 |            |

|    |    |               |                               |                                |            |
|----|----|---------------|-------------------------------|--------------------------------|------------|
| Ø7 | T8 | End           | = F1F2                        | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3              | Recirculate A                  | T7 thru T0 |
|    |    | rA( " )       | = A( " ) "                    |                                |            |
|    |    | sA(3-23)      | = A(0-20)Ar3                  |                                |            |
|    |    | rA( " )       | = A( " ) "                    |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3              | Recirculate B                  | T7 thru T0 |
|    |    | rB( " )       | = B( " ) "                    |                                |            |
|    |    | sB(3-23)      | = B(0-20)Ar3                  |                                |            |
|    |    | rB( " )       | = B( " ) "                    |                                |            |
|    |    | Pr3           | = F1GOQ2                      |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3 | Recirculate P                  | T7 thru T3 |
|    |    | rP( " )       | = P( " ) " ( " ) "            |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                  |                                |            |
|    |    | rP( " )       | = P( " ) "                    |                                |            |
|    | T4 | Sc            | = T4EndInr                    | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                          |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                  |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = P( " ) " ( " ) "            | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                  |                                |            |
|    |    | rS( " )       | = P( " ) "                    |                                |            |
|    | T0 | rSk           | = Ø7T0                        |                                |            |
|    | Tr | Cxm           | = EndGOTsm(Tr+Tp)             | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                  |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCxm                       |                                |            |
|    |    | rIa           | = F1Tr                        |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)              |                                |            |
|    | Tp | rA00          | = TpEndGO                     |                                |            |
|    |    | rB00          | = TpEndGO                     |                                |            |
|    |    | sCp           | = M24CxmHtTsTp                | Initiate parity                |            |
|    |    | rF(1-3)       | = TpEndSK                     | Ø0 next                        |            |
|    |    | Oc            | = TpEndSK                     |                                |            |
|    |    | sO2           | = Oc                          |                                |            |
|    |    | rO(1,3,4,5,6) | = Oc                          | NOP (20) → 0                   |            |

| 37 | STX | Store X  | X → C   | 3 Cycles   |
|----|-----|--|---|--|
| 00 | T8  | rCz = 00T8<br>sIx = 00T8C1G0<br>Oxc = (00T8IaG0)C2<br>sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>rO2 = C4Oxc   | Initialize indexing<br>Instruction → 0  |  |
|    | T7  | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>Cr3 = F1F2(TsQ1)<br>sC(0-2) = Add(1-3)00JuTsCr3<br>rC( " ) = Add( " ) "<br>sC(3-23) = C(0-20)Cr3<br>rC( " ) = C( " ) "<br>Xz(1-3) = Xn(1-3)00·Ix<br>Xz( " ) = Xn( " )00Ix+Ix<br>Yz(1-3) = C(21-23)07<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T007<br>rCz = KzQ1<br>sCp = (C21C22C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp " | Recirculate A<br>Recirculate B<br>C+X·Ix → C (Add=Xz+Yz)<br>Adder input (XIx)<br>Adder input (C)<br>Carry logic<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T1<br>T7 thru T0 |
|    | T4  | Sc = T4F1F2Inr<br>rS(1-14) = Sc  | Clear S   |  |
|    | T3  | Sxc = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc   | C + X·Ix → S  |  |
|    | T0  | rCz = F1T0   |   |  |
|    | Tr  | Cxm = Ju00Tsm(Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = TrCxm<br>sHt = CpTrK002<br>rIx = Tr(F1F3)(GOHt)<br>rK0 = GOTrF2   | M → C (Fetch operand)<br>Parity error   | Tr thru Tp   |
|    | Tp  | sCp = M24CxmHtTsTp<br>sFl = (TpIa00)0304   | Initiate parity<br>04 next clock (T8)   |  |

|    |    |          |  |                                 |            |
|----|----|----------|--|---------------------------------|------------|
| 04 | T8 | rC24     | = $T8(Ts\overline{Ts}r)$   | Initialize parity generation    |            |
|    |    | sIa      | = $F1\overline{F3}r$   | Initialize P register increment |            |
|    |    | Mxc      | = $04\overline{Tsm}$   |                                 | T8 thru Tp |
|    | T7 | Ar3      | = $(01020304)Q1$   |                                 |            |
|    |    | sA(0-2)  | = $A(21-23)\overline{Anr}Ar3$                                    |                                 |            |
|    |    | rA( " )  | = $A( " )$ "   | Recirculate A                   | T7 thru T0 |
|    |    | sA(3-23) | = $A(0-20)Ar3$   |                                 |            |
|    |    | rA( " )  | = $A( " )$ "   |                                 |            |
|    |    | sB(0-2)  | = $B(21-23)\overline{Bnr}Ar3$                                    |                                 |            |
|    |    | rB( " )  | = $B( " )$ "   | Recirculate B                   | T7 thru T0 |
|    |    | sB(3-23) | = $B(0-20)Ar3$   |                                 |            |
|    |    | rB( " )  | = $B( " )$ "   |                                 |            |
|    |    | Cr3      | = $F1\overline{F3}(TsQ1)$  |                                 |            |
|    |    | sC(0-2)  | = $X(1-3)04040506\overline{Ts}Cr3$                               | X → C                           | T7 thru T0 |
|    |    | rC( " )  | = $X( " )$ "   |                                 |            |
|    |    | sC(3-23) | = $C(0-20)Cr3$   |                                 |            |
|    |    | rC( " )  | = $C( " )$ "   |                                 |            |
|    |    | Pr3      | = $(F1G0)Q2$   |                                 |            |
|    |    | sP0      | = $(P1\overline{P}P13P14Ia)F1G0(02040506)Pr3$                    |                                 |            |
|    |    | rP0      | = ( " ) "  |                                 |            |
|    |    | sP1      | = $(P13\overline{P}P14Ia)$ "                                     |                                 |            |
|    |    | rP1      | = ( " ) "  |                                 |            |
|    |    | sP2      | = $(P14\overline{P}Ia)$ "  | P + 1 → P                       | T7 thru    |
|    |    | rP2      | = ( " ) "  |                                 |            |
|    |    | sP(3-14) | = $P(0-11)Pr3$   |                                 |            |
|    |    | rP( " )  | = $P( " )$ "   |                                 |            |
|    |    | rIa      | = $(P12P13P14)Q2F1$  |                                 |            |
|    | T6 | sC24     | = $(C0\overline{C}C1\overline{C}C2)C24(Ts\overline{Ts}r)(Q3+Q5)$ | Generate parity                 | T6 thru Tr |
|    |    | rC24     | = ( " )C24( " )( " )   |                                 |            |
|    | T3 | rM(0-24) | = T3   | Clear M                         |            |
|    | T0 | rCp      | = $TsT0HtK0(F1\overline{0}701\overline{0}6)\overline{0}2$        |                                 |            |
|    | Tr | sHt      | = $CpTrK0\overline{K}0\overline{0}2$                             | Parity error                    |            |
|    |    | rIa      | = $TrF1$   |                                 |            |
|    |    | rK0      | = $TrGOF2$   |                                 |            |
|    | Tp | sF(1-3)  | = $Tp04$   | 07 next clock (T8)              |            |
|    |    | sM(0-24) | = $C(0-24)MxcTp$   |                                 |            |
|    |    | rM( " )  | = $C( " )$ "   | C → M (Store operand)           |            |

|    |    |               |                                  |                                |            |
|----|----|---------------|----------------------------------|--------------------------------|------------|
| Ø7 | T8 | End           | = F1F2                           | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                   |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                 |                                |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "         | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                     |                                |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "         |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                 |                                |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "         | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                     |                                |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "         |                                |            |
|    |    | Pr3           | = F1GOQ2                         |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3    |                                |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) " ( " ) " | Recirculate P                  | T7 thru T3 |
|    |    | sP(3-14)      | = P(0-11)Pr3                     |                                |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) "         |                                |            |
|    | T4 | Sc            | = T4EndInr                       | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                             |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                     |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp    | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = $\overline{P}$ ( " ) " ( " ) " | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                     |                                |            |
|    |    | rS( " )       | = $\overline{P}$ ( " ) "         |                                |            |
|    | T0 | rSk           | = Ø7T0                           |                                |            |
|    | Tr | Cxm           | = EndGO $\overline{Tsm}$ (Tr+Tp) | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                     |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCxm                          |                                |            |
|    |    | rIa           | = F1Tr                           |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)                 |                                |            |
|    | Tp | rA00          | = TpEndGO                        |                                |            |
|    |    | rB00          | = TpEndGO                        |                                |            |
|    |    | sCp           | = M24CxmHtTsTp                   | Initiate parity                |            |
|    |    | rF(1-3)       | = TpEndSk                        | Ø0 next                        |            |
|    |    | Oc            | = TpEndSk                        |                                |            |
|    |    | s02           | = Oc                             |                                |            |
|    |    | r0(1,3,4,5,6) | = Oc                             | NOP (20) → 0                   |            |

|    |           |   |  |   |
|----|-----------|---|--|---|
| 40 | SKS 10400 | Channel Inter-Record Test<br>(W Buffer)   | Inter-Record Condition<br>Not True = P + 1 → P<br>Inter-Record Condition<br>True = P + 2 → P   | 1 Cycle<br>2 Cycles                               |
| 00 | T8        | rC24 = T8( $\overline{\text{TsTsr}}$ )<br>rCz = 00T8<br>sF1 = (00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )<br>sF3 = ( " )<br>sHz = T8<br>sIa = 00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )<br>Oxc = (00T8 $\overline{\text{IaGO}}$ ) $\overline{\text{C2}}$<br>sO(1,3,4,5,6) = Ox $\overline{\text{cC}}$ (3,5,6,7,8)<br>rO2 = Ox $\overline{\text{cC4}}$<br>Skr = $\overline{\text{C1C17C9C10C11C19C20C21C22C23C15Wsc}}$<br>Sks = $\overline{\text{Skrz}}$  | 05 next. (17)<br><br>Initiate P register increment<br>C(3-8) → 0 instruction to 0 register<br>Signal complete  |   |
| 05 | T7        | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23) $\overline{\text{AnrAr3}}$<br>rA( " ) = $\overline{\text{A}}$ ( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = $\overline{\text{A}}$ ( " ) "<br>sB(0-2) = B(21-23) $\overline{\text{BnrAr3}}$<br>rB( " ) = $\overline{\text{B}}$ ( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = $\overline{\text{B}}$ ( " ) "<br>End = 05 $\overline{\text{Bc23}}$<br>Pr3 = (F1GO)Q2<br>sP0 = (F1GO(02040506))(P12 <del>⊕</del> (P13P14Ia))<br>rP0 = ( " )(P12 <del>⊕</del> (P13P14Ia))<br>sP1 = ( " )(P13 <del>⊕</del> (P14Ia))<br>rP1 = ( " )(P13 <del>⊕</del> (P14Ia))<br>sP2 = ( " )(P14 <del>⊕</del> Ia)<br>rP2 = ( " )(P14 <del>⊕</del> Ia)<br>rIa = (P12P13P14)Q2F1<br>sP(3-14) = P(0-11)Pr3<br>rP( " ) = $\overline{\text{P}}$ ( " ) "<br>T4 Sc = T4(End+F1F2) $\overline{\text{Inr}}$<br>rS(1-14) = Sc<br>T3 Sxp = T3 $\overline{\text{Int}}$ ( $\overline{\text{End+JuEax}}$ )GO+T3 $\overline{\text{Kmc}}$<br>sS1 = (F1GO(02040506))(P13 <del>⊕</del> (P14Ia))Sxp<br>sS2 = ( " )(P14 <del>⊕</del> Ia)Sxp<br>sS(3-14) = P(0-11)Sxp<br>Tr Cxm = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = $\overline{\text{M}}$ ( " ) "<br>rIa = TrF1<br>rIx = Tr(F1F3)( $\overline{\text{GOHt}}$ )<br>rRc = Tr<br>sSk = 050104A00TrSks<br>Tp rF1 = TpEnd $\overline{\text{Sk}}$<br>sF2 = TpSk<br>rF3 = TpEnd $\overline{\text{Sk}}$<br>rRf = Tp $\overline{\text{OI}}$ ( $\overline{\text{GOHt}}$ )<br>rJu = Tp<br>Oc = TpEnd $\overline{\text{Sk}}$<br>rO(1,3,4,5,6) = Oc<br>sO2 = Oc | Recirculate A<br>Recirculate B<br>Last cycle<br>P+1 → P<br>P → S<br>M → C<br>Skip if Sks<br>00 next clock (T8) if Sk not set<br>07 next clock (T8) if Sk set<br>NOP (20) → 0 | T7 thru T0<br>T7 thru T0<br>T7 thru T3<br>Tr + Tp |



|    |    |               |  |                               |            |
|----|----|---------------|--|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8( $\overline{\text{Ts1sr}}$ )                            |                               |            |
|    |    | Ck            | = Ø7T8 $\overline{\text{Ts}}$                                |                               |            |
|    |    | End           | = F1F2   | Last cycle                    |            |
|    |    | s1a           | = T8Ø7sk $\overline{\text{tjkr}}$                            | Initiate P register increment |            |
| T7 |    | Ar3           | = (Ø1Ø2Ø3Ø4)Q1   |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                        |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3   |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                        |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3   |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              |                               |            |
|    |    | Cr3           | = Ø7Ø5( $\overline{\text{TsQ1}}$ )                           |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3   | O → C                         |            |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) "                              |                               |            |
|    |    | Pr3           | = (F1GØ)Q2   |                               |            |
|    |    | sP0           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12 $\oplus$ (P13P14Ia))                |                               |            |
|    |    | rP0           | = ( " ) (P12 $\oplus$ (P13P14Ia))                            |                               |            |
|    |    | sP1           | = ( " ) (P13 $\oplus$ (P14Ia))                               |                               |            |
|    |    | rP1           | = ( " ) (P13 $\oplus$ (P14Ia))                               | P+1 → P                       | T7 thru T3 |
|    |    | sP2           | = ( " ) (P14 $\oplus$ Ia)                                    |                               |            |
|    |    | rP2           | = ( " ) (P14 $\oplus$ Ia)                                    |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1  |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3   |                               |            |
|    |    | rP( " )       | = $\overline{\text{P}}$ ( " ) "                              |                               |            |
| T4 |    | Sc            | = T4End $\overline{\text{Inr}}$                              |                               |            |
|    |    | rS(1-14)      | = Sc   | Clear S                       |            |
| T3 |    | Sxp           | = T3 $\overline{\text{IntEndGO}}$                            |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13 $\oplus$ (P14Ia))Sxp                  |                               |            |
|    |    | sS2           | = ( " ) (P14 $\oplus$ Ia)Sxp                                 | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp   |                               |            |
| T0 |    | rSk           | = Ø7TØ   | Reset skip                    |            |
| Tr |    | Cxm           | = EndGØTsm(Tr+Tp)  |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm   | M → C                         |            |
|    |    | rC( " )       | = $\overline{\text{M}}$ ( " ) "                              |                               |            |
|    |    | rIa           | = TrF1   |                               |            |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ )( $\overline{\text{GOHt}}$ ) |                               |            |
|    |    | rRc           | = Tr   |                               |            |
| Tp |    | sCp           | = M24Cxm $\overline{\text{HtTsTp}}$                          | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEnd $\overline{\text{Sk}}$                               | ØØ next clock (T8)            |            |
|    |    | rRf           | = TpØ1( $\overline{\text{GOHt}}$ )                           |                               |            |
|    |    | rJu           | = Tp   |                               |            |
|    |    | Oc            | = TpEnd $\overline{\text{Sk}}$                               |                               |            |
|    |    | rØ(1,3,4,5,6) | = OØ   | NØP → Ø                       |            |
|    |    | sØ2           | = OØ   |                               |            |

|    |   |   |   |
|----|---|---|---|
| 40 | SKS 10500   | Channel Inter-Record Test<br>(Y Buffer)   | Inter-Record Not True = 1 Cycle<br>P + 1 → P<br>Inter-Record True = 2 Cycles<br>P + 2 → P                           |
| 00 | T8  | rC24 = $T8(\overline{TsTsr})$<br>rCz = $\emptyset 0T8$<br>sF1 = $(\emptyset 0T8\overline{Ia}\overline{C2}\overline{C5}\overline{C8}(\overline{C3}+\overline{C4}))$<br>sF3 = $(\quad\quad\quad)$<br>sHz = $T8$<br>sIa = $\emptyset 0T8\overline{Ia}\overline{C2}\overline{C5}\overline{C8}(\overline{C3}+\overline{C4})$<br>Oxc = $(\emptyset 0T8\overline{Ia}GO)\overline{C2}$<br>sO(1,3,4,5,6) = $OxcC(3,5,6,7,8)$<br>rO2 = $Oxc\overline{C4}$<br>Skr = $\overline{C1}\overline{C17}\overline{C9}\overline{C10}\overline{C11}\overline{C19}\overline{C20}\overline{C21}\overline{C22}\overline{C23}\overline{C15}Ysc$<br>Sks = $\overline{Skrz}$   | $\emptyset 5$ next (17)<br>Initiate P register increment<br>C(3-8) → 0 instruction to 0 register<br>Signal complete |
| 05 | T7  | Ar3 = $(01020304)Q1$<br>sA(0-2) = $A(21-23)\overline{Anr}Ar3$<br>rA( " ) = $\overline{A}(\quad\quad)$<br>sA(3-23) = $A(0-20)Ar3$<br>rA( " ) = $\overline{A}(\quad\quad)$<br>sB(0-2) = $B(21-23)\overline{Bnr}Ar3$<br>rB( " ) = $\overline{B}(\quad\quad)$<br>sB(3-23) = $B(0-20)Ar3$<br>rB( " ) = $\overline{B}(\quad\quad)$<br>End = $\emptyset 5\overline{Bc}23$<br>Pr3 = $(F1GO)Q2$<br>sP0 = $(F1GO(\overline{02040506}))(P12\oplus(P13P14Ia))$<br>rP0 = $(\quad\quad)(\overline{P12}\oplus(\overline{P13P14Ia}))$<br>sP1 = $(\quad\quad)(P13\oplus(P14Ia))$<br>rP1 = $(\quad\quad)(\overline{P13}\oplus(\overline{P14Ia}))$<br>sP2 = $(\quad\quad)(P14\oplus Ia)$<br>rP2 = $(\quad\quad)(\overline{P14}\oplus Ia)$<br>rIa = $(\overline{P12P13P14})Q2F1$<br>sP(3-14) = $P(0-11)Pr3$<br>rP( " ) = $\overline{P}(\quad\quad)$ | Recirculate A T7 thru T0<br>Recirculate B T7 thru T0<br>Last cycle<br>P+1 → P T7 thru T3                            |
| T4 | Sc  | rS(1-14) = $T4(End+\overline{F1F2})\overline{Inr}$<br>= Sc  | Clear S   |
| T3 | Sxp   | sS1 = $T3\overline{Int}(\overline{End+JuEax})GO+T3\overline{Kmc}$<br>sS2 = $(F1GO(\overline{02040506}))(P13\oplus(P14Ia))Sxp$<br>sS(3-14) = $P(0-11)Sxp$<br>= $(\quad\quad)(P14\oplus Ia)Sxp$   | P → S   |
| Tr | Cxm   | sC(0-23) = $EndGO\overline{Tsm}(Tr+Tp)$<br>rC( " ) = $\overline{M}(\quad\quad)$<br>rIa = $TrF1$<br>rIx = $Tr(\overline{F1F3})(\overline{GOHt})$<br>rRc = $Tr$<br>sSk = $\emptyset 50107A00TrSks$  | M → C Tr + Tp<br>Skip if Sks  |
| Tp | rF1 = $TpEnd\overline{SK}$<br>sF2 = $TpSk$<br>rF3 = $TpEnd\overline{SK}$<br>rRf = $Tp\overline{01}(\overline{GOHt})$<br>rJu = $Tp$<br>Oc = $TpEnd\overline{SK}$<br>rO(1,3,4,5,6) = $Oc$<br>sO2 = $Oc$ | $\emptyset 0$ next clock (T8) if Sk not set<br>$\emptyset 7$ next clock (T8) if Sk set<br>NOP (20) → 0  |   |

|    |     |               |   |                               |            |
|----|-----|---------------|---|-------------------------------|------------|
| Ø7 | T8  | rC24          | = T8( $\overline{\text{Ts1sr}}$ )             |                               |            |
|    |     | Ck            | = Ø7T8Ts                                      |                               |            |
|    |     | End           | = F1F2  | Last cycle                    |            |
|    |     | s1a           | = T8Ø7Sk( $\overline{\text{Ikr}}$ )           | Initiate P register increment |            |
| T7 | Ar3 | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                                |                               |            |
|    |     | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$         |                               |            |
|    |     | rA( " )       | = $\overline{\text{A( " )}}$ "                | Recirculate A                 | T7 thru TØ |
|    |     | sA(3-23)      | = A(0-20)Ar3                                  |                               |            |
|    |     | rA( " )       | = $\overline{\text{A( " )}}$ "                |                               |            |
|    |     | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$         |                               |            |
|    |     | rB( " )       | = $\overline{\text{B( " )}}$ "                | Recirculate B                 | T7 thru TØ |
|    |     | sB(3-23)      | = B(0-20)Ar3                                  |                               |            |
|    |     | rB( " )       | = $\overline{\text{B( " )}}$ "                |                               |            |
|    |     | Cr3           | = Ø7Ø5(TsQ1)                                  |                               |            |
|    |     | sC(3-23)      | = C(0-20)Cr3                                  | O → C                         |            |
|    |     | rC( " )       | = $\overline{\text{C( " )}}$ "                |                               |            |
|    |     | Pr3           | = (F1GØ)Q2                                    |                               |            |
|    |     | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12 $\oplus$ (P13P14Ia)) |                               |            |
|    |     | rPØ           | = ( " ) (P12 $\oplus$ (P13P14Ia))             |                               |            |
|    |     | sP1           | = ( " ) (P13 $\oplus$ (P14Ia))                | P+1 → P                       | T7 thru T3 |
|    |     | rP1           | = ( " ) (P13 $\oplus$ (P14Ia))                |                               |            |
|    |     | sP2           | = ( " ) (P14 $\oplus$ Ia)                     |                               |            |
|    |     | rP2           | = ( " ) (P14 $\oplus$ Ia)                     |                               |            |
|    |     | rIa           | = (P12P13P14)Q2F1                             |                               |            |
|    |     | sP(3-14)      | = P(0-11)Pr3                                  |                               |            |
|    |     | rP( " )       | = $\overline{\text{P( " )}}$ "                |                               |            |
| T4 | Sc  | Sc            | = T4EndInr                                    | Clear S                       |            |
|    |     | rS(1-14)      | = Sc  |                               |            |
| T3 | Sxp | Sxp           | = T3IntEndGØ                                  |                               |            |
|    |     | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6))(P13 $\oplus$ (P14Ia))Sxp  |                               |            |
|    |     | sS2           | = ( " ) (P14 $\oplus$ Ia)Sxp                  | P → S                         |            |
|    |     | sS(3-14)      | = P(0-11)Sxp                                  |                               |            |
| TØ | rSk | rSk           | = Ø7TØ  | Reset skip                    |            |
| Tr | Cxm | Cxm           | = EndGØTsm(Tr+Tp)                             |                               |            |
|    |     | sC(0-23)      | = M(0-23)Cxm                                  | M → C                         |            |
|    |     | rC( " )       | = $\overline{\text{M( " )}}$ "                |                               |            |
|    |     | rIa           | = TrF1  |                               |            |
|    |     | rIx           | = Tr(F1F3)(GØHt)                              |                               |            |
|    |     | rRc           | = Tr  |                               |            |
| Tp | sCp | sCp           | = M24CxmHtTsTp                                | Initiate parity               |            |
|    |     | rF(1-3)       | = TpEndSk                                     |                               |            |
|    |     | rRf           | = TpØ1(GØHt)                                  | ØØ next clock (T8)            |            |
|    |     | rJu           | = Tp  |                               |            |
|    |     | Oc            | = TpEndSk                                     |                               |            |
|    |     | rØ(1,3,4,5,6) | = OØ  | NØP → Ø                       |            |
|    |     | sØ2           | = OØ  |                               |            |

40 SKS 20001 Skip if Overflow not set

Set = P+1 → P reset overflow 1 Cycle  
 Reset = P+2 → P 2 Cycles

00 T8 rC24 = T8(TsTsr)  
 rCz = 00T8  
 sF1 = (00T8IaC2C508(C3+C4))  
 sF3 = ( " )  
 sHz = T8  
 sIa = 00T8IaC2C5C8(C3+C4)  
 Oxc = (00T8IaGO)C2  
 sO(1,3,4,5,6) = OxcC(3,5,6,7,8)  
 rO2 = OxcC4  
 Sks = (C10C11)C230f  
 05 T7 Ar3 = (01020304)Q1  
 sA(0-2) = A(21-23)AnrAr3  
 rA( " ) = A( " ) "  
 sA(3-23) = A(0-20)Ar3  
 rA( " ) = A( " ) "  
 sB(0-2) = B(21-23)BnrAr3  
 rB( " ) = B( " ) "  
 sB(3-23) = B(0-20)Ar3  
 rB( " ) = B( " ) "  
 End = 05Bc23  
 Pr3 = (F1GO)Q2  
 sP0 = (F1GO(02040506))(P12⊕(P13P14Ia))  
 rP0 = ( " )(P12⊕(P13P14Ia))  
 sP1 = ( " )(P13⊕(P14Ia))  
 rP1 = ( " )(P13⊕(P14Ia))  
 sP2 = ( " )(P14Ia)  
 rP2 = ( " )(P14Ia)  
 rIa = (P12P13P14)Q2F1  
 sP(3-14) = P(0-11)Pr3  
 rP( " ) = P( " ) "  
 T4 Sc = T4(End+F1F2)Inr  
 rS(1-14) = Sc  
 T3 Sxp = T3Int(End+JuEax)GO+T3Imc  
 sS1 = (F1GO(02040506))(P13⊕(P14Ia))Sxp  
 sS2 = ( " )(P14Ia)Sxp  
 sS(3-14) = P(0-11)Sxp  
 Tr Cxm = EndGOTsm(Tr+Tp)  
 sC(0-23) = M(0-23)Cxm  
 rC( " ) = M( " ) "  
 rIa = TrF1  
 rIx = Tr(F1F3)(GOht)  
 rRc = Tr  
 sSk = 050104A00TrSks  
 Tp rF1 = TpEndSk  
 sF2 = TpSk  
 rF3 = TpEndSk  
 rRf = Tp01(GOht)  
 rJu = Tp  
 Oc = TpEndSk  
 rO(1,3,4,5,6) = Oc  
 sO2 = Oc

05 next (T7)

initiate P register increment

C(3-8) → 0 instruction to 0 register

Overflow not set

Recirculate A T7 thru T0

Recirculate B T7 thru T0

last cycle

P+1 → P T7 thru T3

Clear S

P → S

M → C Tr + Tp

Skip if Sks

00 next clock (T8) if Sk not set

07 next clock (T8) if Sk set

NOP (20) → 0

|    |    |               |                                      |                               |            |
|----|----|---------------|--------------------------------------|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8(TsTsr)                          |                               |            |
|    |    | Ck            | = Ø7T8Ts                             |                               |            |
|    |    | End           | = F1F2                               | Last Cycle                    |            |
|    |    | sIa           | = T8Ø7SkI(Kr)                        | Initiate P register increment |            |
| T7 |    | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                       |                               |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                     |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "             | Recirculate A                 | T7 thru TØ |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "             |                               |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                     |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "             | Recirculate B                 | T7 thru TØ |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "             |                               |            |
|    |    | Cr3           | = Ø7Ø5(TsQ1)                         |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                         | O → C                         |            |
|    |    | rC( " )       | = $\overline{C}$ ( " ) "             |                               |            |
|    |    | Pr3           | = (F1GØ)Q2                           |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12⊕(P13P14Ia)) |                               |            |
|    |    | rPØ           | = ( " ) ( " )                        |                               |            |
|    |    | sP1           | = ( " ) (P13⊕(P14Ia))                | P+1 → P                       | T7 thru T3 |
|    |    | rP1           | = ( " ) ( " )                        |                               |            |
|    |    | sP2           | = ( " ) (P14⊕Ia)                     |                               |            |
|    |    | rP2           | = ( " ) ( " )                        |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                    |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                         |                               |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) "             |                               |            |
| T4 |    | Sc            | = T4EndInr                           | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                                 |                               |            |
| T3 |    | Sxp           | = T3IntEndGØ                         |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13⊕(P14Ia))Sxp   |                               |            |
|    |    | sS2           | = ( " ) (P14⊕Ia)Sxp                  | P → S                         |            |
|    |    | sS(3=14)      | = P(0-11)Sxp                         |                               |            |
| TØ |    | rSk           | = Ø7TØ                               | Reset skip                    |            |
| Tr |    | Cxm           | = EndGØTsm(Tr+Tp)                    |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                         | M → C                         |            |
|    |    | rC( " )       | = $\overline{M}$ ( " ) "             |                               |            |
|    |    | rIa           | = TrF1                               |                               |            |
|    |    | rIx           | = Tr(F1F3)(GØHt)                     |                               |            |
|    |    | rRc           | = Tr                                 |                               |            |
| Tp |    | sCp           | = M24CxmHtTsTp                       | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                            |                               |            |
|    |    | rRf           | = TpØ1(GØHt)                         | ØØ next clock (T8)            |            |
|    |    | rJu           | = Tp                                 |                               |            |
|    |    | Oc            | = TpEndSk                            |                               |            |
|    |    | rØ(1,3,4,5,6) | = OØ                                 | NØP → Ø                       |            |
|    |    | sØ2           | = OØ                                 |                               |            |

|    |           |   |                                      |            |
|----|-----------|---|--------------------------------------|------------|
| 40 | SKS 20002 | Skip if Interrupt Disabled  | Enabled = P+1 → P                    | 1 Cycle    |
|    |           |   | Disabled = P+2 → P                   | 2 Cycles   |
| 00 | T8        | rC24 = T8( $\overline{\text{TsTsr}}$ )                                  |                                      |            |
|    |           | rCz = 00T8  |                                      |            |
|    |           | sF1 = (00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )) | 05 next (T7)                         |            |
|    |           | sF3 = ( " )   |                                      |            |
|    |           | sHz = T8  |                                      |            |
|    |           | sIa = 00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )   | initiate P register increment        |            |
|    |           | Oxc = (00T8 $\overline{\text{IaGO}}$ )C2                                |                                      |            |
|    |           | sO(1,3,4,5,6) = OxcC(3,5,6,7,8)   | C(3-8) → 0 instruction to 0 register |            |
|    |           | rO2 = OxcC4   |                                      |            |
|    |           | Sks = (C10C11)C22En   | Interrupt disabled                   |            |
| 05 | T7        | Ar3 = (01020304)Q1  |                                      |            |
|    |           | sA(0-2) = A(21-23) $\overline{\text{AnrAr3}}$                           |                                      |            |
|    |           | rA( " ) = $\overline{\text{A}}$ ( " ) " "                               | Recirculate A                        | T7 thru T0 |
|    |           | sA(3-23) = A(0-20)Ar3   |                                      |            |
|    |           | rA( " ) = $\overline{\text{A}}$ ( " ) " "                               |                                      |            |
|    |           | sB(0-2) = B(21-23) $\overline{\text{BnrAr3}}$                           |                                      |            |
|    |           | rB( " ) = $\overline{\text{B}}$ ( " ) " "                               | Recirculate B                        | T7 thru T0 |
|    |           | sB(3-23) = B(0-20)Ar3   |                                      |            |
|    |           | rB( " ) = $\overline{\text{B}}$ ( " ) " "                               |                                      |            |
|    |           | End = 05Bc23  | last cycle                           |            |
|    |           | Pr3 = (F1GO)Q2  |                                      |            |
|    |           | sP0 = (F1GO(02040506))(P12⊕(P13P14Ia))                                  |                                      |            |
|    |           | rP0 = ( " )(P12⊕(P13P14Ia))   |                                      |            |
|    |           | sP1 = ( " )(P13⊕(P14Ia))  | P+1 → P                              | T7 thru T3 |
|    |           | rP1 = ( " )(P13⊕(P14Ia))  |                                      |            |
|    |           | sP2 = ( " )(P14⊕Ia)   |                                      |            |
|    |           | rP2 = ( " )(P14⊕Ia)   |                                      |            |
|    |           | rIa = (P12P13P14)Q2F1   |                                      |            |
|    |           | sP(3-14) = P(0-11)Pr3   |                                      |            |
|    |           | rP( " ) = $\overline{\text{P}}$ ( " ) " "                               |                                      |            |
| T4 | Sc        | = T4(End+F1F2) $\overline{\text{Inr}}$                                  | Clear S                              |            |
|    |           | rS(1-14) = Sc   |                                      |            |
| T3 | Sxp       | = T3 $\overline{\text{Int}}$ (End+Ju $\overline{\text{Eax}}$ )GO+T3Kmc  |                                      |            |
|    |           | sS1 = (F1GO(02040506))(P13⊕(P14Ia))Sxp                                  |                                      |            |
|    |           | sS2 = ( " )(P14⊕Ia)Sxp  | P → S                                |            |
|    |           | sS(3-14) = P(0-11)Sxp   |                                      |            |
| Tr | Cxm       | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)                                 | M → C                                | Tr + Tp    |
|    |           | sC(0-23) = M(0-23)Cxm   |                                      |            |
|    |           | rC( " ) = $\overline{\text{M}}$ ( " ) " "                               |                                      |            |
|    |           | rIa = TrF1  |                                      |            |
|    |           | rIx = Tr(F1F3)(GOHt)  |                                      |            |
|    |           | rRc = Tr  |                                      |            |
|    |           | sSk = 050104A00TrSks  | Skip if Sks                          |            |
| Tp | rF1       | = TpEndSk   | 00 next clock (T8) if Sk not set     |            |
|    |           | sF2 = TpSk  | 07 next clock (T8) if Sk set         |            |
|    |           | rF3 = TpEndSk   |                                      |            |
|    |           | rRf = Tp01(GOht)  |                                      |            |
|    |           | rJu = Tp  |                                      |            |
|    |           | Oc = TpEndSk  |                                      |            |
|    |           | rO(1,3,4,5,6) = Oc  | NOP (20) → 0                         |            |
|    |           | sO2 = Oc  |                                      |            |

|    |    |               |  |                               |            |
|----|----|---------------|--|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )      |                               |            |
|    |    | Ck            | = Ø7T8Ts                               |                               |            |
|    |    | End           | = F1F2                                 | Last Cycle                    |            |
|    |    | sIa           | = T8Ø7SkI1Kr                           | Initiate P register increment |            |
| T7 |    | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                         |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{ArAr3}}$   |                               |            |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "         | Recirculate A                 | T7 thru TØ |
|    |    | sA(3-23)      | = A(0-20)Ar3                           |                               |            |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "         |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$  |                               |            |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "         | Recirculate B                 | T7 thru TØ |
|    |    | sB(3-23)      | = B(0-20)Ar3                           |                               |            |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "         |                               |            |
|    |    | Cr3           | = Ø7Ø5( $\overline{\text{TsQ1}}$ )     |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                           | O → C                         |            |
|    |    | rC( " )       | = $\overline{\text{C( " )}}$ "         |                               |            |
|    |    | Pr3           | = (F1GØ)Q2                             |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12Ø(P13P14Ia))   |                               |            |
|    |    | rPØ           | = ( " ) ( " )                          |                               |            |
|    |    | sP1           | = ( " ) (P13Ø(P14Ia))                  | P+1 → P                       | T7 thru T3 |
|    |    | rP1           | = ( " ) ( " )                          |                               |            |
|    |    | sP2           | = ( " ) (P14ØIa)                       |                               |            |
|    |    | rP2           | = ( " ) ( " )                          |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                      |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                           |                               |            |
|    |    | rP( " )       | = $\overline{\text{P( " )}}$ "         |                               |            |
| T4 |    | Sc            | = T4End $\overline{\text{Inr}}$        | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                                   |                               |            |
| T3 |    | Sxp           | = T3 $\overline{\text{IntEndGO}}$      |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13Ø(P14Ia))Sxp     |                               |            |
|    |    | sS2           | = ( " ) (P14ØIa)Sxp                    | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                           |                               |            |
| TØ |    | rSk           | = Ø7TØ                                 | Reset skip                    |            |
| Tr |    | Cxm           | = EndGO $\overline{\text{Tsm(Tr+Tp)}}$ |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                           | M → C                         |            |
|    |    | rC( " )       | = $\overline{\text{M( " )}}$ "         |                               |            |
|    |    | rIa           | = TrF1                                 |                               |            |
|    |    | rIx           | = Tr(F1F3)(GOht)                       |                               |            |
|    |    | rRc           | = Tr                                   |                               |            |
| Tp |    | sCp           | = M24Cxm $\overline{\text{HtTsTp}}$    | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                              | ØØ next clock (T8)            |            |
|    |    | rRf           | = TpØ1(GOht)                           |                               |            |
|    |    | rJu           | = Tp                                   |                               |            |
|    |    | Oc            | = TpEndSk                              |                               |            |
|    |    | rØ(1,3,4,5,6) | = OØ                                   | NØP → Ø                       |            |
|    |    | sØ2           | = OØ                                   |                               |            |

|    |           |                                       |                                      |            |
|----|-----------|---------------------------------------|--------------------------------------|------------|
| 40 | SKS 20004 | Skip of Interrupt Enabled             | Disabled = P+1 → P                   | 1 Cycle    |
|    |           |                                       | Enabled = P+2 → P                    | 2 Cycles   |
| 00 | T8        | rC24 = T8(TsTsr)                      |                                      |            |
|    |           | rCz = 00T8                            |                                      |            |
|    |           | sF1 = (00T8IaC2C5C8(C3+C4))           |                                      |            |
|    |           | sF3 = ( " )                           | 05 next (T7)                         |            |
|    |           | sHz = T8                              |                                      |            |
|    |           | sIa = 00T8IaC2C5C8(C3+C4)             | initiate P register increment        |            |
|    |           | Oxc = (00T8IaGO)C2                    |                                      |            |
|    |           | sO(1,3,4,5,6) = OxcC(3,5,6,7,8)       | C(3-8) → 0 instruction to 0 register |            |
|    |           | rO2 = OxcC4                           |                                      |            |
|    |           | Sks = (C10C11)C21(En+En)              | Interrupts enabled                   |            |
| 05 | T7        | Ar3 = (01020304)Q1                    |                                      |            |
|    |           | sA(0-2) = A(21-23)AnrAr3              |                                      |            |
|    |           | rA( " ) = A( " ) "                    | Recirculate A                        | T7 thru T0 |
|    |           | sA(3-23) = A(0-20)Ar3                 |                                      |            |
|    |           | rA( " ) = A( " ) "                    |                                      |            |
|    |           | sB(0-2) = B(21-23)BnrAr3              |                                      |            |
|    |           | rB( " ) = B( " ) "                    | Recirculate B                        | T7 thru T0 |
|    |           | sB(3-23) = B(0-20)Ar3                 |                                      |            |
|    |           | rB( " ) = B( " ) "                    |                                      |            |
|    |           | End = 05Bc23                          | last cycle                           |            |
|    |           | Pr3 = (F1GO)Q2                        |                                      |            |
|    |           | sP0 = (F1GO(02040506))(P12(P13P14Ia)) |                                      |            |
|    |           | rP0 = ( " ) (P12(P13P14Ia))           |                                      |            |
|    |           | sP1 = ( " ) (P13(P14Ia))              | P+1 → P                              | T7 thru T3 |
|    |           | rP1 = ( " ) (P13(P14Ia))              |                                      |            |
|    |           | sP2 = ( " ) (P14Ia)                   |                                      |            |
|    |           | rP2 = ( " ) (P14Ia)                   |                                      |            |
|    |           | rIa = (P12P13P14)Q2F1                 |                                      |            |
|    |           | sP(3-14) = P(0-11)Pr3                 |                                      |            |
|    |           | rP( " ) = P( " ) "                    |                                      |            |
| T4 | Sc        | = T4(End+F1F2)Inr                     | Clear S                              |            |
|    |           | rS(1-14) = Sc                         |                                      |            |
| T3 | Sxp       | = T3Int(End+JuEax)GO+T3Kmc            |                                      |            |
|    |           | sS1 = (F1GO(02040506))(P13(P14Ia))Sxp |                                      |            |
|    |           | sS2 = ( " ) (P14Ia)Sxp                | P → S                                |            |
|    |           | sS(3-14) = P(0-11)Sxp                 |                                      |            |
| Tr | Cxm       | = EndGOIsm(Tr+Tp)                     | M → C                                | Tr + Tp    |
|    |           | sC(0-23) = M(0-23)Cxm                 |                                      |            |
|    |           | rC( " ) = M( " ) "                    |                                      |            |
|    |           | rIa = TrF1                            |                                      |            |
|    |           | rIx = Tr(F1F3)(GOht)                  |                                      |            |
|    |           | rRc = Tr                              |                                      |            |
|    |           | sSk = 050104A00TrSks                  | Skip if Sks                          |            |
| Tp | rF1       | = TpEndSk                             | 00 next clock (T8) if Sk not set     |            |
|    |           | sF2 = TpSk                            | 07 next clock (T8) if Sk set         |            |
|    |           | rF3 = TpEndSk                         |                                      |            |
|    |           | rRf = Tp01(GOht)                      |                                      |            |
|    |           | rJu = Tp                              |                                      |            |
|    |           | Oc = TpEndSk                          |                                      |            |
|    |           | rO(1,3,4,5,6) = Oc                    | NOP (20) → 0                         |            |
|    |           | sO2 = Oc                              |                                      |            |



|    |     |               |                                      |                               |            |
|----|-----|---------------|--------------------------------------|-------------------------------|------------|
| 07 | T8  | rC24          | = T8(TsTsr)                          |                               |            |
|    |     | Ck            | = 07T8Ts                             |                               |            |
|    |     | End           | = F1F2                               | Last Cycle                    |            |
|    |     | sIa           | = T807Sk(1)Tr                        | Initiate P register increment |            |
| T7 | Ar3 | Ar3           | = (01020304)Q1                       |                               |            |
|    |     | sA(0-2)       | = A(21-23)AnrAr3                     |                               |            |
|    |     | rA( " )       | = A( " ) "                           | Recirculate A                 | T7 thru T0 |
|    |     | sA(3-23)      | = A(0-20)Ar3                         |                               |            |
|    |     | rA( " )       | = A( " ) "                           |                               |            |
|    |     | sB(0-2)       | = B(21-23)BnrAr3                     |                               |            |
|    |     | rB( " )       | = B( " ) "                           | Recirculate B                 | T7 thru T0 |
|    |     | sB(3-23)      | = B(0-20)Ar3                         |                               |            |
|    |     | rB( " )       | = B( " ) "                           |                               |            |
|    |     | Cr3           | = 0705(TsQ1)                         |                               |            |
|    |     | sC(3-23)      | = C(0-20)Cr3                         | O → C                         |            |
|    |     | rC( " )       | = C( " ) "                           |                               |            |
|    |     | Pr3           | = (F1G0)Q2                           |                               |            |
|    |     | sP0           | = ((F1G0)(02040506))(P12⊕(P13P14Ia)) |                               |            |
|    |     | rP0           | = ( " ) ( " )                        |                               |            |
|    |     | sP1           | = ( " ) (P13⊕(P14Ia))                | P+1 → P                       | T7 thru T3 |
|    |     | rP1           | = ( " ) ( " )                        |                               |            |
|    |     | sP2           | = ( " ) (P14⊕Ia)                     |                               |            |
|    |     | rP2           | = ( " ) ( " )                        |                               |            |
|    |     | rIa           | = (P12P13P14)Q2F1                    |                               |            |
|    |     | sP(3-14)      | = P(0-11)Pr3                         |                               |            |
|    |     | rP( " )       | = P( " ) "                           |                               |            |
| T4 | Sc  | Sc            | = T4EndInr                           | Clear S                       |            |
|    |     | rS(1-14)      | = Sc                                 |                               |            |
| T3 | Sxp | Sxp           | = T3IntEndG0                         |                               |            |
|    |     | sS1           | = (F1G0)(02040506)(P13⊕(P14Ia))Sxp   |                               |            |
|    |     | sS2           | = ( " ) (P14⊕Ia)Sxp                  | P → S                         |            |
|    |     | sS(3-14)      | = P(0-11)Sxp                         |                               |            |
| T0 | rSk | rSk           | = 07T0                               | Reset skip                    |            |
| Tr | Cxm | Cxm           | = EndG0Tsm(Tr+Tp)                    |                               |            |
|    |     | sC(0-23)      | = M(0-23)Cxm                         | M → C                         |            |
|    |     | rC( " )       | = M( " ) "                           |                               |            |
|    |     | rIa           | = TrF1                               |                               |            |
|    |     | rIx           | = Tr(F1F3)(G0Ht)                     |                               |            |
|    |     | rRc           | = Tr                                 |                               |            |
| Tp | sCp | sCp           | = M24CxmHtTsTp                       | Initiate parity               |            |
|    |     | rF(1-3)       | = TpEndSk                            | 00 next clock (T8)            |            |
|    |     | rRf           | = Tp01(G0Ht)                         |                               |            |
|    |     | rJu           | = Tp                                 |                               |            |
|    |     | Oc            | = TpEndSk                            |                               |            |
|    |     | rO(1,3,4,5,6) | = Oc                                 | NOP → 0                       |            |
|    |     | sO2           | = Oc                                 |                               |            |

|    |           |                     |                                    |                                      |
|----|-----------|---------------------|------------------------------------|--------------------------------------|
| 40 | SKS 20010 | W Buffer Error Test | Error = P + 1 → P                  | 1 Cycle                              |
|    |           |                     | No Error = P + 2 → P               | 2 Cycles                             |
| 00 | T8        | rC24                | = T8(TaTer)                        |                                      |
|    |           | rCz                 | = 00T8                             |                                      |
|    |           | sF1                 | = (00T8IaC2C5C8(C3+C4))            |                                      |
|    |           | sF3                 | = ( " )                            | 05 next (T7)                         |
|    |           | sHz                 | = T8                               |                                      |
|    |           | sIa                 | = 00T8IaC2C5C8(C3+C4)              | Initiate P register increment        |
|    |           | Oxc                 | = (00T8IaGO)C2                     |                                      |
|    |           | sO(1,3,4,5,6)       | = OxcC(3,5,6,7,8)                  | C(3-8) → 0 instruction to 0 register |
|    |           | rO2                 | = OxcC4                            |                                      |
|    |           | Skr                 | = C10C11c20WeC1                    |                                      |
|    |           | Sks                 | = Skrz                             | No Error Detected                    |
| 05 | T7        | Ar3                 | = (01020304)Q1                     |                                      |
|    |           | sA(0-2)             | = A(21-23)AnrAr3                   |                                      |
|    |           | rA( " )             | = A( " ) "                         | Recirculate A                        |
|    |           | sA(3-23)            | = A(0-20)Ar3                       | T7 thru T0                           |
|    |           | rA( " )             | = A( " ) "                         |                                      |
|    |           | sB(0-2)             | = B(21-23)BnrAr3                   |                                      |
|    |           | rB( " )             | = B( " ) "                         | Recirculate B                        |
|    |           | sB(3-23)            | = B(0-20)Ar3                       | T7 thru T0                           |
|    |           | rB( " )             | = B( " ) "                         |                                      |
|    |           | End                 | = 05Bc23                           | Last cycle                           |
|    |           | Pr3                 | = (F1GO)Q2                         |                                      |
|    |           | sP0                 | = (F1GO(02040506))(P12⊕(P13P14Ia)) |                                      |
|    |           | rP0                 | = ( " ) (P12⊕(P13P14Ia))           |                                      |
|    |           | sP1                 | = ( " ) (P13⊕(P14Ia))              |                                      |
|    |           | rP1                 | = ( " ) (P13⊕(P14Ia))              | P+1 → P                              |
|    |           | sP2                 | = ( " ) (P14Ia)                    | T7 thru T3                           |
|    |           | rP2                 | = ( " ) (P14Ia)                    |                                      |
|    |           | rIa                 | = (P12P13P14)Q2F1                  |                                      |
|    |           | sP(3-14)            | = P(0-11)Pr3                       |                                      |
|    |           | rP( " )             | = P( " ) "                         |                                      |
| T4 | Sc        |                     | = T4(End+P1F2)Inr                  | Clear S                              |
|    |           | rS(1-14)            | = Sc                               |                                      |
| T3 | Sxp       |                     | = T3Int(End+JnLax)GO+T3Inc         |                                      |
|    |           | sS1                 | = (F1GO(02040506))(P13⊕(P14Ia))Sxp |                                      |
|    |           | sS2                 | = ( " ) (P14Ia)Sxp                 | P → S                                |
|    |           | sS(3-14)            | = P(0-11)Sxp                       |                                      |
| Tr | Cxm       |                     | = EndGOTrM(Tr+Tp)                  | M → C                                |
|    |           | sC(0-23)            | = M(0-23)Cxm                       | Tr + Tp                              |
|    |           | rC( " )             | = M( " ) "                         |                                      |
|    |           | rIa                 | = TrF1                             |                                      |
|    |           | rIx                 | = Tr(F1F3)(GOHt)                   |                                      |
|    |           | rIc                 | = Tr                               |                                      |
|    |           | sSk                 | = 050104A00TrSks                   | Skip if Sks                          |
| Tp | rF1       |                     | = TpEndSK                          | 00 next clock (T8) if Sk not set     |
|    |           | sF2                 | = TpSk                             | 07 next clock (T8) if Sk set         |
|    |           | rF3                 | = TpEndSK                          |                                      |
|    |           | rRf                 | = TpPI(GOht)                       |                                      |
|    |           | rJu                 | = Tp                               |                                      |
|    |           | Oc                  | = TpEndSK                          |                                      |
|    |           | rO(1,3,4,5,6)       | = Oc                               | NOP (20) → 0                         |
|    |           | sO2                 | = Oc                               |                                      |

|    |    |               |                                      |                               |            |
|----|----|---------------|--------------------------------------|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8( $\overline{T8Tsr}$ )           |                               |            |
|    |    | Ck            | = Ø7T8Ts                             |                               |            |
|    |    | End           | = F1F2                               | Last cycle                    |            |
|    |    | sIa           | = T8Ø7Sk( $\overline{Kr}$ )          | Initiate P register increment |            |
|    | T7 | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                       |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{Ar}$ Ar3       |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "           | Recirculate A                 | T7 thru TØ |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "           |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{Br}$ Ar3       |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "           | Recirculate B                 | T7 thru TØ |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "           |                               |            |
|    |    | Cr3           | = Ø7Ø5(TsQ1)                         |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                         | Ø → C                         |            |
|    |    | rC( " )       | = $\overline{C}$ ( " ) " "           |                               |            |
|    |    | Pr3           | = (F1GØ)Q2                           |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12Ø(P13P14Ia)) |                               |            |
|    |    | rPØ           | = ( " ) (P12Ø(P13P14Ia))             |                               |            |
|    |    | sP1           | = ( " ) (P13Ø(P14Ia))                | P+1 → P                       | T7 thru T3 |
|    |    | rP1           | = ( " ) (P13Ø(P14Ia))                |                               |            |
|    |    | sP2           | = ( " ) (P14ØIa)                     |                               |            |
|    |    | rP2           | = ( " ) (P14ØIa)                     |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                    |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                         |                               |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) " "           |                               |            |
|    | T4 | Sc            | = T4End $\overline{Inr}$             |                               |            |
|    |    | rS(1-14)      | = Sc                                 | Clear S                       |            |
|    | T3 | Sxp           | = T3 $\overline{InT}$ EndGØ          |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13Ø(P14Ia))Sxp   |                               |            |
|    |    | sS2           | = ( " ) (P14ØIa)Sxp                  | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                         |                               |            |
|    | TØ | rSk           | = Ø7TØ                               | Reset skip                    |            |
|    | Tr | Cxm           | = EndGØTsm(Tr+Tp)                    |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                         | M → C                         |            |
|    |    | rC( " )       | = $\overline{M}$ ( " ) " "           |                               |            |
|    |    | rIa           | = TrF1                               |                               |            |
|    |    | rIx           | = Tr(F1F3)(GØHt)                     |                               |            |
|    |    | rRc           | = Tr                                 |                               |            |
|    | TP | sCp           | = M24CxmHtTsTp                       | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                            | ØØ next clock (T8)            |            |
|    |    | rRf           | = TpØI(GØHt)                         |                               |            |
|    |    | rJu           | = Tp                                 |                               |            |
|    |    | Øc            | = TpEndSk                            |                               |            |
|    |    | rØ(1,3,4,5,6) | = Øc                                 | NØP → Ø                       |            |
|    |    | sØ2           | = Øc                                 |                               |            |

40 SKS 20020 Y Buffer Error Test

Error = P + 1 → P 1 Cycle  
 No Error = P + 2 → P 2 Cycles

|    |     |               |                                   |         |                                      |
|----|-----|---------------|-----------------------------------|---------|--------------------------------------|
| 00 | T8  | rC24          | = T8(TsTsr)                       |         |                                      |
|    |     | rCz           | = 00T8                            |         |                                      |
|    |     | sF1           | = (00T8IaC2C5C8(C3+C4))           |         |                                      |
|    |     | sF3           | = ( " )                           |         | 05 next (T7)                         |
|    |     | sHz           | = T8                              |         |                                      |
|    |     | sIa           | = 00T8IaC2C5C8(C3+C4)             |         | Initiate P register increment        |
|    |     | Oxc           | = (00T8IaGO)C2                    |         |                                      |
|    |     | sO(1,3,4,5,6) | = OxcC(3,5,6,7,8)                 |         | C(3-8) → 0 instruction to 0 register |
|    |     | rO2           | = OxcC4                           |         |                                      |
|    |     | Skr           | = C10C11C19YeC1                   |         |                                      |
|    |     | Sks           | = Skrz                            |         | No error detected                    |
| 05 | T7  | Ar3           | = (01020304)Q1                    |         |                                      |
|    |     | sA(0-2)       | = A(21-23)ArAr3                   |         |                                      |
|    |     | rA( " )       | = A( " ) "                        |         | Recirculate A T7 thru T0             |
|    |     | sA(3-23)      | = A(0-20)Ar3                      |         |                                      |
|    |     | rA( " )       | = A( " ) "                        |         |                                      |
|    |     | sB(0-2)       | = B(21-23)BrAr3                   |         |                                      |
|    |     | rB( " )       | = B( " ) "                        |         | Recirculate B T7 thru T0             |
|    |     | sB(3-23)      | = B(0-20)Ar3                      |         |                                      |
|    |     | rB( " )       | = B( " ) "                        |         |                                      |
|    |     | End           | = 05Bc23                          |         | Last cycle                           |
|    |     | Pr3           | = (F1GO)Q2                        |         |                                      |
|    |     | sP0           | = (F1GO(02040506))(P12(P13P14Ia)) |         |                                      |
|    |     | rP0           | = ( " )(P12(P13P14Ia))            |         |                                      |
|    |     | sP1           | = ( " )(P13(P14Ia))               |         |                                      |
|    |     | rP1           | = ( " )(P13(P14Ia))               | P+1 → P | T7 thru T3                           |
|    |     | sP2           | = ( " )(P14Ia)                    |         |                                      |
|    |     | rP2           | = ( " )(P14Ia)                    |         |                                      |
|    |     | rIa           | = (P12P13P14)Q2F1                 |         |                                      |
|    |     | sP(3-14)      | = P(0-11)Pr3                      |         |                                      |
|    |     | rP( " )       | = P( " ) "                        |         |                                      |
| T4 | Sc  |               | = T4(End+P1F2)Inr                 |         |                                      |
|    |     | rS(1-14)      | = Sc                              |         | Clear S                              |
| T3 | Sxp |               | = T3Int(End+JuEx)GO+T3Inc         |         |                                      |
|    |     | sS1           | = (F1GO(02040506))(P13(P14Ia))Sxp |         |                                      |
|    |     | sS2           | = ( " )(P14Ia)Sxp                 | P → S   |                                      |
|    |     | sS(3-14)      | = P(0-11)Sxp                      |         |                                      |
| Tr | Cxm |               | = EndGOIsm(Tr+Tp)                 |         |                                      |
|    |     | sC(0-23)      | = M(0-23)Cxm                      | M → C   | Tr + Tp                              |
|    |     | rC( " )       | = M( " ) "                        |         |                                      |
|    |     | rIa           | = TrF1                            |         |                                      |
|    |     | rIx           | = Tr(P1F3)(GOHt)                  |         |                                      |
|    |     | rRc           | = Tr                              |         |                                      |
|    |     | sSk           | = 050104A00TrSks                  |         | Skip if Sks                          |
| Tp | rF1 |               | = TpEndSk                         |         |                                      |
|    |     | sF2           | = TpSk                            |         | 00 next clock (T8) if Sk not set     |
|    |     | rF3           | = TpEndSk                         |         | 07 next clock (T8) if Sk set         |
|    |     | rRf           | = TpOI(GOht)                      |         |                                      |
|    |     | rJu           | = Tp                              |         |                                      |
|    |     | Oc            | = TpEndSk                         |         |                                      |
|    |     | rO(1,3,4,5,6) | = Oc                              |         | NOP (20) → 0                         |
|    |     | sO2           | = Oc                              |         |                                      |

|    |     |               |                                      |         |                               |
|----|-----|---------------|--------------------------------------|---------|-------------------------------|
| Ø7 | T8  | rC24          | = T8(TsTr)                           |         |                               |
|    |     | Ck            | = Ø7T8Ts                             |         |                               |
|    |     | End           | = F1F2                               |         | Last cycle                    |
|    |     | s1a           | = T8Ø7SkTr                           |         | Initiate P register increment |
| T7 | Ar3 |               | = (Ø1Ø2Ø3Ø4)Q1                       |         |                               |
|    |     | sA(0-2)       | = A(21-23)Ar3                        |         |                               |
|    |     | rA( " )       | = A( " ) "                           |         | Recirculate A                 |
|    |     | sA(3-23)      | = A(0-20)Ar3                         |         | T7 thru TØ                    |
|    |     | rA( " )       | = A( " ) "                           |         |                               |
|    |     | sB(0-2)       | = B(21-23)Ar3                        |         |                               |
|    |     | rB( " )       | = B( " ) "                           |         | Recirculate B                 |
|    |     | sB(3-23)      | = B(0-20)Ar3                         |         | T7 thru TØ                    |
|    |     | rB( " )       | = B( " ) "                           |         |                               |
|    |     | Cr3           | = Ø7Ø5(TsQ1)                         |         |                               |
|    |     | sC(3-23)      | = C(0-20)Cr3                         |         | O → C                         |
|    |     | rC( " )       | = C( " ) "                           |         |                               |
|    |     | Pr3           | = (F1GØ)Q2                           |         |                               |
|    |     | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12⊕(P13P14Ia)) |         |                               |
|    |     | rPØ           | = ( " ) (P12⊕(P13P14Ia))             |         |                               |
|    |     | sP1           | = ( " ) (P13⊕(P14Ia))                |         |                               |
|    |     | rP1           | = ( " ) (P13⊕(P14Ia))                | P+1 → P | T7 thru T3                    |
|    |     | sP2           | = ( " ) (P14⊕Ia)                     |         |                               |
|    |     | rP2           | = ( " ) (P14⊕Ia)                     |         |                               |
|    |     | rIa           | = (P12P13P14)Q2F1                    |         |                               |
|    |     | sP(3-14)      | = P(0-11)Pr3                         |         |                               |
|    |     | rP( " )       | = P( " ) "                           |         |                               |
| T4 | Sc  |               | = T4EndInr                           |         |                               |
|    |     | rS(1-14)      | = Sc                                 |         | Clear S                       |
| T3 | Sxp |               | = T3IntEndGØ                         |         |                               |
|    |     | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13⊕(P14Ia))Sxp   |         |                               |
|    |     | sS2           | = ( " ) (P14⊕Ia)Sxp                  | P → S   |                               |
|    |     | sS(3-14)      | = P(0-11)Sxp                         |         |                               |
| TØ | rSk |               | = Ø7TØ                               |         | Reset skip                    |
| Tr | Cxm |               | = EndGØTsm(Tr+Tp)                    |         |                               |
|    |     | sC(0-23)      | = M(0-23)Cxm                         |         | M → C                         |
|    |     | rC( " )       | = M( " ) "                           |         |                               |
|    |     | rIa           | = TrF1                               |         |                               |
|    |     | rIx           | = Tr(F1F3)(GØHt)                     |         |                               |
|    |     | rRc           | = Tr                                 |         |                               |
| Tp | sCp |               | = M24CxmHtTsTp                       |         | Initiate parity               |
|    |     | rF(1-3)       | = TpEndSk                            |         | ØØ next clock (T8)            |
|    |     | rRf           | = TpØ1(GØHt)                         |         |                               |
|    |     | rJu           | = Tp                                 |         |                               |
|    |     | Oc            | = TpEndSk                            |         |                               |
|    |     | rØ(1,3,4,5,6) | = Oc                                 |         | NØP → Ø                       |
|    |     | sØ2           | = Oc                                 |         |                               |

|    |           |  |                                      |            |
|----|-----------|--|--------------------------------------|------------|
| 40 | SKS 20040 | Skip if Break Point 4 not set          | BP4 set = P+1 → P                    | 1 Cycle    |
|    |           |  | BP4 reset = P+2 → P                  | 2 Cycles   |
| 00 | T8        | rC24 = T8(TsTsr)                       |                                      |            |
|    |           | rCz = 0T8                              |                                      |            |
|    |           | sF1 = (00T8IaC2C5C8(C3+C4))            | 05 next (T7)                         |            |
|    |           | sF3 = ( " )                            |                                      |            |
|    |           | sHz = T8                               |                                      |            |
|    |           | sIa = 00T8IaC2C5C8(C3+C4)              | initiate P register increment        |            |
|    |           | Oxc = (00T8IaGO)C2                     |                                      |            |
|    |           | sO(1,3,4,5,6) = OxCC(3,5,6,7,8)        | C(3-8) → 0 instruction to 0 register |            |
|    |           | rO2 = OxCC4                            |                                      |            |
| 05 | T7        | Sks = (C10C11)C18(C14)                 | Break Point 4                        |            |
|    |           | Ar3 = (01020304)Q1                     |                                      |            |
|    |           | sA(0-2) = A(21-23)AnrAr3               |                                      |            |
|    |           | rA( " ) = A( " ) "                     | Recirculate A                        | T7 thru T0 |
|    |           | sA(3-23) = A(0-20)Ar3                  |                                      |            |
|    |           | rA( " ) = A( " ) "                     |                                      |            |
|    |           | sB(0-2) = B(21-23)BnrAr3               |                                      |            |
|    |           | rB( " ) = B( " ) "                     | Recirculate B                        | T7 thru T0 |
|    |           | sB(3-23) = B(0-20)Ar3                  |                                      |            |
|    |           | rB( " ) = B( " ) "                     |                                      |            |
|    |           | End = 05Bc23                           | last cycle                           |            |
|    |           | Pr3 = (F1GO)Q2                         |                                      |            |
|    |           | sP0 = (F1GO(02040506)) (P12(P13P14Ia)) |                                      |            |
|    |           | rP0 = ( " ) (P12(P13P14Ia))            |                                      |            |
|    |           | sP1 = ( " ) (P13(P14Ia))               | P+1 → P                              | T7 thru T3 |
|    |           | rP1 = ( " ) (P13(P14Ia))               |                                      |            |
|    |           | sP2 = ( " ) (P14Ia)                    |                                      |            |
|    |           | rP2 = ( " ) (P14Ia)                    |                                      |            |
|    |           | rIa = (P12P13P14)Q2F1                  |                                      |            |
|    |           | sP(3-14) = P(0-11)Pr3                  |                                      |            |
|    |           | rP( " ) = P( " ) "                     |                                      |            |
| T4 | Sc        | = T4(End+F1F2)Inr                      | Clear S                              |            |
|    |           | rS(1-14) = Sc                          |                                      |            |
| T3 | Sxp       | = T3Int(End+JuEax)GO+T3(Ind)           |                                      |            |
|    |           | sS1 = (F1GO(02040506)) (P13(P14Ia))Sxp |                                      |            |
|    |           | sS2 = ( " ) (P14Ia)Sxp                 | P → S                                |            |
|    |           | sS(3-14) = P(0-11)Sxp                  |                                      |            |
| Tr | Cxm       | = EndGOTsm(Tr+Tp)                      |                                      |            |
|    |           | sC(0-23) = M(0-23)Cxm                  | M → C                                | Tr + Tp    |
|    |           | rC( " ) = M( " ) "                     |                                      |            |
|    |           | rIa = TrF1                             |                                      |            |
|    |           | rIx = Tr(F1F3)(GOHt)                   |                                      |            |
|    |           | rRc = Tr                               |                                      |            |
|    |           | sSk = 050104A00TrSks                   | Skip if Sks                          |            |
| TP | rF1       | = TpEndSk                              | 00 next clock (T8) if Sk not set     |            |
|    |           | sF2 = TpSk                             | 07 next clock (T8) if Sk set         |            |
|    |           | rF3 = TpEndSk                          |                                      |            |
|    |           | rRf = Tp01(GOht)                       |                                      |            |
|    |           | rJu = Tp                               |                                      |            |
|    |           | Oc = TpEndSk                           |                                      |            |
|    |           | rO(1,3,4,5,6) = Oc                     | NOP (20) → 0                         |            |
|    |           | sO2 = Oc                               |                                      |            |

|    |    |               |                                      |                               |            |
|----|----|---------------|--------------------------------------|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8(TsTsr)                          |                               |            |
|    |    | Ck            | = Ø7T8Ts                             |                               |            |
|    |    | End           | = F1F2                               | Last Cycle                    |            |
|    |    | sIa           | = T8Ø7SkI1Kr                         | Initiate P register increment |            |
|    | T7 | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                       |                               |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                     |                               |            |
|    |    | rA( " )       | = A( " ) " "                         | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |                               |            |
|    |    | rA( " )       | = A( " ) " "                         |                               |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                     |                               |            |
|    |    | rB( " )       | = B( " ) " "                         | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |                               |            |
|    |    | rB( " )       | = B( " ) " "                         |                               |            |
|    |    | Cr3           | = Ø7Ø5(TsQ1)                         |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                         | O → C                         |            |
|    |    | rC( " )       | = C( " ) " "                         |                               |            |
|    |    | Pr3           | = (F1GØ)Q2                           |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12⊕(P13P14Ia)) |                               |            |
|    |    | rPØ           | = ( " ) ( " )                        |                               |            |
|    |    | sP1           | = ( " ) (P13⊕(P14Ia))                | P+1 → P                       | T7 thru T3 |
|    |    | rP1           | = ( " ) ( " )                        |                               |            |
|    |    | sP2           | = ( " ) (P14⊕Ia)                     |                               |            |
|    |    | rP2           | = ( " ) ( " )                        |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                    |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                         |                               |            |
|    |    | rP( " )       | = P( " ) " "                         |                               |            |
|    | T4 | Sc            | = T4EndInr                           | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                                 |                               |            |
|    | T3 | Sxp           | = T3IntEndGO                         |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13⊕(P14Ia))Sxp   |                               |            |
|    |    | sS2           | = ( " ) (P14⊕Ia)Sxp                  | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                         |                               |            |
|    | TØ | rSk           | = Ø7TØ                               | Reset skip                    |            |
|    | Tr | Cxm           | = EndGOIsm(Tr+Tp)                    |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                         | M → C                         |            |
|    |    | rC( " )       | = M( " ) " "                         |                               |            |
|    |    | rIa           | = TrF1                               |                               |            |
|    |    | rIx           | = Tr(F1F3)(GOht)                     |                               |            |
|    |    | rRc           | = Tr                                 |                               |            |
|    | Tp | sCp           | = M24CxmHtTsTp                       | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                            | ØØ next clock (T8)            |            |
|    |    | rRf           | = TpØ1(GOht)                         |                               |            |
|    |    | rJu           | = Tp                                 |                               |            |
|    |    | Oc            | = TpEndSk                            |                               |            |
|    |    | rØ(1,3,4,5,6) | = OØ                                 | NØP → Ø                       |            |
|    |    | sØ2           | = OØ                                 |                               |            |

|    |     |               |                                    |                                      |            |
|----|-----|---------------|------------------------------------|--------------------------------------|------------|
| 40 | SKS | 20100         | Skip if Break Point 3 not set      | BP3 set = P+1 → P                    | 1 Cycle    |
|    |     |               |                                    | BP3 reset = P+2 → P                  | 2 Cycles   |
| 00 | T8  | rC24          | = T8(TsTsr)                        |                                      |            |
|    |     | rCz           | = 00T8                             |                                      |            |
|    |     | sF1           | = (00T8IaC2C5C8(C3+C4))            | 05 next (T7)                         |            |
|    |     | sF3           | = ( " )                            |                                      |            |
|    |     | sHz           | = T8                               |                                      |            |
|    |     | sIa           | = 00T8IaC2C5C8(C3+C4)              | initiate P register increment        |            |
|    |     | Oxc           | = (00T8IaGO)C2                     | C(3-8) → 0 instruction to 0 register |            |
|    |     | sO(1,3,4,5,6) | = OxCC(3,5,6,7,8)                  |                                      |            |
|    |     | rO2           | = OxCC4                            |                                      |            |
| 05 | T7  | Sks           | = (C10C11)C17(Kb)3                 | Break Point 3                        |            |
|    |     | Ar3           | = (01020304)Q1                     |                                      |            |
|    |     | sA(0-2)       | = A(21-23)AnrAr3                   |                                      |            |
|    |     | rA( " )       | = A( " ) " "                       | Recirculate A                        | T7 thru T0 |
|    |     | sA(3-23)      | = A(0-20)Ar3                       |                                      |            |
|    |     | rA( " )       | = A( " ) " "                       |                                      |            |
|    |     | sB(0-2)       | = B(21-23)BnrAr3                   |                                      |            |
|    |     | rB( " )       | = B( " ) " "                       | Recirculate B                        | T7 thru T0 |
|    |     | sB(3-23)      | = B(0-20)Ar3                       |                                      |            |
|    |     | rB( " )       | = B( " ) " "                       |                                      |            |
|    |     | End           | = 05Bc23                           | last cycle                           |            |
|    |     | Pr3           | = (F1GO)Q2                         |                                      |            |
|    |     | sP0           | = (F1GO(02040506)) (P12(P13P14Ia)) |                                      |            |
|    |     | rP0           | = ( " ) (P12(P13P14Ia))            |                                      |            |
|    |     | sP1           | = ( " ) (P13(P14Ia))               | P+1 → P                              | T7 thru T3 |
|    |     | rP1           | = ( " ) (P13(P14Ia))               |                                      |            |
|    |     | sP2           | = ( " ) (P14(Ia))                  |                                      |            |
|    |     | rP2           | = ( " ) (P14(Ia))                  |                                      |            |
|    |     | rIa           | = (P12P13P14)Q2F1                  |                                      |            |
|    |     | sP(3-14)      | = P(0-11)Pr3                       |                                      |            |
|    |     | rP( " )       | = P( " ) " "                       |                                      |            |
| T4 | Sc  |               | = T4(End+F1F2)Inr                  | Clear S                              |            |
|    |     | rS(1-14)      | = Sc                               |                                      |            |
| T3 | Sxp |               | = T3Int(End+JuEax)GO+T3(Knc)       |                                      |            |
|    |     | sS1           | = (F1GO(02040506)) (P13(P14Ia))Sxp |                                      |            |
|    |     | sS2           | = ( " ) (P14(Ia))Sxp               | P → S                                |            |
|    |     | sS(3-14)      | = P(0-11)Sxp                       |                                      |            |
| Tr | Cxm |               | = EndGOIsm(Tr+Tp)                  | M → C                                | Tr + Tp    |
|    |     | sC(0-23)      | = M(0-23)Cxm                       |                                      |            |
|    |     | rC( " )       | = M( " ) " "                       |                                      |            |
|    |     | rIa           | = TrF1                             |                                      |            |
|    |     | rIx           | = Tr(F1F3)(GOht)                   |                                      |            |
|    |     | rRc           | = Tr                               |                                      |            |
|    |     | sSk           | = 050104A00TrSks                   | Skip if Sks                          |            |
| Tp | rF1 |               | = TpEndSk                          | 00 next clock (T8) if Sk not set     |            |
|    |     | sF2           | = TpSk                             | 07 next clock (T8) if Sk set         |            |
|    |     | rF3           | = TpEndSk                          |                                      |            |
|    |     | rRf           | = Tp01(GOht)                       |                                      |            |
|    |     | rJu           | = Tp                               |                                      |            |
|    |     | Oc            | = TpEndSk                          |                                      |            |
|    |     | rO(1,3,4,5,6) | = Oc                               | NOP (20) → 0                         |            |
|    |     | sO2           | = Oc                               |                                      |            |



|    |    |               |                                      |                               |            |
|----|----|---------------|--------------------------------------|-------------------------------|------------|
| 07 | T8 | rC24          | = T8(TsTsr)                          |                               |            |
|    |    | Ck            | = 07T8Ts                             |                               |            |
|    |    | End           | = F1F2                               | Last Cycle                    |            |
|    |    | s1a           | = T807Sk1Kr                          | Initiate P register increment |            |
|    | T7 | Ar3           | = (01020304)Q1                       |                               |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                     |                               |            |
|    |    | rA( " )       | = A( " ) " "                         | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |                               |            |
|    |    | rA( " )       | = A( " ) " "                         |                               |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                     |                               |            |
|    |    | rB( " )       | = B( " ) " "                         | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |                               |            |
|    |    | rB( " )       | = B( " ) " "                         |                               |            |
|    |    | Cr3           | = 0705(TsQ1)                         |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                         | 0 → C                         |            |
|    |    | rC( " )       | = C( " ) " "                         |                               |            |
|    |    | Pr3           | = (F1G0)Q2                           |                               |            |
|    |    | sP0           | = ((F1G0)(02040506))(P12⊕(P13P14Ia)) |                               |            |
|    |    | rP0           | = ( " ) ( " )                        |                               |            |
|    |    | sP1           | = ( " ) (P13⊕(P14Ia))                | P+1 → P                       | T7 thru T3 |
|    |    | rP1           | = ( " ) ( " )                        |                               |            |
|    |    | sP2           | = ( " ) (P14⊕Ia)                     |                               |            |
|    |    | rP2           | = ( " ) ( " )                        |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                    |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                         |                               |            |
|    |    | rP( " )       | = P( " ) " "                         |                               |            |
|    | T4 | Sc            | = T4EndInr                           | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                                 |                               |            |
|    | T3 | Sxp           | = T3IntEndG0                         |                               |            |
|    |    | sS1           | = (F1G0)(02040506)(P13⊕(P14Ia))Sxp   |                               |            |
|    |    | sS2           | = ( " ) (P14⊕Ia)Sxp                  | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                         |                               |            |
|    | T0 | rSk           | = 07T0                               | Reset skip                    |            |
|    | Tr | Cxm           | = EndG0Tsm(Tr+Tp)                    |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                         | M → C                         |            |
|    |    | rC( " )       | = M( " ) " "                         |                               |            |
|    |    | rIa           | = TrF1                               |                               |            |
|    |    | rIx           | = Tr(F1F3)(GOht)                     |                               |            |
|    |    | rRc           | = Tr                                 |                               |            |
|    | TP | sCp           | = M24CxmHtTsTp                       | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                            |                               |            |
|    |    | rRf           | = Tp01(GOht)                         | 00 next clock (T8)            |            |
|    |    | rJu           | = Tp                                 |                               |            |
|    |    | Oc            | = TpEndSk                            |                               |            |
|    |    | rO(1,3,4,5,6) | = Oc                                 | NOP → 0                       |            |
|    |    | sO2           | = Oc                                 |                               |            |

|    |           |                                       |                                      |            |
|----|-----------|---------------------------------------|--------------------------------------|------------|
| 40 | SKS 20200 | Skip if Break Point 2 not set         | BP2 set = P+1 → P                    | 1 Cycle    |
|    |           |                                       | BP2 reset = P+2 → P                  | 2 Cycles   |
| 00 | T8        | rC24 = T8(TsTsr)                      |                                      |            |
|    |           | rCz = 00T8                            |                                      |            |
|    |           | sF1 = (00T8IaC2C5C8(C3+C4))           | 05 next (T7)                         |            |
|    |           | sF3 = ( " )                           |                                      |            |
|    |           | sHz = T8                              |                                      |            |
|    |           | sIa = 00T8IaC2C5C8(C3+C4)             | initiate P register increment        |            |
|    |           | Oxc = (00T8IaG0)C2                    |                                      |            |
|    |           | sO(1,3,4,5,6) = OxcC(3,5,6,7,8)       | Q(3-8) → 0 instruction to 0 register |            |
|    |           | rO2 = OxcC4                           |                                      |            |
| 05 | T7        | Sks = (C10C11)C16(KB)2                | Break Point 2                        |            |
|    |           | Ar3 = (01020304)Q1                    |                                      |            |
|    |           | sA(0-2) = A(21-23)AnrAr3              |                                      |            |
|    |           | rA( " ) = A( " ) "                    | Recirculate A                        | T7 thru T0 |
|    |           | sA(3-23) = A(0-20)Ar3                 |                                      |            |
|    |           | rA( " ) = A( " ) "                    |                                      |            |
|    |           | sB(0-2) = B(21-23)BnrAr3              |                                      |            |
|    |           | rB( " ) = B( " ) "                    | Recirculate B                        | T7 thru T0 |
|    |           | sB(3-23) = B(0-20)Ar3                 |                                      |            |
|    |           | rB( " ) = B( " ) "                    |                                      |            |
|    |           | End = 05Bc23                          | last cycle                           |            |
|    |           | Pr3 = (F1G0)Q2                        |                                      |            |
|    |           | sP0 = (F1G0(02040506))(P12(P13P14Ia)) |                                      |            |
|    |           | rP0 = ( " )(P12(P13P14Ia))            |                                      |            |
|    |           | sP1 = ( " )(P13(P14Ia))               | P+1 → P                              | T7 thru T3 |
|    |           | rP1 = ( " )(P13(P14Ia))               |                                      |            |
|    |           | sP2 = ( " )(P14Ia)                    |                                      |            |
|    |           | rP2 = ( " )(P14Ia)                    |                                      |            |
|    |           | rIa = (P12P13P14)Q2F1                 |                                      |            |
|    |           | sP(3-14) = P(0-11)Pr3                 |                                      |            |
|    |           | rP( " ) = P( " ) "                    |                                      |            |
| T4 | Sc        | = T4(End+F1F2)Inr                     | Clear S                              |            |
|    |           | rS(1-14) = Sc                         |                                      |            |
| T3 | Sxp       | = T3Int(End+JuEax)GO+T3(Knc)          |                                      |            |
|    |           | sS1 = (F1G0(02040506))(P13(P14Ia))Sxp |                                      |            |
|    |           | sS2 = ( " )(P14Ia)Sxp                 | P → S                                |            |
|    |           | sS(3-14) = P(0-11)Sxp                 |                                      |            |
| Tr | Cxm       | = EndGOIsm(Tr+Tp)                     | M → C                                | Tr + Tp    |
|    |           | sC(0-23) = M(0-23)Cxm                 |                                      |            |
|    |           | rC( " ) = M( " ) "                    |                                      |            |
|    |           | rIa = TrF1                            |                                      |            |
|    |           | rIx = Tr(F1F3)(GOht)                  |                                      |            |
|    |           | rRc = Tr                              |                                      |            |
|    |           | sSk = 050104A00TrSks                  | Skip if Sks                          |            |
| Tp | rF1       | = TpEndSk                             | 00 next clock (T8) if Sk not set     |            |
|    |           | sF2 = TpSk                            | 07 next clock (T8) if Sk set         |            |
|    |           | rF3 = TpEndSk                         |                                      |            |
|    |           | rRf = Tp01(GOht)                      |                                      |            |
|    |           | rJu = Tp                              |                                      |            |
|    |           | Oc = TpEndSk                          |                                      |            |
|    |           | rO(1,3,4,5,6) = Oc                    | NOP (20) → 0                         |            |
|    |           | sO2 = Oc                              |                                      |            |

|    |    |               |                                      |                               |            |
|----|----|---------------|--------------------------------------|-------------------------------|------------|
| 07 | T8 | rC24          | = T8(TsTr)                           |                               |            |
|    |    | Ck            | = 07T8Ts                             |                               |            |
|    |    | End           | = FlF2                               | Last Cycle                    |            |
|    |    | sIa           | = T807Sk1Tr                          | Initiate P register increment |            |
| T7 |    | Ar3           | = (01020304)Q1                       |                               |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                     |                               |            |
|    |    | rA( " )       | = A( " ) " "                         | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |                               |            |
|    |    | rA( " )       | = A( " ) " "                         |                               |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                     |                               |            |
|    |    | rB( " )       | = B( " ) " "                         | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |                               |            |
|    |    | rB( " )       | = B( " ) " "                         |                               |            |
|    |    | Cr3           | = 0705(TsQ1)                         |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                         | O → C                         |            |
|    |    | rC( " )       | = C( " ) " "                         |                               |            |
|    |    | Pr3           | = (FlGO)Q2                           |                               |            |
|    |    | sP0           | = ((FlGO)(02040506))(P12⊕(P13P14Ia)) |                               |            |
|    |    | rP0           | = ( " ) ( " )                        |                               |            |
|    |    | sP1           | = ( " ) (P13⊕(P14Ia))                | P+1 → P                       |            |
|    |    | rP1           | = ( " ) ( " )                        |                               | T7 thru T3 |
|    |    | sP2           | = ( " ) (P14⊕Ia)                     |                               |            |
|    |    | rP2           | = ( " ) ( " )                        |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                    |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                         |                               |            |
|    |    | rP( " )       | = P( " ) " "                         |                               |            |
| T4 |    | Sc            | = T4EndInr                           | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                                 |                               |            |
| T3 |    | Sxp           | = T3IntEndGO                         |                               |            |
|    |    | sS1           | = (FlGO)(02040506)(P13⊕(P14Ia))Sxp   |                               |            |
|    |    | sS2           | = ( " ) (P14⊕Ia)Sxp                  | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                         |                               |            |
| T0 |    | rSk           | = 07T0                               | Reset skip                    |            |
| Tr |    | Cxm           | = EndGOtSm(Tr+Tp)                    |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                         | M → C                         |            |
|    |    | rC( " )       | = M( " ) " "                         |                               |            |
|    |    | rIa           | = TrFl                               |                               |            |
|    |    | rIx           | = Tr(FlF3)(GOHt)                     |                               |            |
|    |    | rRc           | = Tr                                 |                               |            |
| Tp |    | sCp           | = M24CxmHtTsTp                       | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                            | 00 next clock (T8)            |            |
|    |    | rRf           | = Tp01(GOht)                         |                               |            |
|    |    | rJu           | = Tp                                 |                               |            |
|    |    | Oc            | = TpEndSk                            |                               |            |
|    |    | rO(1,3,4,5,6) | = Oc                                 | NOP → O                       |            |
|    |    | sO2           | = Oc                                 |                               |            |

|    |           |   |                                      |            |
|----|-----------|---|--------------------------------------|------------|
| 40 | SKS 20400 | Skip if Break Point 1 not set   | BPl set = P+1 → P                    | 1 Cycle    |
|    |           |   | BPl reset = P+2 → P                  | 2 Cycles   |
| 00 | T8        | rC24 = T8( $\overline{\text{TsTsr}}$ )                                  |                                      |            |
|    |           | rCz = 00T8  |                                      |            |
|    |           | sF1 = (00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )) | 05 next (T7)                         |            |
|    |           | sF3 = ( " )   |                                      |            |
|    |           | sHz = T8  |                                      |            |
|    |           | sIa = 00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )   | initiate P register increment        |            |
|    |           | Oxc = (00T8 $\overline{\text{IaGO}}$ ) $\overline{\text{C2}}$           |                                      |            |
|    |           | sO(1,3,4,5,6) = OxcC(3,5,6,7,8)   | C(3-8) → 0 instruction to 0 register |            |
|    |           | rO2 = OxcC4   |                                      |            |
|    |           | Sks = (C10C11)C15 $\overline{\text{Cb1}}$                               | Break Point 1                        |            |
| 05 | T7        | Ar3 = (01020304)Q1  |                                      |            |
|    |           | sA(0-2) = A(21-23) $\overline{\text{AnrAr3}}$                           |                                      |            |
|    |           | rA( " ) = $\overline{\text{A}}$ ( " ) " "                               | Recirculate A                        | T7 thru T0 |
|    |           | sA(3-23) = A(0-20)Ar3   |                                      |            |
|    |           | rA( " ) = $\overline{\text{A}}$ ( " ) " "                               |                                      |            |
|    |           | sB(0-2) = B(21-23) $\overline{\text{BnrAr3}}$                           |                                      |            |
|    |           | rB( " ) = $\overline{\text{B}}$ ( " ) " "                               | Recirculate B                        | T7 thru T0 |
|    |           | sB(3-23) = B(0-20)Ar3   |                                      |            |
|    |           | rB( " ) = $\overline{\text{B}}$ ( " ) " "                               |                                      |            |
|    |           | End = 05Bc23  | last cycle                           |            |
|    |           | Pr3 = (F1GO)Q2  |                                      |            |
|    |           | sP0 = (F1GO(02040506))(P12 $\oplus$ (P13P14Ia))                         |                                      |            |
|    |           | rP0 = ( " ) (P12 $\oplus$ (P13P14Ia))                                   |                                      |            |
|    |           | sP1 = ( " ) (P13 $\oplus$ (P14Ia))                                      | P+1 → P                              | T7 thru T3 |
|    |           | rP1 = ( " ) (P13 $\oplus$ (P14Ia))                                      |                                      |            |
|    |           | sP2 = ( " ) (P14 $\oplus$ Ia)   |                                      |            |
|    |           | rP2 = ( " ) (P14 $\oplus$ Ia)   |                                      |            |
|    |           | rIa = (P12P13P14)Q2F1   |                                      |            |
|    |           | sP(3-14) = P(0-11)Pr3   |                                      |            |
|    |           | rP( " ) = $\overline{\text{P}}$ ( " ) " "                               |                                      |            |
| T4 | Sc        | = T4(End+F1F2) $\overline{\text{Inr}}$                                  | Clear S                              |            |
|    |           | rS(1-14) = Sc   |                                      |            |
| T3 | Sxp       | = T3 $\overline{\text{Int}}$ (End+JuEax)GO+T3 $\overline{\text{Inc}}$   |                                      |            |
|    |           | sS1 = (F1GO(02040506))(P13 $\oplus$ (P14Ia))Sxp                         | P → S                                |            |
|    |           | sS2 = ( " ) (P14 $\oplus$ Ia)Sxp  |                                      |            |
|    |           | sS(3-14) = P(0-11)Sxp   |                                      |            |
| Tr | Cxm       | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)                                 | M → C                                | Tr + Tp    |
|    |           | sC(0-23) = M(0-23)Cxm   |                                      |            |
|    |           | rC( " ) = $\overline{\text{M}}$ ( " ) " "                               |                                      |            |
|    |           | rIa = TrF1  |                                      |            |
|    |           | rIx = Tr(F1F3)(GOHt)  |                                      |            |
|    |           | rRc = Tr  |                                      |            |
|    |           | sSk = 050104A00TrSks  | Skip if Sks                          |            |
| TP | rF1       | = TpEnd $\overline{\text{Sk}}$  | 00 next clock (T8) if Sk not set     |            |
|    |           | sF2 = TpSk  | 07 next clock (T8) if Sk set         |            |
|    |           | rF3 = TpEnd $\overline{\text{Sk}}$                                      |                                      |            |
|    |           | rRf = Tp01(GOht)  |                                      |            |
|    |           | rJu = Tp  |                                      |            |
|    |           | Oc = TpEnd $\overline{\text{Sk}}$                                       |                                      |            |
|    |           | rO(1,3,4,5,6) = Oc  | NOP (20) → 0                         |            |
|    |           | sO2 = Oc  |                                      |            |

|    |    |               |   |                               |            |
|----|----|---------------|---|-------------------------------|------------|
| 07 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                             |                               |            |
|    |    | Ck            | = 07T8 $\overline{\text{Ts}}$                                 |                               |            |
|    |    | Ernd          | = F1F2  | Last Cycle                    |            |
|    |    | sIa           | = T807Sk( $\overline{\text{I} \oplus \text{r}}$ )             | Initiate P register increment |            |
| T7 |    | Ar3           | = (01020304)Q1  |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                         |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "                             | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3  |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "                             |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                         |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "                             | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3  |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "                             |                               |            |
|    |    | Cr3           | = 0705( $\overline{\text{TsQ1}}$ )                            |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3  | O → C                         |            |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) " "                             |                               |            |
|    |    | Pr3           | = (F1G0)Q2  |                               |            |
|    |    | sP0           | = ((F1G0)(02040506))( $\text{P12} \oplus (\text{P13P14Ia})$ ) |                               |            |
|    |    | rP0           | = ( " ) ( " )   |                               |            |
|    |    | sP1           | = ( " ) ( $\text{P13} \oplus (\text{P14Ia})$ )                | P+1 → P                       | T7 thru T3 |
|    |    | rP1           | = ( " ) ( " )   |                               |            |
|    |    | sP2           | = ( " ) ( $\text{P14} \oplus \text{Ia}$ )                     |                               |            |
|    |    | rP2           | = ( " ) ( " )   |                               |            |
|    |    | rIa           | = ( $\text{P12P13P14}$ )Q2F1                                  |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3  |                               |            |
|    |    | rP( " )       | = $\overline{\text{P}}$ ( " ) " "                             |                               |            |
| T4 |    | Sc            | = T4EndInr  | Clear S                       |            |
|    |    | rS(1-14)      | = Sc  |                               |            |
| T3 |    | Sxp           | = T3IntEndGO  |                               |            |
|    |    | sS1           | = (F1G0)(02040506)( $\text{P13} \oplus (\text{P14Ia})$ )Sxp   |                               |            |
|    |    | sS2           | = ( " ) ( $\text{P14} \oplus \text{Ia}$ )Sxp                  | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp  |                               |            |
| T0 |    | rSk           | = 07T0  | Reset skip                    |            |
| Tr |    | Cxm           | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)                       |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm  | M → C                         |            |
|    |    | rC( " )       | = $\overline{\text{M}}$ ( " ) " "                             |                               |            |
|    |    | rIa           | = TrF1  |                               |            |
|    |    | rIx           | = Tr(F1F3)(GOht)  |                               |            |
|    |    | rRc           | = Tr  |                               |            |
| Tp |    | sCp           | = M24Cxm $\overline{\text{HtTs}}$ Tp                          | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk   | 00 next clock (T8)            |            |
|    |    | rRf           | = Tp01(GOht)  |                               |            |
|    |    | rJu           | = Tp  |                               |            |
|    |    | Oc            | = TpEndSk   |                               |            |
|    |    | rO(1,3,4,5,6) | = Oc  | NOP → 0                       |            |
|    |    | sO2           | = Oc  |                               |            |

|    |           |   |                                      |            |
|----|-----------|---|--------------------------------------|------------|
| 40 | SKS 21000 | Skip if W Buffer Ready                  | Not Ready = P + 1 → P                | 1 Cycle    |
|    |           |   | Ready = P + 2 → P                    | 2 Cycles   |
| 00 | T8        | rC24 = T8( $\overline{\text{TsTsr}}$ )  |                                      |            |
|    |           | rCz = 00T8                              |                                      |            |
|    |           | sF1 = (00T8IaC2C5C8(C3+C4))             |                                      |            |
|    |           | sF3 = ( " )                             | 05 next (T7)                         |            |
|    |           | sHz = T8                                |                                      |            |
|    |           | sIa = 00T8IaC2C5C8(C3+C4)               | Initiate P register increment        |            |
|    |           | Oxc = (00T8IaGO)C2                      |                                      |            |
|    |           | sO(1,3,4,5,6) = OxCC(3,5,6,7,8)         | C(3-8) → 0 instruction to 0 register |            |
|    |           | rO2 = OxCC4                             |                                      |            |
|    |           | Skr = C10C11C14W10W11W12W13W14C1        |                                      |            |
|    |           | Sks = Skrz                              | Buffer ready (disconnected)          |            |
| 05 | T7        | Ar3 = (01020304)Q1                      |                                      |            |
|    |           | sA(0-2) = A(21-23)AnrAr3                |                                      |            |
|    |           | rA( " ) = A( " ) "                      | Recirculate A                        | T7 thru T0 |
|    |           | sA(3-23) = A(0-20)Ar3                   |                                      |            |
|    |           | rA( " ) = A( " ) "                      |                                      |            |
|    |           | sB(0-2) = B(21-23)BnrAr3                |                                      |            |
|    |           | rB( " ) = B( " ) "                      | Recirculate B                        | T7 thru T0 |
|    |           | sB(3-23) = B(0-20)Ar3                   |                                      |            |
|    |           | rB( " ) = B( " ) "                      |                                      |            |
|    |           | End = 05Bc23                            | Last cycle                           |            |
|    |           | Pr3 = (F1GO)Q2                          |                                      |            |
|    |           | sP0 = (F1GO(02040506))(P12⊕(P13P14Ia))  |                                      |            |
|    |           | rP0 = ( " )(P12⊕(P13P14Ia))             |                                      |            |
|    |           | sP1 = ( " )(P13⊕(P14Ia))                |                                      |            |
|    |           | rP1 = ( " )(P13⊕(P14Ia))                | P+1 → P                              | T7 thru T3 |
|    |           | sP2 = ( " )(P14⊕Ia)                     |                                      |            |
|    |           | rP2 = ( " )(P14⊕Ia)                     |                                      |            |
|    |           | rIa = (P12P13P14)Q2F1                   |                                      |            |
|    |           | sP(3-14) = P(0-11)Pr3                   |                                      |            |
|    |           | rP( " ) = P( " ) "                      |                                      |            |
| T4 | Sc        | = T4(End+F1F2)Inr                       | Clear S                              |            |
|    |           | rS(1-14) = Sc                           |                                      |            |
| T3 | Sxp       | = T3Int(End+JuEax)GO+T3Kmc              |                                      |            |
|    |           | sS1 = (F1GO(02040506))(P13⊕(P14Ia))Sxp  |                                      |            |
|    |           | sS2 = ( " )(P14⊕Ia)Sxp                  | P → S                                |            |
|    |           | sS(3-14) = P(0-11)Sxp                   |                                      |            |
| Tr | Cxm       | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp) | M → C                                | Tr + Tp    |
|    |           | sC(0-23) = M(0-23)Cxm                   |                                      |            |
|    |           | rC( " ) = M( " ) "                      |                                      |            |
|    |           | rIa = TrF1                              |                                      |            |
|    |           | rIx = Tr(F1F3)(GOHt)                    |                                      |            |
|    |           | rRc = Tr                                |                                      |            |
|    |           | sSk = 050104A00TrSks                    | Skip if Sks                          |            |
| Tp | rF1       | = TpEndSK                               | 00 next clock (T8) if Sk not set     |            |
|    |           | sF2 = TpSk                              | 07 next clock (T8) if Sk set         |            |
|    |           | rF3 = TpEndSK                           |                                      |            |
|    |           | rRf = Tp01(GOht)                        |                                      |            |
|    |           | rJu = Tp                                |                                      |            |
|    |           | Oc = TpEndSK                            |                                      |            |
|    |           | rO(1,3,4,5,6) = Oc                      | NOP (20) → 0                         |            |
|    |           | sO2 = Oc                                |                                      |            |

|    |    |               |  |                               |            |
|----|----|---------------|--|-------------------------------|------------|
| 07 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                            |                               |            |
|    |    | Ck            | = 07T8 $\overline{\text{Ts}}$                                |                               |            |
|    |    | End           | = F1F2   | Last cycle                    |            |
|    |    | s1a           | = T807Sk( $\overline{\text{ikr}}$ )                          | Initiate P register increment |            |
| T7 |    | Ar3           | = (01020304)Q1   |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                        |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3   |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                        |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3   |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              |                               |            |
|    |    | Cr3           | = 0705( $\overline{\text{TsQ1}}$ )                           |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3   | O → C                         |            |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) "                              |                               |            |
|    |    | Pr3           | = (F1G0)Q2   |                               |            |
|    |    | sP0           | = ((F1G0)(02040506))(P12 $\oplus$ (P13P14Ia))                |                               |            |
|    |    | rP0           | = ( " ) (P12 $\oplus$ (P13P14Ia))                            |                               |            |
|    |    | sP1           | = ( " ) (P13 $\oplus$ (P14Ia))                               |                               |            |
|    |    | rP1           | = ( " ) (P13 $\oplus$ (P14Ia))                               | P+1 → P                       | T7 thru T3 |
|    |    | sP2           | = ( " ) (P14 $\oplus$ Ia)                                    |                               |            |
|    |    | rP2           | = ( " ) (P14 $\oplus$ Ia)                                    |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1  |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3   |                               |            |
|    |    | rP( " )       | = $\overline{\text{P}}$ ( " ) "                              |                               |            |
| T4 |    | Sc            | = T4EndInr   |                               |            |
|    |    | rS(1-14)      | = Sc   | Clear S                       |            |
| T3 |    | Sxp           | = T3IntEndG0   |                               |            |
|    |    | sS1           | = (F1G0)(02040506)(P13 $\oplus$ (P14Ia))Sxp                  |                               |            |
|    |    | sS2           | = ( " ) (P14 $\oplus$ Ia)Sxp                                 | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp   |                               |            |
| T0 |    | rSk           | = 07T0   | Reset skip                    |            |
| Tr |    | Cxm           | = EndG0 $\overline{\text{Tsm}}$ (Tr+Tp)                      |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm   | M → C                         |            |
|    |    | rC( " )       | = $\overline{\text{M}}$ ( " ) "                              |                               |            |
|    |    | rIa           | = TrF1   |                               |            |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ )( $\overline{\text{GOHt}}$ ) |                               |            |
|    |    | rRc           | = Tr   |                               |            |
| Tp |    | sCp           | = M24Cxm $\overline{\text{HtTs}}$ Tp                         | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEnd $\overline{\text{Sk}}$                               |                               |            |
|    |    | rRf           | = Tp01( $\overline{\text{GOHt}}$ )                           | 00 next clock (T8)            |            |
|    |    | rJu           | = Tp   |                               |            |
|    |    | Oc            | = TpEnd $\overline{\text{Sk}}$                               |                               |            |
|    |    | rO(1,3,4,5,6) | = Oc   | NOP → 0                       |            |
|    |    | sO2           | = Oc   |                               |            |

|    |               |  |                                      |            |
|----|---------------|--|--------------------------------------|------------|
| 40 | SKS 22000     | Skip if Y Buffer Ready   | Not Ready = P + 1 → P                | 1 Cycle    |
|    |               |  | Ready = P + 2 → P                    | 2 Cycles   |
| 00 | T8            | rC24 = T8( $\overline{\text{TsTsr}}$ )   |                                      |            |
|    |               | rCz = 00T8   |                                      |            |
|    |               | sF1 = (00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ ))                        | 05 next. (T7)                        |            |
|    |               | sF3 = ( " )  |                                      |            |
|    |               | sHz = T8   |                                      |            |
|    |               | sIa = 00T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )                          | Initiate P register increment        |            |
|    |               | Oxc = (00T8 $\overline{\text{IaGO}}$ ) $\overline{\text{C2}}$                                  |                                      |            |
|    |               | sO(1,3,4,5,6) = Oxcc(3,5,6,7,8)  | C(3-8) → 0 instruction to 0 register |            |
|    |               | rO2 = Oxcc $\overline{\text{C4}}$  |                                      |            |
|    |               | Skr = C10C11C13Y10Y11Y12Y13Y14C1   |                                      |            |
|    |               | Sks = Skrz   | Buffer ready (disconnected)          |            |
| 05 | T7            | Ar3 = (01020304)Q1   |                                      |            |
|    |               | sA(0-2) = A(21-23) $\overline{\text{AnrAr3}}$  |                                      |            |
|    |               | rA( " ) = $\overline{\text{A}}$ ( " ) "  | Recirculate A                        | T7 thru T0 |
|    |               | sA(3-23) = A(0-20)Ar3  |                                      |            |
|    |               | rA( " ) = $\overline{\text{A}}$ ( " ) "  |                                      |            |
|    |               | sB(0-2) = B(21-23) $\overline{\text{BnrAr3}}$  |                                      |            |
|    |               | rB( " ) = $\overline{\text{B}}$ ( " ) "  | Recirculate B                        | T7 thru T0 |
|    |               | sB(3-23) = B(0-20)Ar3  |                                      |            |
|    |               | rB( " ) = $\overline{\text{B}}$ ( " ) "  |                                      |            |
|    |               | End = 05Bc23   | Last cycle                           |            |
|    |               | Pr3 = (F1GO)Q2   |                                      |            |
|    |               | sP0 = (F1GO(02040506))(P12 $\oplus$ (P13P14Ia))  |                                      |            |
|    |               | rP0 = ( " ) (P12 $\oplus$ (P13P14Ia))  |                                      |            |
|    |               | sP1 = ( " ) (P13 $\oplus$ (P14Ia))   |                                      |            |
|    |               | rP1 = ( " ) (P13 $\oplus$ (P14Ia))   | P+1 → P                              | T7 thru T3 |
|    |               | sP2 = ( " ) (P14 $\oplus$ Ia)  |                                      |            |
|    |               | rP2 = ( " ) (P14 $\oplus$ Ia)  |                                      |            |
|    |               | rIa = (P12P13P14)Q2F1  |                                      |            |
|    |               | sP(3-14) = P(0-11)Pr3  |                                      |            |
|    |               | rP( " ) = $\overline{\text{P}}$ ( " ) "  |                                      |            |
| T4 | Sc            | = T4(End+F1F2) $\overline{\text{Inr}}$   |                                      |            |
|    | rS(1-14)      | = Sc   | Clear S                              |            |
| T3 | Sxp           | = T3 $\overline{\text{Int}}$ ( $\overline{\text{End+JuFax}}$ )GO+T3( $\overline{\text{Kmc}}$ ) |                                      |            |
|    | sS1           | = (F1GO(02040506))(P13 $\oplus$ (P14Ia))Sxp  |                                      |            |
|    | sS2           | = ( " ) (P14 $\oplus$ Ia)Sxp   | P → S                                |            |
|    | sS(3-14)      | = P(0-11)Sxp   |                                      |            |
| Tr | Cxm           | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)  |                                      |            |
|    | sC(0-23)      | = M(0-23)Cxm   | M → C                                | Tr + Tp    |
|    | rC( " )       | = $\overline{\text{M}}$ ( " ) "  |                                      |            |
|    | rIa           | = TrF1   |                                      |            |
|    | rIx           | = Tr(F1F3)( $\overline{\text{GOHt}}$ )   |                                      |            |
|    | rRc           | = Tr   |                                      |            |
|    | sSk           | = 050104A00TrSks   | Skip if Sks                          |            |
| Tp | rF1           | = TpEndSk  | 00 next clock (T8) if Sk not set     |            |
|    | sF2           | = TpSk   | 07 next clock (T8) if Sk set         |            |
|    | rF3           | = TpEndSk  |                                      |            |
|    | rRf           | = Tp01( $\overline{\text{GOHt}}$ )   |                                      |            |
|    | rJu           | = Tp   |                                      |            |
|    | Oc            | = TpEndSk  |                                      |            |
|    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                         |            |
|    | sO2           | = Oc   |                                      |            |



|    |    |               |  |                               |            |
|----|----|---------------|--|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8( $\overline{TsTs}$ r)                     |                               |            |
|    |    | Ck            | = Ø7T8Ts                                       |                               |            |
|    |    | End           | = F1F2   | Last cycle                    |            |
|    |    | s1a           | = T8Ø7Sk( $\overline{1}k$ r)                   | Initiate P register increment |            |
| T7 |    | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                                 |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{Anr}$ Ar3                |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "                       | Recirculate A                 | T7 thru TØ |
|    |    | sA(3-23)      | = A(0-20)Ar3                                   |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) "                       |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{Bnr}$ Ar3                |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "                       | Recirculate B                 | T7 thru TØ |
|    |    | sB(3-23)      | = B(0-20)Ar3                                   |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) "                       |                               |            |
|    |    | Cr3           | = Ø7Ø5(TsQ1)                                   |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                                   | O → C                         |            |
|    |    | rC( " )       | = $\overline{C}$ ( " ) "                       |                               |            |
|    |    | Pr3           | = (F1GØ)Q2                                     |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12 $\oplus$ (P13P14Ia))  |                               |            |
|    |    | rPØ           | = ( " ) (P12 $\oplus$ (P13P14Ia))              |                               |            |
|    |    | sP1           | = ( " ) (P13 $\oplus$ (P14Ia))                 | P+1 → P                       | T7 thru T3 |
|    |    | rP1           | = ( " ) (P13 $\oplus$ (P14Ia))                 |                               |            |
|    |    | sP2           | = ( " ) (P14 $\oplus$ Ia)                      |                               |            |
|    |    | rP2           | = ( " ) (P14 $\oplus$ Ia)                      |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                              |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                                   |                               |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) "                       |                               |            |
| T4 |    | Sc            | = T4EndInr                                     | Clear S                       |            |
|    |    | rS(1-14)      | = Sc   |                               |            |
| T3 |    | Sxp           | = T3IntEndGØ                                   |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6))(P13 $\oplus$ (P14Ia))Sxp   |                               |            |
|    |    | sS2           | = ( " ) (P14 $\oplus$ Ia)Sxp                   | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                                   |                               |            |
| TØ |    | rSk           | = Ø7TØ   | Reset skip                    |            |
| Tr |    | Cxm           | = EndGØTsm(Tr+Tp)                              |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                                   | M → C                         |            |
|    |    | rC( " )       | = $\overline{M}$ ( " ) "                       |                               |            |
|    |    | rIa           | = TrF1   |                               |            |
|    |    | rIx           | = Tr( $\overline{F1F3}$ )( $\overline{GØHt}$ ) |                               |            |
|    |    | rRc           | = Tr   |                               |            |
| Tp |    | sCp           | = M24CxmHtTsTp                                 | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEnd $\overline{Sk}$                        | ØØ next clock (T8)            |            |
|    |    | rRf           | = TpØ1( $\overline{GØHt}$ )                    |                               |            |
|    |    | rJu           | = Tp   |                               |            |
|    |    | Oc            | = TpEnd $\overline{Sk}$                        |                               |            |
|    |    | rØ(1,3,4,5,6) | = Oc   | NØP → Ø                       |            |
|    |    | sØ2           | = Oc   |                               |            |

|    |               |  |  |
|----|---------------|--|--|
| 40 | SKS 24000     | Power Off Test   | Power Off = P + 1 → P 1 Cycle<br>Power Not Off = P+2 → P 2 Cycles                                    |
| 00 | T8            | rC24 = T8( $\overline{\text{TsTsr}}$ )<br>rCz = 00T8<br>sF1 = (00T8IaC2C5C8(C3+C4))<br>sF3 = ( " )<br>sHz = T8<br>sIa = (00T8IaC2C5C8(C3+C4))<br>Oxc = (00T8IaGO)C2<br>sO(1,3,4,5,6) = Oxcc(3,5,6,7,8)<br>rO2 = Oxcc4  | 05 next (T7)<br><br>Initiate P register increment<br>C(3-8) → 0 instruction to 0 register            |
| 05 | T7            | Sks = (C10C11)C15(Kb1)<br>Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = $\overline{\text{A}}$ ( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = $\overline{\text{A}}$ ( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = $\overline{\text{B}}$ ( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = $\overline{\text{B}}$ ( " ) "<br>End = 05Bc23<br>Pr3 = (F1GO)Q2<br>sP0 = (F1GO(02040506))(P12(P13P14Ia))<br>rP0 = ( " )(P12(P13P14Ia))<br>sP1 = ( " )(P13(P14Ia))<br>rP1 = ( " )(P13(P14Ia))<br>sP2 = ( " )(P14Ia)<br>rP2 = ( " )(P14Ia)<br>rIa = (P12P13P14)Q2F1<br>sP(3-14) = P(0-11)Pr3<br>rP( " ) = $\overline{\text{P}}$ ( " ) " | Recirculate A T7 thru T0<br><br>Recirculate B T7 thru T0<br><br>Last cycle<br><br>P+1 → P T7 thru T3 |
| T4 | Sc            | rS(1-14) = T4(End+F1F2)Inr = Sc  | Clear S  |
| T3 | Sxp           | sS1 = (F1GO(02040506))(P13(P14Ia))Sxp<br>sS2 = ( " )(P14Ia)Sxp   | P → S  |
| Tr | Cxm           | sC(0-23) = M(0-23)Cxm<br>rC( " ) = $\overline{\text{M}}$ ( " ) "<br>rIa = TrF1<br>rIx = Tr(F1F3)(GOHt)<br>rRc = Tr   | M → C Tr + Tp  |
| Tp | rF1           | sSk = 050107A00TrSks<br>rF1 = TpEndSk<br>sF2 = TpSk<br>rF3 = TpEndSk<br>rRf = Tp0I(GOHT)<br>rJu = Tp<br>Oc = TpEndSk   | Skip if Sks<br>00 next clock (T8) if Sk not set<br>07 next clock (T8) if Sk set                      |
|    | rO(1,3,4,5,6) | sO2 = Oc   | NOP (20) → 0   |

|    |    |               |                                       |                               |            |
|----|----|---------------|---------------------------------------|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )     |                               |            |
|    |    | Ck            | = Ø7T8Ts                              |                               |            |
|    |    | End           | = F1F2                                | Last cycle                    |            |
|    |    | s1a           | = T8Ø7SkØ1kr                          | Initiate P register increment |            |
| T7 |    | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                        |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$ |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "       | Recirculate A                 | T7 thru TØ |
|    |    | sA(3-23)      | = A(0-20)Ar3                          |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "       |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$ |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "       | Recirculate B                 | T7 thru TØ |
|    |    | sB(3-23)      | = B(0-20)Ar3                          |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "       |                               |            |
|    |    | Cr3           | = Ø7Ø5(TsQ1)                          |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                          | O → C                         |            |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) "       |                               |            |
|    |    | Pr3           | = (F1GØ)Q2                            |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12⊕(P13P14Ia))  |                               |            |
|    |    | rPØ           | = ( " ) (P12⊕(P13P14Ia))              |                               |            |
|    |    | sP1           | = ( " ) (P13⊕(P14Ia))                 |                               |            |
|    |    | rP1           | = ( " ) (P13⊕(P14Ia))                 | P+1 → P                       | T7 thru T3 |
|    |    | sP2           | = ( " ) (P14⊕Ia)                      |                               |            |
|    |    | rP2           | = ( " ) (P14⊕Ia)                      |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                     |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                          |                               |            |
|    |    | rP( " )       | = $\overline{\text{P}}$ ( " ) "       |                               |            |
| T4 |    | Sc            | = T4EndInr                            | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                                  |                               |            |
| T3 |    | Sxp           | = T3IntEndGØ                          |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13⊕(P14Ia))Sxp    |                               |            |
|    |    | sS2           | = ( " ) (P14⊕Ia)Sxp                   | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                          |                               |            |
| TØ |    | rSk           | = Ø7TØ                                | Reset skip                    |            |
| Tr |    | Cxm           | = EndGØTsm(Tr+Tp)                     |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                          | M → C                         |            |
|    |    | rC( " )       | = $\overline{\text{M}}$ ( " ) "       |                               |            |
|    |    | rIa           | = TrF1                                |                               |            |
|    |    | rIx           | = Tr(F1F3)(GØHt)                      |                               |            |
|    |    | rRc           | = Tr                                  |                               |            |
| Tp |    | sCp           | = M24CxmHtTsTp                        | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                             |                               |            |
|    |    | rRf           | = TpØ1(GØHt)                          | ØØ next clock (T8)            |            |
|    |    | rJu           | = Tp                                  |                               |            |
|    |    | Oc            | = TpEndSk                             |                               |            |
|    |    | rØ(1,3,4,5,6) | = Oc                                  | NØP → Ø                       |            |
|    |    | sØ2           | = Oc                                  |                               |            |

|    |           |   |  |
|----|-----------|---|--|
| 40 | SKS 40001 | Skip if Not Bank Register 2   | Bank Register 2 = P+1 → P1 Cycle<br>Not Bank Register 2 = 2 Cycles<br>P + 2 → P  |
| 00 | T8        | rC24 = T8( $\overline{TsTsr}$ )<br>rCz = 00T8<br>sF1 = (00T8 $\overline{IaC2C5C8(C3+C4)}$ )<br>sF3 = ( " )<br>sHz = T8<br>sIa = 00T8 $\overline{IaC2C5C8(C3+C4)}$<br>Oxc = (00T8 $\overline{IaGO}C2$ )<br>s0(1,3,4,5,6) = Oxcc(3,5,6,7,8)<br>r02 = Oxcc4<br>Sks = $\overline{C10C11C9C23(E2m0E2m1E2m2)}$  | 05 next (T7)<br><br>Initiate P register increment<br><br>C(3-8) → 0 instruction to 0 register<br><br>Not Bank Register 2   |
| 05 | T7        | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23) $\overline{AnrAr3}$<br>rA( " ) = $\overline{A}$ ( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = $\overline{A}$ ( " ) "<br>sB(0-2) = B(21-23) $\overline{BnrAr3}$<br>rB( " ) = $\overline{B}$ ( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = $\overline{B}$ ( " ) "<br>End = 05Bc23<br>Pr3 = (F1GO)Q2<br>sP0 = (F1GO(02040506))(P12 <del>P</del> (P13P14Ia))<br>rP0 = ( " ) (P12 <del>P</del> (P13P14Ia))<br>sP1 = ( " ) (P13 <del>P</del> (P14Ia))<br>rP1 = ( " ) (P13 <del>P</del> (P14Ia))<br>sP2 = ( " ) (P14 <del>P</del> Ia)<br>rP2 = ( " ) (P14 <del>P</del> Ia)<br>rIa = (P12P13P14)Q2F1<br>sP(3-14) = P(0-11)Pr3<br>rP( " ) = $\overline{P}$ ( " ) "<br>T4 Sc = T4(End+F1F2) $\overline{Inr}$<br>rS(1-14) = Sc<br>T3 Sxp = T3Int( $\overline{End+JuEax}$ )GO+T3( $\overline{Kmc}$ )<br>sS1 = (F1GO(02040506))(P13 <del>P</del> (P14Ia))Sxp<br>sS2 = ( " ) (P14 <del>P</del> Ia)Sxp<br>sS(3-14) = P(0-11)Sxp<br>Tr Cxm = EndGO $\overline{Tsm(Tr+Tp)}$<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = $\overline{M}$ ( " ) "<br>rIa = TrF1<br>rIx = Tr(F1F3)( $\overline{GOHt}$ )<br>rRc = Tr<br>sSk = 050104A00TrSks<br>Tp rF1 = TpEndSk<br>sF2 = TpSk<br>rF3 = TpEndSk<br>rRf = Tp01( $\overline{GOHt}$ )<br>rJu = Tp<br>Oc = TpEndSk<br>r0(1,3,4,5,6) = Oc<br>s02 = Oc | Recirculate A T7 thru T0<br><br>Recirculate B T7 thru T0<br><br>Last cycle<br><br>P+1 → P T7 thru T3<br><br>Clear S<br><br>P → S<br><br>M → C Tr + Tp<br><br>Skip if Sks<br>00 next clock (T8) if Sk not set<br>07 next clock (T8) if Sk set<br><br>NOP (20) → 0 |

|    |    |               |  |                               |            |
|----|----|---------------|--|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                            |                               |            |
|    |    | Ck            | = Ø7T8 $\overline{\text{Ts}}$                                |                               |            |
|    |    | End           | = F1F2   | Last cycle                    |            |
|    |    | s1a           | = T8Ø7Sk $\overline{\text{Ukr}}$                             | Initiate P register increment |            |
| T7 |    | Ar3           | = (Ø1Ø2Ø3Ø4)Q1   |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                        |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              | Recirculate A                 | T7 thru TØ |
|    |    | sA(3-23)      | = A(0-20)Ar3   |                               |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                        |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              | Recirculate B                 | T7 thru TØ |
|    |    | sB(3-23)      | = B(0-20)Ar3   |                               |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              |                               |            |
|    |    | Cr3           | = Ø7Ø5( $\overline{\text{TsQ1}}$ )                           |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3   | O → C                         |            |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) "                              |                               |            |
|    |    | Pr3           | = (F1GØ)Q2   |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12 $\oplus$ (P13P14Ia))                |                               |            |
|    |    | rPØ           | = ( " ) (P12 $\oplus$ (P13P14Ia))                            |                               |            |
|    |    | sP1           | = ( " ) (P13 $\oplus$ (P14Ia))                               |                               |            |
|    |    | rP1           | = ( " ) (P13 $\oplus$ (P14Ia))                               | P+1 → P                       | T7 thru T3 |
|    |    | sP2           | = ( " ) (P14 $\oplus$ Ia)                                    |                               |            |
|    |    | rP2           | = ( " ) (P14 $\oplus$ Ia)                                    |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1  |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3   |                               |            |
|    |    | rP( " )       | = $\overline{\text{P}}$ ( " ) "                              |                               |            |
| T4 |    | Sc            | = T4End $\overline{\text{Inr}}$                              | Clear S                       |            |
|    |    | rS(1-14)      | = Sc   |                               |            |
| T3 |    | Sxp           | = T3Int $\overline{\text{EndGO}}$                            |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13 $\oplus$ (P14Ia))Sxp                  |                               |            |
|    |    | sS2           | = ( " ) (P14 $\oplus$ Ia)Sxp                                 | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp   |                               |            |
| TØ |    | rSk           | = Ø7TØ   | Reset skip                    |            |
| Tr |    | Cxm           | = EndGØ $\overline{\text{Tsm}}$ (Tr+Tp)                      |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm   | M → C                         |            |
|    |    | rC( " )       | = $\overline{\text{M}}$ ( " ) "                              |                               |            |
|    |    | rIa           | = TrF1   |                               |            |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ )( $\overline{\text{GOHt}}$ ) |                               |            |
|    |    | rRc           | = Tr   |                               |            |
| Tp |    | sCp           | = M24Cxm $\overline{\text{HtTsTp}}$                          | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEnd $\overline{\text{Sk}}$                               |                               |            |
|    |    | rRf           | = TpØ1( $\overline{\text{GOHt}}$ )                           | ØØ next clock (T8)            |            |
|    |    | rJu           | = Tp   |                               |            |
|    |    | Oc            | = TpEnd $\overline{\text{Sk}}$                               |                               |            |
|    |    | rØ(1,3,4,5,6) | = Oc   | NØP → Ø                       |            |
|    |    | sØ2           | = Oc   |                               |            |

|    |           |   |  |
|----|-----------|---|--|
| 40 | SKS 40002 | Skip if Not Bank Register 3   | Bank Register 2 = P+1 → P 1 Cycle<br>Not Bank Register 2 = 2 Cycles<br>P + 2 → P   |
| 00 | T8        | rC24 = T8(TsTsr)<br>rCz = 00T8<br>sF1 = (00T8IaC2C5C8(C3+C4))<br>sF3 = ( " )<br>sHz = T8<br>sIa = 00T8IaC2C5C8(C3+C4)<br>Oxc = (00T8IaGO)C2<br>sO(1,3,4,5,6) = Oxcc(3,5,6,7,8)<br>rO2 = Oxcc4<br>Sks = C10C11C9C22(E3m0E3m1E3m2)  | 05 next (T7)<br><br>Initiate P register increment<br><br>C(3-8) → 0 instruction to 0 register<br><br>Not Bank Register 3 |
| 05 | T7        | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>End = 05Bc23<br>Pr3 = (F1GO)Q2<br>sP0 = (F1GO(02040506))(P12(P13P14Ia))<br>rP0 = ( " )(P12(P13P14Ia))<br>sP1 = ( " )(P13(P14Ia))<br>rP1 = ( " )(P13(P14Ia))<br>sP2 = ( " )(P14Ia)<br>rP2 = ( " )(P14Ia)<br>rIa = (P12P13P14)Q2F1<br>sP(3-14) = P(0-11)Pr3<br>rP( " ) = P( " ) " | Recirculate A T7 thru T0<br><br>Recirculate B T7 thru T0<br><br>Last cycle<br><br>P+1 → P T7 thru T3                     |
| T4 | Sc        | rS(1-14) = T4(End+F1F2)Inr = Sc   | Clear S  |
| T3 | Sxp       | sS1 = (F1GO(02040506))(P13(P14Ia))Sxp<br>sS2 = ( " )(P14Ia)Sxp<br>sS(3-14) = P(0-11)Sxp   | P → S  |
| Tr | Cxm       | sC(0-23) = M(0-23)Cxm<br>rC( " ) = M( " ) "<br>rIa = TrF1<br>rIx = Tr(F1F3)(GOht)<br>rRc = Tr<br>sSk = 050104A00TrSks   | M → C Tr + Tp<br><br>Skip if Sks   |
| Tp | rF1       | sF2 = TpSk<br>rF3 = TpEndSk<br>rRf = Tp01(GOht)<br>rJu = Tp<br>Oc = TpEndSk<br>rO(1,3,4,5,6) = Oc<br>sO2 = Oc   | 00 next clock (T8) if Sk not set<br>07 next clock (T8) if Sk set<br><br>NOP (20) → 0                                     |

|    |    |               |   |                               |            |
|----|----|---------------|---|-------------------------------|------------|
| Ø7 | T8 | rC24          | = T8( $\overline{T_s T_{sr}}$ )               |                               |            |
|    |    | Ck            | = Ø7T8T $\overline{s}$                        |                               |            |
|    |    | End           | = F1F2  | Last cycle                    |            |
|    |    | sIa           | = T8Ø7Sk( $\overline{Ikr}$ )                  | Initiate P register increment |            |
| T7 |    | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                                |                               |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{ArAr3}$                 |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "                    | Recirculate A                 | T7 thru TØ |
|    |    | sA(3-23)      | = A(0-20)Ar3                                  |                               |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "                    |                               |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{BrAr3}$                 |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "                    | Recirculate B                 | T7 thru TØ |
|    |    | sB(3-23)      | = B(0-20)Ar3                                  |                               |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "                    |                               |            |
|    |    | Cr3           | = Ø7Ø5( $\overline{T_s Q1}$ )                 |                               |            |
|    |    | sC(3-23)      | = C(0-20)Cr3                                  | O → C                         |            |
|    |    | rC( " )       | = $\overline{C}$ ( " ) " "                    |                               |            |
|    |    | Pr3           | = (F1GØ)Q2                                    |                               |            |
|    |    | sPØ           | = ((F1GØ)(Ø2Ø4Ø5Ø6))(P12 $\oplus$ (P13P14Ia)) |                               |            |
|    |    | rPØ           | = ( " ) (P12 $\oplus$ (P13P14Ia))             |                               |            |
|    |    | sP1           | = ( " ) (P13 $\oplus$ (P14Ia))                |                               |            |
|    |    | rP1           | = ( " ) (P13 $\oplus$ (P14Ia))                | P+1 → P                       | T7 thru T3 |
|    |    | sP2           | = ( " ) (P14 $\oplus$ Ia)                     |                               |            |
|    |    | rP2           | = ( " ) (P14 $\oplus$ Ia)                     |                               |            |
|    |    | rIa           | = (P12P13P14)Q2F1                             |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                                  |                               |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) " "                    |                               |            |
| T4 |    | Sc            | = T4EndInr                                    |                               |            |
|    |    | rS(1-14)      | = Sc  | Clear S                       |            |
| T3 |    | Sxp           | = T3InrEndGØ                                  |                               |            |
|    |    | sS1           | = (F1GØ)(Ø2Ø4Ø5Ø6)(P13 $\oplus$ (P14Ia))Sxp   |                               |            |
|    |    | sS2           | = ( " ) (P14 $\oplus$ Ia)Sxp                  | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                                  |                               |            |
| TØ |    | rSk           | = Ø7TØ  | Reset skip                    |            |
| Tr |    | Cxm           | = EndGØTsm(Tr+Tp)                             |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                                  | M → C                         |            |
|    |    | rC( " )       | = $\overline{M}$ ( " ) " "                    |                               |            |
|    |    | rIa           | = TrF1  |                               |            |
|    |    | rIx           | = Tr(F1F3)( $\overline{GOHt}$ )               |                               |            |
|    |    | rRc           | = Tr  |                               |            |
| Tp |    | sCp           | = M24CxmHtT $\overline{s}$ TP                 | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                                     |                               |            |
|    |    | rRf           | = TpØ1( $\overline{GOHt}$ )                   | ØØ next clock (T8)            |            |
|    |    | rJu           | = Tp  |                               |            |
|    |    | Oc            | = TpEndSk                                     |                               |            |
|    |    | rØ(1,3,4,5,6) | = OØ  | NØP → O                       |            |
|    |    | sØ2           | = OØ  |                               |            |

|    |          |  |   |                     |
|----|----------|--|---|---------------------|
| 41 | BRX      | Increment Index and Branch   | (X+1 → X) If X(9)=1<br>M → P branch<br>(X+1 → X) If X(9)=0<br>P+1 → P | 1 Cycle<br>2 Cycles |
| ∅0 | T8       | rCz = ∅0T8   |   |                     |
|    |          | sHz = T8   |   |                     |
|    |          | sIx = C1G0∅0T8   | Initialize indexing   |                     |
|    |          | sJu = $\overline{1}aG0\overline{C}4\overline{C}5C8\overline{C}9T8$ |   |                     |
|    |          | Hx(1-3) = $\overline{Xn(1-3)F1}$                                   | Half adder inputs   |                     |
|    |          | Ha1 = $\overline{Hx1(Hx2Hx3Hz)} + Hx1(Hx2Hx3Hz)$                   |   |                     |
|    |          | Ha2 = $\overline{Hx2(Hx3Hz)} + Hx2(Hx3Hz)$                         | Half adder outputs  |                     |
|    |          | Ha3 = $\overline{Hx3Hz} + Hx3Hz$                                   |   |                     |
| T7 | Ar3      | = 05∅0Q1   |   |                     |
|    | sA(0-2)  | = $\overline{A(21-23)AnrAr3}$                                      |   |                     |
|    | rA( " )  | = $\overline{A( " ) "}$  | Recirculate A   | T7 thru T0          |
|    | sA(3-23) | = $\overline{A(0-20)Ar3}$  |   |                     |
|    | rA( " )  | = $\overline{A( " ) "}$  |   |                     |
|    | sB(0-2)  | = $\overline{B(21-23)BnrAr3}$                                      |   |                     |
|    | rB( " )  | = $\overline{B( " ) "}$  | Recirculate B   | T7 thru T0          |
|    | sB(3-23) | = $\overline{B(0-20)Ar3}$  |   |                     |
|    | rB( " )  | = $\overline{B( " ) "}$  |   |                     |
|    | Cr3      | = $\overline{Ts\emptyset0Q1}$                                      |   |                     |
|    | sC0      | = (P12)JuTsCr3Q6   |   |                     |
|    | rC0      | = ( " ) " "  |   |                     |
|    | sC(1,2)  | = P(13,14)JuTsCr3Q2  | P(1-14) → C(10-23)  | T7 thru T           |
|    | rC( " )  | = $\overline{P( " ) "}$  |   |                     |
|    | sC(3-23) | = $\overline{C(0-20)Cr3}$  |   |                     |
|    | rC( " )  | = $\overline{C( " ) "}$  |   |                     |
|    | sCp      | = $\overline{(C21\oplus C22\oplus C23)CpTsHtQ1F1F2}$               | Parity check  | T7 thru T0          |
|    | rCp      | = ( " ) Cp " "   |   |                     |
|    | rHz      | = $\overline{(Hx1+Hx2+Hx3)T8}$                                     |   |                     |
|    | Pr3      | = JuQ2   |   |                     |
|    | sP(0-2)  | = Add(1-3)02040506Pr3  |   |                     |
|    | rP( " )  | = $\overline{Add( " ) "}$  | C + X·Ix → P  | T7 thru T3          |
|    | sP(3-14) | = $\overline{P(0-11)Pr3}$  |   |                     |
|    | rP( " )  | = $\overline{P( " ) "}$  |   |                     |
|    | Xnr      | = Ju0105   |   |                     |
|    | sXw(1-3) | = $\overline{Ha(1-3)TsJu0105}$                                     | X + 1 → X   |                     |
|    | rXw( " ) | = $\overline{Ha( " ) "}$   |   |                     |
|    | Xz(1-3)  | = $\overline{Xn(1-3)\emptyset0Ix}$                                 | Adder input (X·Ix)  | T7 thru T0          |
|    | Xz( " )  | = $\overline{Xn( " )\emptyset0Ix+Ix}$                              |   |                     |
|    | Yz(1-3)  | = $\overline{C(21-23)\emptyset7}$                                  | Adder input (C)   | T7 thru T0          |
|    | Yz( " )  | = $\overline{C( " ) "}$  |   |                     |
|    | sCz      | = KzQ1T0   | Carry logic   | T7 thru T1          |
|    | rCz      | = $\overline{KzQ1}$  |   |                     |
| T4 | Sc       | = $\overline{InrF1F2T4}$   | Clear S   |                     |
|    | rS(1-14) | = Sc   |   |                     |
| T3 | rC0      | = JuTsCr3Q4Q6  | No input to C3, C6, C9  | T3 thru T1          |



|    |               |   |                                  |
|----|---------------|---|----------------------------------|
|    | Sxp           | = $\overline{\text{Int}}\overline{\text{Ju}}\overline{\text{Eax}}\overline{\text{GOT}}3$              |                                  |
|    | sS(1,2)       | = $\text{Add}(2,3)(\overline{\text{Ju}}\overline{\text{Eax}}+\overline{02040506})\text{Sxp}$          |                                  |
|    | sS(3-14)      | = $\text{P}(0-11)\text{Sxp}$  | P → S                            |
| T2 | rO1           | = $\text{Xw1}\overline{\text{Ju}}\overline{05}\text{T2}$  | Reset O1 if (X9 = 1)             |
|    | rC(1,2)       | = $(\overline{\text{Ju}}\overline{\text{Ts}}\overline{\text{Cr}}3)\text{T2}$                          | No input to C7, C8               |
| T1 | sC(1,2)       | = $\overline{\text{Em}}(1,2)(\overline{\text{Ju}}\overline{\text{Ts}}\overline{\text{Cr}}3)\text{T1}$ |                                  |
|    | rC( " )       | = $\overline{\text{Em}}( " )( " ) "$  |                                  |
|    | End           | = $\overline{\text{Ju}}\overline{\text{Eax}}\text{O1}$  | Branch condition (X9 = 1)        |
| T0 | rCz           | = $\overline{\text{Fl}}\text{T0}$   |                                  |
|    | sC0           | = $\text{Of}(\overline{\text{Ju}}\overline{\text{Ts}}\overline{\text{Cr}}3)\text{T0}$                 |                                  |
|    | rC0           | = $\overline{\text{Of}}( " )$   |                                  |
|    | rC(1,2)       | = $\overline{\text{Ju}}\overline{\text{Ts}}\overline{\text{Cr}}3\text{T0}$                            | No input to C1, C2               |
| Tr | Cxm           | = $\text{End}\overline{\text{GOT}}\overline{\text{sm}}(\text{Tr}+\text{Tp})$                          | Branch condition (X9 = 1)        |
|    | sC(0-23)      | = $\text{M}(0-23)\text{Cxm}$  | M → C (Fetch operand) Tr thru Tp |
|    | rC( " )       | = $\text{Cxm}\text{Tr}$   |                                  |
|    | sCz           | = $\overline{04050600}\text{Tr}$  | Initiate C register increment    |
|    | sHt           | = $\text{Cp}\overline{\text{Tr}}(\overline{\text{Kp}})\overline{\text{K002}}$                         | Parity error                     |
|    | rIx           | = $(\overline{\text{Fl}}\overline{\text{F}}3)(\overline{\text{GO}}\text{Ht})\text{Tr}$                |                                  |
|    | rRc           | = $\text{Tr}$   |                                  |
| TP | rA00          | = $\text{End}\overline{\text{GOT}}\text{p}$   | Branch condition (X9 = 1)        |
|    | rB00          | = $( " )$   | Initiate parity                  |
|    | sCp           | = $\text{M}24\overline{\text{Cxm}}\overline{\text{Ht}}\overline{\text{Ts}}\text{Tp}$                  | 06 next if O1 (X9 = 0)           |
|    | sF1           | = $\overline{04}\overline{\text{Ia}}\text{O100}\text{Tp}$   |                                  |
|    | sF2           | = $\overline{02} "$   |                                  |
|    | rJu           | = $\text{Tp}$   |                                  |
|    | Oc            | = $(\text{O103}\overline{\text{Ia}}+\overline{\text{End}}\overline{\text{Sk}})\text{Tp}$              |                                  |
|    | rO(1,3,4,5,6) | = $\text{Oc}$   |                                  |
|    | sO2           | = $\text{Oc}$   | NOP (20) → 0 if O1 (X9 = 1)      |

|    |    |               |                                      |                                 |            |
|----|----|---------------|--------------------------------------|---------------------------------|------------|
| 06 | T8 | End           | = F1F3                               |                                 |            |
|    |    | sIa           | = F1F3(1)KrT8                        |                                 |            |
|    | T7 | Ar3           | = (01020304)Q1                       |                                 |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                     |                                 |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "           | Recirculate A                   | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |                                 |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "           |                                 |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                     |                                 |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "           | Recirculate B                   | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |                                 |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "           |                                 |            |
|    |    | Cr3           | = $\overline{T}$ sF1F3Q1             |                                 |            |
|    |    | sC(0-2)       | = Add(1-3) $\overline{T}$ sCr306     |                                 |            |
|    |    | rC( " )       | = $\overline{Add}$ ( " ) " "         | Recirculate C                   | T7 thru T0 |
|    |    | sC(3-23)      | = C(0-20)Cr3                         |                                 |            |
|    |    | rC( " )       | = $\overline{C}$ ( " ) " "           |                                 |            |
|    |    | Pr3           | = F1GOQ2                             |                                 |            |
|    |    | sP(0-2)       | = Add(1-3)02040506Pr3                |                                 |            |
|    |    | rP( " )       | = $\overline{Add}$ ( " ) " "         | C + 1 → P                       | T7 thru T3 |
|    |    | sP(3-14)      | = P(0-11)Pr3                         |                                 |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) " "           |                                 |            |
|    |    | XZ(1-3)       | = $\overline{I}$ x                   |                                 |            |
|    |    | Yz(1-3)       | = C(21-23)07                         | Adder input (C)                 | T7 thru T0 |
|    |    | YZ( " )       | = $\overline{C}$ ( " ) " "           |                                 |            |
|    |    | sCz           | = KzF1Q1                             |                                 |            |
|    |    | rCz           | = $\overline{Kz}$ Q1                 | Carry logic                     | T7 thru T1 |
|    |    | rIa           | = (PI2PI3PI4)Q2F1                    |                                 |            |
|    | T4 | Sc            | = $\overline{Inr}$ T4                | Clear S                         |            |
|    |    | rS(1-14)      | = Sc                                 |                                 |            |
|    | T3 | Sxp           | = $\overline{Int}$ EndGOT3           |                                 |            |
|    |    | sS(1,2)       | = Add(2,3)02040506Sxp                |                                 |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                         | C+1 → S (C contains original P) |            |
|    | T0 | rCz           | = $\overline{F1}$ T0                 |                                 |            |
|    |    | rCp           | = $\overline{T}$ sHtKOF1(070403)02T0 |                                 |            |
|    | Tr | Cxm           | = EndGOTsm(Tr+Tp)                    | M → C (Fetch next instruction)  |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                         |                                 | Tr thru Tp |
|    |    | rC( " )       | = CxmTr                              |                                 |            |
|    |    | rRc           | = Tr                                 |                                 |            |
|    | Tp | rA00          | = EndGOTp                            |                                 |            |
|    |    | rB00          | = ( " )                              |                                 |            |
|    |    | sCp           | = M24CxmHtTsTp                       | Initiate parity                 |            |
|    |    | rF1           | = EndSkTp                            | 00 next clock (T8)              |            |
|    |    | rF2           | = ( " )                              |                                 |            |
|    |    | Oc            | = ( " )                              |                                 |            |
|    |    | rO(1,3,4,5,6) | = Oc                                 |                                 |            |
|    |    | sO2           | = Oc                                 | NOP (20) → 0                    |            |

| 43 | BRM                          | Mark Place and Branch  | P → (M)9-23 Of → (M)<br>M + 1 → P | 2 Cycles                           |
|----|------------------------------|--|-----------------------------------|------------------------------------|
| ∅0 | T8                           | rC24 = T8( $\overline{\text{TsTs}}\overline{\text{r}}$ )     |                                   | Initialize parity generation       |
|    |                              | rCz = ∅0T8   |                                   |                                    |
|    |                              | sHz = T8   |                                   |                                    |
|    |                              | sIx = C1G0∅0T8   |                                   | Initiate indexing                  |
|    |                              | sJu = $\overline{\text{IaGOC4C5C8C9T8}}$                     |                                   |                                    |
|    |                              | Oxc = $\overline{\text{IaGOC2∅0T8}}$                         |                                   |                                    |
|    |                              | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc                              |                                   | Instruction to 0 register          |
|    |                              | rO2 = $\overline{\text{C4Oxc}}$                              |                                   |                                    |
| T7 | Ar3                          | = $(\overline{\text{O1O2O3O4}})Q1$                           |                                   |                                    |
|    | sA(0-2)                      | = A(21-23) $\overline{\text{AnrAr3}}$                        |                                   |                                    |
|    | rA( " )                      | = $\overline{\text{A( " )}}$ "                               |                                   | Recirculate A T7 thru T0           |
|    | sA(3-23)                     | = A(0-20)Ar3   |                                   |                                    |
|    | rA( " )                      | = $\overline{\text{A( " )}}$ "                               |                                   |                                    |
|    | sB(0-2)                      | = B(21-23) $\overline{\text{BnrAr3}}$                        |                                   |                                    |
|    | rB( " )                      | = $\overline{\text{B( " )}}$ "                               |                                   | Recirculate B T7 thru T0           |
|    | sB(3-23)                     | = B(0-20)Ar3   |                                   |                                    |
|    | rB( " )                      | = $\overline{\text{B( " )}}$ "                               |                                   |                                    |
|    | Cr3                          | = $\overline{\text{Ts}}\∅0Q1$                                |                                   |                                    |
|    | sC0                          | = (P12)Ju $\overline{\text{TsCr3Q6}}$                        |                                   |                                    |
|    | rC0                          | = $(\overline{\text{ " }})$ "                                |                                   |                                    |
|    | sC(1,2)                      | = P(13,14)Ju $\overline{\text{TsCr3Q2}}$                     | P(1-14) → C(10-23)                | T7 thru T3                         |
|    | rC( " )                      | = $\overline{\text{P( " )}}$ "                               |                                   |                                    |
|    | sC(3-23)                     | = C(0-20)Cr3   |                                   |                                    |
|    | rC( " )                      | = $\overline{\text{C( " )}}$ "                               |                                   |                                    |
|    | sCp                          | = (C21- <del>C22</del> C23) $\overline{\text{CpTsHtQ1F1F2}}$ |                                   |                                    |
|    | rCp                          | = ( " )Cp "  |                                   | Parity check T7 thru T0            |
|    | Mxc                          | = Ju0105 $\overline{\text{Tsm}}$                             |                                   | Initialize store into memory       |
|    | Pr3                          | = JuQ2   |                                   | T7 thru Tp                         |
|    | sP(0-2)                      | = Add(1-3)Ju $\overline{\text{EaxPr3}}$                      |                                   |                                    |
|    | rP( " )                      | = $\overline{\text{Add( " )}}$ "                             |                                   |                                    |
|    | sP(3-14)                     | = P(0-11)Pr3   | C + X·Ix → P                      | T7 thru T3                         |
|    | rP( " )                      | = $\overline{\text{P( " )}}$ "                               |                                   |                                    |
|    | Xz(1-3)                      | = Xn(1-3) $\∅0Ix$  |                                   |                                    |
|    | $\overline{\text{Xz}}$ ( " ) | = $\overline{\text{Xn( " )}}\∅0Ix+\overline{\text{Ix}}$      |                                   | Adder input (X·Ix) T7 thru T0      |
|    | Yz(1-3)                      | = C(21-23) $\∅7$   |                                   |                                    |
|    | $\overline{\text{Yz}}$ ( " ) | = $\overline{\text{C( " )}}$ "                               |                                   | Adder input (C) T7 thru T0         |
|    | sCz                          | = KzQ1 $\overline{\text{T0}}$                                |                                   |                                    |
|    | rCz                          | = $\overline{\text{KzQ1}}$                                   |                                   | Carry logic T7 thru T1             |
| T6 | sC24                         | = $\overline{\text{C24(TsTs}r\text{COC1C2)(Q3+Q5)}}$         |                                   |                                    |
|    | rC24                         | = C24( " ) ( " )   |                                   | Generate parity T6 thru Tr         |
| T4 | Sc                           | = $\overline{\text{InrF1F2T4}}$                              |                                   |                                    |
|    | rS(1-14)                     | = Sc   |                                   | Clear S                            |
| T3 | rC0                          | = Ju $\overline{\text{TsCr3Q4Q6}}$                           |                                   | No input to C3, C6, C9 T3 thru T1  |
|    | rM(0-24)                     | = T3   |                                   |                                    |
|    | Sxp                          | = $\overline{\text{IntJuEaxGOT3}}$                           |                                   |                                    |
|    | sS(1,2)                      | = Add(2,3)(Ju $\overline{\text{Eax+O2O4O5O6}}$ )Sxp          |                                   |                                    |
|    | sS(3-14)                     | = P(0-11)Sxp   | P → S P(C+X·Ix)                   |                                    |
| T2 | sC(0-2)                      | = $\overline{\text{E2m(0-2)T2(JuTs)Cr3}}$                    |                                   | Record bank register 2 into C(6-8) |
|    | rC( " )                      | = $\overline{\text{E2m( " )T2( " )}}$ "                      |                                   |                                    |
| T1 | sC(0-2)                      | = $\overline{\text{E3m(0-2)T2(JuTs)Cr3}}$                    |                                   | Record bank register 3 into C(3-5) |
|    | rC( " )                      | = $\overline{\text{E3m( " )T2( " )}}$ "                      |                                   |                                    |

|    |          |   |                               |
|----|----------|---|-------------------------------|
| T0 | rCz      | = $\overline{FlT0}$                               |                               |
|    | sC0      | = $Of(Ju\overline{I}sCr3T0)$                      |                               |
|    | rC0      | = $\overline{Of}$ ( " )                           | Set C0 if overflow            |
|    | rC(1,2)  | = $Ju\overline{I}sCr3T0$                          | No input to C1, C2            |
| Tr | sHt      | = $Cp\overline{Tr}(Kp\overline{K0}\overline{02})$ | Parity error                  |
|    | rIx      | = $(\overline{FlF3})(\overline{GOHt})Tr$          |                               |
|    | rRc      | = Tr  |                               |
| Tp | sF1      | = $\overline{O4Ia01}\overline{00}Tp$              |                               |
|    | sF2      | = $\overline{O2}$ "                               | $\emptyset 6$ next clock (T8) |
|    | rJu      | = Tp  |                               |
|    | sM(0-24) | = C(0-24)MxcTp                                    | C → M                         |

The C register at Tp contains the following information:

|              |                                       |
|--------------|---------------------------------------|
| C0           | = State of the Overflow Flip-Flop     |
| C1 thru C2   | = $\emptyset$                         |
| C3 thru C5   | = Contents of Bank Register 3         |
| C6 thru C8   | = Contents of Bank Register 2         |
| C9           | = $\emptyset$                         |
| C10 thru C23 | = Original contents of the P register |

|    |      |                       |                                    |                                  |            |
|----|------|-----------------------|------------------------------------|----------------------------------|------------|
| 06 | T8   | End                   | = F1F2                             |                                  |            |
|    |      | sIa                   | = F1F3( <del>K</del> CrT8)         | Initiate P register increment    |            |
| T7 | Ar3  | Ar3                   | = (01020304)Q1                     |                                  |            |
|    |      | sA(0-2)               | = A(21-23)ArAr3                    |                                  |            |
|    |      | rA( " )               | = $\overline{A}$ ( " ) "           | Recirculate A                    | T7 thru T0 |
|    |      | sA(3-23)              | = A(0-20)Ar3                       |                                  |            |
|    |      | rA( " )               | = $\overline{A}$ ( " ) "           |                                  |            |
|    |      | sB(0-2)               | = B(21-23)BnrAr3                   |                                  |            |
|    |      | rB( " )               | = $\overline{B}$ ( " ) "           | Recirculate B                    | T7 thru T0 |
|    |      | sB(3-23)              | = B(0-20)Ar3                       |                                  |            |
|    |      | rB( " )               | = $\overline{B}$ ( " ) "           |                                  |            |
|    |      | Cr3                   | = F1F3(TsQ1)                       |                                  |            |
|    |      | sC(0-2)               | = Add(1-3)TsCr306                  |                                  |            |
|    |      | rC( " )               | = $\overline{\text{Add}}$ ( " ) "  | Recirculate C                    | T7 thru T0 |
|    |      | sC(3-23)              | = C(0-20)Cr3                       |                                  |            |
|    |      | rC( " )               | = $\overline{C}$ ( " ) "           |                                  |            |
|    |      | Pr3                   | = F1G0Q2                           |                                  |            |
|    |      | sP0                   | = (F1G0(02040506))(P12P13P14Ia)Pr3 |                                  |            |
|    |      | rP0                   | = ( " ) ( " ) "                    |                                  |            |
|    |      | sP1                   | = ( " ) (P13P14Ia)Pr3              | P+1 → P (P contains the original |            |
|    |      | rP1                   | = ( " ) ( " ) "                    | contents of the C register.)     |            |
|    |      | sP2                   | = ( " ) (P14Ia)Pr3                 |                                  | T7 thru T3 |
|    |      | rP2                   | = ( " ) ( " ) "                    |                                  |            |
|    |      | rIa                   | = (P12P13P14)Q2F1                  |                                  |            |
|    |      | sP(3-14)              | = P(0-11)Pr3                       |                                  |            |
|    |      | rP( " )               | = $\overline{P}$ ( " ) "           |                                  |            |
|    |      | Xz(1-3)               | = $\overline{I_x}$                 |                                  |            |
|    |      | Yz(1-3)               | = C(21-23)07                       | Adder input (C)                  | T7 thru T0 |
|    |      | $\overline{Yz}$ ( " ) | = $\overline{C}$ ( " ) "           |                                  |            |
|    |      | sCz                   | = KzQ1F1                           | Carry logic                      | T7 thru T0 |
|    |      | rCz                   | = $\overline{KzQ1}$                |                                  |            |
| T4 | Sc   | Sc                    | = InrT4                            | Clear S                          |            |
|    |      | rS(1-14)              | = Sc                               |                                  |            |
| T3 | Sxp  | Sxp                   | = IntEndGOT3                       |                                  |            |
|    |      | sS1                   | = (F1G0(02040506))(P13P14Ia)Sxp    |                                  |            |
|    |      | sS2                   | = ( " ) (P14Ia)Sxp                 | P → S                            |            |
|    |      | sS(3-14)              | = P(0-11)Sxp                       |                                  |            |
| T0 | rCp  | rCp                   | = TsHtK0(F1070403)02T0             |                                  |            |
| Tr | Cxm  | Cxm                   | = EndGOTsm(Tr+Tp)                  | M → C (Fetch next instruction)   |            |
|    |      | sC(0-23)              | = M(0-23)Cxm                       |                                  | Tr thru Tp |
|    |      | rC( " )               | = CxmTr                            |                                  |            |
|    |      | rRc                   | = Tr                               |                                  |            |
| Tp | rA00 | rA00                  | = EndGOTp                          |                                  |            |
|    |      | rB00                  | = ( " )                            |                                  |            |
|    |      | sCp                   | = M24CxmHtTsTp                     | Initiate parity                  |            |
|    |      | rF(1,2)               | = EndSkTp                          | 00 next clock (T8)               |            |
|    |      | Oc                    | = ( " )                            |                                  |            |
|    |      | rO(1,3,4,5,6)         | = Oc                               |                                  |            |
|    |      | sO2                   | = Oc                               | NOP (20) → 0                     |            |

|               |             |               |   |  |
|---------------|-------------|---------------|---|--|
| 46            | CLX 00000,2 | Clear X       |   | 1 Cycle  |
| $\emptyset 0$ | T8          | rC24          | = $T8(\overline{T_s T_{sr}})$   |  |
|               |             | rCz           | = $\emptyset 0 T8$  |  |
|               |             | sF1           | = $(\emptyset 0 T8 \overline{I_a} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4}))$ | $\emptyset 5$ next (T7)                          |
|               |             | sF3           | = ( " )   |  |
|               |             | sHz           | = T8  |  |
|               |             | sIa           | = $\emptyset 0 T8 \overline{I_a} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4})$   | initiate P register increment                    |
|               |             | sIx           | = $\emptyset 0 T8 C1 G0$  | Initialize Clear X                               |
|               |             | Oxc           | = $(\emptyset 0 T8 \overline{I_a} G0) \overline{C2}$  |  |
|               |             | sO(1,3,4,5,6) | = $Oxc C(3,5,6,7,8)$  | C(3-8) $\rightarrow$ 0 instruction to 0 register |
|               |             | rO2           | = $Oxc \overline{C4}$   |  |
|               |             | sRc           | = $(\emptyset 0 T8 \overline{I_a} G0) \overline{C2} \overline{C3} \overline{C4} \overline{C5} \overline{C6}$  |  |
| $\emptyset 5$ | T7          | Ar3           | = $(01020304) Q1$   |  |
|               |             | sA(0-2)       | = $A(21-23) \overline{A} n r A r 3$   |  |
|               |             | rA( " )       | = $\overline{A}( " ) " "$   | Recirculate A T7 thru T0                         |
|               |             | sA(3-23)      | = $A(0-20) A r 3$   |  |
|               |             | rA( " )       | = $\overline{A}( " ) " "$   |  |
|               |             | sB(0-2)       | = $B(21-23) \overline{B} n r A r 3$   |  |
|               |             | rB( " )       | = $\overline{B}( " ) " "$   | Recirculate B T7 thru T0                         |
|               |             | sB(3-23)      | = $B(0-20) A r 3$   |  |
|               |             | rB( " )       | = $\overline{B}( " ) " "$   |  |
|               |             | End           | = $\emptyset 5 (\overline{A00} + \overline{G0})$  | last cycle                                       |
|               |             | Pr3           | = $(F1 G0) Q2$  |  |
|               |             | sP0           | = $(F1 G0 (\overline{02040506})) (P12 \oplus (P13 P14 I_a))$  |  |
|               |             | rP0           | = ( " ) $(P12 \oplus (P13 P14 I_a))$  |  |
|               |             | sP1           | = ( " ) $(P13 \oplus (P14 I_a))$  |  |
|               |             | rP1           | = ( " ) $(P13 \oplus (P14 I_a))$  | P+1 $\rightarrow$ P T7 thru T3                   |
|               |             | sP2           | = ( " ) $(P14 \oplus I_a)$  |  |
|               |             | rP2           | = ( " ) $(P14 \oplus I_a)$  |  |
|               |             | rIa           | = $(\overline{P12} \overline{P13} \overline{P14}) Q2 F1$  |  |
|               |             | sP(3-14)      | = $P(0-11) P r 3$   |  |
|               |             | rP( " )       | = $\overline{P}( " ) " "$   |  |
|               |             | Xnr           | = $(01020304 I_x)$  | T7   |
| T6            |             | sXw(1-3)      | = ( " ) $Xw(1-3) \overline{T7}$   | $\emptyset \rightarrow X$ T6 thru T0             |
|               |             | rXw( " )      | = ( " ) $Xw( " ) \overline{T7}$   |  |
| T4            |             | Sc            | = $T4 (\text{End} + \overline{F1} \overline{F2}) \overline{I} n r$  |  |
|               |             | rS(1-14)      | = Sc  | Clear S  |
| T3            |             | Sxp           | = $T3 \overline{I} n t (\text{End} + \overline{J u} \overline{E a x}) G0 + T3 (\overline{K m c})$             |  |
|               |             | sS1           | = $(F1 G0 (\overline{02040506})) (P13 \oplus (P14 I_a)) Sxp$  |  |
|               |             | sS2           | = ( " ) $(P14 \oplus I_a) Sxp$  | P $\rightarrow$ S                                |
|               |             | sS(3-14)      | = $P(0-11) Sxp$   |  |
| Tr            |             | Cxm           | = $\text{End} G0 \overline{T} s m (\overline{T r} + \overline{T p})$  |  |
|               |             | sC(0-23)      | = $M(0-23) Cxm$   | M $\rightarrow$ C Tr + Tp                        |
|               |             | rC( " )       | = $\overline{M}( " ) " "$   |  |
|               |             | rIa           | = $\overline{T r} \overline{F1}$  |  |
|               |             | rIx           | = $\overline{T r} (\overline{F1} \overline{F3}) (\overline{G0} \overline{Ht})$                                |  |
|               |             | rRc           | = Tr  |  |
| Tp            |             | rF1           | = $\overline{T p} \overline{E} n d \overline{S} k$  |  |
|               |             | rF3           | = ( " )   | $\emptyset 0$ next clock (T8)                    |
|               |             | rRf           | = $\overline{T p} \overline{01} (\overline{G0} \overline{Ht})$  |  |
|               |             | rJu           | = Tp  |  |
|               |             | Oc            | = $\overline{T p} \overline{E} n d \overline{S} k$  |  |
|               |             | rO(1,3,4,5,6) | = Oc  | 100 NOP (20) $\rightarrow$ 0                     |
|               |             | sO2           | = Oc  |  |

|    |           |               |   |                                      |
|----|-----------|---------------|---|--------------------------------------|
| 46 | CLA 00001 | Clear A       |   | 1 Cycle                              |
| ∅0 | T8        | rC24          | = $T8(\overline{TsTsr})$                                      |                                      |
|    |           | rCz           | = $\emptyset0T8$  |                                      |
|    |           | sF1           | = $(\emptyset0T8\overline{IaC2C5C8}(\overline{C3+C4}))$       |                                      |
|    |           | sF3           | = ( " )   | ∅5 next (T7)                         |
|    |           | sHz           | = T8  |                                      |
|    |           | sIa           | = $\emptyset0T8\overline{IaC2C5C8}(\overline{C3+C4})$         | initiate P register increment        |
|    |           | Oxc           | = $(\emptyset0T8\overline{IaGO})C2$                           |                                      |
|    |           | sO(1,3,4,5,6) | = $OxcC(3,5,6,7,8)$   | C(3-8) → 0 instruction to 0 register |
|    |           | rO2           | = $OxcC4$   |                                      |
| ∅5 | T7        | sRc           | = $(\emptyset0T8\overline{IaGO})\overline{C2C3C4C5C6}$        |                                      |
|    |           | Ar3           | = $(01020304)Q1$  |                                      |
|    |           | Anr           | = $RcC23$   |                                      |
|    |           | sA(3-23)      | = $A(0-20)Ar3$  | no inputs to A(0-2)                  |
|    |           | rA( " )       | = $\overline{A( " ) "}$                                       | causes ∅ → A T7 thru T0              |
|    |           | sB(0-2)       | = $B(21-23)\overline{BnrAr3}$                                 |                                      |
|    |           | rB( " )       | = $\overline{B( " ) "}$                                       |                                      |
|    |           | sB(3-23)      | = $B(0-20)Ar3$  | Recirculate B T7 thru T0             |
|    |           | rB( " )       | = $\overline{B( " ) "}$                                       |                                      |
|    |           | End           | = $\emptyset5(\overline{A00+G0})$                             | last cycle                           |
|    |           | Pr3           | = $(F1GO)Q2$  |                                      |
|    |           | sP0           | = $(F1GO(\overline{02040506})) (P12\oplus(P13P14Ia))$         |                                      |
|    |           | rP0           | = ( " ) $(P12\oplus(P13P14Ia))$                               |                                      |
|    |           | sP1           | = ( " ) $(P13\oplus(P14Ia))$                                  |                                      |
|    |           | rP1           | = ( " ) $(P13\oplus(P14Ia))$                                  | P+1 → P T7 thru T3                   |
|    |           | sP2           | = ( " ) $(P14\oplus Ia)$                                      |                                      |
|    |           | rP2           | = ( " ) $(P14\oplus Ia)$                                      |                                      |
|    |           | rIa           | = $(P12P13P14)Q2F1$   |                                      |
|    |           | sP(3-14)      | = $P(0-11)Pr3$  |                                      |
|    |           | rP( " )       | = $\overline{P( " ) "}$                                       |                                      |
| T4 | Sc        |               | = $T4(\overline{End+F1F2})\overline{Inr}$                     | Clear S                              |
|    |           | rS(1-14)      | = Sc  |                                      |
| T3 | Sxp       |               | = $T3\overline{Int}(\overline{End+JuEax})\overline{GO+T3Kmc}$ |                                      |
|    |           | sS1           | = $(F1GO(\overline{02040506})) (P13\oplus(P14Ia))Sxp$         |                                      |
|    |           | sS2           | = ( " ) $(P14\oplus Ia)Sxp$                                   | P → S                                |
|    |           | sS(3-14)      | = $P(0-11)Sxp$  |                                      |
| Tr | Cxm       |               | = $\overline{EndGO}\overline{Tsm}(\overline{Tr+Tp})$          |                                      |
|    |           | sC(0-24)      | = $M(0-24)Cxm$  | M → C Tr + Tp                        |
|    |           | rC( " )       | = $\overline{M( " ) "}$                                       |                                      |
|    |           | rIa           | = $\overline{TrF1}$   |                                      |
|    |           | rIx           | = $\overline{Tr(F1F3)}(\overline{GOHt})$                      |                                      |
|    |           | rRc           | = Tr  |                                      |
| Tp | rF1       |               | = $\overline{TpEndS\overline{k}}$                             |                                      |
|    |           | rF3           | = ( " )   | ∅0 next clock (T8)                   |
|    |           | rRf           | = $\overline{Tp\overline{01}}(\overline{GOHt})$               |                                      |
|    |           | rJu           | = Tp  |                                      |
|    |           | Oc            | = $\overline{TpEndS\overline{k}}$                             |                                      |
|    |           | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                         |
|    |           | sO2           | = Oc  |                                      |

|               |           |               |  |  |
|---------------|-----------|---------------|--|--|
| 46            | CLB 00002 | Clear B       |  | 1 Cycle  |
| $\emptyset 0$ | T8        | rC24          | = $T8(\overline{T_s T_{sr}})$  |  |
|               |           | rCz           | = $\emptyset 0 T8$   |  |
|               |           | sF1           | = $(\emptyset 0 T8 \overline{I_a C2 C5 C8} (\overline{C3 + C4}))$        | $\emptyset 5$ next (T7)                          |
|               |           | sF3           | = ( " )  |  |
|               |           | sHz           | = T8   |  |
|               |           | sIa           | = $\emptyset 0 T8 \overline{I_a C2 C5 C8} (\overline{C3 + C4})$          | initiate P register increment                    |
|               |           | Oxc           | = $(\emptyset 0 T8 \overline{I_a G0}) C2$                                |  |
|               |           | sO(1,3,4,5,6) | = $Oxc C(3,5,6,7,8)$   | C(3-8) $\rightarrow$ 0 instruction to 0 register |
|               |           | rO2           | = $Oxc \overline{C4}$  |  |
| $\emptyset 5$ | T7        | sRc           | = $(\emptyset 0 T8 \overline{I_a G0}) \overline{C2 C3 C4 C5 C6}$         |  |
|               |           | Ar3           | = $(01020304) Q1$  |  |
|               |           | sA(0-2)       | = $A(21-23) \overline{Anr} Ar3$  |  |
|               |           | rA( " )       | = $\overline{A( " ) "}$  | Recirculate A                                    |
|               |           | sA(3-23)      | = $A(0-20) Ar3$  | T7 thru T0                                       |
|               |           | rA( " )       | = $\overline{A( " ) "}$  |  |
|               |           | Bnr           | = $Rc C22$   |  |
|               |           | sB(3-23)      | = $B(0-20) Ar3$  | no inputs to B(0-2)                              |
|               |           | rB( " )       | = $\overline{B( " ) "}$  | causes $\emptyset \rightarrow B$                 |
|               |           | End           | = $\emptyset 5 (\overline{A00 + G0})$                                    | last cycle                                       |
|               |           | Pr3           | = $(F1 G0) Q2$   |  |
|               |           | sP0           | = $(F1 G0 (\overline{02040506})) (P12 \oplus (P13 P14 I_a))$             |  |
|               |           | rP0           | = ( " ) $(P12 \oplus (P13 P14 I_a))$                                     |  |
|               |           | sP1           | = ( " ) $(P13 \oplus (P14 I_a))$   |  |
|               |           | rP1           | = ( " ) $(P13 \oplus (P14 I_a))$   | P+1 $\rightarrow$ P                              |
|               |           | sP2           | = ( " ) $(P14 \oplus I_a)$   |  |
|               |           | rP2           | = ( " ) $(P14 \oplus I_a)$   |  |
|               |           | rIa           | = $(P12 P13 P14) Q2 F1$  |  |
|               |           | sP(3-14)      | = $P(0-11) Pr3$  |  |
|               |           | rP( " )       | = $\overline{P( " ) "}$  |  |
| T4            |           | Sc            | = $T4 (\overline{End + F1 F2}) \overline{Inr}$                           | Clear S  |
|               |           | rS(1-14)      | = Sc   |  |
| T3            |           | Sxp           | = $T3 \overline{Int} (\overline{End + Ju Eax}) G0 + T3 (\overline{Kmc})$ |  |
|               |           | sS1           | = $(F1 G0 (\overline{02040506})) (P13 \oplus (P14 I_a)) Sxp$             |  |
|               |           | sS2           | = ( " ) $(P14 \oplus I_a) Sxp$   | P $\rightarrow$ S                                |
|               |           | sS(3-14)      | = $P(0-11) Sxp$  |  |
| Tr            |           | Cxm           | = $\overline{End G0 Tsm} (\overline{Tr + Tp})$                           |  |
|               |           | sC(0-23)      | = $\overline{M(0-23) Cxm}$   | M $\rightarrow$ C                                |
|               |           | rC( " )       | = $\overline{M( " ) "}$  | Tr + Tp  |
|               |           | rIa           | = $\overline{Tr F1}$   |  |
|               |           | rIx           | = $\overline{Tr (F1 F3) (G0 Ht)}$  |  |
|               |           | rRc           | = Tr   |  |
| Tp            |           | rF1           | = $\overline{Tp End S_k}$  | $\emptyset 0$ next clock (T8)                    |
|               |           | rF3           | = ( " )  |  |
|               |           | rRf           | = $\overline{Tp \emptyset 1 (G0 Ht)}$                                    |  |
|               |           | rJu           | = Tp   |  |
|               |           | Oc            | = $\overline{Tp End S_k}$  |  |
|               |           | rO(1,3,4,5,6) | = Oc   | NOP (20) $\rightarrow$ 0                         |
|               |           | sO2           | = Oc   |  |



|    | 6  | CAB 00004     | Copy A into B  |                                      | 1 Cycle    |
|----|----|---------------|--|--------------------------------------|------------|
| 00 | T8 | rC24          | = $T8(\overline{TsTsr})$   |                                      |            |
|    |    | rCz           | = $\emptyset T8$   |                                      |            |
|    |    | sF1           | = $(\emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4}))$           | $\emptyset 5$ next (T7)              |            |
|    |    | sF3           | = ( " )  |                                      |            |
|    |    | sHz           | = T8   |                                      |            |
|    |    | sIa           | = $\emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4})$             | initiate P register increment        |            |
|    |    | Oxc           | = $(\emptyset T8 \overline{Ia} \overline{GO}) \overline{C2}$   |                                      |            |
|    |    | sO(1,3,4,5,6) | = $OxcC(3,5,6,7,8)$  | C(3-8) → 0 instruction to 0 register |            |
|    |    | rO2           | = $Oxc\overline{C4}$   |                                      |            |
|    |    | sRc           | = $(\emptyset T8 \overline{Ia} \overline{GO}) \overline{C2} \overline{C3} \overline{C4} \overline{C5} \overline{C6}$ |                                      |            |
| 05 | T7 | Ar3           | = $(O1020304)Q1$   |                                      |            |
|    |    | sA(0-2)       | = $A(21-23) \overline{Anr} Ar3$  |                                      |            |
|    |    | rA( " )       | = $\overline{A}( " ) " "$  | Recirculate A                        | T7 thru T0 |
|    |    | sA(3-23)      | = $A(0-20) Ar3$  |                                      |            |
|    |    | rA( " )       | = $\overline{A}( " ) " "$  |                                      |            |
|    |    | Bnr           | = $RcC21$  |                                      |            |
|    |    | sB(0-2)       | = $A(21-23) RcC21 Ar3$   |                                      |            |
|    |    | rB( " )       | = $\overline{A}( " ) " "$  | A → B                                | T7 thru T0 |
|    |    | sB(3-23)      | = $B(0-20) Ar3$  |                                      |            |
|    |    | rB( " )       | = $\overline{B}( " ) " "$  |                                      |            |
|    |    | End           | = $\emptyset 5 (\overline{A00} + \overline{GO})$   | last cycle                           |            |
|    |    | Pr3           | = $(F1GO)Q2$   |                                      |            |
|    |    | sP0           | = $(F1GO(\overline{O2040506})) (P12 \oplus (P13P14Ia))$  |                                      |            |
|    |    | rP0           | = ( " ) $(P12 \oplus (P13P14Ia))$  |                                      |            |
|    |    | sP1           | = ( " ) $(P13 \oplus (P14Ia))$   |                                      |            |
|    |    | rP1           | = ( " ) $(P13 \oplus (P14Ia))$   | P+1 → P                              | T7 thru T3 |
|    |    | sP2           | = ( " ) $(P14 \oplus Ia)$  |                                      |            |
|    |    | rP2           | = ( " ) $(P14 \oplus Ia)$  |                                      |            |
|    |    | rIa           | = $(P12P13P14)Q2F1$  |                                      |            |
|    |    | sP(3-14)      | = $P(0-11) Pr3$  |                                      |            |
|    |    | rP( " )       | = $\overline{P}( " ) " "$  |                                      |            |
| T4 |    | Sc            | = $T4(\overline{End} + \overline{F1F2}) \overline{Inr}$  | Clear S                              |            |
|    |    | rS(1-14)      | = Sc   |                                      |            |
| T3 |    | Sxp           | = $T3 \overline{Int} (\overline{End} + \overline{JuEax}) \overline{GO} + T3(\overline{mc})$                          |                                      |            |
|    |    | sS1           | = $(F1GO(\overline{O2040506})) (P13 \oplus (P14Ia)) Sxp$   |                                      |            |
|    |    | sS2           | = ( " ) $(P14 \oplus Ia) Sxp$  | P → S                                |            |
|    |    | sS(3-14)      | = $P(0-11) Sxp$  |                                      |            |
| Tr |    | Cxm           | = $\overline{End} \overline{GO} \overline{Tsm} (\overline{Tr} + \overline{Tp})$                                      |                                      |            |
|    |    | sC(0-23)      | = $M(0-23) Cxm$  | M → C                                | Tr + Tp    |
|    |    | rC( " )       | = $\overline{M}( " ) " "$  |                                      |            |
|    |    | rIa           | = $\overline{Tr} \overline{F1}$  |                                      |            |
|    |    | rIx           | = $\overline{Tr} (\overline{F1F3}) (\overline{GO} \overline{Ht})$  |                                      |            |
|    |    | rRc           | = Tr   |                                      |            |
| Tp |    | rF1           | = $\overline{Tp} \overline{End} \overline{Sk}$   | $\emptyset 0$ next clock (T8)        |            |
|    |    | rF3           | = ( " )  |                                      |            |
|    |    | rRf           | = $\overline{Tp} \overline{01} (\overline{GO} \overline{Ht})$  |                                      |            |
|    |    | rJu           | = Tp   |                                      |            |
|    |    | Oc            | = $\overline{Tp} \overline{End} \overline{Sk}$   |                                      |            |
|    |    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                         |            |
|    |    | sO2           | = Oc   |                                      |            |

|    |           |               |  |                                      |
|----|-----------|---------------|--|--------------------------------------|
| 46 | CBA 00010 | Copy B into A |  | 1 Cycle                              |
| ∅0 | T8        | rC24          | = T8( $\overline{\text{TsTsr}}$ )  |                                      |
|    |           | rCz           | = ∅0T8   |                                      |
|    |           | sF1           | = (∅0T8 $\overline{\text{IaG2C5C8}}$ ( $\overline{\text{C3+C4}}$ ))                            | ∅5 next (T7)                         |
|    |           | sF3           | = ( " " )  |                                      |
|    |           | sHz           | = T8   |                                      |
|    |           | sIa           | = ∅0T8 $\overline{\text{IaG2C5C8}}$ ( $\overline{\text{C3+C4}}$ )                              | initiate P register increment        |
|    |           | Oxc           | = (∅0T8 $\overline{\text{IaG0}}$ ) $\overline{\text{C2}}$                                      |                                      |
|    |           | sO(1,3,4,5,6) | = OxcC(3,5,6,7,8)  | C(3-8) → 0 instruction to 0 register |
|    |           | rO2           | = Oxc $\overline{\text{C4}}$   |                                      |
|    |           | sRc           | = (∅0T8 $\overline{\text{IaG0}}$ ) $\overline{\text{C2C3C4C5C6}}$                              |                                      |
| ∅5 | T7        | Ar3           | = (01020304)Q1   |                                      |
|    |           | Anr           | = RcC20  |                                      |
|    |           | sA(0-2)       | = B(21-23)RcC20Ar3   |                                      |
|    |           | rA( " )       | = $\overline{\text{B}}$ ( " ) " "  | B → A T7 thru T0                     |
|    |           | sA(3-23)      | = A(0-20)Ar3   |                                      |
|    |           | rA( " )       | = $\overline{\text{A}}$ ( " ) " "  |                                      |
|    |           | sB(0-2)       | = B(21-23) $\overline{\text{Bnr}}$ Ar3   |                                      |
|    |           | rB( " )       | = $\overline{\text{B}}$ ( " ) " "  | Recirculate B T7 thru T0             |
|    |           | sB(3-23)      | = B(0-20)Ar3   |                                      |
|    |           | rB( " )       | = $\overline{\text{B}}$ ( " ) " "  |                                      |
|    |           | End           | = ∅5( $\overline{\text{A00+G0}}$ )   | last cycle                           |
|    |           | Pr3           | = (F1G0)Q2   |                                      |
|    |           | sP0           | = (F1G0( $\overline{\text{02040506}}$ ))(P12 $\oplus$ (P13P14Ia))                              |                                      |
|    |           | rP0           | = ( " " ) (P12 $\oplus$ (P13P14Ia))  |                                      |
|    |           | sP1           | = ( " " ) (P13 $\oplus$ (P14Ia))   |                                      |
|    |           | rP1           | = ( " " ) (P13 $\oplus$ (P14Ia))   | P+1 → P T7 thru T3                   |
|    |           | sP2           | = ( " " ) (P14 $\oplus$ Ia)  |                                      |
|    |           | rP2           | = ( " " ) (P14 $\oplus$ Ia)  |                                      |
|    |           | rIa           | = (P12P13P14)Q2F1  |                                      |
|    |           | sP(3-14)      | = P(0-11)Pr3   |                                      |
|    |           | rP( " )       | = $\overline{\text{P}}$ ( " ) " "  |                                      |
| T4 |           | Sc            | = T4(End+F1F2) $\overline{\text{Inr}}$   | Clear S                              |
|    |           | rS(1-14)      | = Sc   |                                      |
| T3 |           | Sxp           | = T3 $\overline{\text{Int}}$ (End+Ju $\overline{\text{Eax}}$ )G0+T3( $\overline{\text{Kmc}}$ ) |                                      |
|    |           | sS1           | = (F1G0( $\overline{\text{02040506}}$ ))(P13 $\oplus$ (P14Ia))Sxp                              |                                      |
|    |           | sS2           | = ( " " ) (P14 $\oplus$ Ia)Sxp   | P → S                                |
|    |           | sS(3-14)      | = P(0-11)Sxp   |                                      |
| Tr |           | Cxm           | = EndG0 $\overline{\text{Tsm}}$ (Tr+Tp)  |                                      |
|    |           | sC(0-23)      | = M(0-23)Cxm   | M → C Tr + Tp                        |
|    |           | rC( " )       | = $\overline{\text{M}}$ ( " ) " "  |                                      |
|    |           | rIa           | = TrF1   |                                      |
|    |           | rIx           | = Tr( $\overline{\text{F1F3}}$ )( $\overline{\text{GOHt}}$ )                                   |                                      |
|    |           | rRc           | = Tr   |                                      |
| Tp |           | rF1           | = TpEnd $\overline{\text{Sk}}$   |                                      |
|    |           | rF3           | = ( " " )  | ∅0 next clock (T8)                   |
|    |           | rRf           | = Tp $\overline{\text{01}}$ ( $\overline{\text{GOHt}}$ )                                       |                                      |
|    |           | rJu           | = Tp   |                                      |
|    |           | Oc            | = TpEnd $\overline{\text{Sk}}$   |                                      |
|    |           | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                         |
|    |           | sO2           | = Oc   |                                      |

|    |           |               |  |                                      |
|----|-----------|---------------|--|--------------------------------------|
| 46 | CBX 00020 | Copy B into X |  | 1 Cycle                              |
| 00 | T8        | rC24          | = $T8(\overline{TsTsr})$   |                                      |
|    |           | rCz           | = $\emptyset 0T8$  |                                      |
|    |           | sF1           | = $(\emptyset 0T8\overline{Ia}\overline{C2}\overline{C5}\overline{C8}(\overline{C3}+\overline{C4}))$ |                                      |
|    |           | sF3           | = ( " )  | 05 next (T7)                         |
|    |           | sHz           | = T8   |                                      |
|    |           | sIa           | = $\emptyset 0T8\overline{Ia}\overline{C2}\overline{C5}\overline{C8}(\overline{C3}+\overline{C4})$   | initiate P register increment        |
|    |           | Oxc           | = $(\emptyset 0T8\overline{Ia}GO)\overline{C2}$  |                                      |
|    |           | sO(1,3,4,5,6) | = $OxcC(3,5,6,7,8)$  | C(3-8) → 0 instruction to 0 register |
|    |           | rO2           | = $Oxc\overline{C4}$   |                                      |
|    |           | sRc           | = $(\emptyset 0T8\overline{Ia}GO)\overline{C2}\overline{C3}\overline{C4}\overline{C5}\overline{C6}$  |                                      |
| 05 | T7        | Ar3           | = $(01020304)Q1$   |                                      |
|    |           | sA(0-2)       | = $A(21-23)\overline{Anr}Ar3$  |                                      |
|    |           | rA( " )       | = $\overline{A}( " ) " "$  | Recirculate A                        |
|    |           | sA(3-23)      | = $A(0-20)Ar3$   | T7 thru T0                           |
|    |           | rA( " )       | = $\overline{A}( " ) " "$  |                                      |
|    |           | sB(0-2)       | = $B(21-23)\overline{Bnr}Ar3$  |                                      |
|    |           | rB( " )       | = $\overline{B}( " ) " "$  | Recirculate B                        |
|    |           | sB(3-23)      | = $B(0-20)Ar3$   | T7 thru T0                           |
|    |           | rB( " )       | = $\overline{B}( " ) " "$  |                                      |
|    |           | End           | = $\emptyset 5(\overline{A00}+\overline{GO})$  | last cycle                           |
|    |           | Pr3           | = $(F1GO)Q2$   |                                      |
|    |           | sP0           | = $(F1GO(\overline{02040506})) (P12\oplus(P13P14Ia))$  |                                      |
|    |           | rP0           | = ( " ) $(P12\oplus(P13P14Ia))$  |                                      |
|    |           | sP1           | = ( " ) $(P13\oplus(P14Ia))$   |                                      |
|    |           | rP1           | = ( " ) $(P13\oplus(P14Ia))$   | P+1 → P                              |
|    |           | sP2           | = ( " ) $(P14\oplus Ia)$   | T7 thru T3                           |
|    |           | rP2           | = ( " ) $(P14\oplus Ia)$   |                                      |
|    |           | rIa           | = $(P12P13P14)Q2F1$  |                                      |
|    |           | sP(3-14)      | = $P(0-11)Pr3$   |                                      |
|    |           | rP( " )       | = $\overline{P}( " ) " "$  |                                      |
|    |           | Xnr           | = $(Rc19)$   |                                      |
|    |           | sXw(1-3)      | = ( " ) $B(21-23)$   | B → X                                |
|    |           | rXw( " )      | = ( " ) $\overline{B}( " )$  | T7 thru T0                           |
| T4 |           | Sc            | = $T4(\overline{End}+\overline{F1F2})\overline{Inr}$   |                                      |
|    |           | rS(1-14)      | = Sc   | Clear S                              |
| T3 |           | Sxp           | = $T3\overline{Int}(\overline{End}+\overline{JuEax})GO+T3(\overline{Kmc})$                           |                                      |
|    |           | sS1           | = $(F1GO(\overline{02040506})) (P13\oplus(P14Ia))Sxp$  |                                      |
|    |           | sS2           | = ( " ) $(P14\oplus Ia)Sxp$  | P → S                                |
|    |           | sS(3-14)      | = $P(0-11)Sxp$   |                                      |
| Tr |           | Cxm           | = $\overline{End}GO\overline{Tsm}(Tr+Tp)$  |                                      |
|    |           | sC(0-23)      | = $M(0-23)Cxm$   | M → C                                |
|    |           | rC( " )       | = $\overline{M}( " ) " "$  | Tr + Tp                              |
|    |           | rIa           | = TrF1   |                                      |
|    |           | rIx           | = $Tr(\overline{F1F3})(\overline{GOHt})$   |                                      |
|    |           | rRc           | = Tr   |                                      |
| Tp |           | rF1           | = $Tp\overline{EndSk}$   |                                      |
|    |           | rF3           | = ( " )  | 00 next clock (T8)                   |
|    |           | rRf           | = $Tp\overline{01}(\overline{GOHt})$   |                                      |
|    |           | rJu           | = Tp   |                                      |
|    |           | Oc            | = $Tp\overline{EndSk}$   |                                      |
|    |           | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                         |
|    |           | sO2           | = Oc   |                                      |

|    |               |               |  |                                      |
|----|---------------|---------------|--|--------------------------------------|
| 46 | CXB 00040     | Copy X into B |  | 1 Cycle                              |
| 00 | T8            | rC24          | = $T8(\overline{TsTsr})$   |                                      |
|    |               | rCz           | = $\emptyset T8$   |                                      |
|    |               | sF1           | = $(\emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4}))$           | $\emptyset 5$ next (T7)              |
|    |               | sF3           | = ( " )  |                                      |
|    |               | sHz           | = T8   |                                      |
|    |               | sIa           | = $\emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4})$             | initiate P register increment        |
|    |               | Oxc           | = $(\emptyset T8 \overline{Ia} \overline{GO}) \overline{C2}$   |                                      |
|    |               | sO(1,3,4,5,6) | = $OxcC(3,5,6,7,8)$  | C(3-8) → 0 instruction to 0 register |
|    |               | rO2           | = $Oxc \overline{C4}$  |                                      |
|    |               | sRc           | = $(\emptyset T8 \overline{Ia} \overline{GO}) \overline{C2} \overline{C3} \overline{C4} \overline{C5} \overline{C6}$ |                                      |
| 05 | T7            | Ar3           | = $(O1O2O3O4)Q1$   |                                      |
|    |               | sA(0-2)       | = $A(21-23) \overline{Anr} Ar3$  |                                      |
|    |               | rA( " )       | = $\overline{A}( " )$ "  | Recirculate A                        |
|    |               | sA(3-23)      | = $A(0-20) Ar3$  | T7 thru T0                           |
|    |               | rA( " )       | = $\overline{A}( " )$ "  |                                      |
|    |               | Bnr           | = $RcC18$  |                                      |
|    |               | sB(0-2)       | = $Xn(1-3) RcC18 Ar3$  |                                      |
|    |               | rB( " )       | = $\overline{Xn}( " )$ "   | X → B                                |
|    |               | sB(3-23)      | = $B(0-20) Ar3$  | T7 thru T0                           |
|    |               | rB( " )       | = $\overline{B}( " )$ "  |                                      |
|    |               | End           | = $\emptyset 5 (\overline{A00} + \overline{G0})$   | last cycle                           |
|    |               | Pr3           | = $(F1GO)Q2$   |                                      |
|    |               | sP0           | = $(F1GO) (\overline{O2O4O5O6}) (P12 \oplus (P13P14Ia))$   |                                      |
|    |               | rP0           | = ( " ) $(P12 \oplus (P13P14Ia))$  |                                      |
|    |               | sP1           | = ( " ) $(P13 \oplus (P14Ia))$   |                                      |
|    |               | rP1           | = ( " ) $(P13 \oplus (P14Ia))$   | P+1 → P                              |
|    |               | sP2           | = ( " ) $(P14 \oplus Ia)$  |                                      |
|    |               | rP2           | = ( " ) $(P14 \oplus Ia)$  | T7 thru T3                           |
|    |               | rIa           | = $(P12P13P14)Q2F1$  |                                      |
|    |               | sP(3-14)      | = $P(0-11) Pr3$  |                                      |
|    |               | rP( " )       | = $\overline{P}( " )$ "  |                                      |
| T4 | Sc            |               | = $T4(\overline{End} + \overline{F1F2}) \overline{Inr}$  |                                      |
|    | rS(1-14)      |               | = Sc   | Clear S                              |
| T3 | Sxp           |               | = $T3 \overline{Int} (\overline{End} + \overline{JuEax}) \overline{GO} + T3 \overline{Kmc}$                          |                                      |
|    | sS1           |               | = $(F1GO) (\overline{O2O4O5O6}) (P13 \oplus (P14Ia)) Sxp$  |                                      |
|    | sS2           |               | = ( " ) $(P14 \oplus Ia) Sxp$  | P → S                                |
|    | sS(3-14)      |               | = $P(0-11) Sxp$  |                                      |
| Tr | Cxm           |               | = $\overline{End} \overline{GO} \overline{Tsm} (\overline{Tr} + \overline{Tp})$                                      |                                      |
|    | sC(0-23)      |               | = $M(0-23) Cxm$  | M → C                                |
|    | rC( " )       |               | = $\overline{M}( " )$ "  | Tr + Tp                              |
|    | rIa           |               | = TrF1   |                                      |
|    | rIx           |               | = $\overline{Tr} (\overline{F1F3}) (\overline{GO} \overline{Ht})$  |                                      |
|    | rRc           |               | = Tr   |                                      |
| Tp | rF1           |               | = $Tp \overline{End} \overline{Sk}$  |                                      |
|    | rF3           |               | = ( " )  | $\emptyset 0$ next clock (T8)        |
|    | rRf           |               | = $Tp \overline{01} (\overline{GO} \overline{Ht})$   |                                      |
|    | rJu           |               | = Tp   |                                      |
|    | Oc            |               | = $Tp \overline{End} \overline{Sk}$  |                                      |
|    | rO(1,3,4,5,6) |               | = Oc   | NOP (20) → 0                         |
|    | sO2           |               | = Oc   |                                      |

|    |               |   |   |
|----|---------------|---|---|
| 46 | RCH 00100     | Copy least significant 9 bits only<br>extend bit 15 throughout X when<br>X is designation register.   | 1 Cycle   |
| ∅0 | T8            | $rC24 = T8(\overline{TsTsr})$<br>$rCz = \emptyset T8$<br>$sF1 = (\emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4}))$<br>$sF3 = ( \quad " \quad )$<br>$sHz = T8$<br>$sIa = \emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4})$<br>$Oxc = (\emptyset T8 \overline{Ia} \overline{GO}) \overline{C2}$<br>$sO(1,3,4,5,6) = OxcC(3,5,6,7,8)$<br>$rO2 = Oxc\overline{C4}$<br>$sRc = (\emptyset T8 \overline{Ia} \overline{GO}) \overline{C2} \overline{C3} \overline{C4} \overline{C5} \overline{C6}$   | <br><br><br>∅5 next (T7)<br><br>initiate P register increment<br><br>C(3-8) → 0 instruction to 0 register |
| ∅5 | T7            | $Ar3 = (01020304)Q1$<br>$sA(0-2) = A(21-23)\overline{Anr}Ar3$<br>$rA( " ) = \overline{A}( " ) " "$<br>$sA(3-23) = A(0-20)Ar3$<br>$rA( " ) = \overline{A}( " ) " "$<br>$sB(0-2) = B(21-23)\overline{Bnr}Ar3$<br>$rB( " ) = \overline{B}( " ) " "$<br>$sB(3-23) = B(0-20)Ar3$<br>$rB( " ) = \overline{B}( " ) " "$<br>$End = \emptyset 5 (\overline{A00} + \overline{GO})$<br>$Pr3 = (F1GO)Q2$<br>$sP0 = (F1GO(\overline{02040506})) (P12\oplus(P13P14Ia))$<br>$rP0 = ( \quad " \quad ) (P12\oplus(P13P14Ia))$<br>$sP1 = ( \quad " \quad ) (P13\oplus(P14Ia))$<br>$rP1 = ( \quad " \quad ) (P13\oplus(P14Ia))$<br>$sP2 = ( \quad " \quad ) (P14\oplus Ia)$<br>$rP2 = ( \quad " \quad ) (P14\oplus Ia)$<br>$rIa = (P12P13P14)Q2F1$<br>$sP(3-14) = P(0-11)Pr3$<br>$rP( " ) = \overline{P}( " ) " "$ | <br><br><br>Recirculate A<br><br>Recirculate B<br><br>last cycle<br><br><br>P+1 → P<br><br><br><br>       |
| T5 | sIx           | $= RcC17T5(C15+C19)$  | only for CAX or CBX   |
|    | rRc           | $= C17T5$   | A and B recirculate   |
| T4 | Sc            | $= T4(End+\overline{F1F2})\overline{Inr}$   | T4 thru T0  |
|    | rS(1-14)      | $= Sc$  | Clear S   |
|    | Xnr           | $= 01020304Ix$  |   |
|    | sXw(1-3)      | $= ( \quad " \quad )Xw1\overline{T7}$   | extend X15 thru X0  |
|    | rXw(1-3)      | $= ( \quad " \quad )\overline{Xw1T7}$   |   |
| T3 | Sxp           | $= T3\overline{Int}(End+Ju\overline{Eax})GO+T3\overline{Kmd}$   |   |
|    | sS1           | $= (F1GO(\overline{02040506})) (P13\oplus(P14Ia))Sxp$   |   |
|    | sS2           | $= ( \quad " \quad ) (P14\oplus Ia)Sxp$   | P → S   |
|    | sS(3-14)      | $= P(0-11)Sxp$  |   |
| Tr | Cxm           | $= EndGO\overline{Tsm}(Tr+Tp)$  |   |
|    | sC(0-23)      | $= M(0-23)Cxm$  | M → C   |
|    | rC( " )       | $= \overline{M}( " ) " "$   | Tr + Tp   |
|    | rIa           | $= TrF1$  |   |
|    | rIx           | $= Tr(\overline{F1F3})(\overline{GOHt})$  |   |
|    | rRc           | $= Tr$  |   |
| Tp | rF1           | $= TpEnd\overline{Sk}$  | ∅0 next clock (T8)  |
|    | rF3           | $= ( \quad " \quad )$   |   |
|    | rRf           | $= Tp\overline{01}(GOHt)$   |   |
|    | rJu           | $= Tp$  |   |
|    | Oc            | $= TpEnd\overline{Sk}$  |   |
|    | rO(1,3,4,5,6) | $= Oc$  | 107   |
|    | sO2           | $= Oc$  | NOP (20) → 0  |

|    |           |               |   |                                      |
|----|-----------|---------------|---|--------------------------------------|
| 46 | CXA 00200 | Copy X into A |   | 1 Cycle                              |
| ∅0 | T8        | rC24          | = T8( $\overline{\text{TsTsr}}$ )   |                                      |
|    |           | rCz           | = ∅0T8  |                                      |
|    |           | sF1           | = (∅0T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ ))                         | ∅5 next (T7)                         |
|    |           | sF3           | = ( " )   |                                      |
|    |           | sHz           | = T8  |                                      |
|    |           | sIa           | = ∅0T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )                           | initiate P register increment        |
|    |           | Oxc           | = (∅0T8 $\overline{\text{IaGO}}$ )C2  |                                      |
|    |           | sO(1,3,4,5,6) | = OxcC(3,5,6,7,8)   | C(3-8) → 0 instruction to 0 register |
|    |           | rO2           | = OxcC4   |                                      |
| ∅5 | T7        | sRc           | = (∅0T8 $\overline{\text{IaGO}}$ ) $\overline{\text{C2C3C4C5C6}}$                           |                                      |
|    |           | Ar3           | = (01020304)Q1  |                                      |
|    |           | Anr           | = RcC16   |                                      |
|    |           | sA(0-2)       | = $\overline{\text{Xn}}$ (1-3)RcC16Ar3  |                                      |
|    |           | rA( " )       | = $\overline{\text{Xn}}$ ( " ) " "  | X → A T7 thru T0                     |
|    |           | sA(3-23)      | = A(0-20)Ar3  |                                      |
|    |           | rA( " )       | = $\overline{\text{A}}$ ( " ) " "   |                                      |
|    |           | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$   |                                      |
|    |           | rB( " )       | = $\overline{\text{B}}$ ( " ) " "   | Recirculate B T7 thru T0             |
|    |           | sB(3-23)      | = B(0-20)Ar3  |                                      |
|    |           | rB( " )       | = $\overline{\text{B}}$ ( " ) " "   |                                      |
|    |           | End           | = ∅5(A00+G0)  | last cycle                           |
|    |           | Pr3           | = (F1G0)Q2  |                                      |
|    |           | sP0           | = (F1G0(02040506))(P12 <del>⊕</del> (P13P14Ia))   |                                      |
|    |           | rP0           | = ( " ) (P12 <del>⊕</del> (P13P14Ia))   |                                      |
|    |           | sP1           | = ( " ) (P13 <del>⊕</del> (P14Ia))  |                                      |
|    |           | rP1           | = ( " ) (P13 <del>⊕</del> (P14Ia))  | P+1 → P T7 thru T3                   |
|    |           | sP2           | = ( " ) (P14 <del>⊕</del> Ia)   |                                      |
|    |           | rP2           | = ( " ) (P14 <del>⊕</del> Ia)   |                                      |
|    |           | rIa           | = (P12P13P14)Q2F1   |                                      |
|    |           | sP(3-14)      | = P(0-11)Pr3  |                                      |
|    |           | rP( " )       | = $\overline{\text{P}}$ ( " ) " "   |                                      |
| T4 | Sc        |               | = T4(End+F1F2) $\overline{\text{Inr}}$  | Clear S                              |
|    |           | rS(1-14)      | = Sc  |                                      |
| T3 | Sxp       |               | = T3 $\overline{\text{Int}}$ (End+Ju $\overline{\text{Eax}}$ )GO+T3 $\overline{\text{Kmc}}$ |                                      |
|    |           | sS1           | = (F1G0(02040506))(P13 <del>⊕</del> (P14Ia))Sxp   |                                      |
|    |           | sS2           | = ( " ) (P14 <del>⊕</del> Ia)Sxp  | P → S                                |
|    |           | sS(3-14)      | = P(0-11)Sxp  |                                      |
| Tr | Cxm       |               | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)   |                                      |
|    |           | sC(0-23)      | = M(0-23)Cxm  | M → C Tr + Tp                        |
|    |           | rC( " )       | = $\overline{\text{M}}$ ( " ) " "   |                                      |
|    |           | rIa           | = TrF1  |                                      |
|    |           | rIx           | = Tr(F1F3)(GOHt)  |                                      |
|    |           | rRc           | = Tr  |                                      |
| Tp | rF1       |               | = TpEnd $\overline{\text{Sk}}$  |                                      |
|    |           | rF3           | = ( " )   | ∅0 next clock (T8)                   |
|    |           | rRf           | = Tp $\overline{\text{OI}}$ (GOHt)  |                                      |
|    |           | rJu           | = Tp  |                                      |
|    |           | Oc            | = TpEnd $\overline{\text{Sk}}$  |                                      |
|    |           | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                         |
|    |           | sO2           | = Oc  |                                      |

CAX 00400

Copy A into X

1 Cycle

|    |    |               |   |                                      |            |
|----|----|---------------|---|--------------------------------------|------------|
| ∅0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                                   |                                      |            |
|    |    | rCz           | = ∅0T8  |                                      |            |
|    |    | sF1           | = (∅0T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )) |                                      |            |
|    |    | sF3           | = ( " )   | ∅5 next (T7)                         |            |
|    |    | sHz           | = T8  |                                      |            |
|    |    | sIa           | = ∅0T8 $\overline{\text{IaC2C5C8}}$ ( $\overline{\text{C3+C4}}$ )   | initiate P register increment        |            |
|    |    | Oxc           | = (∅0T8 $\overline{\text{IaGO}}$ )C2                                |                                      |            |
|    |    | sO(1,3,4,5,6) | = OxcC(3,5,6,7,8)   | C(3-8) → 0 instruction to 0 register |            |
|    |    | rO2           | = OxcC4   |                                      |            |
| ∅5 | T7 | sRc           | = (∅0T8 $\overline{\text{IaGO}}$ )C2C3C4C5C6                        |                                      |            |
|    |    | Ar3           | = (01020304)Q1  |                                      |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{ArAr3}}$                                |                                      |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                                     | Recirculate A                        | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)AR3  |                                      |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                                     |                                      |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                               |                                      |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                                     | Recirculate B                        | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3  |                                      |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                                     |                                      |            |
|    |    | End           | = ∅5(A00+G0)  | last cycle                           |            |
|    |    | Pr3           | = (F1G0)Q2  |                                      |            |
|    |    | sP0           | = (F1G0( $\overline{02040506}$ ))(P12 <del>⊕</del> (P13P14Ia))      |                                      |            |
|    |    | rP0           | = ( " ) (P12 <del>⊕</del> (P13P14Ia))                               |                                      |            |
|    |    | sP1           | = ( " ) (P13 <del>⊕</del> (P14Ia))                                  | P+1 → P                              | T7 thru T3 |
|    |    | rP1           | = ( " ) (P13 <del>⊕</del> (P14Ia))                                  |                                      |            |
|    |    | sP2           | = ( " ) (P14 <del>⊕</del> Ia)                                       |                                      |            |
|    |    | rP2           | = ( " ) (P14 <del>⊕</del> Ia)                                       |                                      |            |
|    |    | rIa           | = (P12P13P14)Q2F1   |                                      |            |
|    |    | sP(3-14)      | = P(0-11)Pr3  |                                      |            |
|    |    | rP( " )       | = $\overline{\text{P}}$ ( " ) "                                     |                                      |            |
|    |    | Xnr           | = (RcC15)   |                                      |            |
|    |    | sXw(1-3)      | = ( " )A(21-23)   | A → X                                | T7 thru T0 |
|    |    | rXw( " )      | = ( " )A(21-23)   |                                      |            |
| T4 |    | Sc            | = T4(End+F1F2)Inr   |                                      |            |
|    |    | rS(1-14)      | = Sc  | Clear S                              |            |
| T3 |    | Sxp           | = T3Int( $\overline{\text{End+JuEax}}$ )GO+T3Kmd                    |                                      |            |
|    |    | sS1           | = (F1G0( $\overline{02040506}$ ))(P13 <del>⊕</del> (P14Ia))Sxp      |                                      |            |
|    |    | sS2           | = ( " ) (P14 <del>⊕</del> Ia)Sxp                                    | P → S                                |            |
|    |    | sS(3-14)      | = P(0-11)Sxp  |                                      |            |
| Tr |    | Cxm           | = EndGOTsm(Tr+Tp)   |                                      |            |
|    |    | sC(0-23)      | = M(0-23)Cxm  | M → C                                | Tr + Tp    |
|    |    | rC( " )       | = $\overline{\text{M}}$ ( " ) "                                     |                                      |            |
|    |    | rIa           | = TrF1  |                                      |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)  |                                      |            |
|    |    | rRc           | = Tr  |                                      |            |
| Tp |    | rF1           | = TpEndS $\overline{\text{k}}$                                      |                                      |            |
|    |    | rF3           | = ( " )   | ∅0 next clock (T8)                   |            |
|    |    | rRf           | = Tp $\overline{01}$ (GOHt)   |                                      |            |
|    |    | rJu           | = Tp  |                                      |            |
|    |    | Oc            | = TpEndS $\overline{\text{k}}$                                      |                                      |            |
|    |    | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                         |            |
|    |    | sO2           | = Oc  |                                      |            |

|    |           |  |  |
|----|-----------|--|--|
| 46 | CNA 01000 | Copy Negative of A into A  | 1 Cycle  |
| 00 | T8        | $rC24 = T8(\overline{TsTsr})$<br>$rCz = \emptyset T8$<br>$sF1 = (\emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4}))$<br>$sF3 = ( \quad \quad \quad )$<br>$sHz = T8$<br>$sIa = \emptyset T8 \overline{Ia} \overline{C2} \overline{C5} \overline{C8} (\overline{C3} + \overline{C4})$<br>$Oxc = (\emptyset T8 \overline{Ia} GO) \overline{C2}$<br>$sO(1,3,4,5,6) = OxcC(3,5,6,7,8)$<br>$rO2 = Oxc \overline{C4}$<br>$sRc = (\emptyset T8 \overline{Ia} GO) \overline{C2} \overline{C3} \overline{C4} \overline{C5} \overline{C6}$   | <p>05 next (T7)</p> <p>Set carry into half adder<br/>initiate P register increment</p> <p>C(3-8) → 0 instruction to 0 register</p>                 |
| 05 | T7        | $Ar3 = (O1O2O3O4)Q1$<br>$Anr = RcC14$<br>$sA(0-2) = Ha(1-3)RcC14$<br>$rA( \quad ) = \overline{Ha}( \quad ) \quad "$<br>$Hx(1-3) = F1\overline{O3A}(21-23)$<br>$sA(3-23) = A(0-20)Ar3$<br>$rA( \quad ) = \overline{A}( \quad ) \quad "$<br>$sB(0-2) = B(21-23)\overline{Bnr}Ar3$<br>$rB( \quad ) = \overline{B}( \quad ) \quad "$<br>$sB(3-23) = B(0-20)Ar3$<br>$rB( \quad ) = \overline{B}( \quad ) \quad "$<br>$End = \emptyset 5(A\overline{O0} + \overline{GO})$<br>$Pr3 = (F1GO)Q2$<br>$sP0 = (F1GO(\overline{O2O4O5O6})) (P12 \oplus (P13P14Ia))$<br>$rP0 = ( \quad \quad \quad ) (P12 \oplus (P13P14Ia))$<br>$sP1 = ( \quad \quad \quad ) (P13 \oplus (P14Ia))$<br>$rP1 = ( \quad \quad \quad ) (P13 \oplus (P14Ia))$<br>$sP2 = ( \quad \quad \quad ) (P14 \oplus Ia)$<br>$rP2 = ( \quad \quad \quad ) (P14 \oplus Ia)$<br>$rIa = (P12P13P14)Q2F1$<br>$sP(3-14) = P(0-11)Pr3$<br>$rP( \quad ) = \overline{P}( \quad ) \quad "$ | <p>Ha = Hx+1<br/>Hx = <math>\overline{A}</math><br/>A = <math>\overline{A}+1 = -A</math></p> <p>Recirculate B</p> <p>last cycle</p> <p>P+1 → P</p> |
| T4 | Sc        | $rS(1-14) = T4(End + \overline{F1F2}) \overline{Inr}$<br>$= Sc$  | Clear S  |
| T3 | Sxp       | $sS1 = T3 \overline{Int} (\overline{End} + \overline{JuEax}) GO + T3 \overline{Kmc}$<br>$sS2 = (F1GO(\overline{O2O4O5O6})) (P13 \oplus (P14Ia)) Sxp$<br>$sS(3-14) = ( \quad \quad \quad ) (P14 \oplus Ia) Sxp$   | P → S  |
| Tr | Cxm       | $sC(0-23) = EndGO \overline{Tsm}(Tr + Tp)$<br>$rC( \quad ) = \overline{M}( \quad ) \quad "$<br>$rIa = TrF1$<br>$rIx = Tr(\overline{F1F3})(\overline{GOht})$<br>$rRc = Tr$  | M → C<br>Tr + Tp   |
| Tp | rF1       | $rF3 = Tp \overline{EndSk}$<br>$rRf = Tp \overline{O1}(\overline{GOht})$<br>$rJu = Tp$<br>$Oc = Tp \overline{EndSk}$<br>$rO(1,3,4,5,6) = Oc$<br>$sO2 = Oc$   | <p>00 next clock (T8)</p> <p>NOP (20) → 0</p>  |



|    |     |   |   |  |
|----|-----|---|---|--|
| 50 | SKE | Skip if A Equals (M)  | A ≠ (M); P + 1 → P<br>A = (M); P + 2 → P  | 2 Cycles<br>3 Cycles   |
| 00 | T8  | rCz = 00T8<br>sIx = 00T8C1G0<br>Oxc = (00T8IaG0)C2<br>s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>rO2 = C4Oxc  | Initialize carry<br>Initialize indexing<br>Instruction → 0  |  |
|    | T7  | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>Cr3 = F1F2(TsQ1)<br>sC(0-2) = Add(1-3)00JuTsCr3<br>rC( " ) = Add( " ) "<br>sC(3-23) = C(0-20)Cr3<br>rC( " ) = C( " ) "<br>Xz(1-3) = Xn(1-3)00Ix<br>Xz( " ) = Xn( " )00Ix+Ix<br>Yz(1-3) = C(21-23)07<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T007<br>rCz = KzQ1<br>sCp = (C21C22C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp " | Recirculate A<br>Recirculate B<br>C+X·Ix → C (Add=Xz+Yz)<br>Adder input if Ix (indexing)<br>Adder input C register<br>Carry for Adder<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T1<br>T7 thru T0 |
|    | T4  | Sc = T4F1F2Inr<br>rS(1-14) = Sc   | Clear S   |  |
|    | T3  | Sxc = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc  | C + X·Ix → S  |  |
|    | T0  | rCz = F1T0  |   |  |
|    | Tr  | Cxm = Ju0Tsm(Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = TrCxm<br>sHt = CpTrCxm002<br>rIx = Tr(F1F3)(GOHt)<br>rK0 = GOTrF2   | M → C (Fetch operand)<br>Parity error   | Tr thru Tp   |
|    | Ip  | sCp = M24CxmHtTsTp<br>sF1 = (TpIa0)0104<br>sF2 = ( " )0301  | Initiate parity<br>06 next clock (T8)   |  |

|    |    |          |                                   |                                |            |
|----|----|----------|-----------------------------------|--------------------------------|------------|
| 66 | T8 | sIa      | = T8F1F3                          | Initiate P register increment  |            |
|    |    | End      | = F1F2                            | Last cycle                     |            |
|    |    | sSk      | = (01030406)T8                    |                                |            |
|    | T7 | Ar3      | = (01020304)Q1                    |                                |            |
|    |    | sA(0-2)  | = A(21-23)ArAr3                   |                                |            |
|    |    | rA( " )  | = A( " ) "                        | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |    | rA( " )  | = A( " ) "                        | Recirculate B                  | T7 thru T0 |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |    | rB( " )  | = B( " ) "                        | Recirculate C                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |    | rB( " )  | = B( " ) "                        | Adder input (ø)                | T7 thru T0 |
|    |    | Cr3      | = F1F3(TsQ1)                      | Adder input (C)                | T7 thru T0 |
|    |    | sC(0-2)  | = Add(1-3)ø6TsCr3                 | Carry logic                    | T7 thru T0 |
|    |    | rC( " )  | = Add( " ) "                      | Check parity                   | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |    | rC( " )  | = C( " ) "                        | P + 1 → P                      | T7 thru T3 |
|    |    | Xz(1-3)  | = Xz                              |                                |            |
|    |    | Yz(1-3)  | = C(21-23)ø7                      |                                |            |
|    |    | Yz( " )  | = C( " ) "                        |                                |            |
|    |    | sCz      | = KzQ1F1ø7                        |                                |            |
|    |    | rCz      | = KzQ1                            |                                |            |
|    |    | sCp      | = (C21øC22øC23)CpTsHtQ1ø603       |                                |            |
|    |    | rCp      | = ( " ) Cp "                      |                                |            |
|    |    | Pr3      | = (F1G0)Q2                        |                                |            |
|    |    | sP0      | = (P12øP13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |    | rP0      | = ( " ) "                         |                                |            |
|    |    | sP1      | = (P13øP14Ia) "                   |                                |            |
|    |    | rP1      | = ( " ) "                         |                                |            |
|    |    | sP2      | = (P14øIa) "                      |                                |            |
|    |    | rP2      | = ( " ) "                         |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |    | rP( " )  | = P( " ) "                        |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    |    | rSk      | = AøC(21-23)(ø60103040506Q1)02    | Not skip logic                 | T7 thru T0 |
|    | T4 | Sc       | = T4EndInr                        | Clear S                        |            |
|    |    | rS(1-14) | = Sc                              |                                |            |
|    | T3 | Sxp      | = T3IntEndG0                      |                                |            |
|    |    | sS1      | = (P13øP14Ia)F1G0(02040506)Sxp    | P13,14 contains P1,P2 at T3    |            |
|    |    | rS1      | = ( " ) "                         | P + 1 → S                      |            |
|    |    | sS2      | = (P14øIa) "                      |                                |            |
|    |    | rS2      | = ( " ) "                         |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |    | rS( " )  | = P( " ) "                        |                                |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                 | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23) | = M(0-23)Cxm                      |                                |            |
|    |    | rC( " )  | = TrCxm                           | Parity error                   |            |
|    |    | sHt      | = CpTrøø2                         |                                |            |

|    |               |                   |                 |
|----|---------------|-------------------|-----------------|
|    | rLs           | = TrFl            |                 |
|    | rIx           | = Tr(F1F3) (GOHt) |                 |
| Tp | rA00          | = TpEndGO         |                 |
|    | rB00          | = ( " )           |                 |
|    | sCp           | = M24CxmHtTsTp    | Initiate parity |
|    | rF(1,2)       | = TpEndSk         | 00 next if Sk   |
|    | sF3           | = TpSk            | 07 next if Sk   |
|    | Oc            | = TpEndSk         |                 |
|    | s02           | = Oc              |                 |
|    | r0(1,3,4,5,6) | = Oc              | NOP (20) → 0    |

|    |      |               |                                   |                                |            |
|----|------|---------------|-----------------------------------|--------------------------------|------------|
| 07 | T8   | sIa           | = <del>Sk07T8</del> <del>Kr</del> | Initiate P register increment  |            |
|    |      | End           | = FIF2                            | Last cycle                     |            |
| T7 | Ar3  |               | = (01020304)Q1                    |                                |            |
|    |      | sA(0-2)       | = A(21-23)ArAr3                   |                                |            |
|    |      | rA( " )       | = A( " ) " "                      | Recirculate A                  | T7 thru T0 |
|    |      | sA(3-23)      | = A(0-20)Ar3                      |                                |            |
|    |      | rA( " )       | = A( " ) " "                      |                                |            |
|    |      | sB(0-2)       | = B(21-23)BnrAr3                  |                                |            |
|    |      | rB( " )       | = B( " ) " "                      | Recirculate B                  | T7 thru T0 |
|    |      | sB(3-23)      | = B(0-20)Ar3                      |                                |            |
|    |      | rB( " )       | = B( " ) " "                      |                                |            |
|    |      | Pr3           | = (F1G0)Q2                        |                                |            |
|    |      | sP0           | = (P12P13P14Ia)F1G0(02040506)Pr3  |                                |            |
|    |      | rP0           | = ( " ) " "                       |                                |            |
|    |      | sP1           | = (P13P14Ia) " "                  |                                |            |
|    |      | rP1           | = ( " ) " "                       |                                |            |
|    |      | sP2           | = (P14Ia) " "                     | P + 1 → P                      | T7 thru T3 |
|    |      | rP2           | = ( " ) " "                       |                                |            |
|    |      | sP(3-14)      | = P(0-11)Pr3                      |                                |            |
|    |      | rP( " )       | = P( " ) " "                      |                                |            |
|    |      | rIa           | = (P12P13P14)Q2F1                 |                                |            |
| T4 | Sc   |               | = T4EndInr                        | Clear S                        |            |
|    |      | rS(1-14)      | = Sc                              |                                |            |
| T3 | Sxp  |               | = T3IntEndGO                      |                                |            |
|    |      | sS1           | = (P13P14Ia)F1G0(02040506)Sxp     | P13, P14 contain P1, P2 at T3  |            |
|    |      | rS1           | = ( " ) " "                       | P + 1 → S                      |            |
|    |      | sS2           | = (P14Ia) " "                     |                                |            |
|    |      | rS2           | = ( " ) " "                       |                                |            |
|    |      | sS(3-14)      | = P(0-11)Sxp                      |                                |            |
|    |      | rS( " )       | = P( " ) " "                      |                                |            |
| T0 | rSk  |               | = 07T0                            |                                |            |
|    | rCp  |               | = T5T0HtK0(F1030406)02            |                                |            |
| Tr | Com  |               | = EndGOIsm(Tr+Tp)                 | M → C (Fetch next instruction) |            |
|    |      | sC(0-23)      | = M(0-23)Com                      | Tr thru Tp                     |            |
|    |      | rC( " )       | = TrCom                           |                                |            |
|    |      | rIa           | = TrF1                            |                                |            |
|    |      | rIx           | = Tr(F1F3)(GOHt)                  |                                |            |
| Tp | rA00 |               | = TpEndGO                         |                                |            |
|    |      | rB00          | = ( " )                           |                                |            |
|    |      | sCp           | = M24ComHtTsTp                    | Initiate parity check          |            |
|    |      | rF(1-3)       | = TpEndSk                         | 00 next clock (T8)             |            |
|    |      | Oc            | = ( " )                           |                                |            |
|    |      | sO2           | = Oc                              |                                |            |
|    |      | rO(1,3,4,5,6) | = Oc                              | NOP (20) → 0                   |            |

| 51 | BRR                   | Return Branch  | (M) + 1 → P                   | 2 Cycles   |
|----|-----------------------|--|-------------------------------|------------|
| ∅0 | T8                    | rCz = ∅OT8   |                               |            |
|    |                       | sHz = T8   |                               |            |
|    |                       | sIx = C1G0∅OT8   | Initiate indexing             |            |
|    |                       | Oxc = $\overline{1a}GOC2∅OT8$  |                               |            |
|    |                       | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc  | Instruction to 0 register     |            |
|    |                       | rO2 = $\overline{C4}Oxc$   |                               |            |
| T7 | Ar3                   | = (01020304)Q1   |                               |            |
|    | sA(0-2)               | = A(21-23)AnrAr3   |                               |            |
|    | rA( " )               | = $\overline{A}$ ( " ) " "   | Recirculate A                 | T7 thru T0 |
|    | sA(3-23)              | = A(0-20)Ar3   |                               |            |
|    | rA( " )               | = $\overline{A}$ ( " ) " "   |                               |            |
|    | sB(0-2)               | = B(21-23)BnrAr3   |                               |            |
|    | rB( " )               | = $\overline{B}$ ( " ) " "   | Recirculate B                 | T7 thru T0 |
|    | sB(3-23)              | = B(0-20)Ar3   |                               |            |
|    | rB( " )               | = $\overline{B}$ ( " ) " "   |                               |            |
|    | Cr3                   | = ( $\overline{Ts}Q1$ ) $\overline{F1F2}$                                  |                               |            |
|    | sC(0-2)               | = Add(1-3)Ju $\overline{Ts}$ Cr3∅0   |                               |            |
|    | rC( " )               | = $\overline{Add}$ ( " ) " "   | C + X·Ix → C                  | T7 thru T0 |
|    | sC(3-23)              | = C(0-20)Cr3   |                               |            |
|    | rC( " )               | = $\overline{C}$ ( " ) " "   |                               |            |
|    | sCp                   | = (C21 $\overline{C}C22\overline{C}C23)\overline{CpTsHt}Q1\overline{F1F2}$ |                               |            |
|    | rCp                   | = ( " ) Cp " "   | Parity check                  | T7 thru T0 |
|    | Xz(1-3)               | = Xn(1-3)∅0Ix  |                               |            |
|    | $\overline{Xz}$ ( " ) | = $\overline{Xn}$ ( " )∅0Ix+ $\overline{Ix}$                               | Adder input (X·Ix)            | T7 thru T0 |
|    | Yz(1-3)               | = C(21-23)∅7   |                               |            |
|    | $\overline{Yz}$ ( " ) | = $\overline{C}$ ( " ) " "   | Adder input (C)               | T7 thru T0 |
|    | sCz                   | = KzQ1 $\overline{T0}$   |                               |            |
|    | rCz                   | = $\overline{Kz}Q1$  | Carry logic                   | T7 thru T1 |
| T4 | Sc                    | = $\overline{InrF1F2}T4$   |                               |            |
|    | rS(1-14)              | = Sc   | Clear S                       |            |
| T3 | Sxc                   | = Ju $\overline{F1F2}T3$   |                               |            |
|    | sS(1,2)               | = Add(2,3)Sxc  |                               |            |
|    | sS(3-14)              | = C(0-11)Sxc   | C(10-23) → S                  |            |
| T0 | rCz                   | = $\overline{F1T0}$  |                               |            |
| Tr | Cxm                   | = Ju $\overline{Ts}m$ ∅0(Tr+Tp)  |                               |            |
|    | sC(0-23)              | = M(0-23)Cxm   | M → C (Fetch operand)         | Tr thru Tp |
|    | rC( " )               | = CxmTr  |                               |            |
|    | sCz                   | = $\overline{040506}∅0Tr$  | Initiate C register increment |            |
|    | sHt                   | = Cp( $\overline{Kp}∅0$ ) $\overline{2Tr}$                                 | Parity error                  |            |
|    | rIx                   | = ( $\overline{F1F3}$ )( $\overline{GOHt}$ )Tr                             |                               |            |
|    | rRc                   | = Tr   |                               |            |
| Tp | sCp                   | = M24CxmHtTsTp   | Initiate parity               |            |
|    | sF1                   | = $\overline{04Ta01}∅0Tp$  |                               |            |
|    | sF2                   | = $\overline{02}$ " "  | ∅6 next clock (T8)            |            |

|    |    |               |  |                                |            |
|----|----|---------------|--|--------------------------------|------------|
| Ø6 | T8 | End           | = F1F2   |                                |            |
|    |    | sIa           | = F1F3 <del>U</del> <del>K</del> <del>r</del> <del>T</del> 8 |                                |            |
|    | T7 | Ar3           | = (01020304)Q1   |                                |            |
|    |    | sA(0-2)       | = A(21-23)ArAr3  |                                |            |
|    |    | rA( " )       | = A( " ) " "   | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3   |                                |            |
|    |    | rA( " )       | = A( " ) " "   |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3   |                                |            |
|    |    | rB( " )       | = B( " ) " "   | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3   |                                |            |
|    |    | rB( " )       | = B( " ) " "   |                                |            |
|    |    | Cr3           | = TsF1F3Q1   |                                |            |
|    |    | sC(0-2)       | = Add(1-3)TsCr3Ø6  |                                |            |
|    |    | rC( " )       | = Add( " ) " "   | Recirculate C                  | T7 thru T0 |
|    |    | sC(3-23)      | = C(0-20)Cr3   |                                |            |
|    |    | rC( " )       | = C( " ) " "   |                                |            |
|    |    | sCp           | = TsCpHt03Ø6Q1   | Check parity                   |            |
|    |    | rCp           | = TsCp " "   |                                |            |
|    |    | sOf           | = 03(Ø2Ø4Ø5Ø6)CØØ6T7   | Set overflow if CØ             |            |
|    |    | Pr3           | = F1GØQ2   |                                |            |
|    |    | sP(0-2)       | = Add(1-3)Ø2Ø4Ø5Ø6Pr3  | C + 1 → P                      | T7 thru T3 |
|    |    | rP( " )       | = Add( " ) " "   |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3   |                                |            |
|    |    | rP( " )       | = P( " ) " "   |                                |            |
|    |    | Xz(1-3)       | = X  |                                |            |
|    |    | Yz(1-3)       | = C(21-23)Ø7   | Adder input (C)                | T7 thru T0 |
|    |    | Yz( " )       | = C( " ) " "   |                                |            |
|    |    | sCz           | = KzF1Q1   | Carry logic                    | T7 thru T1 |
|    |    | rCz           | = KzQ1   |                                |            |
|    |    | rIa           | = (P12P13P14)Q2F1  |                                |            |
|    | T4 | Sc            | = InrT4  | Clear S                        |            |
|    |    | rS(1-14)      | = Sc   |                                |            |
|    | T3 | Sxp           | = IntEndGØT3   |                                |            |
|    |    | sS(1,2)       | = Add(2,3)Ø2Ø4Ø5Ø6Sxp  | C + 1 → S                      |            |
|    |    | sS(3-14)      | = P(0-11)Sxp   |                                |            |
|    | Tr | Cxm           | = EndGØTsm(Tr+Tp)  | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23)      | = M(0-23)Cxm   |                                |            |
|    |    | rC( " )       | = CxmTr  |                                |            |
|    |    | sHt           | = CpTrKØØ2   | Parity error                   |            |
|    |    | rRc           | = Tr   |                                |            |
|    | Tp | rAØØ          | = EndGØTp  |                                |            |
|    |    | rBØØ          | = ( " )  |                                |            |
|    |    | sCp           | = M24CxmHtTsTp   | Initiate parity                |            |
|    |    | rF(1,2)       | = EndSkTp  | ØØ next clock (T8)             |            |
|    |    | Oc            | = ( " )  |                                |            |
|    |    | rØ(1,3,4,5,6) | = OØ   |                                |            |
|    |    | sØ2           | = OØ   | NØP (20) → 0                   |            |

|               |     |                                     |  |  |
|---------------|-----|-------------------------------------|--|--|
| 2             | SKB | Skip if B and M do not Compare Ones | $B_i \cdot (M)_i = 1; P + 1 \rightarrow P$   | 2 Cycles   |
|               |     |                                     | $B_i \cdot (M)_i = 0; P + 2 \rightarrow P$   | 3 Cycles   |
| $\emptyset 0$ | T8  | rCz                                 | = $\emptyset 0 T8$   | Initialize carry                                 |
|               |     | sIx                                 | = $\emptyset 0 T8 C1 G0$   | Initialize indexing                              |
|               |     | Oxc                                 | = $(\emptyset 0 T8 \overline{Ia} G0) \overline{C2}$  |  |
|               |     | sO(1,3,4,5,6)                       | = $C(3,5,6,7,8) Oxc$   | Instruction $\rightarrow 0$                      |
|               |     | rO2                                 | = $\overline{C4} Oxc$  |  |
|               | T7  | Ar3                                 | = $(01020304) Q1$  |  |
|               |     | sA(0-2)                             | = $A(21-23) \overline{Anr} Ar3$  |  |
|               |     | rA( " )                             | = $\overline{A( " ) "}$  | Recirculate A                                    |
|               |     | sA(3-23)                            | = $A(0-20) Ar3$  | T7 thru T0                                       |
|               |     | rA( " )                             | = $\overline{A( " ) "}$  |  |
|               |     | sB(0-2)                             | = $B(21-23) \overline{Bnr} Ar3$  |  |
|               |     | rB( " )                             | = $\overline{B( " ) "}$  | Recirculate B                                    |
|               |     | sB(3-23)                            | = $B(0-20) Ar3$  | T7 thru T0                                       |
|               |     | rB( " )                             | = $\overline{B( " ) "}$  |  |
|               |     | Cr3                                 | = $\overline{F1} \overline{F2} (\overline{Ts} Q1)$   |  |
|               |     | sC(0-2)                             | = $Add(1-3) \emptyset 0 Ju \overline{Ts} Cr3$  |  |
|               |     | rC( " )                             | = $\overline{Add( " ) "}$  | $C + X \cdot Ix \rightarrow C$ (Add= $Xz + Yz$ ) |
|               |     | sC(3-23)                            | = $C(0-20) Cr3$  | T7 thru T0                                       |
|               |     | rC( " )                             | = $\overline{C( " ) "}$  |  |
|               |     | Xz(1-3)                             | = $\overline{Xn}(1-3) \emptyset 0 \cdot Ix$  | Adder input if Ix (indexing)                     |
|               |     | Xz( " )                             | = $\overline{Xn( " )} \emptyset 0 Ix + Ix$   | T7 thru T0                                       |
|               |     | Yz(1-3)                             | = $C(21-23) \emptyset 7$   |  |
|               |     | Yz( " )                             | = $\overline{C( " ) "}$  | Adder input C register                           |
|               |     | sCz                                 | = $Kz Q1 \overline{T0} \emptyset 7$  | T7 thru T0                                       |
|               |     | rCz                                 | = $\overline{Kz} Q1$   | Carry for Adder                                  |
|               |     | sCp                                 | = $(C21 \oplus C22 \oplus C23) \overline{Cp} \overline{Ts} \overline{Ht} Q1 \overline{F1} \overline{F2}$ | T7 thru T1                                       |
|               |     | rCp                                 | = ( " ) Cp "   | Check parity                                     |
|               |     |                                     |  | T7 thru T0                                       |
|               | T4  | Sc                                  | = $T4 \overline{F1} \overline{F2} \overline{Inr}$  |  |
|               |     | rS(1-14)                            | = Sc   | Clear S  |
|               | T3  | Sxc                                 | = $T3 \overline{F1} \overline{F2} \overline{Ju}$   |  |
|               |     | sS(1,2)                             | = $Add(2,3) Sxc$   |  |
|               |     | sS(3-14)                            | = $C(0-11) Sxc$  | $C + X \cdot Ix \rightarrow S$                   |
|               | T0  | rCz                                 | = $\overline{F1} T0$   |  |
|               | Tr  | Cxm                                 | = $Ju \emptyset 0 \overline{Ts} m(Tr + Tp)$  |  |
|               |     | sC(0-23)                            | = $M(0-23) Cxm$  | $M \rightarrow C$ (Fetch operand)                |
|               |     | rC( " )                             | = $\overline{Tr} Cxm$  | Tr thru Tp                                       |
|               |     | sHt                                 | = $Cp \overline{Tr} \overline{Cp} \overline{K0} \emptyset 2$   | Parity error                                     |
|               |     | rIx                                 | = $\overline{Tr} (\overline{F1} \overline{F3}) (\overline{GO} \overline{Ht})$                            |  |
|               |     | rK0                                 | = $\overline{GO} \overline{Tr} \overline{F2}$  |  |
|               | Tp  | sCp                                 | = $M24 Cxm \overline{Ht} \overline{Ts} Tp$   | Initiate parity                                  |
|               |     | sF1                                 | = $(Tp \overline{Ia} \emptyset 0) 0104$  |  |
|               |     | sF2                                 | = ( " ) 0301   | $\emptyset 6$ next clock (T8)                    |

|    |     |          |                                   |                                |            |
|----|-----|----------|-----------------------------------|--------------------------------|------------|
| 06 | T8  | sIa      | = T8F1F3(1)Kz                     | Initiate P register increment  |            |
|    |     | End      | = F1F2                            | Last cycle                     |            |
|    |     | sSk      | = (0103040606)T8                  |                                |            |
| T7 | Ar3 | Ar3      | = (01020304)Q1                    |                                |            |
|    |     | sA(0-2)  | = A(21-23)AnrAr3                  |                                |            |
|    |     | rA( " )  | = A( " ) " "                      | Recirculate A                  | T7 thru T0 |
|    |     | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |     | rA( " )  | = A( " ) " "                      |                                |            |
|    |     | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |     | rB( " )  | = B( " ) " "                      | Recirculate B                  | T7 thru T0 |
|    |     | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |     | rB( " )  | = B( " ) " "                      |                                |            |
|    |     | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |     | sC(0-2)  | = Add(1-3)06TsCr3                 |                                |            |
|    |     | rC( " )  | = Add( " ) " "                    | Recirculate C                  | T7 thru T0 |
|    |     | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |     | rC( " )  | = C( " ) " "                      |                                |            |
|    |     | Xz(1-3)  | = Xz                              | Adder input (0)                | T7 thru T0 |
|    |     | Yz(1-3)  | = C(21-23)07                      | Adder input (C)                | T7 thru T0 |
|    |     | Yz( " )  | = C( " ) " "                      |                                |            |
|    |     | sCz      | = KzQ1F107                        | Carry logic                    | T7 thru T0 |
|    |     | rCz      | = KzQ1                            |                                |            |
|    |     | sCp      | = (C210C220C23)CpTsHtQ10603       | Check parity                   | T7 thru T0 |
|    |     | rCp      | = ( " ) Cp " "                    |                                |            |
|    |     | Pr3      | = (F1G0)Q2                        |                                |            |
|    |     | sP0      | = (P120P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |     | rP0      | = ( " ) " "                       |                                |            |
|    |     | sP1      | = (P130P14Ia) " "                 |                                |            |
|    |     | rP1      | = ( " ) " "                       |                                |            |
|    |     | sP2      | = (P140Ia) " "                    | P + 1 → P                      | T7 thru T3 |
|    |     | rP2      | = ( " ) " "                       |                                |            |
|    |     | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |     | rP( " )  | = P( " ) " "                      |                                |            |
|    |     | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    |     | rSk      | = B·C(21-23)02(060103040605Q1)    | Don't skip if B·(M)            | T7 thru T0 |
| T4 | Sc  | Sc       | = T4EndInr                        | Clear S                        |            |
|    |     | rS(1-14) | = Sc                              |                                |            |
| T3 | Sxp | Sxp      | = T3IntEndGO                      |                                |            |
|    |     | sS1      | = (P130P14Ia)F1G0(02040506)Sxp    | P13,14 contains P1,P2 at T3    |            |
|    |     | rS1      | = ( " ) " "                       | P + 1 → S                      |            |
|    |     | sS2      | = (P140Ia) " "                    |                                |            |
|    |     | rS2      | = ( " ) " "                       |                                |            |
|    |     | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |     | rS( " )  | = P( " ) " "                      |                                |            |
| Tr | Cxm | Cxm      | = EndGOIsm(Tr+Tp)                 | M → C (Fetch next instruction) | Tr thru Tp |
|    |     | sC(0-23) | = M(0-23)Cxm                      |                                |            |
|    |     | rC( " )  | = TrCxm                           |                                |            |
|    |     | sHt      | = CpTrCpK002                      | Parity error                   |            |



|    |               |                   |                            |
|----|---------------|-------------------|----------------------------|
|    | rIa           | = TrF1            |                            |
|    | *Ix           | = Tr(F1F3) (GOHt) |                            |
| Tp | rA00          | = TpEndGO         |                            |
|    | rB00          | = ( " )           |                            |
|    | sCp           | = M24CmHtTsTp     | Initiate parity            |
|    | rF(1,2)       | = TpEndSk         | 00 next if $\overline{Sk}$ |
|    | sF3           | = TpSk            | 07 next if Sk              |
|    | Oc            | = TpEndSk         |                            |
|    | s02           | = Oc              |                            |
|    | r0(1,3,4,5,6) | = Oc              | NOP (20) → 0               |

|               |    |               |   |  |
|---------------|----|---------------|---|--|
| $\emptyset 7$ | T8 | sIa           | = Sk $\emptyset 7$ T8I <del>Kr</del>  | Initiate P register increment              |
|               |    | End           | = F1F2  | Last cycle                                 |
|               | T7 | Ar3           | = (O1O2O3O4)Q1  |  |
|               |    | sA(0-2)       | = A(21-23) $\overline{\text{Ar}}\text{Ar3}$                                   |  |
|               |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "   | Recirculate A T7 thru T0                   |
|               |    | sA(3-23)      | = A(0-20)Ar3  |  |
|               |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "   |  |
|               |    | sB(0-2)       | = B(21-23) $\overline{\text{Bnr}}\text{Ar3}$                                  |  |
|               |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "   | Recirculate B T7 thru T0                   |
|               |    | sB(3-23)      | = B(0-20)Ar3  |  |
|               |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "   |  |
|               |    | Pr3           | = (F1G0)Q2  |  |
|               |    | sP0           | = (P1 <del>3</del> P13P14Ia)F1G0(O2O4O5O6)Pr3                                 |  |
|               |    | rP0           | = ( " ) " "   |  |
|               |    | sP1           | = (P13 <del>3</del> P14Ia) " "  |  |
|               |    | rP1           | = ( " ) " "   |  |
|               |    | sP2           | = (P14 <del>3</del> Ia) " "   | P + 1 $\rightarrow$ P T7 thru T3           |
|               |    | rP2           | = ( " ) " "   |  |
|               |    | sP(3-14)      | = P(0-11)Pr3  |  |
|               |    | rP( " )       | = $\overline{\text{P}}$ ( " ) " "   |  |
|               |    | rIa           | = (P12P13P14)Q2F1   |  |
|               | T4 | Sc            | = T4EndInr  | Clear S                                    |
|               |    | rS(1-14)      | = Sc  |  |
|               | T3 | Sxp           | = T3IntEndGO  |  |
|               |    | sS1           | = (P13 <del>3</del> P14Ia)F1G0(O2O4O5O6)Sxp                                   | P13, P14 contain P1, P2 at T3              |
|               |    | rS1           | = ( " ) " "   | P + 1 $\rightarrow$ S                      |
|               |    | sS2           | = (P14 <del>3</del> Ia) " "   |  |
|               |    | rS2           | = ( " ) " "   |  |
|               |    | sS(3-14)      | = P(0-11)Sxp  |  |
|               |    | rS( " )       | = $\overline{\text{P}}$ ( " ) " "   |  |
|               | T0 | rSk           | = $\emptyset 7$ T0  |  |
|               |    | rCp           | = $\overline{\text{T8T0HtK0}}$ (F1O3 <del>4</del> 6) $\overline{\emptyset 2}$ |  |
|               | Tr | Ccm           | = EndGO $\overline{\text{Tsm}}$ (Tr+Tp)                                       | M $\rightarrow$ C (Fetch next instruction) |
|               |    | sC(0-23)      | = M(0-23)Ccm  | Tr thru Tp                                 |
|               |    | rC( " )       | = TrCcm   |  |
|               |    | rIa           | = TrF1  |  |
|               |    | rIx           | = Tr(F1F3)(GOHt)  |  |
|               | Tp | rA00          | = TpEndGO   |  |
|               |    | rB00          | = ( " )   |  |
|               |    | sCp           | = M24CcmHtTsTp  | Initiate parity check                      |
|               |    | rF(1-3)       | = TpEndSk   | $\emptyset 0$ next clock (T8)              |
|               |    | Oc            | = ( " )   |  |
|               |    | sO2           | = Oc  |  |
|               |    | rO(1,3,4,5,6) | = Oc  | NOP (20) $\rightarrow$ 0                   |

|    |     |   |  |  |
|----|-----|---|--|--|
| }  | SKN | Skip if M Negative  | $M \geq 0; P + 1 \rightarrow P$<br>$M < 0; P + 2 \rightarrow P$  | 2 Cycles<br>3 Cycles   |
| 00 | T8  | rCz = 00T8<br>sIx = 00T8C1G0<br>Oxc = (00T8IaG0)C2<br>sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>rO2 = C4Oxc  | Initialize carry<br>Initialize indexing<br>Instruction → 0   |  |
| T7 | Ar3 | = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>Cr3 = F1F2(TsQ1)<br>sC(0-2) = Add(1-3)00JuTsCr3<br>rC( " ) = Add( " ) "<br>sC(3-23) = C(0-20)Cr3<br>rC( " ) = C( " ) "<br>Xz(1-3) = Xn(1-3)00Ix<br>Xz( " ) = Xn( " )00Ix+Ix<br>Yz(1-3) = C(21-23)07<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T007<br>rCz = KzQ1<br>sCp = (C210C220C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp " | Recirculate A<br>Recirculate B<br>C+X·Ix → C. (Add=Xz+Yz)<br>Adder input if Ix (indexing)<br>Adder input C register<br>Carry for Adder<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T1<br>T7 thru T0 |
| T4 | Sc  | = T4F1F2Inr<br>rS(1-14) = Sc  | Clear S  |  |
| T3 | Sxc | = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc  | C + X·Ix → S   |  |
| T0 | rCz | = F1T0  |  |  |
| Tr | Cxm | = Ju00Tsm(Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = TrCxm<br>sHt = CpTrKpK002<br>rIx = Tr(F1F3)(GOHt)<br>rK0 = GOTrF2  | M → C (Fetch operand)<br>Parity error  | Tr thru Tp   |
| Tp | sCp | = M24CxmHtTsTp<br>sF1 = (TpIa00)0104<br>sF2 = ( " )0301   | Initiate parity<br>06 next clock (T8)  |  |

|    |    |          |                                   |                                |            |
|----|----|----------|-----------------------------------|--------------------------------|------------|
| Ø6 | T8 | sIa      | = T8F1F3(I)Kr                     | Initiate P register increment  |            |
|    |    | End      | = F1F2                            | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                    |                                |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                  |                                |            |
|    |    | rA( " )  | = A( " ) "                        | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |    | rA( " )  | = A( " ) "                        |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |    | rB( " )  | = B( " ) "                        | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |    | rB( " )  | = B( " ) "                        |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |    | sC(0-2)  | = Add(1-3)Ø6TsCr3                 | Recirculate C                  | T7 thru T0 |
|    |    | rC( " )  | = Add( " ) "                      |                                |            |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |    | rC( " )  | = C( " ) "                        |                                |            |
|    |    | Xz(1-3)  | = Ix                              | Adder input (Ø)                | T7 thru T0 |
|    |    | Yz(1-3)  | = C(21-23)Ø7                      | Adder input (C)                | T7 thru T0 |
|    |    | Yz( " )  | = C( " ) "                        |                                |            |
|    |    | sCz      | = KzQ1F1Ø7                        | Carry logic                    | T7 thru T0 |
|    |    | rCz      | = KzQ1                            |                                |            |
|    |    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1Ø603       | Check parity                   | T7 thru T0 |
|    |    | rCp      | = ( " ) Cp "                      |                                |            |
|    |    | Pr3      | = (F1G0)Q2                        |                                |            |
|    |    | sP0      | = (P12⊕P13P14Ia)F1G0(Ø2040506)Pr3 |                                |            |
|    |    | rP0      | = ( " ) "                         |                                |            |
|    |    | sP1      | = (P13⊕P14Ia) "                   |                                |            |
|    |    | rP1      | = ( " ) "                         |                                |            |
|    |    | sP2      | = (P14⊕Ia) "                      | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) "                         |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |    | rP( " )  | = P( " ) "                        |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    | T4 | Sc       | = T4EndInr                        | Clear S                        |            |
|    |    | rS(1-14) | = Sc                              |                                |            |
|    | T3 | Sxp      | = T3IntEndGO                      |                                |            |
|    |    | sS1      | = (P13⊕P14Ia)F1G0(Ø2040506)Sxp    | P13, P14 contain P1, P2 at T3  |            |
|    |    | rS1      | = ( " ) "                         | P + 1 → S                      |            |
|    |    | sS2      | = (P14⊕Ia) "                      |                                |            |
|    |    | rS2      | = ( " ) "                         |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |    | rS( " )  | = P( " ) "                        |                                |            |
|    | Tr | Cxm      | = EndGOIsm(Tr+Tp)                 | M → C (Fetch next instruction) |            |
|    |    | sC(0-23) | = M(0-23)Cxm                      |                                | Tr thru Tp |
|    |    | rC( " )  | = TrCxm                           |                                |            |
|    |    | sHt      | = CpTrKØØ2                        | Parity error                   |            |

|    |               |                        |                 |
|----|---------------|------------------------|-----------------|
|    | rIa           | = TrF1                 |                 |
|    | rIx           | = Tr(FIF3) (GOHt)      |                 |
|    | sSk           | = 010307060506Tr(C0Ix) | Sk if M < 0     |
| Tp | rA00          | = TpEndGO              |                 |
|    | rB00          | = ( " )                |                 |
|    | sCp           | = M24CxmHtTsTp         | Initiate parity |
|    | rF(1,2)       | = TpEndSk              | 00 next if SK   |
|    | sF3           | = TpSk                 | 07 next if Sk   |
|    | Oc            | = TpEndSk              |                 |
|    | sO2           | = Oc                   |                 |
|    | rO(1,3,4,5,6) | = Oc                   | NOP (20) → 0    |

|    |    |               |                                  |                                |
|----|----|---------------|----------------------------------|--------------------------------|
| 07 | T8 | sIa           | = Sk07T8I <del>Tr</del>          | Initiate P register increment  |
|    |    | End           | = F1F2                           | Last cycle                     |
|    | T7 | Ar3           | = (01020304)Q1                   |                                |
|    |    | sA(0-2)       | = A(21-23)ArAr3                  |                                |
|    |    | rA( " )       | = A( " ) " "                     | Recirculate A                  |
|    |    | sA(3-23)      | = A(0-20)Ar3                     | T7 thru T0                     |
|    |    | rA( " )       | = A( " ) " "                     |                                |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                 |                                |
|    |    | rB( " )       | = B( " ) " "                     | Recirculate B                  |
|    |    | sB(3-23)      | = B(0-20)Ar3                     | T7 thru T0                     |
|    |    | rB( " )       | = B( " ) " "                     |                                |
|    |    | Pr3           | = (F1G0)Q2                       |                                |
|    |    | sP0           | = (P12P13P14Ia)F1G0(02040506)Pr3 |                                |
|    |    | rP0           | = ( " ) " "                      |                                |
|    |    | sP1           | = (P13P14Ia) " "                 |                                |
|    |    | rP1           | = ( " ) " "                      |                                |
|    |    | sP2           | = (P14Ia) " "                    | P + 1 → P                      |
|    |    | rP2           | = ( " ) " "                      | T7 thru T3                     |
|    |    | sP(3-14)      | = P(0-11)Pr3                     |                                |
|    |    | rP( " )       | = P( " ) " "                     |                                |
|    |    | rIa           | = (P12P13P14)Q2F1                |                                |
|    | T4 | Sc            | = T4EndInr                       | Clear S                        |
|    |    | rS(1-14)      | = Sc                             |                                |
|    | T3 | Sxp           | = T3IntEndGO                     |                                |
|    |    | sS1           | = (P13P14Ia)F1G0(02040506)Sxp    | P13, P14 contain P1, P2 at T3  |
|    |    | rS1           | = ( " ) " "                      | P + 1 → S                      |
|    |    | sS2           | = (P14Ia) " "                    |                                |
|    |    | rS2           | = ( " ) " "                      |                                |
|    |    | sS(3-14)      | = P(0-11)Sxp                     |                                |
|    |    | rS( " )       | = P( " ) " "                     |                                |
|    | T0 | rSk           | = 07T0                           |                                |
|    |    | rCp           | = TsTOHtK0(F1030406)02           |                                |
|    | Tr | Com           | = EndGOTsm(Tr+Tp)                | M → C (Fetch next instruction) |
|    |    | sC(0-23)      | = M(0-23)Com                     | Tr thru Tp                     |
|    |    | rC( " )       | = TrCom                          |                                |
|    |    | rIa           | = TrF1                           |                                |
|    |    | rIx           | = Tr(F1F3)(GOHt)                 |                                |
|    | Tp | rA00          | = TpEndGO                        |                                |
|    |    | rB00          | = ( " )                          |                                |
|    |    | sCp           | = M24ComHtTsTp                   | Initiate parity check          |
|    |    | rF(1-3)       | = TpEndSk                        | 00 next clock (T8)             |
|    |    | Oc            | = ( " )                          |                                |
|    |    | sO2           | = Oc                             |                                |
|    |    | rO(1,3,4,5,6) | = Oc                             | NOP (20) → 0                   |

|    |     |                                 |                                |            |
|----|-----|---------------------------------|--------------------------------|------------|
| 54 | SUB | Subtract                        | A - (M) → A                    | 2 Cycles   |
| 00 | T8  | rCz = 00T8                      | Initialize carry               |            |
|    |     | sIx = 00T8C1G0                  | Initialize indexing            |            |
|    |     | Oxc = (00T8IaG0)C2              |                                |            |
|    |     | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0                |            |
|    |     | rO2 = C4Oxc                     |                                |            |
|    | T7  | Ar3 = (01020304)Q1              |                                |            |
|    |     | sA(0-2) = A(21-23)AnrAr3        | Recirculate A                  | T7 thru T0 |
|    |     | rA( " ) = A( " ) "              |                                |            |
|    |     | sA(3-23) = A(0-20)Ar3           |                                |            |
|    |     | rA( " ) = A( " ) "              |                                |            |
|    |     | sB(0-2) = B(21-23)BnrAr3        | Recirculate B                  | T7 thru T0 |
|    |     | rB( " ) = B( " ) "              |                                |            |
|    |     | sB(3-23) = B(0-20)Ar3           |                                |            |
|    |     | rB( " ) = B( " ) "              |                                |            |
|    |     | Cr3 = F1F2(TsQ1)                |                                |            |
|    |     | sC(0-2) = Add(1-3)00JuTsCr3     | C+X·Ix → C (Add=Xz+Yz)         | T7 thru T0 |
|    |     | rC( " ) = Add( " ) "            |                                |            |
|    |     | sC(3-23) = C(0-20)Cr3           |                                |            |
|    |     | rC( " ) = C( " ) "              |                                |            |
|    |     | Xz(1-3) = Xn(1-3)00·Ix          | Adder input if Ix (indexing)   |            |
|    |     | Xz( " ) = Xn( " )00Ix+Ix        |                                | T7 thru T0 |
|    |     | Yz(1-3) = C(21-23)07            | Adder input C register         | T7 thru T0 |
|    |     | Yz( " ) = C( " ) "              |                                |            |
|    |     | sCz = KzQ1T007                  | Carry for Adder                | T7 thru T1 |
|    |     | rCz = KzQ1                      |                                |            |
|    |     | sCp = (C21C22C23)CpTsHtQ1F1F2   | Check parity                   | T7 thru T0 |
|    |     | rCp = ( " )Cp "                 |                                |            |
|    | T4  | Sc = T4F1F2Inr                  | Clear S                        |            |
|    |     | rS(1-14) = Sc                   |                                |            |
|    | T3  | Sxc = T3F1F2Ju                  | C+X·Ix → S                     |            |
|    |     | sS(1,2) = Add(2,3)Sxc           |                                |            |
|    |     | sS(3-14) = C(0-11)Sxc           |                                |            |
|    | T0  | rCz = F1T0                      |                                |            |
|    | Tr  | Cxm = Ju00Tsm(Tr+Tp)            | M → C (Fetch Operand)          | Tr thru Tp |
|    |     | sC(0-23) = M(0-23)Cxm           |                                |            |
|    |     | rC( " ) = TrCxm                 |                                |            |
|    |     | sCz = (Tr00)(040506)            | Set carry for two's complement |            |
|    |     | sHt = CpTrCp002                 | Parity error                   |            |
|    |     | rIx = Tr(F1F3)(GOHt)            |                                |            |
|    |     | rK0 = G0TrF2                    |                                |            |
|    | TP  | sCp = M24CxmHtTsTp              | Initiate parity                |            |
|    |     | sF1 = (TpIa00)0304              | 06 next clock (T8)             |            |
|    |     | sF2 = ( " )0302                 |                                |            |

|    |    |          |                                     |  |                               |            |
|----|----|----------|-------------------------------------|--|-------------------------------|------------|
| 06 | T8 | Anr      | = 0102030406                        |  |                               |            |
|    |    | Ck       | = (0601020304)06T8Ts                |  |                               |            |
|    |    | sC(0-23) | = C(0-23)Ck                         |  | Invert C                      |            |
|    |    | rC( " )  | = C( " )"                           |  |                               |            |
|    |    | sIa      | = T8F1F3I1Kr                        |  | Initiate P register increment |            |
|    |    | End      | = F1F2                              |  | Last cycle                    |            |
|    | T7 | Ar3      | = (01020304)Q1                      |  |                               |            |
|    |    | sA(0-2)  | = Add(1-3)(0102030406)Ar3           |  |                               |            |
|    |    | rA( " )  | = Add( " ) ( " ) "                  |  | A + C + 1 → A =               | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                        |  | A - (M) → A                   |            |
|    |    | rA( " )  | = A( " ) "                          |  |                               |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                    |  |                               |            |
|    |    | rB( " )  | = B( " ) "                          |  | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                        |  |                               |            |
|    |    | rB( " )  | = B( " ) "                          |  |                               |            |
|    |    | Cr3      | = F1F3(TsQ1)                        |  |                               |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                   |  |                               |            |
|    |    | rC( " )  | = Add( " ) "                        |  | A + C + 1 → C                 | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                        |  |                               |            |
|    |    | rC( " )  | = C( " ) "                          |  |                               |            |
|    |    | Xz(1-3)  | = A(21-23)060204                    |  | Adder input (A)               | T7 thru T0 |
|    |    | Xz( " )  | = A( " ) "                          |  |                               |            |
|    |    | Yz(1-3)  | = C(21-23)07                        |  | Adder input (C)               | T7 thru    |
|    |    | Yz( " )  | = C( " ) "                          |  |                               |            |
|    |    | sCz      | = KzQ1F107                          |  |                               |            |
|    |    | rCz      | = KzQ1                              |  | Carry logic                   | T7 thru T0 |
|    |    | sCp      | = (C21 ⊕ C22 ⊕ C23) CpTsHtQ10603    |  |                               |            |
|    |    | rCp      | = ( " ) Cp "                        |  | Check parity of C             | T7 thru T0 |
|    |    | Pr3      | = (F1G0)Q2                          |  |                               |            |
|    |    | sP0      | = (P12 ⊕ P13P14Ia)F1G0(02040506)Pr3 |  |                               |            |
|    |    | rP0      | = ( " ) "                           |  |                               |            |
|    |    | sP1      | = (P13 ⊕ P14Ia) "                   |  |                               |            |
|    |    | rP1      | = ( " ) "                           |  |                               |            |
|    |    | sP2      | = (P14 ⊕ Ia) "                      |  | P + 1 → P                     | T7 thru T3 |
|    |    | rP2      | = ( " ) "                           |  |                               |            |
|    |    | sP(3-14) | = P(0-11)Pr3                        |  |                               |            |
|    |    | rP( " )  | = P( " ) "                          |  |                               |            |
|    |    | rIa      | = (P12P13P14)Q2F1                   |  |                               |            |
|    | T4 | Sc       | = T4EndInr                          |  |                               |            |
|    |    | rS(1-14) | = Sc                                |  | Clear S                       |            |
|    | T3 | Sxp      | = T3IntEndGO                        |  |                               |            |
|    |    | sS1      | = (P13 ⊕ P14Ia)F1G0(02040506)Sxp    |  |                               |            |
|    |    | rS1      | = ( " ) "                           |  |                               |            |
|    |    | sS2      | = (P14 ⊕ Ia) "                      |  | P + 1 → S                     |            |
|    |    | rS2      | = ( " ) "                           |  |                               |            |
|    |    | sS(3-14) | = P(0-11)Sxp                        |  |                               |            |
|    |    | rS( " )  | = P( " ) "                          |  |                               |            |



|    |                  |   |                                |
|----|------------------|---|--------------------------------|
| T0 | sOf              | = $(\overline{0601020304})T00\overline{fe}$ | Overflow logic                 |
|    | Ofe              | = $\overline{Add1Xz1Yz1+Add1Xz1Yz1}$        |                                |
| Tr | Cxm              | = $\overline{EndGO\overline{Tsm}(Tr+Tp)}$   |                                |
|    | sC(0-23)         | = $\overline{M(0-23)Cxm}$                   | M → C (Fetch next instruction) |
|    | rC( " )          | = $\overline{TrCxm}$                        | Tr thru Tp                     |
|    | sHt              | = $\overline{CpTr(Kp\overline{K002})}$      | Parity error                   |
|    | rIa              | = $\overline{TrF1}$                         |                                |
|    | rIx              | = $\overline{Tr(F1F3)(\overline{GOHt})}$    |                                |
|    | Xld              | = $\overline{Cz(01\overline{02030406})Tr}$  |                                |
|    | $\overline{Xld}$ | = $\overline{Cz( " ) "}$                    | Save carry                     |
| Tp | rA00             | = $\overline{TpEndGO}$                      |                                |
|    | rB00             | = ( " )                                     |                                |
|    | sCp              | = $\overline{M24Cxm\overline{HtTsTp}}$      | Initiate parity                |
|    | rF(1,2)          | = $\overline{TpEnd\overline{Sk}}$           | 00 next clock (T8)             |
|    | Oc               | = ( " )                                     |                                |
|    | s02              | = Oc  |                                |
|    | r0(1,3,4,5,6)    | = Oc  | NOP (20) → 0                   |

| 55 | ADD      | Add                             | A + (M) → A                  | 2 Cycles   |
|----|----------|---------------------------------|------------------------------|------------|
| 00 | T8       | rCz = 00T8                      | Initialize carry             |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing          |            |
|    |          | Oxc = (00T8IaG0)C2              |                              |            |
|    |          | s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0              |            |
|    |          | rO2 = C4Oxc                     |                              |            |
| T7 | Ar3      | = (01020304)Q1                  |                              |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                              |            |
|    | rA( " )  | = A( " ) " "                    | Recirculate A                | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                              |            |
|    | rA( " )  | = A( " ) " "                    |                              |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                              |            |
|    | rB( " )  | = B( " ) " "                    | Recirculate B                | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                              |            |
|    | rB( " )  | = B( " ) " "                    |                              |            |
|    | Cr3      | = F1F2(TsQ1)                    |                              |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             |                              |            |
|    | rC( " )  | = Add( " ) " "                  | C+X·Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                              |            |
|    | rC( " )  | = C( " ) " "                    |                              |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input if Ix (indexing) |            |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                              | T7 thru T0 |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input C register       | T7 thru T0 |
|    | Yz( " )  | = C( " ) " "                    |                              |            |
|    | sCz      | = KzQ1T007                      | Carry for Adder              | T7 thru T1 |
|    | rCz      | = KzQ1                          |                              |            |
|    | sCp      | = (C21C22C23)CpTsHtQ1F1F2       | Check parity                 | T7 thru T0 |
|    | rCp      | = ( " )Cp " "                   |                              |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                      |            |
|    | rS(1-14) | = Sc                            |                              |            |
| T3 | Sxc      | = T3F1F2Ju                      |                              |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   | C + X·Ix → S                 |            |
|    | sS(3-14) | = C(0-11)Sxc                    |                              |            |
| T0 | rCz      | = F1T0                          |                              |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch operand)        | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                              |            |
|    | rC( " )  | = TrCxm                         |                              |            |
|    | sHt      | = CpTrKpK002                    | Parity error                 |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                              |            |
|    | rK0      | = GOTrF2                        |                              |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity              |            |
|    | sF1      | = (TpIa00)0304                  | 06 next clock (T8)           |            |
|    | sF2      | = ( " )0302                     |                              |            |

|    |    |          |                                   |  |                                |            |
|----|----|----------|-----------------------------------|--|--------------------------------|------------|
| Ø6 | T8 | Anr      | = 01020304Ø6                      |  |                                |            |
|    |    | sIa      | = T8F1F3(Ø1)Kr                    |  | Initiate P register increment  |            |
|    |    | End      | = F1F2                            |  | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                    |  |                                |            |
|    |    | sA(0-2)  | = Add(1-3)(01020304Ø6)Ar3         |  | A + C → A =                    | T7 thru T0 |
|    |    | rA( " )  | = Add( " ) " "                    |  | A + (M) → A                    |            |
|    |    | sA(3-23) | = A(0-20)Ar3                      |  |                                |            |
|    |    | rA( " )  | = A( " ) " "                      |  |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |  | Recirculate B                  | T7 thru T0 |
|    |    | rB( " )  | = B( " ) " "                      |  |                                |            |
|    |    | sB(3-23) | = B(0-20)Ar3                      |  |                                |            |
|    |    | rB( " )  | = B( " ) " "                      |  |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |  |                                |            |
|    |    | sC(0-2)  | = Add(1-3)Ø6TsCr3                 |  | A + C → C                      | T7 thru T0 |
|    |    | rC( " )  | = Add( " ) " "                    |  |                                |            |
|    |    | sC(3-23) | = C(0-20)Cr3                      |  |                                |            |
|    |    | rC( " )  | = C( " ) " "                      |  |                                |            |
|    |    | Xz(1-3)  | = A(21-23)Ø6Ø204                  |  | Adder input (A)                | T7 thru T0 |
|    |    | Xz( " )  | = A( " ) " "                      |  |                                |            |
|    |    | Yz(1-3)  | = C(21-23)Ø7                      |  | Adder input (C)                | T7 thru T0 |
|    |    | Yz( " )  | = C( " ) " "                      |  |                                |            |
|    |    | sCz      | = KzQ1F1Ø7                        |  | Carry logic                    | T7 thru T0 |
|    |    | rCz      | = KzQ1                            |  |                                |            |
|    |    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1Ø603       |  | Check parity                   | T7 thru T0 |
|    |    | rCp      | = ( " )Cp " "                     |  |                                |            |
|    |    | Pr3      | = (F1G0)Q2                        |  |                                |            |
|    |    | sP0      | = (P12⊕P13P14Ia)F1G0(Ø204Ø506)Pr3 |  |                                |            |
|    |    | rP0      | = ( " ) " "                       |  |                                |            |
|    |    | sP1      | = (P13⊕P14Ia) " "                 |  |                                |            |
|    |    | rP1      | = ( " ) " "                       |  |                                |            |
|    |    | sP2      | = (P14⊕Ia) " "                    |  | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) " "                       |  |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |  |                                |            |
|    |    | rP( " )  | = P( " ) " "                      |  |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |  |                                |            |
|    | T4 | Sc       | = T4EndInr                        |  | Clear S                        |            |
|    |    | rS(1-14) | = Sc                              |  |                                |            |
|    | T3 | Sxp      | = T3IntEndG0                      |  |                                |            |
|    |    | sS1      | = (P13⊕P14Ia)F1G0(Ø204Ø506)Sxp    |  |                                |            |
|    |    | rS1      | = ( " ) " "                       |  | P + 1 → S                      |            |
|    |    | sS2      | = (P14⊕Ia) " "                    |  |                                |            |
|    |    | rS2      | = ( " ) " "                       |  |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |  |                                |            |
|    |    | rS( " )  | = P( " ) " "                      |  |                                |            |
|    | T0 | sOf      | = (Ø601Ø20304)T00fe               |  | Overflow logic                 |            |
|    |    | Ofe      | = Add1Xz1Yz1+Add1Xz1Yz1           |  |                                |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                 |  | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23) | = M(0-23)Cxm                      |  |                                |            |
|    |    | rC( " )  | = TrCxm                           |  |                                |            |
|    |    | sHt      | = CpTrCpXØ2                       |  | Parity error                   |            |

|    |                         |   |                    |
|----|-------------------------|---|--------------------|
|    | rIa                     | = TrF1  |                    |
|    | rIx                     | = Tr( $\overline{\text{F1F3}}$ ) ( $\overline{\text{GOHt}}$ ) |                    |
|    | X1d                     | = Cz(0102030406)Tr  |                    |
|    | $\overline{\text{X1d}}$ | = $\overline{\text{Cz}}$ ( " ) "                              | Save carry         |
| Tp | rA00                    | = TpEndGO   |                    |
|    | rB00                    | = ( " )   |                    |
|    | sCp                     | = M24CxmHtTsTp  | Initiate parity    |
|    | rF(1,2)                 | = TpEndSk   | Ø0 next clock (T8) |
|    | Oc                      | = ( " )   |                    |
|    | sO2                     | = Oc  |                    |
|    | rO(1,3,4,5,6)           | = Oc  | NOP (20) → 0       |

| 76 | Suc | Subtract With Carry             | A - (M) + Carry → A          | 2 Cycles   |
|----|-----|---------------------------------|------------------------------|------------|
| 00 | T8  | rCz = 00T8                      | Initialize carry             |            |
|    |     | sIx = 00T8C1G0                  | Initialize indexing          |            |
|    |     | Oxc = (00T8IaG0)C2              |                              |            |
|    |     | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0              |            |
|    |     | rO2 = C4Oxc                     |                              |            |
|    | T7  | Ar3 = (01020304)Q1              |                              |            |
|    |     | sA(0-2) = A(21-23)AnrAr3        |                              |            |
|    |     | rA( " ) = A( " ) " "            | Recirculate A                | T7 thru T0 |
|    |     | sA(3-23) = A(0-20)Ar3           |                              |            |
|    |     | rA( " ) = A( " ) " "            |                              |            |
|    |     | sB(0-2) = B(21-23)BnrAr3        |                              |            |
|    |     | rB( " ) = B( " ) " "            | Recirculate B                | T7 thru T0 |
|    |     | sB(3-23) = B(0-20)Ar3           |                              |            |
|    |     | rB( " ) = B( " ) " "            |                              |            |
|    |     | Cr3 = F1F2(TsQ1)                |                              |            |
|    |     | sC(0-2) = Add(1-3)00JuTsCr3     |                              |            |
|    |     | rC( " ) = Add( " ) " "          | C+X•Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    |     | sC(3-23) = C(0-20)Cr3           |                              |            |
|    |     | rC( " ) = C( " ) " "            |                              |            |
|    |     | Xz(1-3) = Xn(1-3)00•Ix          | Adder input if Ix (indexing) |            |
|    |     | Xz( " ) = Xn( " )00Ix+Ix        |                              | T7 thru T0 |
|    |     | Yz(1-3) = C(21-23)07            | Adder input C register       | T7 thru T0 |
|    |     | Yz( " ) = C( " ) " "            |                              |            |
|    |     | sCz = KzQ1T007                  | Carry for Adder              | T7 thru T1 |
|    |     | rCz = KzQ1                      |                              |            |
|    |     | sCp = (C21⊕C22⊕C23)CpTsHtQ1F1F2 | Check parity                 | T7 thru T0 |
|    |     | rCp = ( " ) Cp " "              |                              |            |
|    | T4  | Sc = T4F1F2Inr                  | Clear S                      |            |
|    |     | rS(1-14) = Sc                   |                              |            |
|    | T3  | Sxc = T3F1F2Ju                  |                              |            |
|    |     | sS(1,2) = Add(2,3)Sxc           |                              |            |
|    |     | sS(3-14) = C(0-11)Sxc           | C+X•Ix → S                   |            |
|    | T0  | rCz = F1T0                      |                              |            |
|    | Tr  | Cxm = Ju00Tsm(Tr+Tp)            | M → C (Fetch Operand)        | Tr thru Tp |
|    |     | sC(0-23) = M(0-23)Cxm           |                              |            |
|    |     | rC( " ) = TrCxm                 |                              |            |
|    |     | sCz = (Tr00)0405Xw1             | Set carry if Xw1             |            |
|    |     | sHt = CpTr(CpX002)              | Parity error                 |            |
|    |     | rIx = Tr(F1F3)(GOHt)            |                              |            |
|    |     | rK0 = GOTrF2                    |                              |            |
|    | Tp  | sCp = M24CxmHtTsTp              | Initiate parity              |            |
|    |     | sF1 = (TpIa00)0304              |                              |            |
|    |     | sF2 = ( " )0302                 | 06 next clock (T8)           |            |

|    |    |          |                                       |                               |            |
|----|----|----------|---------------------------------------|-------------------------------|------------|
| 06 | T8 | Anr      | = 0102030406                          |                               |            |
|    |    | Ck       | = ( " ) 06T8Ts                        |                               |            |
|    |    | sC(0-23) | = C(0-23)Ck                           | Invert C                      |            |
|    |    | rC( " )  | = C( " ) "                            |                               |            |
|    |    | sIa      | = T8F1F3T8Kr                          | Initiate P register increment |            |
|    |    | End      | = F1F2                                | Last cycle                    |            |
| T7 |    | Ar3      | = (01020304)Q1                        |                               |            |
|    |    | sA(0-2)  | = Add(1-3)(0102030406)Ar3             |                               |            |
|    |    | rA( " )  | = Add( " )( " ) "                     | A + C + Carry → A =           |            |
|    |    | sA(3-23) | = A(0-20)Ar3                          | A - (M) + Carry → A           | T7 thru T0 |
|    |    | rA( " )  | = A( " ) "                            |                               |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                      |                               |            |
|    |    | rB( " )  | = B( " ) "                            | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                          |                               |            |
|    |    | rB( " )  | = B( " ) "                            |                               |            |
|    |    | Cr3      | = F1F3(TsQ1)                          |                               |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                     |                               |            |
|    |    | rC( " )  | = Add( " ) "                          | A + C + Carry → C             | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                          |                               |            |
|    |    | rC( " )  | = C( " ) "                            |                               |            |
|    |    | Xz(1-3)  | = A(21-23)060204                      | Adder input (A)               | T7 thru T0 |
|    |    | Xz( " )  | = A( " ) "                            |                               |            |
|    |    | Yz(1-3)  | = C(21-23)07                          | Adder input (C)               | T7 thru    |
|    |    | Yz( " )  | = C( " ) "                            |                               |            |
|    |    | sCz      | = K2Q1F107                            | Carry logic                   | T7 thru T0 |
|    |    | rCz      | = KzQ1                                |                               |            |
|    |    | sCp      | = (C21 ⊕ C22 ⊕ C23) CpTsHtQ10603      | Check parity of C             | T7 thru T0 |
|    |    | rCp      | = ( " ) Cp "                          |                               |            |
|    |    | Pr3      | = (F1G0)Q2                            |                               |            |
|    |    | sP0      | = (P12 ⊕ P13P14Ia) F1G0(02040506) Pr3 |                               |            |
|    |    | rP0      | = ( " ) "                             |                               |            |
|    |    | sP1      | = (P13 ⊕ P14Ia) "                     |                               |            |
|    |    | rP1      | = ( " ) "                             |                               |            |
|    |    | sP2      | = (P14 ⊕ Ia) "                        | P + 1 → P                     | T7 thru T3 |
|    |    | rP2      | = ( " ) "                             |                               |            |
|    |    | sP(3-14) | = P(0-11) Pr3                         |                               |            |
|    |    | rP( " )  | = P( " ) "                            |                               |            |
|    |    | rIa      | = (P12P13P14) Q2F1                    |                               |            |
|    |    | rOf      | = (0601020304) 05Q2                   | Reset Overflow                | T7 thru T3 |
| T4 |    | Sc       | = T4EndInr                            |                               |            |
|    |    | rS(1-14) | = Sc                                  | Clear S                       |            |
| T3 |    | Sxp      | = T3IntEndG0                          |                               |            |
|    |    | sS1      | = (P13 ⊕ P14Ia) F1G0(02040506) Sxp    |                               |            |
|    |    | rS1      | = ( " ) "                             |                               |            |
|    |    | sS2      | = (P14 ⊕ Ia) "                        | P + 1 → S                     |            |
|    |    | rS2      | = ( " ) "                             |                               |            |
|    |    | sS(3-14) | = P(0-11) Sxp                         |                               |            |
|    |    | rS( " )  | = P( " ) "                            |                               |            |

|    |               |  |                                |
|----|---------------|--|--------------------------------|
| T0 | sOf           | = $(\overline{0601020304})T0\overline{of}$ | Overflow logic                 |
|    | Ofe           | = $\overline{Add1Xz1Yz1+Add1Xz1Yz1}$       |                                |
| Tr | Cxm           | = $\overline{EndGOTsm(Tr+Tp)}$             | M → C (Fetch next instruction) |
|    | sC(0-23)      | = $\overline{M(0-23)Cxm}$                  | Tr thru Tp                     |
|    | rC( " )       | = $\overline{TrCxm}$                       |                                |
|    | sHt           | = $\overline{CpTrKpK0\overline{02}}$       | Parity error                   |
|    | rIa           | = $\overline{TrF1}$                        |                                |
|    | rIx           | = $\overline{Tr(F1F3)(G\overline{O}Ht)}$   |                                |
|    | Xld           | = $\overline{Cz(01020304\overline{06})Tr}$ | Save carry                     |
|    | Xld           | = $\overline{Cz( " ) "}$                   |                                |
| Tp | rA00          | = $\overline{TpEndGO}$                     | Initiate parity                |
|    | rB00          | = $( " )$                                  | 00 next clock (T8)             |
|    | sCp           | = $\overline{M24CxmHtTsTp}$                |                                |
|    | rF(1,2)       | = $\overline{TpEndSk}$                     |                                |
|    | Oc            | = $( " )$                                  |                                |
|    | sO2           | = $\overline{Oc}$                          |                                |
|    | rO(1,3,4,5,6) | = $\overline{Oc}$                          | NOP (20) → 0                   |

|    |     |                      |  |  |
|----|-----|----------------------|--|--|
| 57 | ADC | Add With Carry       | $A + (M) + \text{Carry} \rightarrow A$   | 2 Cycles                                     |
| 00 | T8  | rCz                  | = $\overline{0}T8$   | Initialize carry                             |
|    |     | sIx                  | = $\overline{0}T8C1G0$   | Initialize indexing                          |
|    |     | Oxc                  | = $(\overline{0}T8IaG0)\overline{C2}$  |  |
|    |     | sO(1,3,4,5,6)        | = $C(3,5,6,7,8)Oxc$  | Instruction $\rightarrow 0$                  |
|    |     | rO2                  | = $\overline{C4}Oxc$   |  |
|    | T7  | Ar3                  | = $(01020304)Q1$   |  |
|    |     | sA(0-2)              | = $A(21-23)AnrAr3$   |  |
|    |     | rA( " )              | = $\overline{A}( " ) " "$  | Recirculate A                                |
|    |     | sA(3-23)             | = $A(0-20)Ar3$   |  |
|    |     | rA( " )              | = $\overline{A}( " ) " "$  |  |
|    |     | sB(0-2)              | = $B(21-23)BnrAr3$   |  |
|    |     | rB( " )              | = $\overline{B}( " ) " "$  | Recirculate B                                |
|    |     | sB(3-23)             | = $B(0-20)Ar3$   |  |
|    |     | rB( " )              | = $\overline{B}( " ) " "$  |  |
|    |     | Cr3                  | = $\overline{F1F2}(TsQ1)$  |  |
|    |     | sC(0-2)              | = $\text{Add}(1-3)\overline{0}JuTsCr3$   |  |
|    |     | rC( " )              | = $\overline{\text{Add}}( " ) " "$   | $C+X \cdot Ix \rightarrow C$ (Add= $Xz+Yz$ ) |
|    |     | sC(3-23)             | = $C(0-20)Cr3$   |  |
|    |     | rC( " )              | = $\overline{C}( " ) " "$  |  |
|    |     | Xz(1-3)              | = $Xn(1-3)\overline{0} \cdot Ix$   | Adder input if Ix (indexing)                 |
|    |     | $\overline{Xz}( " )$ | = $\overline{Xn}( " )\overline{0}Ix+Ix$  |  |
|    |     | Yz(1-3)              | = $C(21-23)\overline{07}$  | Adder input C register                       |
|    |     | $\overline{Yz}( " )$ | = $\overline{C}( " ) " "$  |  |
|    |     | sCz                  | = $KzQ1T0\overline{07}$  | Carry for Adder                              |
|    |     | rCz                  | = $\overline{Kz}Q1$  |  |
|    |     | sCp                  | = $(C21\overline{0}C22\overline{0}C23)\overline{Cp}Ts\overline{Ht}Q1\overline{F1F2}$ | Check parity                                 |
|    |     | rCp                  | = $( " )Cp " "$  |  |
|    | T4  | Sc                   | = $T4\overline{F1F2}Inr$   | Clear S                                      |
|    |     | rS(1-14)             | = $Sc$   |  |
|    | T3  | Sxc                  | = $T3\overline{F1F2}Ju$  |  |
|    |     | sS(1,2)              | = $\text{Add}(2,3)Sxc$   |  |
|    |     | sS(3-14)             | = $C(0-11)Sxc$   | $C+X \cdot Ix \rightarrow S$                 |
|    | T0  | rCz                  | = $\overline{F1}T0$  |  |
|    | Tr  | Cxm                  | = $\overline{Ju}\overline{0}Tsm(Tr+Tp)$  | M $\rightarrow$ C (Fetch Operand)            |
|    |     | sC(0-23)             | = $M(0-23)Cxm$   |  |
|    |     | rC( " )              | = $TrCxm$  |  |
|    |     | sCz                  | = $(Tr\overline{0})0405Xw1$  | Set carry if Xw1                             |
|    |     | sHt                  | = $CpTr\overline{Kx}0\overline{02}$  | Parity error                                 |
|    |     | rIx                  | = $Tr(\overline{F1F3})(\overline{G0Ht})$   |  |
|    |     | rK0                  | = $G0Tr\overline{F2}$  |  |
|    | Tp  | sCp                  | = $M24Cxm\overline{Ht}TsTp$  | Initiate parity                              |
|    |     | sF1                  | = $(TpIa\overline{0})0304$   |  |
|    |     | sF2                  | = $( " )0302$  | $\overline{06}$ next clock (T8)              |



|    |    |          |                                   |                                |            |
|----|----|----------|-----------------------------------|--------------------------------|------------|
| 06 | T8 | Anr      | = 0102030406                      |                                |            |
|    |    | sIa      | = T8F1F3I1Kr                      | Initiate P register increment  |            |
|    |    | End      | = F1F2                            | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                    |                                |            |
|    |    | sA(0-2)  | = Add(1-3)(0102030406)Ar3         |                                |            |
|    |    | rA( " )  | = Add( " )( " ) "                 | A + C → A =                    |            |
|    |    | sA(3-23) | = A(0-20)Ar3                      | A + (M) + Carry → A            | T7 thru T0 |
|    |    | rA( " )  | = A( " ) "                        |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |    | rB( " )  | = B( " ) "                        |                                |            |
|    |    | sB(3-23) | = B(0-20)Ar3                      | Recirculate B                  | T7 thru T0 |
|    |    | rB( " )  | = B( " ) "                        |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                 |                                |            |
|    |    | rC( " )  | = Add( " ) "                      | A + C → C                      | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |    | rC( " )  | = C( " ) "                        |                                |            |
|    |    | Xz(1-3)  | = A(21-23)060204                  | Adder input (A)                | T7 thru T0 |
|    |    | Xz( " )  | = A( " ) "                        |                                |            |
|    |    | Yz(1-3)  | = C(21-23)07                      | Adder input (C)                | T7 thru T0 |
|    |    | Yz( " )  | = C( " ) "                        |                                |            |
|    |    | sCz      | = KzQ1F107                        | Carry logic                    | T7 thru T0 |
|    |    | rCz      | = KzQ1                            |                                |            |
|    |    | sCp      | = (C210C220C23)CpTsHtQ10603       | Check parity                   | T7 thru T0 |
|    |    | rCp      | = ( " )Cp "                       |                                |            |
|    |    | Pr3      | = (F1G0)Q2                        |                                |            |
|    |    | sP0      | = (P120P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |    | rP0      | = ( " ) "                         |                                |            |
|    |    | sP1      | = (P130P14Ia) "                   |                                |            |
|    |    | rP1      | = ( " ) "                         |                                |            |
|    |    | sP2      | = (P140Ia) "                      | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) "                         |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |    | rP( " )  | = P( " ) "                        |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    |    | rOf      | = (0601020304)05Q2                | Reset Overflow                 |            |
|    | T4 | Sc       | = T4EndInr                        |                                |            |
|    |    | rS(1-14) | = Sc                              | Clear S                        |            |
|    | T3 | Sxp      | = T3IntEndG0                      |                                |            |
|    |    | sS1      | = (P130P14Ia)F1G0(02040506)Sxp    |                                |            |
|    |    | rS1      | = ( " ) "                         |                                |            |
|    |    | sS2      | = (P140Ia) "                      | P + 1 → S                      |            |
|    |    | rS2      | = ( " ) "                         |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |    | rS( " )  | = P( " ) "                        |                                |            |
|    | T0 | sOf      | = (0601020304)T00fe               |                                |            |
|    |    | Ofe      | = Add1Xz1Yz1+Add1Xz1Yz1           | Overflow logic                 |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                 |                                |            |
|    |    | sC(0-23) | = M(0-23)Cxm                      | M → C (Fetch next instruction) |            |
|    |    | rC( " )  | = TrCxm                           |                                | Tr thru Tp |
|    |    | sHt      | = CpTrCpK002                      | Parity error                   |            |

|    |               |                    |                    |
|----|---------------|--------------------|--------------------|
|    | rIa           | = TrF1             |                    |
|    | rIx           | = Tr(F1F3)(GOHt)   |                    |
|    | Xld           | = Cz(0102030406)Tr |                    |
|    | Xld           | = Cz( " )"         | Save carry         |
| Tp | rA00          | = TpEndGO          |                    |
|    | rB00          | = ( " )            |                    |
|    | sCp           | = M24CxmHtTsTp     | Initiate parity    |
|    | rF(1,2)       | = TpEndSk          | 00 next clock (T8) |
|    | Oc            | = ( " )            |                    |
|    | sO2           | = Oc               |                    |
|    | rO(1,3,4,5,6) | = Oc               | NOP (20) → 0       |

|    |     |  |   |  |
|----|-----|--|---|--|
| 60 | SKR | Reduce Memory and Skip if Negative   | (M) - 1 → (M)<br>(M) ≥ 0; P + 1 → P<br>(M) < 0; P + 2 → P   | 3 Cycles   |
| ∅0 | T8  | rCz = ∅0T8<br>sIx = ∅0T8C1GO<br>Oxc = (∅0T8IaGO)C2<br>sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>rO2 = C4Oxc   | Initialize indexing<br>Instruction → 0  |  |
|    | T7  | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>Cr3 = F1F2(TsQ1)<br>sC(0-2) = Add(1-3)∅0JuTsCr3<br>rC( " ) = Add( " ) "<br>sC(3-23) = C(0-20)Cr3<br>rC( " ) = C( " ) "<br>Xz(1-3) = Xn(1-3)∅0·Ix<br>Xz( " ) = Xn( " )∅0Ix+Ix<br>Yz(1-3) = C(21-23)∅7<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T0∅7<br>rCz = KzQ1<br>sCp = (C21∅C22∅C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp " | Recirculate A<br>Recirculate B<br>C+X·Ix → C (Add=Xz+Yz)<br>Adder input (XIx)<br>Adder input (C)<br>Carry logic<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T1<br>T7 thru T0 |
|    | T4  | Sc = T4F1F2Inr<br>rS(1-14) = Sc  | Clear S   |  |
|    | T3  | Sxc = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc   | C + X·Ix → S  |  |
|    | T0  | rCz = F1T0   |   |  |
|    | Tr  | Cxm = Ju∅0Tsm(Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = TrCxm<br>sHt = CpTrCpK0∅2<br>rIx = Tr(F1F3)(GOHt)<br>rK0 = GOTrF2   | M → C (Fetch operand)<br>Parity error   | Tr thru Tp   |
|    | Tp  | sCp = M24CxmHtTsTp<br>sF1 = (TpIa∅0)0104   | Initiate parity<br>∅4 next clock (T8)   |  |

| 61 | MIN      | Memory Increment                | (M) + 1 → (M)          | 3 Cycles   |
|----|----------|---------------------------------|------------------------|------------|
| ∅0 | T8       | rCz = ∅0T8                      |                        |            |
|    |          | sIx = ∅0T8C1G0                  | Initialize indexing    |            |
|    |          | Oxc = (∅0T8IaG0)C2              |                        |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |            |
|    |          | rO2 = C4Oxc                     |                        |            |
| T7 | Ar3      | = (O1O2O3O4)Q1                  |                        |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |            |
|    | rA( " )  | = A( " ) " "                    | Recirculate A          | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |            |
|    | rA( " )  | = A( " ) " "                    |                        |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |            |
|    | rB( " )  | = B( " ) " "                    | Recirculate B          | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |            |
|    | rB( " )  | = B( " ) " "                    |                        |            |
|    | Cr3      | = F1F2(TsQ1)                    |                        |            |
|    | sC(0-2)  | = Add(1-3)∅0JuTsCr3             |                        |            |
|    | rC( " )  | = Add( " ) " "                  | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |            |
|    | rC( " )  | = C( " ) " "                    |                        |            |
|    | Xz(1-3)  | = Xn(1-3)∅0·Ix                  | Adder input (XIx)      | T7 thru T0 |
|    | Xz( " )  | = Xn( " )∅0Ix+Ix                |                        |            |
|    | Yz(1-3)  | = C(21-23)∅7                    | Adder input (C)        | T7 thru T0 |
|    | Yz( " )  | = C( " ) " "                    |                        |            |
|    | sCz      | = KzQ1T0∅7                      | Carry logic            | T7 thru T1 |
|    | rCz      | = KzQ1                          |                        |            |
|    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2     | Check parity           | T7 thru T0 |
|    | rCp      | = ( " ) Cp " "                  |                        |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |            |
|    | rS(1-14) | = Sc                            |                        |            |
| T3 | Sxc      | = T3F1F2Ju                      |                        |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                        |            |
|    | sS(3-14) | = C(0-11)Sxc                    | C + X·Ix → S           |            |
| T0 | rCz      | = F1T0                          |                        |            |
| Tr | Cxm      | = Ju∅0Tsm(Tr+Tp)                | M → C (Fetch operand)  | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                        |            |
|    | rC( " )  | = TrCxm                         |                        |            |
|    | sCz      | = (Tr∅0)O4O5O6                  | Initiate increment C   |            |
|    | sHt      | = CpTr(K∅K0∅2)                  | Parity error           |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |            |
|    | rK0      | = GOTrF2                        |                        |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |            |
|    | sFl      | = (TpIa∅0)O1O4                  | ∅4 next clock (T8)     |            |

|    |    |          |  |                                 |            |
|----|----|----------|--|---------------------------------|------------|
| 04 | T8 | rC24     | = $T8(\overline{TsTsr})$                                     | Initialize parity generation    |            |
|    |    | sIa      | = $F1\overline{F3}(\overline{IjKr})$                         | Initialize P register increment |            |
|    |    | Mxc      | = $\overline{\phi 4Tsm}$                                     |                                 | T8 thru Tp |
|    | T7 | Ar3      | = $(01020304)Q1$   |                                 |            |
|    |    | sA(0-2)  | = $\overline{A(21-23)AnrAr3}$                                |                                 |            |
|    |    | rA( " )  | = $\overline{A( " ) "}$                                      | Recirculate A                   | T7 thru T0 |
|    |    | sA(3-23) | = $\overline{A(0-20)Ar3}$                                    |                                 |            |
|    |    | rA( " )  | = $\overline{A( " ) "}$                                      |                                 |            |
|    |    | sB(0-2)  | = $\overline{B(21-23)BnrAr3}$                                |                                 |            |
|    |    | rB( " )  | = $\overline{B( " ) "}$                                      | Recirculate B                   | T7 thru T0 |
|    |    | sB(3-23) | = $\overline{B(0-20)Ar3}$                                    |                                 |            |
|    |    | rB( " )  | = $\overline{B( " ) "}$                                      |                                 |            |
|    |    | sCp      | = $(C21 \oplus C22 \oplus C23) \overline{CpTsHtQ1} \phi 401$ | Parity check                    | T7 thru T0 |
|    |    | rCp      | = $( " ) Cp " "$   |                                 |            |
|    |    | Cr3      | = $F1\overline{F3}(\overline{TsQ1})$                         |                                 |            |
|    |    | sC(0-2)  | = $\overline{Add(1-3) \phi 40105TsCr3}$                      |                                 |            |
|    |    | rC( " )  | = $\overline{Add( " ) "}$                                    | C + 1 → M                       | T7 thru T0 |
|    |    | sC(3-23) | = $\overline{C(0-20)Cr3}$                                    |                                 |            |
|    |    | rC( " )  | = $\overline{C( " ) "}$                                      | Adder input (0's)               |            |
|    |    | Xz(1-3)  | = $\phi 40506Ix$   | Adder input (C)                 | T7 thru T0 |
|    |    | Yz(1-3)  | = $\overline{C(21-23) \phi 7}$                               |                                 |            |
|    |    | Yz( " )  | = $\overline{C( " ) "}$                                      |                                 |            |
|    |    | sCz      | = $\overline{KzQ1F1 \phi 7}$                                 | Carry logic                     | T7 thru T0 |
|    |    | rCz      | = $\overline{KzQ1}$  |                                 |            |
|    |    | Pr3      | = $(F1G0)Q2$   |                                 |            |
|    |    | sP0      | = $(P12 \oplus P13P14Ia) F1G0(\overline{02040506}) Pr3$      |                                 |            |
|    |    | rP0      | = $( " ) " "$  |                                 |            |
|    |    | sP1      | = $(P13 \oplus P14Ia) " "$                                   |                                 |            |
|    |    | rP1      | = $( " ) " "$  |                                 |            |
|    |    | sP2      | = $(P14 \oplus Ia) " "$                                      | P + 1 → P                       | T7 thru T3 |
|    |    | rP2      | = $( " ) " "$  |                                 |            |
|    |    | sP(3-14) | = $\overline{P(0-11)Pr3}$                                    |                                 |            |
|    |    | rP( " )  | = $\overline{P( " ) "}$                                      |                                 |            |
|    |    | rIa      | = $(P12P13P14)Q2F1$  |                                 |            |
| T6 |    | sC24     | = $(C0 \oplus C1 \oplus C2) \overline{C24(TsTsr)}(Q3+Q5)$    | Generate parity                 | T6 thru Tr |
|    |    | rC24     | = $( " ) C24( " )( " )$                                      |                                 |            |
| T3 |    | rM(0-24) | = T3   | Clear M                         |            |
| T0 |    | sOf      | = $\overline{OfeT0 \phi 40105Ts}$                            | Overflow logic                  |            |
|    |    | Ofe      | = $\overline{AddIXz1Yz1 + AddIYz1Yz1}$                       |                                 |            |
| Tr |    | sHt      | = $\overline{CpTr(KpK0) \phi 2}$                             | Parity error                    |            |
|    |    | rIa      | = $\overline{TrF1}$  |                                 |            |
|    |    | rK0      | = $\overline{TrGOF2}$  |                                 |            |
| Tp |    | sF(1-3)  | = $\overline{Tp \phi 4}$                                     | 07 next clock (T8)              |            |
|    |    | sM(0-24) | = $\overline{C(0-24)MxcTp}$                                  |                                 |            |
|    |    | rM( " )  | = $\overline{C( " ) "}$                                      | C → M (Store operand)           |            |

07 T8 End = F1F2  
 T7 Ar3 = (01020304)Q1  
 sA(0-2) = A(21-23)ArAr3  
 rA( " ) = A( " ) "  
 sA(3-23) = A(0-20)Ar3  
 rA( " ) = A( " ) "  
 sB(0-2) = B(21-23)BArAr3  
 rB( " ) = B( " ) "  
 sB(3-23) = B(0-20)Ar3  
 rB( " ) = B( " ) "  
 Pr3 = F1GQ2  
 sP(0-2) = P(12-14)IaF1G0(02040506)Pr3  
 rP( " ) = P( " ) " ( " ) "  
 sP(3-14) = P(0-11)Pr3  
 rP( " ) = P( " ) "  
 T4 Sc = T4EndInr  
 rS(1-14) = Sc  
 T3 Sxp = T3IntEndGO  
 sS(1,2) = P(13,14)IaF1G0(02040506)Sxp  
 rS( " ) = P( " ) " ( " ) "  
 sS(3-14) = P(0-11)Sxp  
 rS( " ) = P( " ) "  
 T0 rSk = 07T0  
 Tr Cxm = EndGOTsm(Tr+Tp)  
 sC(0-23) = M(0-23)Cxm  
 rC( " ) = TrCxm  
 rIa = F1Tr  
 rIx = Tr(F1F3)(GOHt)  
 Tp rA00 = TpEndGO  
 rB00 = TpEndGO  
 sCp = M24CxmHtTsTp  
 rF(1-3) = TpEndSk  
 Oc = TpEndSk  
 sO2 = Oc  
 rO(1,3,4,5,6) = Oc

Last cycle

Recirculate A T7 thru T0

Recirculate B T7 thru T0

Recirculate P T7 thru T3

Clear B

P(13,14) contains P(1,2) at T3  
P → B

M → C (Fetch next instruction)  
Tr thru Tp

Initiate parity  
00 next

NOP (20) → 0

|    |          |                                 |                        |            |
|----|----------|---------------------------------|------------------------|------------|
| 62 | XMA      | Exchange A and Memory           | A ↔ (M)                | 3 Cycles   |
| ∅0 | T8       | rCz = ∅0T8                      |                        |            |
|    |          | sIx = ∅0T8C1G0                  | Initialize indexing    |            |
|    |          | Oxc = (∅0T8IaG0)C2              |                        |            |
|    |          | s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |            |
|    |          | r02 = C4Oxc                     |                        |            |
| T7 | Ar3      | = (01020304)Q1                  |                        |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |            |
|    | rA( " )  | = A( " ) " "                    | Recirculate A          | T7 thru TC |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |            |
|    | rA( " )  | = A( " ) " "                    |                        |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |            |
|    | rB( " )  | = B( " ) " "                    | Recirculate B          | T7 thru TC |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |            |
|    | rB( " )  | = B( " ) " "                    |                        |            |
|    | Cr3      | = F1F2(TsQ1)                    |                        |            |
|    | sC(0-2)  | = Add(1-3)∅0JuTsCr3             |                        |            |
|    | rC( " )  | = Add( " ) " "                  | C+X·Ix → C (Add=Xz+Yz) | T7 thru TC |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |            |
|    | rC( " )  | = C( " ) " "                    |                        |            |
|    | Xz(1-3)  | = Xn(1-3)∅0·Ix                  | Adder input (XIx)      | T7 thru TC |
|    | Xz( " )  | = Xn( " )∅0Ix+Ix                |                        |            |
|    | Yz(1-3)  | = C(21-23)∅7                    | Adder input (C)        | T7 thru TC |
|    | Yz( " )  | = C( " ) " "                    |                        |            |
|    | sCz      | = KzQ1T0∅7                      | Carry logic            | T7 thru T1 |
|    | rCz      | = KzQ1                          |                        |            |
|    | sCp      | = (C21C22C23)CpTsHtQ1F1F2       | Check parity           | T7 thru TC |
|    | rCp      | = ( " " )Cp " "                 |                        |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |            |
|    | rS(1-14) | = Sc                            |                        |            |
| T3 | Sxc      | = T3F1F2Ju                      |                        |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                        |            |
|    | sS(3-14) | = C(0-11)Sxc                    | C + X·Ix → S           |            |
| T0 | rCz      | = F1T0                          |                        |            |
| Tr | Cxm      | = Ju∅0Tsm(Tr+Tp)                | M → C (Fetch operand)  | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                        |            |
|    | rC( " )  | = TrCxm                         |                        |            |
|    | sHt      | = CpTrKpK0∅2                    | Parity error           |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |            |
|    | rK0      | = GOTrF2                        |                        |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |            |
|    | sF1      | = (TpIa∅0)0104                  | ∅4 next clock (T8)     |            |

|               |    |          |   |                                 |            |
|---------------|----|----------|---|---------------------------------|------------|
| $\emptyset 4$ | T8 | Anr      | = $\emptyset 4010506$   |                                 |            |
|               |    | rC24     | = $T8(Ts\overline{Ts})$   | Initialize parity generation    |            |
|               |    | sIa      | = $F1\overline{F3}(K\overline{K})$  | Initialize P register increment |            |
|               |    | Mxc      | = $\emptyset 4Tsm$  |                                 | T8 thru Tp |
|               | T7 | Ar3      | = $(01020304)Q1$  |                                 |            |
|               |    | sA(0-2)  | = $C(21-23)\emptyset 4010506Ar3$  |                                 |            |
|               |    | rA( " )  | = $\overline{C}( " ) " "$   | C → A                           | T7 thru T0 |
|               |    | sA(3-23) | = $A(0-20)Ar3$  |                                 |            |
|               |    | rA( " )  | = $\overline{A}( " ) " "$   |                                 |            |
|               |    | sB(0-2)  | = $B(21-23)\overline{Bnr}Ar3$   |                                 |            |
|               |    | rB( " )  | = $\overline{B}( " ) " "$   | Recirculate B                   | T7 thru T0 |
|               |    | sB(3-23) | = $B(0-20)Ar3$  |                                 |            |
|               |    | rB( " )  | = $\overline{B}( " ) " "$   |                                 |            |
|               |    | sCp      | = $(C21\oplus C22\oplus C23)\overline{Cp}\overline{Ts}\overline{Ht}Q1\emptyset 401$ |                                 |            |
|               |    | rCp      | = $( " ) Cp " "$  | Parity check                    | T7 thru T0 |
|               |    | Cr3      | = $F1\overline{F3}(\overline{Ts}Q1)$  |                                 |            |
|               |    | sC(0-2)  | = $A(21-23)\emptyset 4010506$   |                                 |            |
|               |    | rC( " )  | = $\overline{A}( " ) " "$   | A → C                           | T7 thru T0 |
|               |    | sC(3-23) | = $C(0-20)Cr3$  |                                 |            |
|               |    | rC( " )  | = $\overline{C}( " ) " "$   |                                 |            |
|               |    | Pr3      | = $(F1G0)Q2$  |                                 |            |
|               |    | sP0      | = $(P12\oplus P13P14Ia)F1G0(\overline{02040506})Pr3$                                |                                 |            |
|               |    | rP0      | = $( " ) " "$   |                                 |            |
|               |    | sP1      | = $(P13\oplus P14Ia) " "$   |                                 |            |
|               |    | rP1      | = $( " ) " "$   |                                 |            |
|               |    | sP2      | = $(P14\oplus Ia) " "$  | P + 1 → P                       | T7 thru T3 |
|               |    | rP2      | = $( " ) " "$   |                                 |            |
|               |    | sP(3-14) | = $P(0-11)Pr3$  |                                 |            |
|               |    | rP( " )  | = $\overline{P}( " ) " "$   |                                 |            |
|               |    | rIa      | = $(\overline{P12P13P14})Q2F1$  |                                 |            |
|               | T6 | sC24     | = $(C0\oplus C1\oplus C2)\overline{C24}(Ts\overline{Ts})(Q3+Q5)$                    | Generate parity                 | T6 thru Tr |
|               |    | rC24     | = $( " ) C24( " )( " )$   |                                 |            |
|               | T3 | rM(0-24) | = T3  | Clear M                         |            |
|               | Tr | sHt      | = $CpTr(K\overline{K})\emptyset 2$  | Parity error                    |            |
|               |    | rIa      | = $TrF1$  |                                 |            |
|               |    | rK0      | = $TrG\overline{O}\overline{F}2$  |                                 |            |
|               | Tp | sF(1-3)  | = $Tp\emptyset 4$   | $\emptyset 7$ next clock (T8)   |            |
|               |    | sM(0-24) | = $C(0-24)MxcTp$  |                                 |            |
|               |    | rM( " )  | = $\overline{C}( " ) " "$   | C → M (Store operand)           |            |



|    |    |               |                                  |                                |            |
|----|----|---------------|----------------------------------|--------------------------------|------------|
| Ø7 | T8 | End           | = F1F2                           | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                   |                                |            |
|    |    | sA(0-2)       | = A(21-23)ArAr3                  |                                |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "       | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                     |                                |            |
|    |    | rA( " )       | = $\overline{A}$ ( " ) " "       |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                 |                                |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "       | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                     |                                |            |
|    |    | rB( " )       | = $\overline{B}$ ( " ) " "       |                                |            |
|    |    | Pr3           | = F1GOQ2                         |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3    |                                |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) " ( " ) " | Recirculate P                  | T7 thru T3 |
|    |    | sP(3-14)      | = P(0-11)Pr3                     |                                |            |
|    |    | rP( " )       | = $\overline{P}$ ( " ) " "       |                                |            |
|    | T4 | Sc            | = T4EndInr                       | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                             |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                     |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp    | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = $\overline{P}$ ( " ) " ( " ) " | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                     |                                |            |
|    |    | rS( " )       | = $\overline{P}$ ( " ) " "       |                                |            |
|    | T0 | rSk           | = Ø7T0                           |                                |            |
|    | Tr | Cxm           | = EndGOTsm(Tr+Tp)                | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                     |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCxm                          |                                |            |
|    |    | rIa           | = F1Tr                           |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)                 |                                |            |
|    | Tp | rA00          | = TpEndGO                        |                                |            |
|    |    | rB00          | = TpEndGO                        |                                |            |
|    |    | sCp           | = M24CxmHtTsTp                   | Initiate parity                |            |
|    |    | rF(1-3)       | = TpEndSk                        | Ø0 next                        |            |
|    |    | Oc            | = TpEndSk                        |                                |            |
|    |    | sO2           | = Oc                             |                                |            |
|    |    | rO(1,3,4,5,6) | = Oc                             | NOF (20) → 0                   |            |

| 63 | ADM      | Add A to (M) and Store in (M)   | A + (M) → (M)          | 3 Cycles   |
|----|----------|---------------------------------|------------------------|------------|
| 00 | T8       | rCz = 00T8                      |                        |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing    |            |
|    |          | Oxc = (00T8IaG0)C2              |                        |            |
|    |          | s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |            |
|    |          | r02 = C4Oxc                     |                        |            |
| T7 | Ar3      | = (01020304)Q1                  |                        |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |            |
|    | rA( " )  | = A( " ) "                      | Recirculate A          | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |            |
|    | rA( " )  | = A( " ) "                      |                        |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |            |
|    | rB( " )  | = B( " ) "                      | Recirculate B          | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |            |
|    | rB( " )  | = B( " ) "                      |                        |            |
|    | Cr3      | = F1F2(TsQ1)                    |                        |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             |                        |            |
|    | rC( " )  | = Add( " ) "                    | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |            |
|    | rC( " )  | = C( " ) "                      |                        |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input (XIx)      | T7 thru T0 |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                        |            |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input (C)        | T7 thru T0 |
|    | Yz( " )  | = C( " ) "                      |                        |            |
|    | sCz      | = KzQ1T007                      | Carry logic            | T7 thru T1 |
|    | rCz      | = KzQ1                          |                        |            |
|    | sCp      | = (C21+C22+C23)CpTsHtQ1F1F2     | Check parity           | T7 thru T0 |
|    | rCp      | = ( " )Cp "                     |                        |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |            |
|    | rS(1-14) | = Sc                            |                        |            |
| T3 | Sxc      | = T3F1F2Ju                      |                        |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   | C + X·Ix → S           |            |
|    | sS(3-14) | = C(0-11)Sxc                    |                        |            |
| T0 | rCz      | = F1T0                          |                        |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch operand)  | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                        |            |
|    | rC( " )  | = TrCxm                         |                        |            |
|    | sHt      | = CpTrKpK002                    | Parity error           |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |            |
|    | rK0      | = GOTrF2                        |                        |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |            |
|    | sF1      | = (TpIa00)0104                  | 04 next clock (T8)     |            |

|    |    |                             |  |  |            |
|----|----|-----------------------------|--|--|------------|
| 04 | T8 | rC24                        | = T8( $\overline{\text{TsTsr}}$ )  | Initialize parity generation           |            |
|    |    | sIa                         | = F1F3( $\overline{\text{Cr}}$ )   | Initialize P register increment        |            |
|    |    | Mxc                         | = $\overline{\text{04Tsm}}$  |  | T8 thru Tp |
|    | T7 | Ar3                         | = (01020304)Q1   |  |            |
|    |    | sA(0-2)                     | = A(21-23) $\overline{\text{Ar}}$ Ar3  |  |            |
|    |    | rA( " )                     | = $\overline{\text{A( " )}}$ "   | Recirculate A                          | T7 thru T0 |
|    |    | sA(3-23)                    | = A(0-20)Ar3   |  |            |
|    |    | rA( " )                     | = $\overline{\text{A( " )}}$ "   |  |            |
|    |    | sB(0-2)                     | = B(21-23) $\overline{\text{Bnr}}$ Ar3   |  |            |
|    |    | rB( " )                     | = $\overline{\text{B( " )}}$ "   | Recirculate B                          | T7 thru T0 |
|    |    | sB(3-23)                    | = B(0-20)Ar3   |  |            |
|    |    | rB( " )                     | = $\overline{\text{B( " )}}$ "   |  |            |
|    |    | sCp                         | = (C21 $\oplus$ C22 $\oplus$ C23) $\overline{\text{CpTsHt}}$ Q1 $\overline{\text{0401}}$ | Parity check                           | T7 thru T0 |
|    |    | rCp                         | = ( " ) Cp "   |  |            |
|    |    | Cr3                         | = F1F3( $\overline{\text{TsQ1}}$ )   |  |            |
|    |    | sC(0-2)                     | = Add(1-3) $\overline{\text{040106Ts}}$ Cr3  |  |            |
|    |    | rC( " )                     | = $\overline{\text{Add( " )}}$ "   |  |            |
|    |    | sC(3-23)                    | = C(0-20)Cr3   | A + M $\rightarrow$ M                  | T7 thru T0 |
|    |    | rC( " )                     | = $\overline{\text{C( " )}}$ "   |  |            |
|    |    | Xz(1-3)                     | = $\overline{\text{A(21-23)0405}}$   | Adder input (A)                        | T7 thru T0 |
|    |    | $\overline{\text{Xz( " )}}$ | = $\overline{\text{A( " )}}$ "   |  |            |
|    |    | Yz(1-3)                     | = C(21-23) $\overline{\text{07}}$  | Adder input (C)                        | T7 thru T0 |
|    |    | $\overline{\text{Yz( " )}}$ | = $\overline{\text{C( " )}}$ "   |  |            |
|    |    | sCz                         | = KzQ1F1 $\overline{\text{07}}$  | Carry logic                            | T7 thru T0 |
|    |    | rCz                         | = $\overline{\text{KzQ1}}$   |  |            |
|    |    | Pr3                         | = (F1G0)Q2   |  |            |
|    |    | sP0                         | = (P12 $\oplus$ P13P14Ia) F1G0( $\overline{\text{02040506}}$ ) Pr3                       |  |            |
|    |    | rP0                         | = ( " ) "  |  |            |
|    |    | sP1                         | = (P13 $\oplus$ P14Ia) "   |  |            |
|    |    | rP1                         | = ( " ) "  |  |            |
|    |    | sP2                         | = (P14 $\oplus$ Ia) "  | P + 1 $\rightarrow$ P                  | T7 thru T3 |
|    |    | rP2                         | = ( " ) "  |  |            |
|    |    | sP(3-14)                    | = P(0-11)Pr3   |  |            |
|    |    | rP( " )                     | = $\overline{\text{P( " )}}$ "   |  |            |
|    |    | rIa                         | = (P12P13P14)Q2F1  |  |            |
|    | T6 | sC24                        | = (C0 $\oplus$ C1 $\oplus$ C2) $\overline{\text{C24(TsTsr)}}$ (Q3+Q5)                    | Generate parity                        | T6 thru Tr |
|    |    | rC24                        | = ( " ) C24( " )( " )  |  |            |
|    | T3 | rM(0-24)                    | = T3   | Clear M                                |            |
|    | T0 | sOf                         | = Of $\overline{\text{eT00405}}$   | Overflow logic                         |            |
|    |    | Ofe                         | = Add1 $\overline{\text{Xz1Yz1}}$ +Add1 $\overline{\text{Xz1Yz1}}$                       |  |            |
|    | Tr | sHt                         | = CpTr( $\overline{\text{K002}}$ )   | Parity error                           |            |
|    |    | rIa                         | = TrF1   |  |            |
|    |    | rK0                         | = TrGOF2   |  |            |
|    | Tp | sF(1-3)                     | = Tp $\overline{\text{04}}$  | $\overline{\text{07}}$ next clock (T8) |            |
|    |    | sM(0-24)                    | = C(0-24)MxcTp   | C $\rightarrow$ M (Store operand)      |            |
|    |    | rM( " )                     | = $\overline{\text{C( " )}}$ "   |  |            |

|    |    |               |                               |                                |            |
|----|----|---------------|-------------------------------|--------------------------------|------------|
| Ø7 | T8 | End           | = <u>F1F2</u>                 | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3              | Recirculate A                  | T7 thru T0 |
|    |    | rA( " )       | = <u>A( " )</u> " "           |                                |            |
|    |    | sA(3-23)      | = A(0-20)Ar3                  |                                |            |
|    |    | rA( " )       | = <u>A( " )</u> " "           |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3              | Recirculate B                  | T7 thru T0 |
|    |    | rB( " )       | = <u>B( " )</u> " "           |                                |            |
|    |    | sB(3-23)      | = B(0-20)Ar3                  |                                |            |
|    |    | rB( " )       | = <u>B( " )</u> " "           |                                |            |
|    |    | Pr3           | = F1GOQ2                      |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3 | Recirculate P                  | T7 thru T3 |
|    |    | rP( " )       | = <u>P( " )</u> " ( " ) " "   |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                  |                                |            |
|    |    | rP( " )       | = <u>P( " )</u> " "           |                                |            |
|    | T4 | Sc            | = T4EndInr                    | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                          |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                  |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = <u>P( " )</u> " ( " ) " "   | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                  |                                |            |
|    |    | rS( " )       | = <u>P( " )</u> " "           |                                |            |
|    | T0 | rSk           | = Ø7T0                        |                                |            |
|    | Tr | Cxm           | = EndGOTsm(Tr+Tp)             | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                  |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCxm                       |                                |            |
|    |    | rIa           | = F1Tr                        |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)              |                                |            |
|    | Tp | rA00          | = TpEndGO                     | Initiate parity                |            |
|    |    | rB00          | = TpEndGO                     | Ø0 next                        |            |
|    |    | sCp           | = M24CxmHtTsTp                |                                |            |
|    |    | rF(1-3)       | = TpEndSk                     |                                |            |
|    |    | Oc            | = TpEndSk                     |                                |            |
|    |    | sO2           | = Oc                          |                                |            |
|    |    | rO(1,3,4,5,6) | = Oc                          | NOP (20) → 0                   |            |

|               |     |   |   |  |
|---------------|-----|---|---|--|
| 64            | MUL | Multiply  | $A \cdot (M) \rightarrow A$   | 4 Cycles   |
| $\emptyset 0$ | T8  | rCz = $\emptyset 0 T 8$<br>sIx = $\emptyset 0 T 8 C 1 G 0$<br>Oxc = $(\emptyset 0 T 8 \bar{I} a G 0) \bar{C} 2$<br>sO(1,3,4,5,6) = $C(3,5,6,7,8) Oxc$<br>rO2 = $\bar{C} 4 Oxc$  | Initialize indexing<br>Instruction $\rightarrow 0$  |  |
|               | T7  | Ar3 = $(0102\bar{0}304) Q 1$<br>sA(0-2) = $\bar{A}(21-23) \bar{A} n r A r 3$<br>rA( " ) = $\bar{A}( " ) " "$<br>sA(3-23) = $\bar{A}(0-20) A r 3$<br>rA( " ) = $\bar{A}( " ) " "$<br>Bnr = $(\emptyset 0 \bar{0} 3 0 4 \bar{0} 5 \bar{0} 6)$<br>rB( " ) = $( " )$<br>sB(3-23) = $\bar{B}(0-20) A r 3$<br>rB( " ) = $\bar{B}( " ) " "$<br>Cr3 = $\bar{F} 1 \bar{F} 2 (T s Q 1)$<br>sC(0-2) = $A d d(1-3) \emptyset 0 J u \bar{T} s C r 3$<br>rC( " ) = $A d d( " ) " "$<br>sC(3-23) = $\bar{C}(0-20) C r 3$<br>rC( " ) = $\bar{C}( " ) " "$<br>Xz(1-3) = $\bar{X} n(1-3) \emptyset 0 \cdot I x$<br>$\bar{X} z( " ) = \bar{X} n( " ) \emptyset 0 I x + \bar{I} x$<br>Yz(1-3) = $\bar{C}(21-23) \bar{0} 7$<br>$\bar{Y} z( " ) = \bar{C}( " ) " "$<br>sCz = $\bar{K} z Q 1 \bar{T} 0 \bar{0} 7$<br>rCz = $\bar{K} z Q 1$<br>sCp = $(C 2 1 \oplus C 2 2 \oplus C 2 3) \bar{C} p \bar{T} s \bar{H} t Q 1 \bar{F} 1 \bar{F} 2$<br>rCp = $( " ) C p " "$ | Recirculate A<br>$0 \rightarrow B$<br>$C + X \cdot I x \rightarrow C$ (Add= $Xz+Yz$ )<br>Adder input ( $X \cdot Ix$ )<br>Adder input (C)<br>Carry logic<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T1<br>T7 thru T0 |
|               | T4  | Sc = $T 4 \bar{F} 1 \bar{F} 2 \bar{I} n r$  | Clear S   |  |
|               | T3  | Sxc = $T 3 \bar{F} 1 \bar{F} 2 \bar{J} u$<br>sS(1,2) = $A d d(2,3) S x c$<br>sS(3-14) = $\bar{C}(0-11) S x c$   | $C + X \cdot I x \rightarrow S$   |  |
|               | T0  | rCz = $\bar{F} 1 T 0$   |   |  |
|               | Tr  | Cxm = $\bar{J} u \emptyset 0 \bar{T} s m (T r + T p)$<br>sC(0-23) = $\bar{M}(0-23) C x m$<br>rC( " ) = $\bar{T} r C x m$<br>sHt = $\bar{C} p \bar{T} r \bar{C} p \bar{K} 0 \bar{0} 7$<br>rIx = $\bar{T} r (F 1 \bar{F} 3) (G O H t)$<br>rK0 = $\bar{G} O \bar{T} r \bar{F} 2$   | $M \rightarrow C$ (Fetch operand)<br>Parity error   | Tr thru Tp   |
|               | Tp  | sCp = $\bar{M} 2 4 C x m \bar{H} t \bar{T} s T p$<br>sF2 = $(T p \bar{I} a \emptyset 0) 0 4 \bar{0} 5 \bar{0} 6$<br>sF3 = $( " ) \bar{0} 3 0 4$<br>sK0 = $( " ) \bar{0} 3 0 4 \bar{0} 6$  | Initiate parity<br>$\emptyset 3$ next clock (T8)<br>Hold Computer in "1 bit per clock" mode   |  |

|       |          |                   |   |
|-------|----------|-------------------|---|
| Ø3 T8 | Ar1      | = F2F30506K0      |   |
|       | sA0      | = B2305Ar1        |   |
|       | rA0      | = B23 "           |   |
|       | sA(1,2)  | = A(0,1)05Ar1     | Shift A right 1 bit - bring in first product bit (always 0) |
|       | rA( " )  | = A( " ) "        |   |
|       | sA(3-22) | = A(2-21)Ar1      |   |
|       | rA( " )  | = A( " ) "        |   |
|       | sA23     | = A2206Ar1        |   |
|       | rA23     | = A22 "           |   |
|       | Brl      | = (F2F30506K0)A23 | Shift B right if A23  |
|       | Rsa      | = ( " )A23        | Shift B right and add C if A23                              |
|       | sB00     | = RsaC0           | B00 = C0 after the first Rsa                                |

Rsa causes the B register to shift right 1 bit and then be added in parrallel octates with the C register, the results occuring in B. One bit (B23) is shifted into A and represents one product bit.

Brl causes the B register to shift right 1 bit. B23 is shifted into A and represents one product bit.

|       |               |            |       |      |       |
|-------|---------------|------------|-------|------|-------|
| T7    | (refer Ø3 T8) | generates  | B(22) | from | A(22) |
| T6    | ( " )         | "          | B(21) | "    | A(21) |
| T5    | ( " )         | "          | B(20) | "    | A(20) |
| T4    | ( " )         | "          | B(19) | "    | A(19) |
| T3    | ( " )         | "          | B(18) | "    | A(18) |
| T2    | ( " )         | "          | B(17) | "    | A(17) |
| T1    | ( " )         | "          | B(16) | "    | A(16) |
| T0    | ( " )         | "          | B(15) | "    | A(15) |
| Tr    | ( " )         | "          | B(14) | "    | A(14) |
| Tp    | ( " )         | "          | B(13) | "    | A(13) |
|       | sSk           | = Ø30506Tp |       |      |       |
| Ø3 T8 | (refer Ø3 T8) | generates  | B(12) | from | A(12) |
| T7    | ( " )         | "          | B(11) | "    | A(11) |
| T6    | ( " )         | "          | B(10) | "    | A(10) |
| T5    | ( " )         | "          | B(9)  | "    | A(9)  |
| T4    | ( " )         | "          | B(8)  | "    | A(8)  |
| T3    | ( " )         | "          | B(7)  | "    | A(7)  |
| T2    | ( " )         | "          | B(6)  | "    | A(6)  |
| T1    | ( " )         | "          | B(5)  | "    | A(5)  |
| T0    | ( " )         | "          | B(4)  | "    | A(4)  |
| Tr    | ( " )         | "          | B(3)  | "    | A(3)  |
| Tp    | ( " )         | "          | B(2)  | "    | A(2)  |
|       | sFl           | = TpSk     |       |      |       |

Ø7 next clock

|    |  |  |  |                                       |
|----|--|--|--|---------------------------------------|
| Ø7 | T8                                     | (refer Ø3 T8) generates B(1) from A(1) |  |                                       |
|    | Anr                                    | = Ø7Ø304Ø5Ø6                           |  |                                       |
|    | Bnr                                    | = "                                    |  |                                       |
|    | Ck                                     | = Ø7T8Ts                               |  |                                       |
|    | sC(0-23)                               | = C(0-23) Ck                           |  | Invert C                              |
|    | rC( " )                                | = C( " ) "                             |  |                                       |
|    | End                                    | = FlF2                                 |  | Last cycle                            |
|    | sIa                                    | = T8Ø7SkIØKr                           |  | Initiate P register increment         |
| T7 | (refer Ø3 T8) generates B(0) from A(0) |  |  |                                       |
|    | sBc23                                  | = RsaØ7Q1                              |  | Rsa means A0 = 1; C + 1 = -C          |
|    | Cr3                                    | = Ø7Ø5TsQ1                             |  |                                       |
|    | rC(0-2)                                | = "                                    |  | 0 → C                                 |
|    | sC(3-23)                               | = C(0-20) Cr3                          |  | T7 thru T0                            |
|    | rC( " )                                | = C( " ) "                             |  |                                       |
|    | sCp                                    | = (C21⊕C22⊕C23) Cp(Ø7Ø304Ø5Ø6) TsHtQ1  |  | Check parity                          |
|    | rCp                                    | = ( " ) Cp( " ) "                      |  | T7 thru T0                            |
|    | rK0                                    | = Ø7Q1Ø6Ø1                             |  | Release-Computer from 1 bit/clock mod |
|    | Pr3                                    | = (FlGO)Q2                             |  |                                       |
|    | sP0                                    | = (P12⊕P13P14Ia) FlGO(Ø2Ø4Ø5Ø6) Pr3    |  |                                       |
|    | rP0                                    | = ( " ) "                              |  |                                       |
|    | sP1                                    | = (P13⊕P14Ia)                          |  |                                       |
|    | rP1                                    | = ( " ) "                              |  |                                       |
|    | sP2                                    | = (P14⊕Ia)                             |  | P + 1 → P                             |
|    | rP2                                    | = ( " ) "                              |  | T7 thru T3                            |
|    | sP(3-14)                               | = P(0-11) Pr3                          |  |                                       |
|    | rP( " )                                | = P( " ) "                             |  |                                       |
|    | rIa                                    | = (P12P13P14) Q2F1                     |  |                                       |
| T6 | Ar3                                    | = (Ø7Ø304Ø5Ø6) KØTp                    |  |                                       |
|    | sA(0-2)                                | = Add(1-3) (Ø7Ø304Ø5Ø6) Ar3            |  | B+Bc → A (add Bc's to B)              |
|    | rA( " )                                | = Add( " ) ( " ) "                     |  | T6 thru Tr                            |
|    | sA(3-23)                               | = A(0-20) Ar3                          |  |                                       |
|    | rA( " )                                | = A( " ) "                             |  |                                       |
|    | Xz(1-3)                                | = B(21-23) Ø7Ø5Ø6                      |  |                                       |
|    | Xz( " )                                | = B( " ) "                             |  | Adder input (B)                       |
|    | Yz1                                    | = Ø7Rf                                 |  | T6 thru Tr                            |
|    | Yz2                                    | = Ø7KØ                                 |  |                                       |
|    | Yz3                                    | = Ø7Bc23                               |  | Adder input (Bc)                      |
|    | Yz3                                    | = Ø7Bc23                               |  | T6 thru Tr                            |
|    | rB00                                   | = Ar3GO                                |  |                                       |
|    | sB(0-2)                                | = A(21-23) Ø7Ø304Ø5Ø6                  |  |                                       |
|    | rB( " )                                | = A( " ) "                             |  |                                       |
|    | sB(3-23)                               | = A(0-20) Ar3                          |  | A → B                                 |
|    | rB( " )                                | = A( " ) "                             |  | T6 thru Tr                            |
| T4 | Sc                                     | = T4EndInr                             |  |                                       |
|    | rS(1-14)                               | = Sc                                   |  | Clear S                               |
| T3 | Sxp                                    | = T3IntEndGO                           |  |                                       |
|    | sS(1,2)                                | = P(13,14) IaFlGO(Ø2Ø4Ø5Ø6) Sxp        |  | P(13,14) contains P(1,2) at T3        |
|    | rS( " )                                | = P( " ) ( " ) "                       |  | P → S                                 |
|    | sS(3-14)                               | = P(0-11) Sxp                          |  |                                       |
|    | rS( " )                                | = P( " ) "                             |  |                                       |

|    |               |   |                                |
|----|---------------|---|--------------------------------|
| T0 | rSk           | = $\emptyset 7T0$   |                                |
| Tr | Cxm           | = $\text{EndGO} \overline{\text{Tsm}}(\text{Tr}+\text{Tp})$ |                                |
|    | sC(0-23)      | = M(0-23) Cxm   | M → C (Fetch next instruction) |
|    | rC( " )       | = TrCxm   | Tr thru Tp                     |
|    | sHt           | = CpTr(Kp)K002  | Parity error                   |
|    | rIa           | = FlTr  |                                |
|    | rIx           | = Tr(FIF3) (GOHt)   |                                |
| Tp | rA00          | = TpEndGO   |                                |
|    | rB00          | = TpEndGO   |                                |
|    | sCp           | = M24CxmHtTsTp  | Initiate parity                |
|    | rF(1-3)       | = TpEndSK   | $\emptyset 0$ next             |
|    | sOf           | = ( $\emptyset 703040506$ )TpA0A00                          | -1 times -1                    |
|    | Oc            | = TpEndSK   |                                |
|    | sO2           | = Oc  |                                |
|    | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                   |



| 65 | DIV | Divide                          | A,B/(M) → A,B         | 10 Cycles  |
|----|-----|---------------------------------|-----------------------|------------|
| ∅0 | T8  | rCz = ∅0T8                      |                       |            |
|    |     | sIx = ∅0T8C1G0                  | Initialize indexing   |            |
|    |     | Oxc = (∅0T8TāG0)C2              |                       |            |
|    |     | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0       |            |
|    |     | rO2 = C4Oxc                     |                       |            |
|    | T7  | Ar3 = F1F2O5Q1                  |                       |            |
|    |     | sA(0-2) = A(21-23)AnrAr3        |                       |            |
|    |     | rA( " ) = A( " ) "              | Recirculate A         | T7 thru T0 |
|    |     | sA(3-23) = A(0-20)Ar3           |                       |            |
|    |     | rA( " ) = A( " ) "              |                       |            |
|    |     | sA00 = A0∅0T7                   | Set A00 = Sign of A   |            |
|    |     | sB(0-2) = B(21-23)BnrAr3        |                       |            |
|    |     | rB( " ) = B( " ) "              | Recirculate B         | T7 thru T0 |
|    |     | sB(3-23) = B(0-20)Ar3           |                       |            |
|    |     | rB( " ) = B( " ) "              |                       |            |
|    |     | Cr3 = F1F2(TsQ1)                |                       |            |
|    |     | sC(0-2) = Add(1-3)∅0JuT̄sCr3    |                       |            |
|    |     | rC( " ) = Add( " ) "            | C+X·Ix → C(Add=Xz+Yz) | T7 thru T0 |
|    |     | sC(3-23) = C(0-20)Cr3           |                       |            |
|    |     | rC( " ) = C( " ) "              |                       |            |
|    |     | Xz(1-3) = Xn(1-3)∅0·Ix          | Adder input (XIx)     | T7 thru T0 |
|    |     | X̄z( " ) = X̄n( " )∅0Ix+Ix      |                       |            |
|    |     | Yz(1-3) = C(21-23)∅7            | Adder input (C)       | T7 thru T0 |
|    |     | Ȳz( " ) = C( " ) "              |                       |            |
|    |     | sCz = KzQ1T0∅7                  | Carry logic           | T7 thru T1 |
|    |     | rCz = KzQ1                      |                       |            |
|    |     | sCp = (C21⊕C22⊕C23)CpTsHtQ1F1F2 | Check parity          | T7 thru T0 |
|    |     | rCp = ( " )Cp "                 |                       |            |
|    | T4  | Sc = T4F1F2Inr                  | Clear S               |            |
|    |     | rS(1-14) = Sc                   |                       |            |
|    | T3  | Sxc = T3F1F2Ju                  |                       |            |
|    |     | sS(1,2) = Add(2,3)Sxc           | C + X·Ix → S          |            |
|    |     | sS(3-14) = C(0-11)Sxc           |                       |            |
|    | T0  | rCz = F1T0                      |                       |            |
|    | Tr  | Cxm = Ju∅0Tsm(Tr+Tp)            | M → C (Fetch operand) | Tr thru Tp |
|    |     | sC(0-23) = M(0-23)Cxm           |                       |            |
|    |     | rC( " ) = TrCxm                 | Parity error          |            |
|    |     | sHt = CpTr(KpK0∅2)              |                       |            |
|    |     | rIx = Tr(F1F3)(G0Ht)            |                       |            |
|    |     | rK0 = G0TrF2                    |                       |            |
|    | Tp  | sCp = M24CxmHtTsTp              | Initiate parity       |            |
|    |     | sF3 = (TpIa∅0)O304              | ∅1 next clock (T8)    |            |

|    |       |          |                                   |                                     |            |
|----|-------|----------|-----------------------------------|-------------------------------------|------------|
| Ø1 | T8    | Anr      | = Ø1Ø5                            |                                     |            |
|    |       | Bnr      | = Ø1Ø5                            |                                     |            |
|    |       | Ck       | = Ø1T8CØTs                        |                                     |            |
|    |       | sC(0-23) | = C(0-23)Ck                       | Invert C if C ≥ 0                   |            |
|    |       | rC( " )  | = C( " ) "                        |                                     |            |
|    |       | sCz      | = Ø1T8CØ                          |                                     |            |
|    |       | sHz      | = T8                              | Initiate - B if A -                 |            |
|    |       | sIx      | = Ø1T8CØ                          | Set Ix = Sign of (M)                |            |
| T7 | Ar3   |          | = F1F2Ø5Q1                        |                                     |            |
|    |       | sA(0-2)  | = (Ha(1-3)A00+B(21-23)A00)Ø1Ø5Ar3 | B → A if A ≥ 0                      | T7 thru TØ |
|    |       | rA( " )  | = (Ha( " ) " +B( " ) " ) "        | B + 1 → A < 0                       |            |
|    |       | sA(3-23) | = A(0-20)Ar3                      |                                     |            |
|    |       | rA( " )  | = A( " ) "                        |                                     |            |
|    |       | Hx(1-3)  | = B(21-23)Ø1                      | Half Adder inputs (B+1)             | T7 thru TØ |
|    |       | Hx( " )  | = B( " ) "                        | (B23 is turned off unconditionally) |            |
|    |       | sB(0-2)  | = Add(1-3)Ø1Ø5Ar3                 |                                     |            |
|    |       | rB( " )  | = Add( " ) "                      |                                     |            |
|    |       | sB(3-23) | = B(0-20)Ar3                      | A  -  C  → B                        | T7 thru TØ |
|    |       | rB( " )  | = B( " ) "                        |                                     |            |
|    |       | Xz(1-3)  | = (A(21-23)A00+A(21-23)A00)Ø1     | Adder input ( A )                   |            |
|    |       | Xz( " )  | = (A( " ) " +A( " ) " ) "         |                                     | T7 thru TØ |
|    |       | Yz(1-3)  | = C(21-23)Ø7                      | Adder input ( C )                   |            |
|    |       | Yz( " )  | = C( " ) "                        |                                     |            |
|    |       | Cr3      | = F1F2(TsQ1)                      |                                     |            |
|    |       | sC(0-2)  | = C(21-23)F1F2F3TsCr3             | Recirculate C                       | T7 thru TØ |
|    |       | rC( " )  | = C( " ) "                        |                                     |            |
|    |       | sC(3-23) | = C(0-20)Cr3                      |                                     |            |
|    |       | rC( " )  | = C( " ) "                        |                                     |            |
|    |       | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2       | Check parity                        | T7 thru TØ |
|    |       | rCp      | = ( " ) Cp "                      | Rf means  A,B  -  C  ≥ 0            | T6 thru Tp |
| T6 | sRf   |          | = Ø1(Q3Q6)(BØB1B2AØA1A2Bc23)      | when A > 0                          |            |
| T4 | Sc    |          | = T4F1F2Inr                       | Clear S                             |            |
|    |       | rS(1-14) | = Sc                              |                                     |            |
| T3 | Sxc   |          | = T3F1F2Ju                        |                                     |            |
|    |       | sS(1,2)  | = Add(2,3)Sxc                     | Junk input to C                     |            |
|    |       | rS( " )  | = Add( " ) "                      |                                     |            |
|    |       | sS(3-14) | = C(0-11)Sxc                      |                                     |            |
|    |       | rS( " )  | = C( " ) "                        |                                     |            |
| Tr | sBc23 |          | = Ø1TrHzA00                       | Set Bc23 if B = 0 and A < 0         |            |
|    |       | sHt      | = CpTr(KpKØ)Ø2                    | Parity error                        |            |
| Tp | sF2   |          | = Ø1Tp                            | Ø3 next                             |            |
|    |       | Sc       | = Ø1Tp                            |                                     |            |
|    |       | rS(1-14) | = Sc                              | Clear S                             |            |

|    |              |              |   |   |   |
|----|--------------|--------------|---|---|---|
| 03 | T8           | sS2          | = | $\overline{S1S2Sk}(\overline{030506})$  | Set S(1,2)=1 (Counts:0,1,2,0,1...etc)                                 |
|    | T7           | AL2          | = | $(\overline{030506})S2$   | Cycle A,B left 2 bits   |
|    |              | sB00         | = | $(B1\oplus B2Bc2)AL2$   |   |
|    |              | rB00         | = | $(B1\oplus B2Bc2)AL2$   |   |
|    |              | Ck           | = | $(\overline{030506})S2T\overline{s}(C0\oplus B0\oplus Bzo)$   |   |
|    |              | sC(0-23)     | = | $\overline{C}(0-23)Ck$  | Invert C if sign of last result =                                     |
|    |              | rC( " )      | = | $C( " )$  | sign of C   |
|    |              | sOf*         | = | $(\overline{030506})T7(\overline{S9S10S11S12})((\overline{Bzo\oplus B0})(RfB0+(\overline{A00\oplus 1x}))\oplus Bzo\overline{B0})$ |   |
|    |              | sS1          | = | $(\overline{030506})S2$   | Set S(1,2) = 2  |
|    |              | rS2          | = | $( " )$   |   |
| T6 | Arl          |              | = | $(\overline{030506})S1$   | Cycle A(0-21) right 1 bit -<br>cycle B23 → A0                         |
|    |              | sA23         | = | $C0\overline{0506}Arl$  |   |
|    |              | rA23         | = | $\overline{C0}$   | Generate 1st quotient bit (A0)  |
|    |              | Rsa          | = | $(\overline{030506})\overline{Sk}S1$  | $B(00-22)+C(0-23) \rightarrow B(0-23)$                                |
|    |              | sBc23        | = | $(C0\oplus 1x)Rsa06$  | If C is inverted at T7: $\overline{C}+1(sBc23)$                       |
|    |              | rBc23        | = | $(C0\oplus 1x)$   | if $C \neq C$ original; $\overline{C}(rBc23)$ if $C =$<br>C original. |
|    |              | rS1          | = | $(\overline{030506})S1$   | Set S(1,2) = 0  |
| T5 | (refer 03T8) |              |   |   | S(1,2) = 1  |
| T4 | ( " " T7)    |              |   |   | " 2   |
| T3 | ( " " T6)    | generates A1 |   |   | " 0   |
| T2 | ( " " T8)    |              |   |   | " 1   |
| T1 | ( " " T7)    |              |   |   | " 2   |
| T0 | ( " " T6)    | generates A2 |   |   | " 0   |
|    |              | rCp          | = | $T0HtK0Ts(\overline{F2070406})\overline{02}$  |   |
| Tr | (refer 03T8) |              |   |   | S(1,2) = 1  |
| Tp | ( " " T7)    | generates A3 |   |   | " 2   |
|    |              | rRf          | = | $Tp\overline{01}(\overline{C0Ht})$  |   |
|    |              | Sd2          | = | $(\overline{030506})Tp\overline{Sk}$  |   |
|    |              | sS11         | = | $Sd2S11S12S13$  |   |
|    |              | sS12         | = | $Sd2S12S13$   | Set S(11,12,13)=7 (Counts 7,6,5,4...<br>etc)                          |
|    |              | sS13         | = | $Sd2S13$  |   |

\*The overflow logic is as follows:

- $(\overline{Bzo\oplus B0})$  = positive result ( $|A,B| \geq |M|$ )
- $\overline{Rf}$  = all zero's result ( $|A,B| = |M|$ )
- $(\overline{Bzo\oplus B0})(RfB0)$  = all one's with Bc23 set ( $|A,B| = |M|$ ; signs different)
- $(\overline{Bzo\oplus B0})(\overline{A00\oplus 1x})$  = positive result ( $|A,B| > |M|$ )
- $Bzo\overline{B0}$  = minus one inverted in B with Bc23 on

|    |    |              |                    |           |     |                     |
|----|----|--------------|--------------------|-----------|-----|---------------------|
| ∅3 | T8 | (refer ∅3 T6 | <u>S11S12S13</u> ) | generates | A3  | S(1,2) = 0          |
|    | T7 | ( " " T8     | " )                |           |     | " 1                 |
|    | T6 | ( " " T7     | " )                |           |     | " 2                 |
|    | T5 | ( " " T6     | " )                | "         | A4  | " 0                 |
|    | T4 | ( " " T8     | " )                |           |     | " 1                 |
|    | T3 | ( " " T7     | " )                |           |     | " 2                 |
|    | T2 | ( " " T6     | " )                | "         | A5  | " 0                 |
|    | T1 | ( " " T8     | " )                |           |     | " 1                 |
|    | T0 | ( " " T7     | " )                |           |     | " 2                 |
|    | Tr | ( " " T6     | " )                | "         | A6  | " 0                 |
|    | Tp | ( " " T8     | " )                |           |     | " 1                 |
|    |    | rS13         | = Sd2S13           |           |     | Set S(11,12,13) = 6 |
| ∅3 | T8 | (refer ∅3 T7 | <u>S11S12S13</u> ) |           | A7  | S(1,2) = 2          |
|    | T7 | ( " " T6     | " )                | "         |     | " 0                 |
|    | T6 | ( " " T8     | " )                |           |     | " 1                 |
|    | T5 | ( " " T7     | " )                |           |     | " 2                 |
|    | T4 | ( " " T6     | " )                | "         | A8  | " 0                 |
|    | T3 | ( " " T8     | " )                |           |     | " 1                 |
|    | T2 | ( " " T7     | " )                |           |     | " 2                 |
|    | T1 | ( " " T6     | " )                | "         | A9  | " 0                 |
|    | T0 | ( " " T8     | " )                |           |     | " 1                 |
|    | Tr | ( " " T7     | " )                |           |     | " 2                 |
|    | Tp | ( " " T6     | " )                | "         | A10 | " 0                 |
|    |    | rS12         | = Sd2S12S13        |           |     | Set S(11,12,13) = 5 |
|    |    | sS13         | = Sd2S13           |           |     |                     |
| ∅3 | T8 | (refer ∅3 T8 | <u>S11S12S13</u> ) |           |     | S(1,2) = 1          |
|    | T7 | ( " " T7     | " )                |           |     | " 2                 |
|    | T6 | ( " " T6     | " )                | "         | A11 | " 0                 |
|    | T5 | ( " " T8     | " )                |           |     | " 1                 |
|    | T4 | ( " " T7     | " )                |           |     | " 2                 |
|    | T3 | ( " " T6     | " )                | "         | A12 | " 0                 |
|    | T2 | ( " " T8     | " )                |           |     | " 1                 |
|    | T1 | ( " " T7     | " )                |           |     | " 2                 |
|    | T0 | ( " " T6     | " )                | "         | A13 | " 0                 |
|    | Tr | ( " " T8     | " )                |           |     | " 1                 |
|    | Tp | ( " " T7     | " )                |           |     | " 2                 |
|    |    | rS13         | = Sd2S13           |           |     | Set S(11,12,13) = 4 |

|    |        |        |    |                        |                            |           |     |   |
|----|--------|--------|----|------------------------|----------------------------|-----------|-----|---|
| Ø3 | T8     | (refer | Ø3 | T6                     | $\overline{S11S12S13}$     | generates | A14 | S(1,2) = 0                                  |
|    | T7     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | T6     | (      | "  | "                      | T7                         | "         | )   | " 2   |
|    | T5     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | T4     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | T3     | (      | "  | "                      | T7                         | "         | )   | " 2   |
|    | T2     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | T1     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | T0     | (      | "  | "                      | T7                         | "         | )   | " 2   |
|    | Tr     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | Tp     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | rS11   |        |    |                        | = Sd2S11S12S13             |           |     |   |
|    | sS12   |        |    |                        | = Sd2S12S13                |           |     | Set S(11,12,13) = 3                         |
|    | sS13   |        |    |                        | = Sd2S13                   |           |     |   |
| Ø3 | T8     | (refer | Ø3 | T7                     | $\overline{S11S12S13}$     |           |     | S(1,2) = 2                                  |
|    | T7     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | T6     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | T5     | (      | "  | "                      | T7                         | "         | )   | " 2   |
|    | T4     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | T3     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | T2     | (      | "  | "                      | T7                         | "         | )   | " 2   |
|    | T1     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | T0     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | Tr     | (      | "  | "                      | T7                         | "         | )   | " 2   |
|    | Tp     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | rS13   |        |    |                        | = Sd2S13                   |           |     | Set S(11,12,13) = 2                         |
| Ø3 | T8     | (refer | Ø3 | T8                     | $\overline{S11S12S13}$     |           |     | S(1,2) = 1                                  |
|    | T7     | (      | "  | "                      | T7                         | "         | )   | " 2   |
|    | T6     | (      | "  | "                      | T6                         | "         | )   | " 0   |
|    | T5     | (      | "  | "                      | T8                         | "         | )   | " 1   |
|    | sSk    |        |    |                        | = (Ø3Ø506)T5S11S12S13      |           |     | " 2   |
| T4 | (refer | Ø3     | T7 | $\overline{S11S12S13}$ |                            |           |     | Save B0 (B0 would be last by AL2)           |
|    | sK0    |        |    |                        | = (Ø3Ø506)S2Sk(B0⊕B1B2Bc2) |           |     | Cycle A(0-21) right 1 bit -                 |
| T3 | Ar1    |        |    |                        | = (Ø3Ø506)S1               |           |     | cycle B23 → A0                              |
|    | sA23   |        |    |                        | = C0Ø506Ar1                |           |     | Generate last quotient bit (A23)            |
|    | rA23   |        |    |                        | = C0 "                     |           |     | Shift B(00-23) right 1 bit                  |
|    | Br1    |        |    |                        | = (Ø3Ø506)S1Sk             |           |     | Set B00 = B0 (refer sK0 Ø3 T4)              |
|    | sB00   |        |    |                        | = K0Br106                  |           |     |   |
|    | rB00   |        |    |                        | = K0 "                     |           |     |   |
|    | rK0    |        |    |                        | = Ø306Q6                   |           |     |   |
| Tr | sCz    |        |    |                        | = A00(Ø30506)Tr            |           |     | Initiate - A if original sign of A is minus |
| Tp | Rsa    |        |    |                        | = (Ø3Ø506)SkTpC0           |           |     | Force remainder to lie between 0 and + 1    |
|    | Br1    |        |    |                        | = (Ø3Ø506)SkTpC0           |           |     | Ø7 next clock                               |
|    | sF1    |        |    |                        | = TpSk                     |           |     |   |

|    |    |          |   |                                     |
|----|----|----------|---|-------------------------------------|
| Ø7 | T8 | Anr      | = (Ø7Ø304Ø506) (A00⊕Lx)                 |                                     |
|    |    | Bnr      | = ( " )                                 |                                     |
|    |    | rC24     | = T8(TsTsr)                             |                                     |
|    |    | Ck       | = Ø7T8Ts                                |                                     |
|    |    | sHz      | = T8                                    |                                     |
|    |    | End      | = FlF2                                  | Last cycle                          |
|    |    | sIa      | = T8Ø7skLjKr                            | Initiate P register increment       |
|    |    | sK0      | = (Ø7T8Bc23A00)                         | K0 is used to negate the Bcs        |
|    |    | sRf      | = ( " )                                 | Rf combines the - Bcs with B        |
| T7 |    | Ar3      | = Ø706Q1                                |                                     |
|    |    | sA(0-2)  | = A(21-23)Anr+Ha(1-3)Anr(A00⊕Lx)        | A → A if sign A = sign M T7 thru T0 |
|    |    | rA( " )  | = A( " ) " +Ha( " )Anr( " )             | A+1 → A if sign A ≠ sign M          |
|    |    | sA(3-23) | = A(0-20)Ar3                            |                                     |
|    |    | rA( " )  | = A( " ) "                              |                                     |
|    |    | Hx(1-3)  | = A(21-23)FlØ3                          | Half adder input (A)                |
|    |    | Hx( " )  | = A( " ) "                              |                                     |
|    |    | sB(0-2)  | = Add(1-3)Ø7Ø304Ø506Ar3                 | B → B if sign of B = A00 T7 thru T0 |
|    |    | rB( " )  | = Add( " ) "                            | -B → B if sign of B ≠ A00           |
|    |    | sB(3-23) | = B(0-20)Ar3                            |                                     |
|    |    | rB( " )  | = B( " ) "                              |                                     |
|    |    | Xz(1-3)  | = (B(21-23)A00+B(21-23)A00)Ø7Ø506       | Adder input (B) if A00 = +          |
|    |    | Xz( " )  | = (B( " )A00+B( " )A00) "               | Adder input (B) if A00 = -          |
|    |    | Yz(1-3)  | = RfØ7                                  | Negate the Bc's                     |
|    |    | Yz( " )  | = RfØ7                                  |                                     |
|    |    | sK0      | = (Ø706Q1A00Bc20)                       |                                     |
|    |    | sRf      | = ( " )                                 | Form 2's complement of the Bc's     |
|    |    | Cr3      | = Ø7Ø5(TsQ1)                            | T7 thru T0                          |
|    |    | sC(3-23) | = C(0-20)Cr3                            |                                     |
|    |    | rC( " )  | = C( " ) "                              |                                     |
|    |    | Pr3      | = (FlGØ)Q2                              |                                     |
|    |    | sP0      | = ((FlGØ)(Ø204Ø506))(P12⊕(P13P14Ia))Pr3 |                                     |
|    |    | rP0      | = ( " ) ( " ) "                         |                                     |
|    |    | sP1      | = ( " ) (P13⊕(P14Ia))Pr3                |                                     |
|    |    | rP1      | = ( " ) ( " ) " P + 1 → P               | T7 thru T3                          |
|    |    | sP2      | = ( " ) (P14⊕Ia)Pr3                     |                                     |
|    |    | rP2      | = ( " ) ( " ) "                         |                                     |
|    |    | rIa      | = (P12P13P14)Q2F1                       |                                     |
|    |    | sP(3-14) | = P(0-11)Pr3                            |                                     |
|    |    | rP( " )  | = P( " ) "                              |                                     |
| T4 |    | Sc       | = T4EndInr                              | Clear S                             |
|    |    | rS(1-14) | = Sc                                    |                                     |
| T3 |    | Sxp      | = T3IntEndGØ                            |                                     |
|    |    | sS1      | = (FlGØ)(Ø204Ø506))(P13⊕(P14Ia))Sxp     |                                     |
|    |    | sS2      | = ( " ) (P14⊕Ia)Sxp                     | P → S                               |
|    |    | sS(3-14) | = P(0-11)Sxp                            |                                     |
| T0 |    | rSk      | = Ø7T0                                  | Reset skip                          |
| Tr |    | Cxm      | = EndGØTsm(Tr+Tp)                       |                                     |
|    |    | sC(0-23) | = M(0-23)Cxm                            | M → C                               |
|    |    | rC( " )  | = CxmTr                                 | Tr thru Tp                          |
|    |    | rIa      | = TrFl                                  |                                     |
|    |    | rIx      | = Tr(FlF3)(GØHt)                        |                                     |
|    |    | rK0      | = Ø7Tr                                  |                                     |
|    |    | rRc      | = Tr                                    |                                     |

|    |               |                           |                               |
|----|---------------|---------------------------|-------------------------------|
| Tp | rA00          | = EndGOTp                 |                               |
|    | sCp           | = $M24C_{xmHtTsTp}$       | Initiate parity               |
|    | rF(1-3)       | = $TpEnd\overline{Sk}$    | $\emptyset 0$ next clock (T8) |
|    | rRf           | = $Tp\overline{01}(GOHt)$ |                               |
|    | rJu           | = Tp                      |                               |
|    | Oc            | = $TpEnd\overline{Sk}$    |                               |
|    | rO(1,3,4,5,6) | = Oc                      |                               |
|    | sO2           | = Oc                      | NOP → 0                       |

| 66 | RSH 000XX | Right Shift A,B   | A,B right XX bits<br>extend Sign of A     | $2 + \frac{XX-3}{10}$ Cycles |
|----|-----------|---|---|------------------------------|
| ∅0 | T8        | rCz = (∅0T8)  |   |                              |
|    |           | sIx = ( " )C1G0   |   |                              |
|    |           | Oxc = ( " ) $\overline{IaGOC2}$                                   | Initiate indexing                         |                              |
|    |           | sO(1-6) = C(3-8)Oxc   | C(3-8) → 0 if not Indirect Addressing     |                              |
|    |           | rO( " ) = $\overline{C( " )}$ "                                   |   |                              |
|    | T7        | sA00 = A0∅0T7   | Save sign of A                            |                              |
|    |           | Cr3 = $\overline{F1F2TsQ1}$                                       |   |                              |
|    |           | sC(0-2) = Add(1-3)∅0JuTsCr3                                       | C(15-23)+X(15-23)Ix → C T7 thru T5        |                              |
|    |           | rC( " ) = $\overline{Add( " )}$ "                                 |   |                              |
|    |           | Xz(1-3) = Xn(1-3)∅0Ix   |   |                              |
|    |           | $\overline{Xz( " )}$ = $\overline{Xn( " )}$ ∅0Ix+ $\overline{Ix}$ | Adder input (X) if indexing               |                              |
|    |           | Yz(1-3) = C(21-23)∅7  |   |                              |
|    |           | $\overline{Yz( " )}$ = $\overline{C( " )}$ "                      | Adder input C                             |                              |
|    |           | sCz = KzQ1 $\overline{T0∅7}$                                      |   |                              |
|    |           | rCz = $\overline{KzQ1}$   | Adder carry logic                         |                              |
|    |           | sCp = (C21+C22+C23)CpTsHEQ1 $\overline{F1F2}$                     |   |                              |
|    |           | rCp = ( " )Cp "   | Try for parity check T7 thru T2           |                              |
| ∅1 | T5        | sF3 = ∅0 $\overline{IaQ4O3O4O5}$                                  | ∅1 next clock (T4)                        |                              |
|    | T4        | sC(0-2) = C(21-23) $\overline{F1F2F3Ts}$                          | C recirculate. Indexing                   |                              |
|    |           | rC( " ) = $\overline{C( " )}$ "                                   | is terminated. T4 thru T2                 |                              |
|    |           | Sc = T4 $\overline{F1F2Inr}$                                      |   |                              |
|    |           | rS(1-14) = Sc   | Clear S                                   |                              |
|    | T3        | Sxc = T3 $\overline{F1F2Ju}$                                      |   |                              |
|    |           | sS(1,2) = Add(2,3)Sxc   | C(10-23)+X(15-23)Ix → S                   |                              |
|    |           | sS(3-14) = C(0-11)Sxc   | put shift count into S                    |                              |
|    | T2        | sF2 = ∅105Q2  | ∅3 next clock (T1)                        |                              |
|    |           | rS(1-8) = ∅105T2  | Clear S(1-8)                              |                              |
|    |           | Sx48 = (S6S7S8+S9S10)∅105T2                                       |   |                              |
|    |           | sS(9,10) = Sx48   | Set S(9-14) = 48 if shift                 |                              |
|    |           | rS(11-14) = Sx48  | count ≥ 48.                               |                              |
|    |           | sSk = (∅105T2)( $\overline{S6S7S8S9S10S11S12S13S14}$ )            | Shift count = 0                           |                              |
| ∅3 | T1        | Ar1 = ∅30506Sk  |   |                              |
|    |           | sA0 = A0005C4Ar1  |   |                              |
|    |           | rA0 = $\overline{A0005C4Ar1}$                                     | Extend sign bit                           |                              |
|    |           | sA(1-23) = $\overline{A(0-22)Ar1}$                                |   |                              |
|    |           | rA( " ) = $\overline{A( " )}$ "                                   |   |                              |
|    |           | Brl = ∅30506Sk  | Shift A,B right 1 bit if $\overline{Sk}$  |                              |
|    |           | sB0 = A2305Brl  |   |                              |
|    |           | rB0 = $\overline{A2305Brl}$                                       |   |                              |
|    |           | sB(1-23) = $\overline{B(0-22)Brl}$                                |   |                              |
|    |           | rB( " ) = $\overline{B( " )}$ "                                   |   |                              |
|    |           | Sd2 = (∅30506Sk) $\overline{S14}$                                 |   |                              |
|    |           | rS9 = Sd2 $\overline{S10(S11S12S13)}$                             | Count every other clock until Sk set      |                              |
|    |           | sS10 = Sd2 $\overline{S10( " )}$                                  |   |                              |
|    |           | rS10 = Sd2 $\overline{S10( " )}$                                  |   |                              |
|    |           | sS11 = Sd2 $\overline{S11(S12S13)}$                               |   |                              |
|    |           | rS11 = Sd2 $\overline{S11( " )}$                                  |   |                              |
|    |           | sS12 = Sd2 $\overline{S12S13}$                                    |   |                              |
|    |           | rS12 = Sd2 $\overline{S12S13}$                                    | Decrement count by 2<br>every other clock |                              |



(continued)

|       |               |                            |                              |
|-------|---------------|----------------------------|------------------------------|
| Ø3 T1 | sS13          | = Sd2S13                   |                              |
|       | rS13          | = Sd2S13                   |                              |
|       | sS14          | = (Ø30506Sk)S14            | Count each clock             |
|       | rS14          | = ( " )S14                 |                              |
|       | sSk           | = (Ø305Sk)(S9S10S11S12)S13 | Count = 0 or 1               |
| T0    | (refer Ø3 T1) |                            | Initiate X into Xz during Ø7 |
| Tr    | ( " )         |                            |                              |
| Tp    | ( " )         |                            |                              |
| rRf   |               | = TpØ1(GØHt)               | Clear Rf                     |

If Sk is not set ( $\overline{Sk}$ ) at Tp, Ø3 will continue to occur with each clock responding as shown in Ø3 T1 until Sk sets. When this happens, all functions will stop, except the clock, until Tp. The following shows what occurs at Tp when Sk is set.

|    |          |                   |                                 |
|----|----------|-------------------|---------------------------------|
| Tp | Ar1      | = (Ø30506)TpSkS14 |                                 |
|    | sA0      | = A0005C4         |                                 |
|    | rA0      | = A0005C4         |                                 |
|    | sA(1-23) | = A(0-22)Ar1      |                                 |
|    | rA( " )  | = A( " ) "        |                                 |
|    | Br1      | = (Ø30506)TpSkS14 | Clean up right shift A,B        |
|    | sB0      | = A23Br1          | (If S14 reset, no shift occurs) |
|    | rB0      | = A23Br1          |                                 |
|    | sB(1-23) | = B(0-22)Br1      |                                 |
|    | rB( " )  | = B( " ) "        |                                 |
|    | sF1      | = TpSk            | Ø7 next clock (T8)              |
|    | rRf      | = TpØ1(GØHt)      | Clear Rf                        |

|    |    |               |                                     |                               |            |
|----|----|---------------|-------------------------------------|-------------------------------|------------|
| Ø7 | T8 | Ck            | = Ø7T8Ts                            |                               |            |
|    |    | sC(0-23)      | = C(0-23)Ck                         | Invert C                      |            |
|    |    | rC( " )       | = C( " )Ck                          |                               |            |
|    |    | End           | = F1F2                              |                               |            |
|    |    | sIa           | = SkT8Ø7Tjkr                        | Initiate P register increment |            |
| T7 |    | Ar3           | = Ø706Q1                            |                               |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                    |                               |            |
|    |    | rA( " )       | = A( " ) "                          | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                        |                               |            |
|    |    | rA( " )       | = A( " ) "                          |                               |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                    |                               |            |
|    |    | rB( " )       | = B( " ) "                          | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                        |                               |            |
|    |    | rB( " )       | = B( " ) "                          |                               |            |
|    |    | Pr3           | = (F1G0)Q2                          |                               |            |
|    |    | sP0           | = ( " )(Ø2040506) (P12⊕P13P14Ia)Pr3 |                               |            |
|    |    | rP0           | = ( " )( " ) (P12⊕P13P14Ia) "       |                               |            |
|    |    | sP1           | = ( " )( " ) (P13⊕P14Ia)Pr3         |                               |            |
|    |    | rP1           | = ( " )( " ) (P13⊕P14Ia) "          | P + 1 → P                     | T7 thru T3 |
|    |    | sP2           | = ( " )( " ) (P14⊕Ia)Pr3            |                               |            |
|    |    | rP2           | = ( " )( " ) (P14⊕Ia) "             |                               |            |
|    |    | rIa           | = P12P13P14Q2F1                     |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                        |                               |            |
|    |    | rP( " )       | = P( " ) "                          |                               |            |
| T4 |    | Sc            | = T4EndInr                          | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                                |                               |            |
| T3 |    | Sxp           | = T3IntEndGO                        |                               |            |
|    |    | sS1           | = (F1G0) (Ø2040506) (P13⊕P14Ia)Sxp  |                               |            |
|    |    | sS2           | = ( " )( " ) (P14⊕Ia)Sxp            | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                        |                               |            |
| T0 |    | rSk           | = Ø7T0                              |                               |            |
| Tr |    | Cxm           | = EndGOTrsm(Tr+Tp)                  | Fetch next instruction        |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                        |                               |            |
|    |    | rC( " )       | = CxmTr                             |                               |            |
|    |    | rIa           | = TrF1                              |                               |            |
|    |    | rIx           | = Tr(F1F3) (GOHt)                   |                               |            |
|    |    | rK0           | = Ø7Tr                              |                               |            |
|    |    | rA00          | = TpEndGO                           |                               |            |
| Tp |    | sCp           | = M24CxmTpHtTs                      | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                           | Ø0 next clock (T8)            |            |
|    |    | rRf           | = TpØ1 (GOHt)                       |                               |            |
|    |    | Oc            | = TpEndSK                           |                               |            |
|    |    | sO2           | = Oc                                | NOP (20) → 0                  |            |
|    |    | rO(1,3,4,5,6) | = Oc                                |                               |            |

RCY 200XX

Right Cycle A,B

A,B right cycle XX bits  $2 + \frac{XX-3}{10}$  Cycles  
B23 → A0

|    |    |                       |   |  |            |
|----|----|-----------------------|---|--|------------|
| ∅0 | T8 | rCz                   | = (∅0T8)                                      |  |            |
|    |    | sIx                   | = ( " ) C1G0                                  |  |            |
|    |    | Oxc                   | = ( " ) IaGOC $\bar{2}$                       | Initiate indexing                        |            |
|    |    | sO(1-6)               | = C(3-8)Oxc                                   | C(3-8) → 0 if not Indirect Addressing    |            |
|    |    | rO( " )               | = C( " ) "                                    |  |            |
|    | T7 | sA00                  | = A0∅0T7                                      | Save sign of A                           |            |
|    |    | Cr3                   | = $\overline{F1F2Ts}Q1$                       |  |            |
|    |    | sC(0-2)               | = Add(1-3)∅0JuTsCr3                           | C(15-23)+X(15-23)Ix → C                  | T7 thru T5 |
|    |    | rC( " )               | = Add( " ) "                                  |  |            |
|    |    | Xz(1-3)               | = Xn(1-3)∅0Ix                                 | Adder input (X) if indexing              |            |
|    |    | $\overline{Xz}$ ( " ) | = $\overline{Xn}$ ( " )∅0Ix+ $\overline{Ix}$  |  |            |
|    |    | Yz(1-3)               | = C(21-23)∅7                                  | Adder input C                            |            |
|    |    | $\overline{Yz}$ ( " ) | = $\overline{C}$ ( " ) "                      |  |            |
|    |    | sCz                   | = KzQ1 $\overline{T0\bar{0}7}$                | Adder carry logic                        |            |
|    |    | rCz                   | = $\overline{Kz}Q1$                           |  |            |
|    |    | sCp                   | = (C21+C22+C23)CpTsHtQ1 $\overline{F1F2}$     |  |            |
|    |    | rCp                   | = ( " ) Cp "                                  | Try for parity check                     | T7 thru T2 |
|    | T5 | sF3                   | = ∅0IaQ4030405                                | ∅1 next clock (T4)                       |            |
| ∅1 | T4 | sC(0-2)               | = C(21-23) $\overline{F1F2F3Ts}$              | C recirculate. Indexing                  |            |
|    |    | rC( " )               | = $\overline{C}$ ( " ) "                      | is terminated.                           | T4 thru T2 |
|    |    | Sc                    | = T4 $\overline{F1F2Inr}$                     |  |            |
|    |    | rS(1-14)              | = Sc  | Clear S                                  |            |
|    | T3 | Sxc                   | = T3 $\overline{F1F2Ju}$                      |  |            |
|    |    | sS(1,2)               | = Add(2,3)Sxc                                 | C(10-23)+X(15-23)Ix → S                  |            |
|    |    | sS(3-14)              | = C(0-11)Sxc                                  | put shift count into S                   |            |
|    | T2 | sF2                   | = ∅105Q $\bar{2}$                             | ∅3 next clock (T1)                       |            |
|    |    | rS(1-8)               | = ∅105T $\bar{2}$                             | Clear S(1-8)                             |            |
|    |    | Sx48                  | = (S6S7S8+S9S10)∅105T2                        |  |            |
|    |    | sS(9,10)              | = Sx48  | Set S(9-14) = 48 if shift                |            |
|    |    | rS(11-14)             | = Sx48  | count ≥ 48.                              |            |
|    |    | sSk                   | = (∅105T $\bar{2}$ )(S6S7S8S9S10S11S12S13S14) | Shift count = 0                          |            |
| ∅3 | T1 | Arl                   | = ∅30506Sk                                    |  |            |
|    |    | sA0                   | = B23C4C6Arl                                  | Cycle B23 into A0                        |            |
|    |    | rA0                   | = $\overline{B23C4C6}Arl$                     |  |            |
|    |    | sA(1-23)              | = A(0-22)Arl                                  |  |            |
|    |    | rA( " )               | = A( " ) "                                    |  |            |
|    |    | Brl                   | = ∅30506Sk                                    | Shift A,B right 1 bit if $\overline{Sk}$ |            |
|    |    | sB0                   | = A2305Brl                                    |  |            |
|    |    | rB0                   | = $\overline{A2305}Brl$                       |  |            |
|    |    | sB(1-23)              | = B(0-22)Brl                                  |  |            |
|    |    | rB( " )               | = $\overline{B}$ ( " ) "                      |  |            |
|    |    | Sd2                   | = (∅30506Sk)S14                               | Count every other clock until Sk set     |            |
|    |    | rS9                   | = Sd2S10(S11S12S13)                           |  |            |
|    |    | sS10                  | = Sd2S10( " )                                 |  |            |
|    |    | rS10                  | = Sd2S10( " )                                 |  |            |
|    |    | sS11                  | = Sd2S11(S12S13)                              |  |            |
|    |    | rS11                  | = Sd2S11( " )                                 | Decrement count by 2                     |            |
|    |    | sS12                  | = Sd2S12S13                                   | every other clock                        |            |
|    |    | rS12                  | = Sd2S12S13                                   |  |            |

(continued)

|       |               |                            |                              |
|-------|---------------|----------------------------|------------------------------|
| Ø3 T1 | sS13          | = Sd2S13                   |                              |
|       | rS13          | = Sd2S13                   |                              |
|       | sS14          | = (Ø30506Sk)S14            | Count each clock             |
|       | rS14          | = ( " )S14                 | Count = 0 or 1               |
|       | sSk           | = (Ø305Sk)(S9S10S11S12)S13 | Initiate X into Xz during Ø7 |
| T0    | (refer Ø3 T1) |                            |                              |
| Tr    | ( " )         |                            |                              |
| Tp    | ( " )         |                            |                              |
| rRf   |               | = TpØ1(GØHt)               | Clear Rf                     |

If Sk is not set ( $\overline{Sk}$ ) at Tp, Ø3 will continue to occur with each clock responding as shown in Ø3 T1 until Sk sets. When this happens, all functions will stop, except the clock, until Tp. The following shows what occurs at Tp when Sk is set.

|    |          |                   |                                 |
|----|----------|-------------------|---------------------------------|
| Tp | Ar1      | = (Ø30506)TpSkS14 |                                 |
|    | sA0      | = B23C4C6Ar1      | Cycle B23 into A0               |
|    | rA0      | = B23C4C6Ar1      |                                 |
|    | sA(1-23) | = A(0-22)Ar1      |                                 |
|    | rA( " )  | = A( " ) "        |                                 |
|    | Brl      | = (Ø30506)TpSkS14 | Clean up right shift A,B        |
|    | sB0      | = A23Brl          | (If S14 reset, no shift occurs) |
|    | rB0      | = A23Brl          |                                 |
|    | sB(1-23) | = B(0-22)Brl      |                                 |
|    | rB( " )  | = B( " ) "        |                                 |
|    | sF1      | = TpSk            | Ø7 next clock (T8)              |
|    | rRf      | = TpØ1(GØHt)      | Clear Rf                        |

|    |    |               |                                      |                               |            |
|----|----|---------------|--------------------------------------|-------------------------------|------------|
| Ø7 | T8 | Ck            | = Ø7T8T̄s                            |                               |            |
|    |    | sC(0-23)      | = C̄(0-23)Ck                         | Invert C                      |            |
|    |    | rC( " )       | = C( " )Ck                           |                               |            |
|    |    | End           | = F1F2                               |                               |            |
|    |    | sIa           | = SkT8Ø7T̄iKr                        | Initiate P register increment |            |
| T7 |    | Ar3           | = Ø706Q1                             |                               |            |
|    |    | sA(0-2)       | = A(21-23)ĀnrAr3                    |                               |            |
|    |    | rA( " )       | = Ā( " ) " "                        | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |                               |            |
|    |    | rA( " )       | = Ā( " ) " "                        |                               |            |
|    |    | sB(0-2)       | = B(21-23)B̄nrAr3                    |                               |            |
|    |    | rB( " )       | = B̄( " ) " "                        | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |                               |            |
|    |    | rB( " )       | = B̄( " ) " "                        |                               |            |
|    |    | Pr3           | = (F1G0)Q2                           |                               |            |
|    |    | sP0           | = ( " ) (Ø2040506) (P12P13P14Ia) Pr3 |                               |            |
|    |    | rP0           | = ( " ) ( " ) (P12P13P14Ia) "        |                               |            |
|    |    | sP1           | = ( " ) ( " ) (P13P14Ia) Pr3         |                               |            |
|    |    | rP1           | = ( " ) ( " ) (P13P14Ia) "           |                               |            |
|    |    | sP2           | = ( " ) ( " ) (P14Ia) Pr3            | P + 1 → P                     | T7 thru T3 |
|    |    | rP2           | = ( " ) ( " ) (P14Ia) "              |                               |            |
|    |    | rIa           | = P12P13P14Q2F1                      |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                         |                               |            |
|    |    | rP( " )       | = P̄( " ) " "                        |                               |            |
| T4 |    | Sc            | = T4EndInr                           |                               |            |
|    |    | rS(1-14)      | = Sc                                 | Clear S                       |            |
| T3 |    | Sxp           | = T3Int̄EndGO                        |                               |            |
|    |    | sS1           | = (F1G0) (Ø2040506) (P13P14Ia) Sxp   |                               |            |
|    |    | sS2           | = ( " ) ( " ) (P14Ia) Sxp            | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                         |                               |            |
| T0 |    | rSk           | = Ø7T0                               |                               |            |
| Tr |    | Cxm           | = EndGO <sup>Tsm</sup> (Tr+Tp)       |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                         | Fetch next instruction        |            |
|    |    | rC( " )       | = CxmTr                              |                               |            |
|    |    | rIa           | = TrF1                               |                               |            |
|    |    | rIx           | = Tr(F1F3) (GOHt)                    |                               |            |
|    |    | rKO           | = Ø7Tr                               |                               |            |
|    |    | rA00          | = TpEndGO                            |                               |            |
| Tp |    | sCp           | = M24CxmTpHtTs                       | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                            | Ø0 next clock (T8)            |            |
|    |    | rRf           | = TpØ1(GOht)                         |                               |            |
|    |    | Oc            | = TpEndSk                            |                               |            |
|    |    | s02           | = Oc                                 | NOP (20) → 0                  |            |
|    |    | r0(1,3,4,5,6) | = Oc                                 |                               |            |

| 66 | RCY 240XX | Logical Right Cycle A,B   | A,B right XX bits<br>Zero's → A0         | $2 + \frac{XX-3}{10}$ Cy |
|----|-----------|---|--|--------------------------|
| ∅0 | T8        | rCz = (∅0T8)  |  |                          |
|    |           | sIx = ( " ) C1G0  |  |                          |
|    |           | Oxc = ( " ) $\overline{IaGOC2}$                                   | Initiate indexing                        |                          |
|    |           | sO(1-6) = C(3-8)Oxc   | C(3-8) → 0 if not Indirect Addressing    |                          |
|    |           | rO( " ) = $\overline{C( " )}$ "                                   |  |                          |
|    | T7        | sA00 = A0∅0T7   | Save sign of A                           |                          |
|    |           | Cr3 = $\overline{F1F2TsQ1}$                                       |  |                          |
|    |           | sC(0-2) = Add(1-3)∅0JuTsCr3                                       | C(15-23)+X(15-23)Ix → C T7 thru T5       |                          |
|    |           | rC( " ) = Add( " ) "  |  |                          |
|    |           | Xz(1-3) = Xn(1-3)∅0Ix   |  |                          |
|    |           | $\overline{Xz( " )}$ = $\overline{Xn( " )}$ ∅0Ix+ $\overline{Ix}$ | Adder input (X) if indexing              |                          |
|    |           | Yz(1-3) = C(21-23)∅7  |  |                          |
|    |           | $\overline{Yz( " )}$ = $\overline{C( " )}$ "                      | Adder input C                            |                          |
|    |           | sCz = KzQ1 $\overline{T0∅7}$                                      |  |                          |
|    |           | rCz = $\overline{KzQ1}$   | Adder carry logic                        |                          |
|    |           | sCp = (C21-23)C23)CpTsHtQ1F1F2                                    |  |                          |
|    |           | rCp = ( " ) Cp "  | Try for parity check T7 thru T2          |                          |
|    | T5        | sF3 = ∅0IaQ4030405  | ∅1 next clock (T4)                       |                          |
| ∅1 | T4        | sC(0-2) = C(21-23)F1F2F3Ts  | C recirculate. Indexing                  |                          |
|    |           | rC( " ) = $\overline{C( " )}$ "                                   | is terminated. T4 thru T2                |                          |
|    |           | Sc = T4F1F2Inr  |  |                          |
|    |           | rS(1-14) = Sc   | Clear S                                  |                          |
|    | T3        | Sxc = T3F1F2Ju  |  |                          |
|    |           | sS(1,2) = Add(2,3)Sxc   | C(10-23)+X(15-23)Ix → S                  |                          |
|    |           | sS(3-14) = C(0-11)Sxc   | put shift count into S                   |                          |
|    | T2        | sF2 = ∅105Q2  | ∅3 next clock (T1)                       |                          |
|    |           | rS(1-8) = ∅105T2  | Clear S(1-8)                             |                          |
|    |           | Sx48 = (S6S7S8+S9S10)∅105T2                                       |  |                          |
|    |           | sS(9,10) = Sx48   | Set S(9-14) = 48 if shift                |                          |
|    |           | rS(11-14) = Sx48  | count ≥ 48.                              |                          |
|    |           | sSk = (∅105T2)(S6S7S8S9S10S11S12S13S14)                           | Shift count = 0                          |                          |
| ∅3 | T1        | Ar1 = ∅30506Sk  |  |                          |
|    |           | rA0 = C4C605  | ∅ → A0 (C4 cycle bit, C6 logical)        |                          |
|    |           | sA(1-23) = A(0-22)Ar1   |  |                          |
|    |           | rA( " ) = A( " ) "  |  |                          |
|    |           | Br1 = ∅30506Sk  | Shift A,B right 1 bit if $\overline{Sk}$ |                          |
|    |           | sB0 = A2305Br1  |  |                          |
|    |           | rB0 = A2305Br1  |  |                          |
|    |           | sB(1-23) = B(0-22)Br1   |  |                          |
|    |           | rB( " ) = B( " ) "  |  |                          |
|    |           | Sd2 = (∅30506Sk)S14   | Count every other clock until Sk set     |                          |
|    |           | rS9 = Sd2S10(S11S12S13)   |  |                          |
|    |           | sS10 = Sd2S10( " )  |  |                          |
|    |           | rS10 = Sd2S10( " )  |  |                          |
|    |           | sS11 = Sd2S11(S12S13)   |  |                          |
|    |           | rS11 = Sd2S11( " )  | Decrement count by 2                     |                          |
|    |           | sS12 = Sd2S12S13  | every other clock                        |                          |
|    |           | rS12 = Sd2S12S13  |  |                          |

(continued)

|       |               |                             |                              |
|-------|---------------|-----------------------------|------------------------------|
| Ø3 T1 | sS13          | = Sd2S13                    |                              |
|       | rS13          | = Sd2S13                    |                              |
|       | sS14          | = (Ø30506Sk)S14             | Count each clock             |
|       | rS14          | = ( " )S14                  | Count = 0 or 1               |
|       | sSk           | = (Ø305Sk) (S9S10S11S12)S13 | Initiate X into Xz during Ø7 |
| T0    | (refer Ø3 T1) |                             |                              |
| Tr    | ( " )         |                             |                              |
| Tp    | ( " )         |                             |                              |
| rRf   |               | = TpØ1(GØHt)                | Clear Rf                     |

If Sk is not set ( $\overline{Sk}$ ) at Tp, Ø3 will continue to occur with each clock responding as shown in Ø3 T1 until Sk sets. When this happens, all functions will stop, except the clock, until Tp. The following shows what occurs at Tp when Sk is set.

|    |          |                          |                                 |
|----|----------|--------------------------|---------------------------------|
| Tp | Ar1      | = (Ø30506)TpSkS14        |                                 |
|    | rA0      | = C4C605                 | 0 → A0                          |
|    | sA(1-23) | = A(0-22)Ar1             |                                 |
|    | rA( " )  | = $\overline{A}$ ( " ) " |                                 |
|    | Br1      | = (Ø30506)TpSkS14        | Clean up right shift A,B        |
|    | sB0      | = A23Br1                 | (If S14 reset, no shift occurs) |
|    | rB0      | = $\overline{A}$ 23Br1   |                                 |
|    | sB(1-23) | = B(0-22)Br1             |                                 |
|    | rB( " )  | = $\overline{B}$ ( " ) " |                                 |
|    | sF1      | = TpSk                   | Ø7 next clock (T8)              |
|    | rRf      | = TpØ1(GØHt)             | Clear Rf                        |

|    |    |               |                                   |                               |            |
|----|----|---------------|-----------------------------------|-------------------------------|------------|
| Ø7 | T8 | Ck            | = Ø7T8Ts                          |                               |            |
|    |    | sC(0-23)      | = C(0-23)Ck                       | Invert C                      |            |
|    |    | rC( " )       | = C( " )Ck                        |                               |            |
|    |    | End           | = F1F2                            |                               |            |
|    |    | sIa           | = SkT8Ø7T8kr                      | Initiate P register increment |            |
| T7 |    | Ar3           | = Ø706Q1                          |                               |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                  |                               |            |
|    |    | rA( " )       | = A( " ) "                        | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                      |                               |            |
|    |    | rA( " )       | = A( " ) "                        |                               |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                  |                               |            |
|    |    | rB( " )       | = B( " ) "                        | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                      |                               |            |
|    |    | rB( " )       | = B( " ) "                        |                               |            |
|    |    | Pr3           | = (F1GO)Q2                        |                               |            |
|    |    | sP0           | = ( " )(Ø2040506)(P12P13P14Ia)Pr3 |                               |            |
|    |    | rP0           | = ( " )( " )(P12P13P14Ia) "       |                               |            |
|    |    | sP1           | = ( " )( " )(P13P14Ia)Pr3         |                               |            |
|    |    | rP1           | = ( " )( " )(P13P14Ia) "          | P + 1 → P                     | T7 thru T3 |
|    |    | sP2           | = ( " )( " )(P14Ia)Pr3            |                               |            |
|    |    | rP2           | = ( " )( " )(P14Ia) "             |                               |            |
|    |    | rIa           | = P12P13P14Q2F1                   |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                      |                               |            |
|    |    | rP( " )       | = P( " ) "                        |                               |            |
| T4 |    | Sc            | = T4EndInr                        | Clear S                       |            |
|    |    | rS(1-14)      | = Sc                              |                               |            |
| T3 |    | Sxp           | = T3IntEndGO                      |                               |            |
|    |    | sS1           | = (F1GO)(Ø2040506)(P13P14Ia)Sxp   |                               |            |
|    |    | sS2           | = ( " )( " )(P14Ia)Sxp            | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                      |                               |            |
| T0 |    | rSk           | = Ø7T0                            |                               |            |
| Tr |    | Cxm           | = EndGOIsm(Tr+Tp)                 | Fetch next instruction        |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                      |                               |            |
|    |    | rC( " )       | = CxmTr                           |                               |            |
|    |    | rIa           | = TrF1                            |                               |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)                  |                               |            |
|    |    | rK0           | = Ø7Tr                            |                               |            |
|    |    | rA00          | = TpEndGO                         |                               |            |
| Tp |    | sCp           | = M24CxmTpHtTs                    | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSk                         | Ø0 next clock (T8)            |            |
|    |    | rRf           | = TpØ1(GOHt)                      |                               |            |
|    |    | Oc            | = TpEndSk                         |                               |            |
|    |    | s02           | = Oc                              |                               |            |
|    |    | r0(1,3,4,5,6) | = Oc                              | NOP (20) → 0                  |            |



|    |           |                                     |  |               |
|----|-----------|-------------------------------------|--|---------------|
| 67 | LSH 000XX | Left Shift A,B                      | A,B left XX bits                       | 2+XX-6 Cycles |
|    |           |                                     | Set overflow if A0 changes             | 20            |
| ∅0 | T8        | rCz = (∅0T8)                        |  |               |
|    |           | sIx = ( " )C1G0                     |  |               |
|    |           | Oxc = ( " )IaGOC2                   | Initiate indexing                      |               |
|    |           | sO(1-6) = C(3-8)Oxc                 | C(3-8) → 0 if not Indirect Addressing  |               |
|    |           | rO( " ) = C( " ) "                  |  |               |
| T7 | sA00      | = A∅∅0T7                            | Save sign of A                         |               |
|    | Cr3       | = F1F2TsQ1                          |  |               |
|    | sC(0-2)   | = Add(1-3)∅0JuTsCr3                 | C(15-23)+X(15-23)Ix→ C                 | T7 thru T5    |
|    | rC( " )   | = Add( " ) "                        |  |               |
|    | Xz(1-3)   | = Xn(1-3)∅0Ix                       | Adder input (X) if indexing            |               |
|    | Xz( " )   | = Xn( " )∅0Ix+Ix                    |  |               |
|    | Yz(1-3)   | = C(21-23)∅7                        | Adder input C                          |               |
|    | Yz( " )   | = C( " ) "                          |  |               |
|    | sCz       | = KzQ1T∅∅7                          | Adder carry logic                      |               |
|    | rCz       | = KzQ1                              |  |               |
|    | sCp       | = (C21⊕C22⊕C23)CpTsHtQ1F1F2         | Try for parity check                   | T7 thru T2    |
|    | rCp       | = ( " )Cp "                         |  |               |
| T5 | sF3       | = ∅0IaQ4∅3O4O5                      | ∅1 next clock (T4)                     |               |
| ∅1 | T4        | sC(0-2) = C(21-23)F1F2F3Ts          | C recirculate. Indexing                |               |
|    | rC( " )   | = C( " ) "                          | is terminated.                         | T4 thru T2    |
|    | Sc        | = T4F1F2Inr                         |  |               |
|    | rS(1-14)  | = Sc                                | Clear S                                |               |
| T3 | Sxc       | = T3F1F2Ju                          | C(10-23)+X(15-23)Ix→ S                 |               |
|    | sS(1,2)   | = Add(2,3)Sxc                       | put shift count into S                 |               |
|    | sS(3-14)  | = C(0-11)Sxc                        |  |               |
| T2 | sF2       | = ∅1O5Q2                            | ∅3 next clock (T1)                     |               |
|    | rS(1-8)   | = ∅1O5T2                            | Clear S(1-8)                           |               |
|    | Sx48      | = (S6S7S8+S9S10)∅1O5T2              | Set S(9-14) = 48 if shift              |               |
|    | sS(9,10)  | = Sx48                              | count ≥ 48.                            |               |
|    | rS(11-14) | = Sx48                              |  |               |
|    | sSk       | = (∅1O5T2)(S6S7S8S9S10S11S12S13S14) | Shift count = 0                        |               |
| ∅3 | T1        | AL2 = (∅3O5O6)Sk                    | Save old A1 for clean up shift         |               |
|    | sA00      | = A1AL2O5                           | when ∅3 terminates                     |               |
|    | rA00      | = A1 "                              |  |               |
|    | sA(0-21)  | = A(2-23)AL2                        |  |               |
|    | rA( " )   | = A( " ) "                          |  |               |
|    | sA(22,23) | = B(0,1)AL2                         | A,B left 2 bits                        |               |
|    | rA( " )   | = B( " ) "                          |  |               |
|    | sB(0-21)  | = B(2-23)AL2                        |  |               |
|    | rB( " )   | = B( " ) "                          |  |               |
|    | rB(22,23) | = C4AL2O5                           | 0 → B(22,23) C4=C10 (cycle bit) during |               |
|    | sOf       | = (∅3O5O6SkC4C5)(A∅A1)              | ∅3                                     |               |
|    | sOf       | = ( " ) (A1+A2)(S9...S13)           | Normalized and shifting 2              |               |
|    | Sd2       | = ∅3O5O6Sk                          | Normalized in 1 and shifting 2         |               |
|    | rS9       | = Sd2S10(S11S12S13)                 | Count until Sk set.                    |               |
|    | sS10      | = Sd2S10( " )                       |  |               |
|    | rS10      | = Sd2S10( " )                       |  |               |
|    | sS11      | = Sd2S11(S12S13)                    |  |               |
|    | rS11      | = Sd2S11( " )                       | Decrement count by 2                   |               |
|    | sS12      | = Sd2S12S13                         | each clock.                            |               |
|    | rS12      | = Sd2S12S13                         |  |               |

(continued)

|       |               |                              |                              |
|-------|---------------|------------------------------|------------------------------|
| Ø3 T1 | sS13          | = Sd2S13                     |                              |
|       | rS13          | = Sd2S13                     |                              |
|       | sSk           | = (Ø30506Sk)(S9S10S11S12)S14 | Count = 0 or 2               |
|       | sSk           | = (Ø305Sk)(S9S10S11S12)S13   | Count = 0 or 1               |
| T0    | (refer Ø3 T1) |                              | Initiate X into Xz during Ø7 |
| Tr    | ( " )         |                              |                              |
| Tp    | ( " )         |                              |                              |
|       | rRf           | = TpØ1(GØHt)                 | Clear Rf                     |

If Sk is not set ( $\overline{Sk}$ ) at Tp, Ø3 will continue to occur with each clock responding as shown in Ø3 T1 until Sk sets. When this happens, all functions will stop, except the clock, until Tp. The following shows what occurs at Tp when Sk is set.

|    |          |                   |                                 |
|----|----------|-------------------|---------------------------------|
| Tp | Arl      | = (Ø30506)TpSkS14 |                                 |
|    | sA0      | = A0005Ø4         |                                 |
|    | rA0      | = A0005Ø4         |                                 |
|    | sA(1-23) | = A(0-22)Arl      |                                 |
|    | rA( " )  | = A( " ) "        |                                 |
|    | Brl      | = (Ø30506)TpSkS14 | Clean up right shift A,B        |
|    | sB0      | = A23Brl          | (If S14 reset, no shift occurs) |
|    | rB0      | = A23Brl          |                                 |
|    | sB(1-23) | = B(0-22)Brl      |                                 |
|    | rB( " )  | = B( " ) "        |                                 |
|    | sF1      | = TpSk            | Ø7 next clock (T8)              |
|    | rRf      | = TpØ1(GØHt)      | Clear Rf                        |

|    |    |               |  |                                 |            |
|----|----|---------------|--|---------------------------------|------------|
| 07 | T8 | Ck            | = $\overline{07T8Ts}$                              |                                 |            |
|    |    | sC(0-23)      | = $\overline{C(0-23)Ck}$                           | Invert C                        |            |
|    |    | rC( " )       | = C( " )Ck   |                                 |            |
|    |    | End           | = F1F2   |                                 |            |
|    |    | sIa           | = $\overline{SkT807TjKr}$                          | Initiate P register increment   |            |
| T7 |    | Ar3           | = $\overline{0706Q1}$                              |                                 |            |
|    |    | sA(0-2)       | = $\overline{A(21-23)ArAr3}$                       |                                 |            |
|    |    | rA( " )       | = $\overline{A( " ) "}$                            | Recirculate A                   | T7 thru T0 |
|    |    | sA(3-23)      | = $\overline{A(0-20)Ar3}$                          |                                 |            |
|    |    | rA( " )       | = $\overline{A( " ) "}$                            |                                 |            |
|    |    | sB(0-2)       | = $\overline{B(21-23)BrAr3}$                       |                                 |            |
|    |    | rB( " )       | = $\overline{B( " ) "}$                            | Recirculate B                   | T7 thru T0 |
|    |    | sB(3-23)      | = $\overline{B(0-20)Ar3}$                          |                                 |            |
|    |    | rB( " )       | = $\overline{B( " ) "}$                            |                                 |            |
|    |    | Pr3           | = (F1G)Q2  |                                 |            |
|    |    | sP0           | = ( " )( $\overline{02040506}$ ) (P12P13P14Ia) Pr3 |                                 |            |
|    |    | rP0           | = ( " ) ( " ) (P12P13P14Ia) "                      |                                 |            |
|    |    | sP1           | = ( " ) ( " ) (P13P14Ia) Pr3                       |                                 |            |
|    |    | rP1           | = ( " ) ( " ) (P13P14Ia) "                         |                                 |            |
|    |    | sP2           | = ( " ) ( " ) (P14Ia) Pr3                          | P + 1 → P                       | T7 thru T3 |
|    |    | rP2           | = ( " ) ( " ) (P14Ia) "                            |                                 |            |
|    |    | rIa           | = $\overline{P12P13P14Q2F1}$                       |                                 |            |
|    |    | sP(3-14)      | = $\overline{P(0-11)Pr3}$                          |                                 |            |
|    |    | rP( " )       | = $\overline{P( " ) "}$                            |                                 |            |
| T4 |    | Sc            | = $\overline{T4EndInr}$                            |                                 |            |
|    |    | rS(1-14)      | = Sc   | Clear S                         |            |
| T3 |    | Sxp           | = $\overline{T3IntEndGO}$                          |                                 |            |
|    |    | sS1           | = (F1G) ( $\overline{02040506}$ ) (P13P14Ia) Sxp   |                                 |            |
|    |    | sS2           | = ( " ) ( " ) (P14Ia) Sxp                          | P → S                           |            |
|    |    | sS(3-14)      | = $\overline{P(0-11)Sxp}$                          |                                 |            |
| T0 |    | rSk           | = $\overline{07T0}$                                |                                 |            |
| Tr |    | Cxm           | = $\overline{EndGOtSm(Tr+Tp)}$                     |                                 |            |
|    |    | sC(0-23)      | = $\overline{M(0-23)Cxm}$                          | Fetch next instruction          |            |
|    |    | rC( " )       | = CxmTr  |                                 |            |
|    |    | rIa           | = TrF1   |                                 |            |
|    |    | rIx           | = $\overline{Tr(F1F3)(GOHt)}$                      |                                 |            |
|    |    | rK0           | = $\overline{07Tr}$                                |                                 |            |
|    |    | rA00          | = TpEndGO  |                                 |            |
| Tp |    | sCp           | = $\overline{M24CxmTpHtTs}$                        | Initiate parity                 |            |
|    |    | rF(1-3)       | = $\overline{TpEndSK}$                             | $\overline{00}$ next clock (T8) |            |
|    |    | rRf           | = $\overline{Tp01(GOHt)}$                          |                                 |            |
|    |    | Oc            | = TpEndSK  |                                 |            |
|    |    | sO2           | = Oc   |                                 |            |
|    |    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                    |            |

|    |                       |  |  |
|----|-----------------------|--|--|
| 67 | NOD 100XX             | Normalize A,B                                | A,B left until A0/A1, 2 + $\frac{XX-6}{20}$ Cycles<br>or XX shifts have occurred |
| 00 | T8                    | rCz = (00T8)                                 |  |
|    |                       | sIx = ( " ) C1G0                             |  |
|    |                       | Oxc = ( " ) IaGOC2                           | Initiate indexing  |
|    |                       | sO(1-6) = C(3-8)Oxc                          | C(3-8) → 0 if not Indirect Addressing  |
|    |                       | rO( " ) = $\overline{C}$ ( " ) "             |  |
| T7 | sA00                  | = A000T7                                     | Save sign of A   |
|    | Cr3                   | = $\overline{F1F2TsQ1}$                      |  |
|    | sC(0-2)               | = Add(1-3)00JuTsCr3                          | C(15-23)+X(15-23)Ix → C T7 thru T5   |
|    | rC( " )               | = $\overline{Add}$ ( " ) "                   |  |
|    | Xz(1-3)               | = Xn(1-3)00Ix                                |  |
|    | $\overline{Xz}$ ( " ) | = $\overline{Xn}$ ( " )00Ix+ $\overline{Ix}$ | Adder input (X) if indexing  |
|    | Yz(1-3)               | = C(21-23)07                                 |  |
|    | $\overline{Yz}$ ( " ) | = $\overline{C}$ ( " ) "                     | Adder input C  |
|    | sCz                   | = KzQ1T007                                   |  |
|    | rCz                   | = $\overline{KzQ1}$                          | Adder carry logic  |
|    | sCp                   | = (C21 ⊕ C22 ⊕ C23) CpTsHtQ1F1F2             |  |
|    | rCp                   | = ( " ) Cp "                                 | Try for parity check T7 thru T2  |
| T5 | sF3                   | = 00IaQ4030405                               | 01 next clock (T4)   |
| 01 | T4                    | sC(0-2) = C(21-23)F1F2F3Ts                   | C recirculate. Indexing  |
|    | rC( " )               | = $\overline{C}$ ( " ) "                     | is terminated. T4 thru T2  |
|    | Sc                    | = T4F1F2Inr                                  |  |
|    | rS(1-14)              | = Sc   | Clear S  |
| T3 | Sxc                   | = T3F1F2Ju                                   |  |
|    | sS(1,2)               | = Add(2,3)Sxc                                | C(10-23)+X(15-23)Ix → S  |
|    | sS(3-14)              | = C(0-11)Sxc                                 | put shift count into S   |
| T2 | sF2                   | = 0105Q2                                     | 03 next clock (T1)   |
|    | rS(1-8)               | = 0105T2                                     | Clear S(1-8)   |
|    | Sx48                  | = (S6S7S8+S9S10)0105T2                       |  |
|    | sS(9,10)              | = Sx48                                       | Set S(9-14) = 48 if shift  |
|    | rS(11-14)             | = Sx48                                       | count ≥ 48.  |
|    | sSk                   | = (0105T2)(S6S7S8S9S10S11S12S13S14)          | Shift count = 0  |
|    | sSk                   | = ( " ) (A0 ⊕ A1) C2                         | A,B normalized. C2=C11(norm bit) at T2   |
|    | rS14                  | = ( " ) ( " ) C2                             | Avoid clear up shift.  |
| 03 | T1                    | AL2 = (030506)Sk                             |  |
|    | sA00                  | = A1AL205                                    | Save old A1 for clean up shift   |
|    | rA00                  | = $\overline{A1}$ "                          | when 03 terminates   |
|    | sA(0-21)              | = A(2-23)AL2                                 |  |
|    | rA( " )               | = $\overline{A}$ ( " ) "                     |  |
|    | sA(22,23)             | = B(0,1)AL2                                  | A,B left 2 bits  |
|    | rA( " )               | = $\overline{B}$ ( " ) "                     |  |
|    | sB(0-21)              | = B(2-23)AL2                                 |  |
|    | rB( " )               | = $\overline{B}$ ( " ) "                     |  |
|    | rB(22,23)             | = $\overline{C4}$ AL205                      | 0 → B(22,23) C4=C10(cycle bit) during 03   |
|    | rBc23                 | = AL2  | Clear Bc23   |
|    | sIx                   | = 0305                                       | Initiate adder input (X) during 07   |
|    | rK0                   | = 0306Q6                                     | Clear K0 T3 thru Tp  |

(continued)

|                  |                                 |                              |
|------------------|---------------------------------|------------------------------|
| Ø3 T1 Sd2        | = Ø30506Sk                      | Count until Sk set.          |
| sS2              | = (Sd205)S6S7                   |                              |
| sS3              | = ( " )S3(S4S5S6S7)             |                              |
| rS3              | = ( " )S3( " )                  |                              |
| sS4              | = ( " )S4(S5S6S7)               |                              |
| rS4              | = ( " )S4( " )                  | Develop negative count       |
| sS5              | = ( " )S5(S6S7)                 | to be added to the           |
| rS5              | = ( " )S5( " )                  | index register during Ø7.    |
| sS6              | = ( " )S6S7                     | (counts for each AL2)        |
| rS6              | = ( " )S6S7                     |                              |
| sS7              | = ( " )S7                       |                              |
| rS7              | = ( " )S7                       |                              |
| rS9              | = Sd2S10(S11S12S13)             |                              |
| sS10             | = Sd2S10( " )                   |                              |
| rS10             | = Sd2S10( " )                   |                              |
| sS11             | = Sd2S11(S12S13)                |                              |
| rS11             | = Sd2S11( " )                   | Decrement count by 2         |
| sS12             | = Sd2S12S13                     | each clock.                  |
| rS12             | = Sd2S12S13                     |                              |
| sS13             | = Sd2S13                        |                              |
| rS13             | = Sd2S13                        |                              |
| sS14             | = (Ø30506Sk)(A1A2)C5            | Set clean up shift.          |
| rS14             | = ( " )(A1A2)(A2A3)(S9...S13)C5 | No clean up shift.           |
| sSk              | = ( " )(A1A2)C5                 | Over normalized              |
| sSk              | = ( " )(A1A2)(A2A3)(S9...S13)C5 | Normalized                   |
| sSk              | = ( " )(S9S10S11S12)S14         | Count = 0 or 2               |
| sSk              | = (Ø305Sk)(S9S10S11S12)S13      | Count = 0 or 1               |
| T0 (refer Ø3 T1) |                                 | Initiate X into Xz during Ø7 |
| Tr ( " )         |                                 |                              |
| Tp ( " )         |                                 |                              |
| rRf              | = TpØ1(GØHt)                    | Clear Rf                     |

If Sk is not set (Sk) at Tp, Ø3 will continue to occur with each clock responding as shown in Ø3 T1 until Sk sets. When this happens, all functions will stop, except the clock, until Tp. The following shows what occurs at Tp when Sk is set.

|          |                   |                                 |
|----------|-------------------|---------------------------------|
| Tp Ar1   | = (Ø30506)TpSkS14 |                                 |
| sA0      | = A0005C4         |                                 |
| rA0      | = A0005C4         |                                 |
| sA(1-23) | = A(0-22)Ar1      |                                 |
| rA( " )  | = A( " ) "        |                                 |
| Br1      | = (Ø30506)TpSkS14 | Clean up right shift A,B        |
| sB0      | = A23Br1          | (If S14 reset, no shift occurs) |
| rB0      | = A23Br1          |                                 |
| sB(1-23) | = B(0-22)Br1      |                                 |
| rB( " )  | = B( " ) "        |                                 |
| sF1      | = TpSk            | Ø7 next clock (T8)              |
| rRf      | = TpØ1(GØHt)      | Clear Rf                        |

|    |    |                              |  |   |            |
|----|----|------------------------------|--|---|------------|
| Ø7 | T8 | Ck                           | = $\overline{\text{Ø7T8Ts}}$                           |   |            |
|    |    | sC(0-23)                     | = $\overline{\text{C}}(0-23)$ Ck                       | Invert C  |            |
|    |    | rC( " )                      | = C( " ) Ck  |   |            |
|    |    | End                          | = F1F2   |   |            |
|    |    | sIa                          | = SkT8Ø7 <del>Ø7</del> Ø7                              | Initiate P register increment                     |            |
|    |    | sBc23                        | = (Ø7Ø5T8)S14  | Rf, KØ, Bc23 form an Octal input to               |            |
|    |    | sKØ                          | = ( " ) S7   | Yz(1-3) from T8 thru T6 which                     |            |
|    |    | sRf                          | = ( " ) S6   | represent the negative number of                  |            |
|    |    |                              |  | shifts during normalize.                          |            |
| T7 |    | Ar3                          | = Ø7Ø6Q1   |   |            |
|    |    | sA(0-2)                      | = $\overline{\text{A}}(21-23)\overline{\text{AnrAr3}}$ |   |            |
|    |    | rA( " )                      | = $\overline{\text{A}}( " )$ "                         | Recirculate A                                     | T7 thru TØ |
|    |    | sA(3-23)                     | = $\overline{\text{A}}(0-20)\overline{\text{Ar3}}$     |   |            |
|    |    | rA( " )                      | = $\overline{\text{A}}( " )$ "                         |   |            |
|    |    | sB(0-2)                      | = $\overline{\text{B}}(21-23)\overline{\text{BnrAr3}}$ |   |            |
|    |    | rB( " )                      | = $\overline{\text{B}}( " )$ "                         | Recirculate B                                     | T7 thru TØ |
|    |    | sB(3-23)                     | = $\overline{\text{B}}(0-20)\overline{\text{Ar3}}$     |   |            |
|    |    | rB( " )                      | = $\overline{\text{B}}( " )$ "                         |   |            |
|    |    | Pr3                          | = (F1GØ)Q2   |   |            |
|    |    | sPØ                          | = ( " ) (Ø2Ø4Ø5Ø6) (P12 <del>Ø</del> P13P14Ia) Pr3     |   |            |
|    |    | rPØ                          | = ( " ) ( " ) (P12 <del>Ø</del> P13P14Ia) "            |   |            |
|    |    | sP1                          | = ( " ) ( " ) (P13 <del>Ø</del> P14Ia) Pr3             |   |            |
|    |    | rP1                          | = ( " ) ( " ) (P13 <del>Ø</del> P14Ia) "               |   |            |
|    |    | sP2                          | = ( " ) ( " ) (P14 <del>Ø</del> Ia) Pr3                | P + 1 → P   | T7 thru T3 |
|    |    | rP2                          | = ( " ) ( " ) (P14 <del>Ø</del> Ia) "                  |   |            |
|    |    | rIa                          | = P12P13P14Q2F1  |   |            |
|    |    | sP(3-14)                     | = P(0-11) Pr3  |   |            |
|    |    | rP( " )                      | = $\overline{\text{P}}( " )$ "                         |   |            |
|    |    | Xnr                          | = Ø3(Ø4Ø5Ø6) $\overline{\text{C5}}\delta7$             | $\overline{\text{C5}}$ is norm bit inverted at T8 |            |
|    |    | sXw(1-3)                     | = Add(1-3)Ø3(Ø4Ø5Ø6) $\overline{\text{C5}}\delta7$ F1  | X + S(2-7) + S14 → X                              | T7 thru TØ |
|    |    | rXw( " )                     | = Add( " ) "   | (X-number of shifts → X)                          |            |
|    |    | Xz(1-3)                      | = Xn(1-3)IxØ7Ø5  | Adder input (X)                                   | T7 thru TØ |
|    |    | $\overline{\text{Xz}}$ ( " ) | = $\overline{\text{Xn}}$ ( " ) "                       |   |            |
|    |    | Yz1                          | = RfØ7   | Adder input (S)                                   |            |
|    |    | $\overline{\text{Yz1}}$      | = $\overline{\text{Rf}}\delta7$                        | Bits S3 thru S7 contain                           |            |
|    |    | Yz2                          | = KØØ7   | a negative count of the                           |            |
|    |    | $\overline{\text{Yz2}}$      | = $\overline{\text{KØ}}\delta7$                        | AL2's during normalize.                           |            |
|    |    | Yz3                          | = Bc23Ø7   | S14 contains the clean up.                        |            |
|    |    | $\overline{\text{Yz3}}$      | = $\overline{\text{Bc23}}\delta7$                      |   |            |
|    |    | sBc23                        | = (Ø7Ø5T7)S5   |   |            |
|    |    | rBc23                        | = ( " ) S5   |   |            |
|    |    | sKØ                          | = ( " ) S4   | Rf, KØ and Bc23 must                              |            |
|    |    | rKØ                          | = ( " ) S4   | be set for the next                               |            |
|    |    | sRf                          | = ( " ) S3   | clock   |            |
|    |    | rRf                          | = ( " ) S3   |   |            |

|    |               |   |                               |            |
|----|---------------|---|-------------------------------|------------|
| T6 | sBc23         | = ( $\emptyset$ 705T6)S2                        |                               |            |
|    | sK0           | = ( " )S2                                       | Extend minus sign for         |            |
|    | sRf           | = ( " )S2                                       | negative count to Yz          | T5 thru T0 |
| T4 | Sc            | = T4EndInr                                      |                               |            |
|    | rS(1-14)      | = Sc  | Clear S                       |            |
| T3 | Sxp           | = T3IntEndGO                                    |                               |            |
|    | sS1           | = (F1GO) (02040506) (P13 $\oplus$ P14Ia) Sxp    |                               |            |
|    | sS2           | = ( " ) ( " ) (P14 $\oplus$ Ia) Sxp             | P $\rightarrow$ S             |            |
|    | sS(3-14)      | = P(0-11) Sxp                                   |                               |            |
| T0 | rSk           | = $\emptyset$ 7T0                               |                               |            |
| Tr | Cxm           | = EndGOTsm(Tr+Tp)                               |                               |            |
|    | sC(0-23)      | = M(0-23) Cxm                                   | Fetch next instruction        |            |
|    | rC( " )       | = CxmTr   |                               |            |
|    | rIa           | = TrF1  |                               |            |
|    | rIx           | = Tr(F1F3) ( $\overline{\text{GOHt}}$ )         |                               |            |
|    | rK0           | = $\emptyset$ 7Tr                               |                               |            |
|    | rA00          | = TpEndGO                                       |                               |            |
| Tp | sCp           | = M24CxmTpHtTs                                  | Initiate parity               |            |
|    | rF(1-3)       | = TpEndSk                                       | $\emptyset$ 0 next clock (T8) |            |
|    | rRf           | = Tp $\emptyset$ 1 ( $\overline{\text{GOHt}}$ ) |                               |            |
|    | Oc            | = TpEndSk                                       |                               |            |
|    | s02           | = Oc  |                               |            |
|    | r0(1,3,4,5,6) | = Oc  | NOP (20) $\rightarrow$ 0      |            |

|    |           |  |  |                              |
|----|-----------|--|--|------------------------------|
| 67 | LCY 200XX | Left Cycle A,B   | A,B left cycle XX bits<br>A0 into B23  | $2 + \frac{XX-6}{20}$ Cycles |
| ∅0 | T8        | rCz = (∅0T8)<br>sIx = ( " )C1G0<br>Oxc = ( " )IaGOC2<br>sO(1-6) = C(3-8)Oxc<br>rO( " ) = C( " ) "  | Initiate indexing<br>C(3-8) → 0 if not Indirect Addressing   |                              |
|    | T7        | sA00 = A0∅0T7<br>Cr3 = F1F2TsQ1<br>sC(0-2) = Add(1-3)∅0JuTsCr3<br>rC( " ) = Add( " ) "<br>Xz(1-3) = Xn(1-3)∅0Ix<br>Xz( " ) = Xn( " )∅0Ix+Ix<br>Yz(1-3) = C(21-23)∅7<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T0∅7<br>rCz = KZQ1<br>sCp = (C21+C22+C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp "  | Save sign of A<br>C(15-23)+X(15-23)Ix→ C T7 thru T5<br>Adder input (X) if indexing<br>Adder input C<br>Adder carry logic   |                              |
|    | T5        | sF3 = ∅0IaQ4O3O4O5   | Try for parity check T7 thru T2  |                              |
| ∅1 | T4        | sC(0-2) = C(21-23)F1F2F3Ts<br>rC( " ) = C( " ) "<br>Sc = T4F1F2Inr<br>rS(1-14) = Sc  | ∅1 next clock (T4)<br>C recirculate. Indexing is terminated. T4 thru T2  |                              |
|    | T3        | Sxc = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc   | Clear S<br>C(10-23)+X(15-23)Ix→ S<br>put shift count into S  |                              |
|    | T2        | sF2 = ∅105Q2<br>rS(1-8) = ∅105T2<br>Sx48 = (S6S7S8+S9S10)∅105T2<br>sS(9,10) = Sx48<br>rS(11-14) = Sx48   | ∅3 next clock (T1)<br>Clear S(1-8)<br>Set S(9-14) = 48 if shift count > 48.  |                              |
| ∅3 | T1        | sSk = (∅105T2)(S6S7S8S9S10S11S12S13S14)<br>AL2 = (∅30506)Sk<br>sA00 = A1AL205<br>rA00 = AI "<br>sA(0-21) = A(2-23)AL2<br>rA( " ) = A( " ) "<br>sA(22,23) = B(0,1)AL2<br>rA( " ) = B( " ) "<br>sB(0-21) = B(2-23)AL2<br>rB( " ) = B( " ) "<br>sB(22,23) = A(0,1)AL2<br>rB( " ) = A( " ) "<br>Sd2 = ∅30506Sk<br>rS9 = Sd2S10(S11S12S13)<br>sS10 = Sd2S10( " )<br>rS10 = Sd2S10( " )<br>sS11 = Sd2S11(S12S13)<br>rS11 = Sd2S11( " )<br>sS12 = Sd2S12S13<br>rS12 = Sd2S12S13 | Shift count = 0<br>Save old A1 for clean up shift when ∅3 terminates<br>A,B left 2 bits<br>Cycle A0,A1 into B22,B23<br>Count until Sk set.<br>Decrement count by 2 each clock. |                              |



(continued)

|       |               |                               |                              |
|-------|---------------|-------------------------------|------------------------------|
| Ø3 T1 | sS13          | = Sd2S13                      |                              |
|       | rS13          | = Sd2S13                      |                              |
|       | sSk           | = (Ø30506Sk) (S9S10S11S12)S14 | Count = 0 or 2               |
|       | sSk           | = (Ø305Sk) (S9S10S11S12)S13   | Count = 0 or 1               |
| T0    | (refer Ø3 T1) |                               | Initiate X into Xz during Ø7 |
| Tr    | ( " )         |                               |                              |
| Tp    | ( " )         |                               |                              |
| rRf   |               | = TpØ1(GØHt)                  | Clear Rf                     |

If Sk is not set ( $\overline{Sk}$ ) at Tp, Ø3 will continue to occur with each clock responding as shown in Ø3 T1 until Sk sets. When this happens, all functions will stop, except the clock, until Tp. The following shows what occurs at Tp when Sk is set.

|    |          |                   |                                 |
|----|----------|-------------------|---------------------------------|
| Tp | Arl      | = (Ø30506)TpSkS14 |                                 |
|    | sA0      | = B23C4C6Arl      |                                 |
|    | rA0      | = B23C4C6Arl      | Cycle B23 into A0               |
|    | sA(1-23) | = A(0-22)Arl      |                                 |
|    | rA( " )  | = A( " ) "        |                                 |
|    | Brl      | = (Ø30506)TpSkS14 | Clean up right shift A,B        |
|    | sB0      | = A23Brl          | (If S14 reset, no shift occurs) |
|    | rB0      | = A23Brl          |                                 |
|    | sB(1-23) | = B(0-22)Brl      |                                 |
|    | rB( " )  | = B( " ) "        |                                 |
|    | sF1      | = TpSk            | Ø7 next clock (T8)              |
|    | rRf      | = TpØ1(GØHt)      | Clear Rf                        |

|    |    |               |                                   |                               |            |
|----|----|---------------|-----------------------------------|-------------------------------|------------|
| 07 | T8 | Ck            | = 07T8Ts                          |                               |            |
|    |    | sC(0-23)      | = C(0-23)Ck                       | Invert C                      |            |
|    |    | rC( " )       | = C( " )Ck                        |                               |            |
|    |    | End           | = F1F2                            |                               |            |
|    |    | sIa           | = SkT807Ijkr                      | Initiate P register increment |            |
| T7 |    | Ar3           | = 0706Q1                          |                               |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                  |                               |            |
|    |    | rA( " )       | = A( " ) "                        | Recirculate A                 | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                      |                               |            |
|    |    | rA( " )       | = A( " ) "                        |                               |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                  |                               |            |
|    |    | rB( " )       | = B( " ) "                        | Recirculate B                 | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                      |                               |            |
|    |    | rB( " )       | = B( " ) "                        |                               |            |
|    |    | Pr3           | = (F1G0)Q2                        |                               |            |
|    |    | sP0           | = ( " )(02040506)(P12P13P14Ia)Pr3 |                               |            |
|    |    | rP0           | = ( " )( " )(P12P13P14Ia) "       |                               |            |
|    |    | sP1           | = ( " )( " )(P13P14Ia)Pr3         |                               |            |
|    |    | rP1           | = ( " )( " )(P13P14Ia) "          |                               |            |
|    |    | sP2           | = ( " )( " )(P14Ia)Pr3            | P + 1 → P                     | T7 thru T3 |
|    |    | rP2           | = ( " )( " )(P14Ia) "             |                               |            |
|    |    | rIa           | = P12P13P14Q2F1                   |                               |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                      |                               |            |
|    |    | rP( " )       | = P( " ) "                        |                               |            |
| T4 |    | Sc            | = T4EndInr                        |                               |            |
|    |    | rS(1-14)      | = Sc                              | Clear S                       |            |
| T3 |    | Sxp           | = T3IntEndGO                      |                               |            |
|    |    | sS1           | = (F1G0)(02040506)(P13P14Ia)Sxp   |                               |            |
|    |    | sS2           | = ( " )( " )(P14Ia)Sxp            | P → S                         |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                      |                               |            |
| T0 |    | rSk           | = 07T0                            |                               |            |
| Tr |    | Cxm           | = EndGOIsm(Tr+Tp)                 |                               |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                      | Fetch next instruction        |            |
|    |    | rC( " )       | = CxmTr                           |                               |            |
|    |    | rIa           | = TrF1                            |                               |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)                  |                               |            |
|    |    | rK0           | = 07Tr                            |                               |            |
|    |    | rA00          | = TpEndGO                         |                               |            |
| Tp |    | sCp           | = M24CxmTpHtTs                    | Initiate parity               |            |
|    |    | rF(1-3)       | = TpEndSK                         | 00 next clock (T8)            |            |
|    |    | rRf           | = Tp01(GOht)                      |                               |            |
|    |    | Oc            | = TpEndSK                         |                               |            |
|    |    | sO2           | = Oc                              |                               |            |
|    |    | rO(1,3,4,5,6) | = Oc                              | NOP (20) → 0                  |            |

|    |     |   |   |  |
|----|-----|---|---|--|
| 70 | SKM | Skip if A Equal (M) on B Mask   | $A \cdot B \neq (M) \cdot B; P + 1 \rightarrow P$<br>$A \cdot B = (M) \cdot B; P + 2 \rightarrow P$   | 2 Cycles<br>3 Cycles   |
| 00 | T8  | rCz = 00T8<br>sIx = 00T8C1G0<br>Oxc = (00T8IaG0)C2<br>s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>r02 = C4Oxc  | Initialize carry<br>Initialize indexing<br>Instruction → 0  |  |
|    | T7  | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>Cr3 = F1F2(TsQ1)<br>sC(0-2) = Add(1-3)00JuTsCr3<br>rC( " ) = Add( " ) "<br>sC(3-23) = C(0-20)Cr3<br>rC( " ) = C( " ) "<br>Xz(1-3) = Xn(1-3)00Ix<br>Xz( " ) = Xn( " )00Ix+Ix<br>Yz(1-3) = C(21-23)07<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T007<br>rCz = KzQ1<br>sCp = (C21 ⊕ C22 ⊕ C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp " | Recirculate A<br>Recirculate B<br>C+X·Ix → C (Add=Xz+Yz)<br>Adder input if Ix (indexing)<br>Adder input C register<br>Carry for Adder<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T1<br>T7 thru T0 |
|    | T4  | Sc = T4F1F2Inr<br>rS(1-14) = Sc   | Clear S   |  |
|    | T3  | Sxc = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc  | C + X·Ix → S  |  |
|    | T0  | rCz = F1T0  |   |  |
|    | Tr  | Cxm = Ju00Tsm(Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = TrCxm<br>sHt = CpTrKpK002<br>rIx = Tr(F1F3)(G0Ht)<br>rK0 = G0TrF2  | M → C (Fetch operand)<br>Parity error   | Tr thru Tp   |
|    | Tp  | sCp = M24CxmHtTsTp<br>sF1 = (TpIa00)0104<br>sF2 = ( " )0301   | Initiate parity<br>06 next clock (T8)   |  |

|    |     |          |                                   |                                |            |
|----|-----|----------|-----------------------------------|--------------------------------|------------|
| 06 | T8  | sIa      | = T8F1F3I1Kr                      | Initiate P register increment  |            |
|    |     | End      | = F1F2                            | Last cycle                     |            |
|    |     | sSk      | = (0103040606)T8                  |                                |            |
| T7 | Ar3 | Ar3      | = (01020304)Q1                    |                                |            |
|    |     | sA(0-2)  | = A(21-23)AnrAr3                  |                                |            |
|    |     | rA( " )  | = A( " ) "                        | Recirculate A                  | T7 thru T0 |
|    |     | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |     | rA( " )  | = A( " ) "                        |                                |            |
|    |     | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |     | rB( " )  | = B( " ) "                        | Recirculate B                  | T7 thru T0 |
|    |     | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |     | rB( " )  | = B( " ) "                        |                                |            |
|    |     | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |     | sC(0-2)  | = Add(1-3)06TsCr3                 |                                |            |
|    |     | rC( " )  | = Add( " ) "                      | Recirculate C                  | T7 thru T0 |
|    |     | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |     | rC( " )  | = C( " ) "                        |                                |            |
|    |     | Xz(1-3)  | = Xz                              | Adder input (0)                | T7 thru T0 |
|    |     | Yz(1-3)  | = C(21-23)07                      | Adder input (C)                | T7 thru T0 |
|    |     | Yz( " )  | = C( " ) "                        |                                |            |
|    |     | sCz      | = KzQ1F107                        | Carry logic                    | T7 thru T0 |
|    |     | rCz      | = KzQ1                            |                                |            |
|    |     | sCp      | = (C210C220C23)CpTsHtQ10603       | Check parity                   | T7 thru T0 |
|    |     | rCp      | = ( " ) Cp "                      |                                |            |
|    |     | Pr3      | = (F1G0)Q2                        |                                |            |
|    |     | sP0      | = (P120P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |     | rP0      | = ( " ) " "                       |                                |            |
|    |     | sP1      | = (P130P14Ia)                     |                                |            |
|    |     | rP1      | = ( " ) " "                       |                                |            |
|    |     | sP2      | = (P140Ia)                        | P + 1 → P                      | T7 thru T3 |
|    |     | rP2      | = ( " ) " "                       |                                |            |
|    |     | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |     | rP( " )  | = P( " ) "                        |                                |            |
|    |     | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    |     | rSk      | = B(0C)(21-23)(060103040506Q1)    | Don't skip logic               | T7 thru T0 |
| T4 | Sc  | Sc       | = T4EndInr                        | Clear S                        |            |
|    |     | rS(1-14) | = Sc                              |                                |            |
| T3 | Sxp | Sxp      | = T3IntEndG0                      |                                |            |
|    |     | sS1      | = (P130P14Ia)F1G0(02040506)Sxp    | P13,14 contains P1,P2 at T3    |            |
|    |     | rS1      | = ( " ) " "                       | P + 1 → S                      |            |
|    |     | sS2      | = (P140Ia)                        |                                |            |
|    |     | rS2      | = ( " ) " "                       |                                |            |
|    |     | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |     | rS( " )  | = P( " ) "                        |                                |            |
| Tr | Cxm | Cxm      | = EndG0Tsm(Tr+Tp)                 | M → C (Fetch next instruction) | Tr thru Tp |
|    |     | sC(0-23) | = M(0-23)Cxm                      |                                |            |
|    |     | rC( " )  | = TrCxm                           |                                |            |
|    |     | sHt      | = CpTrK002                        | Parity error                   |            |

|    |               |                                  |                            |
|----|---------------|----------------------------------|----------------------------|
|    | rIa           | = TrF1                           |                            |
|    | rIx           | = Tr(F1F3) ( $\overline{GOHt}$ ) |                            |
| Tp | rA00          | = TpEndGO                        |                            |
|    | rB00          | = ( " )                          |                            |
|    | sCp           | = M24CxmHtTsTp                   | Initiate parity            |
|    | rF(1,2)       | = TpEndSk                        | 00 next if $\overline{Sk}$ |
|    | sF3           | = TpSk                           | 07 next if Sk              |
|    | Oc            | = TpEndSk                        |                            |
|    | s02           | = Oc                             |                            |
|    | r0(1,3,4,5,6) | = Oc                             | NOP (20) → 0               |

|    |    |               |                                  |                                |            |
|----|----|---------------|----------------------------------|--------------------------------|------------|
| 07 | T8 | sIa           | = Sk07T8I <del>Kr</del>          | Initiate P register increment  |            |
|    |    | End           | = FIF2                           | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                   |                                |            |
|    |    | sA(0-2)       | = A(21-23)ArAr3                  |                                |            |
|    |    | rA( " )       | = A( " ) " "                     | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                     |                                |            |
|    |    | rA( " )       | = A( " ) " "                     |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                 |                                |            |
|    |    | rB( " )       | = B( " ) " "                     | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                     |                                |            |
|    |    | rB( " )       | = B( " ) " "                     |                                |            |
|    |    | Pr3           | = (F1G0)Q2                       |                                |            |
|    |    | sP0           | = (P12P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |    | rP0           | = ( " ) " "                      |                                |            |
|    |    | sP1           | = (P13P14Ia) " "                 |                                |            |
|    |    | rP1           | = ( " ) " "                      |                                |            |
|    |    | sP2           | = (P14Ia) " "                    | P + 1 → P                      | T7 thru T3 |
|    |    | rP2           | = ( " ) " "                      |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                     |                                |            |
|    |    | rP( " )       | = P( " ) " "                     |                                |            |
|    |    | rIa           | = (P12P13P14)Q2F1                |                                |            |
|    | T4 | Sc            | = T4EndInr                       | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                             |                                |            |
|    | T3 | Sxp           | = T3IntEndG0                     |                                |            |
|    |    | sS1           | = (P13P14Ia)F1G0(02040506)Sxp    | P13, P14 contain P1, P2 at T3  |            |
|    |    | rS1           | = ( " ) " "                      | P + 1 → S                      |            |
|    |    | sS2           | = (P14Ia) " "                    |                                |            |
|    |    | rS2           | = ( " ) " "                      |                                |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                     |                                |            |
|    |    | rS( " )       | = P( " ) " "                     |                                |            |
|    | T0 | rSk           | = 07T0                           |                                |            |
|    |    | rCp           | = TsT0HtK0(F1030406)02           |                                |            |
|    | Tr | Com           | = EndG0Tsm(Tr+Tp)                | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23)      | = M(0-23)Com                     |                                |            |
|    |    | rC( " )       | = TrCom                          |                                |            |
|    |    | rIa           | = TrF1                           |                                |            |
|    |    | rLx           | = Tr(F1F3)(G0Ht)                 |                                |            |
|    | Tp | rA00          | = TpEndG0                        |                                |            |
|    |    | rB00          | = ( " )                          |                                |            |
|    |    | sCp           | = M24ComHtTsTp                   | Initiate parity check          |            |
|    |    | rF(1-3)       | = TpEndSK                        | 00 next clock (T8)             |            |
|    |    | 0c            | = ( " )                          |                                |            |
|    |    | s02           | = 0c                             |                                |            |
|    |    | r0(1,3,4,5,6) | = 0c                             | NOP (20) → 0                   |            |

| 71 | LDX      | Load X                          | (M) → X                      | 2 Cycles   |
|----|----------|---------------------------------|------------------------------|------------|
| 00 | T8       | rCz = 00T8                      | Initialize carry             |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing          |            |
|    |          | Oxc = (00T8IaG0)C2              |                              |            |
|    |          | s0(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0              |            |
|    |          | r02 = C4Oxc                     |                              |            |
| T7 | Ar3      | = (01020304)Q1                  |                              |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                              |            |
|    | rA( " )  | = A( " ) " "                    | Recirculate A                | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                              |            |
|    | rA( " )  | = A( " ) " "                    |                              |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                              |            |
|    | rB( " )  | = B( " ) " "                    | Recirculate B                | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                              |            |
|    | rB( " )  | = B( " ) " "                    |                              |            |
|    | Cr3      | = F1F2(TsQ1)                    |                              |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             |                              |            |
|    | rC( " )  | = Add( " ) " "                  | C+X·Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                              |            |
|    | rC( " )  | = C( " ) " "                    |                              |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input if Ix (indexing) |            |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                              | T7 thru T0 |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input C register       | T7 thru T0 |
|    | Yz( " )  | = C( " ) " "                    |                              |            |
|    | sCz      | = KzQ1T007                      | Carry for Adder              | T7 thru T1 |
|    | rCz      | = KzQ1                          |                              |            |
|    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2     | Check parity                 | T7 thru T0 |
|    | rCp      | = ( " )Cp " "                   |                              |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                      |            |
|    | rS(1-14) | = Sc                            |                              |            |
| T3 | Sxc      | = T3F1F2Ju                      |                              |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                              |            |
|    | sS(3-14) | = C(0-11)Sxc                    | C+X·Ix → S                   |            |
| T0 | rCz      | = F1T0                          |                              |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch Operand)        | Tr thru T1 |
|    | sC(0-23) | = M(0-23)Cxm                    |                              |            |
|    | rC( " )  | = TrCxm                         |                              |            |
|    | sCz      | = (Tr00)0203                    |                              |            |
|    | sHt      | = CpTrK002                      | Parity error                 |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                              |            |
|    | rK0      | = GOTrF2                        |                              |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity              |            |
|    | sF1      | = (TpIa00)0104                  |                              |            |
|    | sF2      | = ( " )0301                     | 06 next clock (T8)           |            |

|    |    |          |                                       |                                |            |
|----|----|----------|---------------------------------------|--------------------------------|------------|
| 06 | T8 | sIa      | = T8F1F3( <del>Ti</del> )Kr           | Initiate P register increment  |            |
|    |    | End      | = F1F2                                | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                        |                                |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                      |                                |            |
|    |    | rA( " )  | = A( " ) " "                          | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                          |                                |            |
|    |    | rA( " )  | = A( " ) " "                          |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                      |                                |            |
|    |    | rB( " )  | = B( " ) " "                          | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                          |                                |            |
|    |    | rB( " )  | = B( " ) " "                          |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                          |                                |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                     |                                |            |
|    |    | rC( " )  | = Add( " ) " "                        | B + C → C                      | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                          |                                |            |
|    |    | rC( " )  | = C( " ) " "                          |                                |            |
|    |    | Xz(1-3)  | = A(21-23)060204                      |                                |            |
|    |    | Xz( " )  | = A( " ) " "                          | Unused adder inputs            | T7 thru T0 |
|    |    | Yz(1-3)  | = C(21-23)07                          |                                |            |
|    |    | Yz( " )  | = C( " ) " "                          |                                |            |
|    |    | sCz      | = KzQ1F107                            |                                |            |
|    |    | rCz      | = KzQ1                                | Carry logic                    | T7 thru T0 |
|    |    | sCp      | = (C21 ⊕ C22 ⊕ C23) CpTsHtQ10603      |                                |            |
|    |    | rCp      | = ( " ) Cp " "                        | Check parity                   | T7 thru T0 |
|    |    | Pr3      | = (F1G0)Q2                            |                                |            |
|    |    | sP0      | = (P12 ⊕ P13P14Ia) F1G0(02040506) Pr3 |                                |            |
|    |    | rP0      | = ( " ) " "                           |                                |            |
|    |    | sP1      | = (P13 ⊕ P14Ia) " "                   |                                |            |
|    |    | rP1      | = ( " ) " "                           |                                |            |
|    |    | sP2      | = (P14 ⊕ Ia) " "                      | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) " "                           |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                          |                                |            |
|    |    | rP( " )  | = P( " ) " "                          |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                     |                                |            |
|    |    | Xnr      | = 06010203040506                      |                                |            |
|    |    | sXw(1-3) | = ( " ) TsC(21-23)                    | C → X                          | T7 thru T0 |
|    |    | rXw( " ) | = ( " ) TsC( " )                      |                                |            |
|    | T4 | Sc       | = T4EndInr                            |                                |            |
|    |    | rS(1-14) | = Sc                                  | Clear S                        |            |
|    | T3 | Sxp      | = T3IntEndGO                          |                                |            |
|    |    | sS1      | = (P13 ⊕ P14Ia) F1G0(02040506) Sxp    |                                |            |
|    |    | rS1      | = ( " ) " "                           | P + 1 → S                      |            |
|    |    | sS2      | = (P14 ⊕ Ia) " "                      |                                |            |
|    |    | rS2      | = ( " ) " "                           |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                          |                                |            |
|    |    | rS( " )  | = P( " ) " "                          |                                |            |
|    | Tr | Cxm      | = EndGO <del>Tsm</del> (Tr+Tp)        |                                |            |
|    |    | sC(0-23) | = M(0-23)Cxm                          | M → C (Fetch next instruction) |            |
|    |    | rC( " )  | = TrCxm                               |                                | Tr thru Tp |
|    |    | sHt      | = CpTr( <del>Kp</del> )K002           | Parity error                   |            |



|    |               |                   |                    |
|----|---------------|-------------------|--------------------|
|    | rIa           | = TrF1            |                    |
|    | rIx           | = Tr(F1F3) (GOHt) |                    |
| Tp | rA00          | = TpEndGO         |                    |
|    | rB00          | = ( " )           |                    |
|    | sCp           | = M24CxmHtTsTp    | Initiate parity    |
|    | rF(1,2)       | = TpEndSk         | 00 next clock (T8) |
|    | Oc            | = ( " )           |                    |
|    | sO2           | = Oc              |                    |
|    | rO(1,3,4,5,6) | = Oc              | NOP (20) → 0       |

|               |     |                                     |  |   |
|---------------|-----|-------------------------------------|--|---|
| 72            | SKA | Skip if A and M do not Compare Ones | $A_i(M)_i=1; P+1 \rightarrow P$<br>$A_i(M)_i=0; P+2 \rightarrow P$                                       | 2 Cycles<br>3 Cycles                                    |
| $\emptyset 0$ | T8  | rCz                                 | = $\emptyset 0 T8$   | Initialize carry  |
|               |     | sIx                                 | = $\emptyset 0 T8 C1 G0$   | Initialize indexing                                     |
|               |     | Oxc                                 | = $(\emptyset 0 T8 \overline{Ia} G0) \overline{C2}$  |   |
|               |     | sO(1,3,4,5,6)                       | = $C(3,5,6,7,8) Oxc$   | Instruction $\rightarrow 0$                             |
|               |     | rO2                                 | = $\overline{C4} Oxc$  |   |
|               | T7  | Ar3                                 | = $(01020304) Q1$  |   |
|               |     | sA(0-2)                             | = $A(21-23) \overline{Anr} Ar3$  |   |
|               |     | rA( " )                             | = $\overline{A( " ) "}$  | Recirculate A T7 thru T0                                |
|               |     | sA(3-23)                            | = $A(0-20) Ar3$  |   |
|               |     | rA( " )                             | = $\overline{A( " ) "}$  |   |
|               |     | sB(0-2)                             | = $B(21-23) \overline{Bnr} Ar3$  |   |
|               |     | rB( " )                             | = $\overline{B( " ) "}$  | Recirculate B T7 thru T0                                |
|               |     | sB(3-23)                            | = $B(0-20) Ar3$  |   |
|               |     | rB( " )                             | = $\overline{B( " ) "}$  |   |
|               |     | Cr3                                 | = $\overline{F1F2} (Ts Q1)$  |   |
|               |     | sC(0-2)                             | = $Add(1-3) \emptyset 0 Ju \overline{Ts} Cr3$  |   |
|               |     | rC( " )                             | = $\overline{Add( " ) "}$  | $C+X \cdot Ix \rightarrow C$ (Add= $Xz+Yz$ ) T7 thru T0 |
|               |     | sC(3-23)                            | = $C(0-20) Cr3$  |   |
|               |     | rC( " )                             | = $\overline{C( " ) "}$  |   |
|               |     | Xz(1-3)                             | = $Xn(1-3) \emptyset 0 \cdot Ix$   | Adder input if Ix (indexing)                            |
|               |     | $\overline{Xz( " )}$                | = $\overline{Xn( " )} \emptyset 0 Ix + Ix$   | T7 thru T0  |
|               |     | Yz(1-3)                             | = $C(21-23) \emptyset 7$   | Adder input C register                                  |
|               |     | $\overline{Yz( " )}$                | = $\overline{C( " ) "}$  | T7 thru T0  |
|               |     | sCz                                 | = $Kz Q1 T0 \emptyset 7$   | Carry for Adder   |
|               |     | rCz                                 | = $\overline{Kz} Q1$   | T7 thru T1  |
|               |     | sCp                                 | = $(C21 \oplus C22 \oplus C23) \overline{Cp} \overline{Ts} \overline{Ht} Q1 \overline{F1} \overline{F2}$ | Check parity  |
|               |     | rCp                                 | = $( " ) Cp$   | T7 thru T0  |
|               | T4  | Sc                                  | = $T4 \overline{F1} \overline{F2} \overline{Inr}$  | Clear S   |
|               |     | rS(1-14)                            | = Sc   |   |
|               | T3  | Sxc                                 | = $T3 \overline{F1} \overline{F2} \overline{Ju}$   |   |
|               |     | sS(1,2)                             | = $Add(2,3) Sxc$   | $C + X \cdot Ix \rightarrow S$                          |
|               |     | sS(3-14)                            | = $C(0-11) Sxc$  |   |
|               | T0  | rCz                                 | = $\overline{F1} T0$   |   |
|               | Tr  | Cxm                                 | = $Ju \emptyset 0 Tsm(Tr+Tp)$  | $M \rightarrow C$ (Fetch operand) Tr thru Tp            |
|               |     | sC(0-23)                            | = $M(0-23) Cxm$  |   |
|               |     | rC( " )                             | = $Tr Cxm$   |   |
|               |     | sHt                                 | = $Cp Tr \overline{Kz} \overline{K0} \overline{02}$  | Parity error  |
|               |     | rIx                                 | = $Tr(\overline{F1F3})(\overline{G0Ht})$   |   |
|               |     | rK0                                 | = $G0 Tr \overline{F2}$  |   |
|               | Tp  | sCp                                 | = $M24 Cxm \overline{Ht} \overline{Ts} Tp$   | Initiate parity   |
|               |     | sF1                                 | = $(Tp Ia \emptyset 0) 0104$   | $\emptyset 6$ next clock (T8)                           |
|               |     | sF2                                 | = $( " ) 0301$   |   |

|    |     |          |                                   |                                |            |
|----|-----|----------|-----------------------------------|--------------------------------|------------|
| 06 | T8  | sIa      | = T8F1F3I <del>Kr</del>           | Initiate P register increment  |            |
|    |     | End      | = F1F2                            | Last cycle                     |            |
|    |     | sSk      | = 0103040606T8                    |                                |            |
| T7 | Ar3 | Ar3      | = (01020304)Q1                    |                                |            |
|    |     | sA(0-2)  | = A(21-23)AnrAr3                  |                                |            |
|    |     | rA( " )  | = A( " ) "                        | Recirculate A                  | T7 thru T0 |
|    |     | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |     | rA( " )  | = A( " ) "                        |                                |            |
|    |     | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |     | rB( " )  | = B( " ) "                        | Recirculate B                  | T7 thru T0 |
|    |     | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |     | rB( " )  | = B( " ) "                        |                                |            |
|    |     | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |     | sC(0-2)  | = Add(1-3)06TsCr3                 |                                |            |
|    |     | rC( " )  | = Add( " ) "                      | Recirculate C                  | T7 thru T0 |
|    |     | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |     | rC( " )  | = C( " ) "                        |                                |            |
|    |     | Xz(1-3)  | = Xz                              | Adder input (0)                | T7 thru T0 |
|    |     | Yz(1-3)  | = C(21-23)07                      | Adder input (C)                | T7 thru T0 |
|    |     | Yz( " )  | = C( " ) "                        |                                |            |
|    |     | sCz      | = KzQ1F107                        |                                |            |
|    |     | rCz      | = KzQ1                            | Carry logic                    | T7 thru T0 |
|    |     | sCp      | = (C21+C22+C23)CpTsHtQ10603       |                                |            |
|    |     | rCp      | = ( " ) Cp "                      | Check parity                   | T7 thru T0 |
|    |     | Pr3      | = (F1G0)Q2                        |                                |            |
|    |     | sP0      | = (P12+P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |     | rP0      | = ( " ) "                         |                                |            |
|    |     | sP1      | = (P13+P14Ia) "                   |                                |            |
|    |     | rP1      | = ( " ) "                         |                                |            |
|    |     | sP2      | = (P14+Ia) "                      | P + 1 → P                      | T7 thru T3 |
|    |     | rP2      | = ( " ) "                         |                                |            |
|    |     | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |     | rP( " )  | = P( " ) "                        |                                |            |
|    |     | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    |     | rSk      | = A·C(21-23)02(0601030406)05Q1    | Don't skip if A·(M)            | T7 thru T0 |
| T4 | Sc  | Sc       | = T4EndInr                        |                                |            |
|    |     | rS(1-14) | = Sc                              | Clear S                        |            |
| T3 | Sxp | Sxp      | = T3IntEndG0                      |                                |            |
|    |     | sS1      | = (P13+P14Ia)F1G0(02040506)Sxp    |                                |            |
|    |     | rS1      | = ( " ) "                         | P13, P14 contain P1, P2 at T3  |            |
|    |     | sS2      | = (P14+Ia) "                      | P + 1 → S                      |            |
|    |     | rS2      | = ( " ) "                         |                                |            |
|    |     | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |     | rS( " )  | = P( " ) "                        |                                |            |
| Tr | Cxm | Cxm      | = EndG0Tsm(Tr+Tp)                 |                                |            |
|    |     | sC(0-23) | = M(0-23)Cxm                      | M → C (Fetch next instruction) |            |
|    |     | rC( " )  | = TrCxm                           |                                | Tr thru Tp |
|    |     | sHt      | = CpTrKpK002                      | Parity error                   |            |

|    |               |                              |                 |
|----|---------------|------------------------------|-----------------|
|    | rIa           | = TrF1                       |                 |
|    | rIx           | = Tr(F1F3) (GOHt)            |                 |
| Tp | rA00          | = TpEndGO                    |                 |
|    | rB00          | = ( " )                      |                 |
|    | sCp           | = M24C <del>om</del> HitTsTp | Initiate parity |
|    | rF(1,2)       | = TpEndSk                    | 00 next if Sk   |
|    | sF3           | = TpSk                       | 07 next if Sk   |
|    | Oc            | = TpEndSk                    |                 |
|    | sO2           | = Oc                         |                 |
|    | rO(1,3,4,5,6) | = Oc                         | NOP (20) → 0    |

|    |    |               |  |                                |            |
|----|----|---------------|--|--------------------------------|------------|
| Ø7 | T8 | sIa           | = SkØ7T8T <del>1</del> Kr                      | Initiate P register increment  |            |
|    |    | End           | = F1F2   | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                                 |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                               |                                |            |
|    |    | rA( " )       | = $\bar{A}$ ( " ) "                            | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                                   |                                |            |
|    |    | rA( " )       | = $\bar{A}$ ( " ) "                            |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                               |                                |            |
|    |    | rB( " )       | = $\bar{B}$ ( " ) "                            | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                                   |                                |            |
|    |    | rB( " )       | = $\bar{B}$ ( " ) "                            |                                |            |
|    |    | Pr3           | = (F1G0)Q2                                     |                                |            |
|    |    | sP0           | = (P12 <del>P</del> P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |    | rP0           | = ( " ) "                                      |                                |            |
|    |    | sP1           | = (P13 <del>P</del> P14Ia) "                   |                                |            |
|    |    | rP1           | = ( " ) "                                      |                                |            |
|    |    | sP2           | = (P14 <del>P</del> Ia) "                      | P + 1 → P                      | T7 thru T3 |
|    |    | rP2           | = ( " ) "                                      |                                |            |
|    |    | sP(3-14)      | = P(0-11)Pr3                                   |                                |            |
|    |    | rP( " )       | = $\bar{P}$ ( " ) "                            |                                |            |
|    |    | rIa           | = (P12P13P14)Q2F1                              |                                |            |
| T4 |    | Sc            | = T4EndInr                                     | Clear S                        |            |
|    |    | rS(1-14)      | = Sc   |                                |            |
| T3 |    | Sxp           | = T3IntEndGO                                   |                                |            |
|    |    | sS1           | = (P13 <del>P</del> P14Ia)F1G0(02040506)Sxp    | P13, P14 contain P1, P2 at T3  |            |
|    |    | rS1           | = ( " ) "                                      | P + 1 → S                      |            |
|    |    | sS2           | = (P14 <del>P</del> Ia) "                      |                                |            |
|    |    | rS2           | = ( " ) "                                      |                                |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                                   |                                |            |
|    |    | rS( " )       | = $\bar{P}$ ( " ) "                            |                                |            |
| T0 |    | rSk           | = Ø7T0   |                                |            |
|    |    | rCp           | = TsTOHtKØ(F103Ø4Ø6)Ø2                         |                                |            |
| Tr |    | Com           | = EndGOtSm(Tr+Tp)                              | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Com                                   |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCom  |                                |            |
|    |    | rIa           | = TrF1   |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)                               |                                |            |
| Ip |    | rA00          | = TpEndGO                                      |                                |            |
|    |    | rB00          | = ( " )  |                                |            |
|    |    | sCp           | = M24ComHtTsTp                                 | Initiate parity check          |            |
|    |    | rF(1-3)       | = TpEndSk                                      | Ø0 next clock (T8)             |            |
|    |    | Oc            | = ( " )  |                                |            |
|    |    | s02           | = Oc   |                                |            |
|    |    | r0(1,3,4,5,6) | = Oc   | NOP (20) → 0                   |            |

73 SKG Skip if A Greater Than M

A ≤ (M); P + 1 → P 2 Cycles  
 A > (M); P + 2 → P 3 Cycles

|    |    |               |                           |                              |            |
|----|----|---------------|---------------------------|------------------------------|------------|
| 00 | T8 | rCz           | = 00T8                    |                              |            |
|    |    | sIx           | = 00T8C1G0                | Initialize indexing          |            |
|    |    | Oxc           | = (00T8IaG0)C2            |                              |            |
|    |    | sO(1,3,4,5,6) | = C(3,5,6,7,8)Oxc         | Instruction → 0              |            |
|    |    | rO2           | = C4Oxc                   |                              |            |
|    | T7 | Ar3           | = (01020304)Q1            |                              |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3          | Recirculate A                | T7 thru T0 |
|    |    | rA( " )       | = A( " ) "                |                              |            |
|    |    | sA(3-23)      | = A(0-20)Ar3              |                              |            |
|    |    | rA( " )       | = A( " ) "                |                              |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3          | Recirculate B                | T7 thru T0 |
|    |    | rB( " )       | = B( " ) "                |                              |            |
|    |    | sB(3-23)      | = B(0-20)Ar3              |                              |            |
|    |    | rB( " )       | = B( " ) "                |                              |            |
|    |    | Cr3           | = F1F2(TsQ1)              |                              |            |
|    |    | sC(0-2)       | = Add(1-3)00JuTsCr3       | C+X*Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    |    | rC( " )       | = Add( " ) "              |                              |            |
|    |    | sC(3-23)      | = C(0-20)Cr3              | Adder input if Ix (indexing) | T7 thru T0 |
|    |    | rC( " )       | = C( " ) "                | Adder input C register       | T7 thru T0 |
|    |    | Xz(1-3)       | = Xn(1-3)00Ix             | Carry logic                  | T7 thru T1 |
|    |    | Xz( " )       | = Xn( " )00Ix+Ix          | Check parity                 | T7 thru T0 |
|    |    | Yz(1-3)       | = C(21-23)07              | Clear S                      |            |
|    |    | Yz( " )       | = C( " ) "                | C+X*Ix → S                   |            |
|    |    | sCz           | = KzQ1T007                |                              |            |
|    |    | rCz           | = KzQ1                    | M → C (Fetch Operand)        | Tr thru Tp |
|    |    | sCp           | = (C21C22C23)CpTsHtQ1F1F2 | Initiate - A into Xz         |            |
|    |    | rCp           | = ( " )Cp "               | Parity error                 |            |
|    | T4 | Sc            | = T4F1F2Inr               | Initiate parity              |            |
|    |    | rS(1-14)      | = Sc                      | 06 next clock (T8)           |            |
|    | T3 | Sxc           | = T3F1F2Ju                |                              |            |
|    |    | sS(1,2)       | = Add(2,3)Sxc             |                              |            |
|    |    | sS(3-14)      | = C(0-11)Sxc              |                              |            |
|    | T0 | rCz           | = F1T0                    |                              |            |
|    | Tr | Cxm           | = Ju00Tsm(Tr+Tp)          |                              |            |
|    |    | sC(0-23)      | = M(0-23)Cxm              |                              |            |
|    |    | rC( " )       | = TrCxm                   |                              |            |
|    |    | sCz           | = Tr00203                 |                              |            |
|    |    | sHt           | = CpTrK002                |                              |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)          |                              |            |
|    |    | rK0           | = GOTrF2                  |                              |            |
|    | Tp | sCp           | = M24CxmHtTsTp            |                              |            |
|    |    | sF1           | = (TpIa0)0104             |                              |            |
|    |    | sF2           | = ( " )0301               |                              |            |

|    |    |          |                                   |  |            |
|----|----|----------|-----------------------------------|--|------------|
| Ø6 | T8 | sIa      | = T8F1F3I <del>Kr</del>           | Initiate P register increment          |            |
|    |    | End      | = F1F2                            | Last cycle                             |            |
|    | T7 | Ar3      | = (01020304)Q1                    |  |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                  |  |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "          | Recirculate A                          | T7 thru T8 |
|    |    | sA(3-23) | = A(0-20)Ar3                      |  |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "          |  |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |  |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "          | Recirculate B                          | T7 thru T8 |
|    |    | sB(3-23) | = B(0-20)Ar3                      |  |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "          |  |            |
|    |    | Cr3      | = F1F3( $\overline{Ts}$ Q1)       |  |            |
|    |    | sC(0-2)  | = Add(1-3)Ø6TsCr3                 | $\overline{A} + C + 1 \rightarrow C =$ |            |
|    |    | rC( " )  | = Add( " ) "                      | (M) - A → C                            | T7 thru T8 |
|    |    | sC(3-23) | = C(0-20)Cr3                      |  |            |
|    |    | rC( " )  | = $\overline{C}$ ( " ) "          |  |            |
|    |    | Xz(1-3)  | = $\overline{A}$ (21-23)0204Ø6    | Adder input ( $\overline{A}$ )         | T7 thru T8 |
|    |    | Xz( " )  | = A( " ) "                        |  |            |
|    |    | Yz(1-3)  | = C(21-23)Ø7                      | Adder input (C)                        | T7 thru T8 |
|    |    | Yz( " )  | = $\overline{C}$ ( " ) "          |  |            |
|    |    | sCz      | = KzQ1F1Ø7                        | Carry logic                            | T7 thru T8 |
|    |    | rCz      | = $\overline{Kz}$ Q1              |  |            |
|    |    | sCp      | = (C21ØC22ØC23)CpTsHtQ1Ø603       | Check parity                           | T7 thru T8 |
|    |    | rCp      | = ( " ) Cp "                      |  |            |
|    |    | Pr3      | = (F1G0)Q2                        |  |            |
|    |    | sP0      | = (P12ØP13P14Ia)F1G0(Ø2040506)Pr3 |  |            |
|    |    | rP0      | = ( " ) "                         |  |            |
|    |    | sP1      | = (P13ØP14Ia) "                   |  |            |
|    |    | rP1      | = ( " ) "                         |  |            |
|    |    | sP2      | = (P14ØIa) "                      | P + 1 → P                              | T7 thru T8 |
|    |    | rP2      | = ( " ) "                         |  |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |  |            |
|    |    | rP( " )  | = $\overline{P}$ ( " ) "          |  |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |  |            |
|    | T4 | Sc       | = T4EndInr                        | Clear S                                |            |
|    |    | rS(1-14) | = Sc                              |  |            |
|    | T3 | Sxp      | = T3IntEndG0                      |  |            |
|    |    | sS1      | = (P13ØP14Ia)F1G0(Ø2040506)Sxp    | P13, P14 contain P1, P2 at T3          |            |
|    |    | rS1      | = ( " ) "                         | P + 1 → S                              |            |
|    |    | sS2      | = (P14ØIa) "                      |  |            |
|    |    | rS2      | = ( " ) "                         |  |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |  |            |
|    |    | rS( " )  | = $\overline{P}$ ( " ) "          |  |            |
|    | T0 | sIx      | = Ø6T00fe                         | Ix if Overflow                         |            |
|    |    | Ofe      | = Add1Xz1Yz1+Add1Xz1Yz1           |  |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                 | M → C (Fetch next instruction)         | Tr thru T8 |
|    |    | sC(0-23) | = M(0-23)Cxm                      |  |            |
|    |    | rC( " )  | = TrCxm                           |  |            |
|    |    | sHt      | = CpTrKØØ2                        | Parity error                           |            |

|    |               |                       |                   |
|----|---------------|-----------------------|-------------------|
|    | rIa           | = TrF1                |                   |
|    | rIx           | = Tr(F1F3)(GOHt)      |                   |
|    | sSk           | = 0103074050606TrC0Ix | Skip if (M-A<0)⊕f |
| Tp | rA00          | = TpEndGO             |                   |
|    | rB00          | = ( " )               |                   |
|    | sCp           | = M24CxmHtTsTp        | Initiate parity   |
|    | rF(1,2)       | = TpEndSk             | 00 next if Sk     |
|    | sF3           | = TpSk                | 07 next if Sk     |
|    | Oc            | = TpEndSk             |                   |
|    | sO2           | = Oc                  |                   |
|    | rO(1,3,4,5,6) | = Oc                  | NOP(20) → 0       |



|    |               |          |                                  |                                |            |
|----|---------------|----------|----------------------------------|--------------------------------|------------|
| Ø7 | T8            | sIa      | = SkØ7T8T1Kr                     | Initiate P register increment  |            |
|    |               | End      | = F1F2                           | Last cycle                     |            |
| T7 | Ar3           |          | = (Ø1Ø2Ø3Ø4)Q1                   |                                |            |
|    |               | sA(0-2)  | = A(21-23)ArAr3                  |                                |            |
|    |               | rA( " )  | = A( " ) " "                     | Recirculate A                  | T7 thru TØ |
|    |               | sA(3-23) | = A(0-20)Ar3                     |                                |            |
|    |               | rA( " )  | = A( " ) " "                     |                                |            |
|    |               | sB(0-2)  | = B(21-23)BnrAr3                 |                                |            |
|    |               | rB( " )  | = B( " ) " "                     | Recirculate B                  | T7 thru TØ |
|    |               | sB(3-23) | = B(0-20)Ar3                     |                                |            |
|    |               | rB( " )  | = B( " ) " "                     |                                |            |
|    |               | PrS      | = (F1GØ)Q2                       |                                |            |
|    |               | sPØ      | = (P12P13P14Ia)F1GØ(Ø2Ø4Ø5Ø6)Pr3 |                                |            |
|    |               | rPØ      | = ( " ) " "                      |                                |            |
|    |               | sP1      | = (P13P14Ia) " "                 |                                |            |
|    |               | rP1      | = ( " ) " "                      |                                |            |
|    |               | sP2      | = (P14Ia) " "                    | P + 1 → P                      | T7 thru T3 |
|    |               | rP2      | = ( " ) " "                      |                                |            |
|    |               | sP(3-14) | = P(0-11)Pr3                     |                                |            |
|    |               | rP( " )  | = P( " ) " "                     |                                |            |
|    |               | rIa      | = (P12P13P14)Q2F1                |                                |            |
| T4 | Sc            |          | = T4EndInr                       | Clear S                        |            |
|    |               | rS(1-14) | = Sc                             |                                |            |
| T3 | Sxp           |          | = T3IntEndGØ                     |                                |            |
|    |               | sS1      | = (P13P14Ia)F1GØ(Ø2Ø4Ø5Ø6)Sxp    | P13, P14 contain P1, P2 at T3  |            |
|    |               | rS1      | = ( " ) " "                      | P + 1 → S                      |            |
|    |               | sS2      | = (P14Ia) " "                    |                                |            |
|    |               | rS2      | = ( " ) " "                      |                                |            |
|    |               | sS(3-14) | = P(0-11)Sxp                     |                                |            |
|    |               | rS( " )  | = P( " ) " "                     |                                |            |
| TØ | rSk           |          | = Ø7TØ                           |                                |            |
|    | rCp           |          | = TsTØHtKØ(F1Ø3Ø4Ø6)Ø2           |                                |            |
| Tr | Csm           |          | = EndGØTsm(Tr+Tp)                | M → C (Fetch next instruction) |            |
|    |               | sC(0-23) | = M(0-23)Csm                     |                                | Tr thru Tp |
|    |               | rC( " )  | = TrCsm                          |                                |            |
|    |               | rIa      | = TrF1                           |                                |            |
|    |               | rIx      | = Tr(F1F3)(GØHt)                 |                                |            |
| Tp | rAØØ          |          | = TpEndGØ                        |                                |            |
|    | rBØØ          |          | = ( " )                          |                                |            |
|    | sCp           |          | = M24CsmHtTsTp                   | Initiate parity check          |            |
|    | rF(1-3)       |          | = TpEndSk                        | ØØ next clock (T8)             |            |
|    | Oc            |          | = ( " )                          |                                |            |
|    | sØ2           |          | = Oc                             |                                |            |
|    | rØ(1,3,4,5,6) |          | = Oc                             | NØP (2Ø) → Ø                   |            |

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B(15-23) - (M)(15-23) → X(14-23)  
 If X14=0 ;P+1 → P 2 Cycles  
 If X14=1, -X → X;P+2 → P 3 Cycles

|    |    |               |                             |                              |            |
|----|----|---------------|-----------------------------|------------------------------|------------|
| ∅0 | T8 | rCz           | = ∅0T8                      | Initialize carry             |            |
|    |    | sIx           | = ∅0T8C1G0                  | Initialize indexing          |            |
|    |    | Oxc           | = (∅0T8IaG0)C2              |                              |            |
|    |    | sO(1,3,4,5,6) | = C(3,5,6,7,8)Oxc           | Instruction → 0              |            |
|    |    | rO2           | = C4Oxc                     |                              |            |
|    | T7 | Ar3           | = (O1O2O3O4)Q1              |                              |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3            | Recirculate A                | T7 thru T0 |
|    |    | rA( " )       | = A( " ) " "                |                              |            |
|    |    | sA(3-23)      | = A(0-20)Ar3                |                              |            |
|    |    | rA( " )       | = A( " ) " "                | Recirculate B                | T7 thru T0 |
|    |    | sB(0-2)       | = B(21-23)BnrAr3            |                              |            |
|    |    | rB( " )       | = B( " ) " "                |                              |            |
|    |    | sB(3-23)      | = B(0-20)Ar3                |                              |            |
|    |    | rB( " )       | = B( " ) " "                |                              |            |
|    |    | Cr3           | = F1F2(TsQ1)                |                              |            |
|    |    | sC(0-2)       | = Add(1-3)∅0JuTsCr3         | C+X•Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    |    | rC( " )       | = Add( " ) " "              | Adder input if Ix (indexing) | T7 thru T0 |
|    |    | sC(3-23)      | = C(0-20)Cr3                | Adder input C register       | T7 thru T0 |
|    |    | rC( " )       | = C( " ) " "                | Carry for Adder              | T7 thru T1 |
|    |    | Xz(1-3)       | = Xn(1-3)∅0•Ix              | Check parity                 | T7 thru T0 |
|    |    | Xz( " )       | = Xn( " )∅0Ix+Ix            | Clear S                      |            |
|    |    | Yz(1-3)       | = C(21-23)∅7                | C+X•Ix → S                   |            |
|    |    | Yz( " )       | = C( " ) " "                | M → C (Fetch Operand)        | Tr thru Tp |
|    |    | sCz           | = KzQ1T0∅7                  | Initiate - M into Yz         |            |
|    |    | rCz           | = KzQ1                      | Parity error                 |            |
|    |    | sCp           | = (C21+C22+C23)CpTsHtQ1F1F2 | Initiate parity              |            |
|    |    | rCp           | = ( " )Cp " "               | ∅6 next clock (T8)           |            |
|    | T4 | Sc            | = T4F1F2Inr                 |                              |            |
|    |    | rS(1-14)      | = Sc                        |                              |            |
|    | T3 | Sxc           | = T3F1F2Ju                  |                              |            |
|    |    | sS(1,2)       | = Add(2,3)Sxc               |                              |            |
|    |    | sS(3-14)      | = C(0-11)Sxc                |                              |            |
|    | T0 | rCz           | = F1T0                      |                              |            |
|    | Tr | Cxm           | = Ju∅0Tsm(Tr+Tp)            |                              |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                |                              |            |
|    |    | rC( " )       | = TrCxm                     |                              |            |
|    |    | sCz           | = (Tr∅0)O4O5O6              |                              |            |
|    |    | sHt           | = CpTrKpK0∅2                |                              |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)            |                              |            |
|    |    | rK0           | = GOTrF2                    |                              |            |
|    | Tp | sCp           | = M24CxmHtTsTp              |                              |            |
|    |    | sF1           | = (TpIa∅0)O3O4              |                              |            |
|    |    | sF2           | = ( " )O3O1                 |                              |            |

|    |    |          |                                     |  |            |
|----|----|----------|-------------------------------------|--|------------|
| ø6 | T8 | Ck       | = 010203040506ø6T8Ts                |  |            |
|    |    | sC(0-23) | = C(0-23) Ck                        | $\overline{C} \rightarrow C$           |            |
|    |    | rC( " )  | = C( " ) "                          |  |            |
|    |    | sIa      | = T8F1F3Tjkr                        | Initiate P register increment          |            |
|    |    | End      | = F1F2                              | Last cycle                             |            |
|    |    | Xnr      | = ø6010203040506                    |  |            |
| T7 |    | Ar3      | = (01020304)Q1                      |  |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                    |  |            |
|    |    | rA( " )  | = A( " ) "                          | Recirculate A                          | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                        |  |            |
|    |    | rA( " )  | = A( " ) "                          |  |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                    |  |            |
|    |    | rB( " )  | = B( " ) "                          | Recirculate B                          | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                        |  |            |
|    |    | rB( " )  | = B( " ) "                          |  |            |
|    |    | Cr3      | = F1F3(TsQ1)                        |  |            |
|    |    | sC(0-2)  | = Add(1-3)ø6TsCr3                   | $B + \overline{C} + 1 \rightarrow C =$ | T7 thru T0 |
|    |    | rC( " )  | = Add( " ) "                        | $B - (M) \rightarrow C$                |            |
|    |    | sC(3-23) | = C(0-20)Cr3                        |  |            |
|    |    | rC( " )  | = C( " ) "                          |  |            |
|    |    | Xz(1-3)  | = B(21-23)ø60204                    | Adder input (B)                        | T7 thru T0 |
|    |    | Xz( " )  | = B( " ) "                          |  |            |
|    |    | Yz(1-3)  | = C(21-23)ø7                        | Adder input ( $\overline{C}$ )         | T7 thru T0 |
|    |    | Yz( " )  | = C( " ) "                          |  |            |
|    |    | sCz      | = KzQ1F1ø7                          | Carry logic                            | T7 thru T0 |
|    |    | rCz      | = KzQ1                              |  |            |
|    |    | sCp      | = (C21⊕C22⊕C23) CpTsHtQ1ø603        | Check parity                           | T7 thru T0 |
|    |    | rCp      | = ( " ) Cp "                        |  |            |
|    |    | Pr3      | = (F1G0)Q2                          |  |            |
|    |    | sP0      | = (P12⊕P13P14Ia) F1G0(02040506) Pr3 |  |            |
|    |    | rP0      | = ( " ) "                           |  |            |
|    |    | sP1      | = (P13⊕P14Ia) "                     |  |            |
|    |    | rP1      | = ( " ) "                           |  |            |
|    |    | sP2      | = (P14⊕Ia) "                        | $P + 1 \rightarrow P$                  | T7 thru T3 |
|    |    | rP2      | = ( " ) "                           |  |            |
|    |    | sP(3-14) | = P(0-11) Pr3                       |  |            |
|    |    | rP( " )  | = P( " ) "                          |  |            |
|    |    | rIa      | = (P12P13P14)Q2F1                   |  |            |
|    |    | sXw(1-3) | = Add(1-3)ø6010203040506F1          | $B - (M) \rightarrow X$                | T7 thru T0 |
|    |    | rXw( " ) | = Add( " ) "                        |  |            |
| T5 |    | sIx      | = ø6ø6T50fe                         | Overflow of X15 into X14               |            |
|    |    | Ofe      | = Add1Xz1Yz1+Add1Xz1Yz1             |  |            |
| T4 |    | Sc       | = T4EndInr                          | Clear S                                |            |
|    |    | rS(1-14) | = Sc                                | Sk if X14 ⊕ Of                         |            |
|    |    | sSk      | = ø6010203040506T4(C0⊕Ix)           |  |            |
| T3 |    | Sxp      | = T3IntEndG0                        |  |            |
|    |    | sS1      | = (P13⊕P14Ia) F1G0(02040506) Sxp    | P13, P14 contain P1, P2 at T3          |            |
|    |    | rS1      | = ( " ) "                           | $P + 1 \rightarrow S$                  |            |
|    |    | sS2      | = (P14⊕Ia) "                        |  |            |
|    |    | rS2      | = ( " ) "                           |  |            |

|    |               |   |  |
|----|---------------|---|--|
|    | sS(3-14)      | = P(0-11)Sxp  |  |
|    | rS( " )       | = $\overline{P}$ ( " ) "                                  |  |
| Tr | Cxm           | = EndGO $\overline{Tsm}$ (Tr+Tp)                          |  |
|    | sC(0-23)      | = M(0-23)Cxm  | M → C (Fetch next instruction)         |
|    | rC( " )       | = TrCxm   | Tr thru Tp                             |
|    | sHt           | = CpTr( $\overline{Kp}$ ) $\overline{K0}$ $\overline{02}$ | Parity error                           |
|    | rIa           | = TrF1  |  |
|    | rIx           | = Tr( $\overline{F1F3}$ )( $\overline{GOHt}$ )            |  |
| Tp | rA00          | = TpEndGO   |  |
|    | rB00          | = ( " )   |  |
|    | sCp           | = M24Cxm $\overline{Ht}$ $\overline{T}$ sTp               | Initiate parity                        |
|    | rF(1,2)       | = TpEnd $\overline{Sk}$                                   | $\overline{0}$ next if $\overline{Sk}$ |
|    | sF3           | = TpSk  | $\overline{07}$ next if Sk             |
|    | Oc            | = TpEnd $\overline{Sk}$                                   |  |
|    | sO2           | = Oc  |  |
|    | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                           |

|               |    |                                     |  |  |            |
|---------------|----|-------------------------------------|--|--|------------|
| $\emptyset 7$ | T8 | End                                 | = F1F2   | Last cycle                                       |            |
|               |    | sHz                                 | = T8   | Initiate - X $\rightarrow$ X                     |            |
|               |    | sIa                                 | = T8Sk $\emptyset 7$ (IjKr)  | Initiate P register increment                    |            |
|               |    | Xnr                                 | = 03040506 $\emptyset 7$   |  |            |
|               | T7 | Ar3                                 | = (01020304)Q1   |  |            |
|               |    | sA(0-2)                             | = A(21-23) $\overline{\text{Ar}}\text{Ar3}$                                |  |            |
|               |    | rA( " )                             | = $\overline{\text{A}}$ ( " ) "  | Recirculate A                                    | T7 thru T0 |
|               |    | sA(3-23)                            | = A(0-20)Ar3   |  |            |
|               |    | rA( " )                             | = $\overline{\text{A}}$ ( " ) "  |  |            |
|               |    | sB(0-2)                             | = B(21-23) $\overline{\text{Bnr}}\text{Ar3}$                               |  |            |
|               |    | rB( " )                             | = $\overline{\text{B}}$ ( " ) "  | Recirculate B                                    | T7 thru T0 |
|               |    | sB(3-23)                            | = B(0-20)Ar3   |  |            |
|               |    | rB( " )                             | = $\overline{\text{B}}$ ( " ) "  |  |            |
|               |    | Pr3                                 | = (F1G0)Q2   |  |            |
|               |    | sP0                                 | = (P12 $\oplus$ P13P14Ia)F1G0(02040506)Pr3                                 |  |            |
|               |    | rP0                                 | = ( " ) "  |  |            |
|               |    | sP1                                 | = (P13 $\oplus$ P14Ia) "   |  |            |
|               |    | rP1                                 | = ( " ) "  |  |            |
|               |    | sP2                                 | = (P14 $\oplus$ Ia) "  | P + 1 $\rightarrow$ P                            | T7 thru T3 |
|               |    | rP2                                 | = ( " ) "  |  |            |
|               |    | sP(3-14)                            | = P(0-11)Pr3   |  |            |
|               |    | rP( " )                             | = $\overline{\text{P}}$ ( " ) "  |  |            |
|               |    | rIa                                 | = (P12P13P14)Q2F1  |  |            |
|               |    | sXw(1-3)                            | = Ha(1-3)03040506 $\emptyset 7$ Ts   | $\overline{\text{X}} + 1 \rightarrow \text{X} =$ |            |
|               |    | rXw( " )                            | = $\overline{\text{H}}\text{a}$ ( " ) "                                    | - X $\rightarrow$ X                              | T7 thru T0 |
|               |    | Hx(1-3)                             | = $\overline{\text{X}}\text{n}$ (1-3)03                                    |  |            |
|               |    | $\overline{\text{H}}\text{x}$ ( " ) | = $\overline{\text{X}}\text{n}$ ( " ) "                                    |  |            |
|               | T4 | Sc                                  | = T4EndInr   |  |            |
|               |    | rS(1-14)                            | = Sc   | Clear S  |            |
|               | T3 | Sxp                                 | = T3 $\overline{\text{Int}}\text{EndGO}$                                   |  |            |
|               |    | sS1                                 | = (P13 $\oplus$ P14Ia)F1G0(02040506)Sxp                                    |  |            |
|               |    | rS1                                 | = ( " ) "  | P13, P14 contain P1, P2 at T3                    |            |
|               |    | sS2                                 | = (P14 $\oplus$ Ia) "  | P + 1 $\rightarrow$ S                            |            |
|               |    | rS2                                 | = ( " ) "  |  |            |
|               |    | sS(3-14)                            | = P(0-11)Sxp   |  |            |
|               |    | rS( " )                             | = $\overline{\text{P}}$ ( " ) "  |  |            |
|               | T0 | rCp                                 | = $\overline{\text{Ts}}\text{TOHtKO}(F103\overline{0406})\emptyset 2$      |  |            |
|               |    | rSk                                 | = $\emptyset 7$ T0   |  |            |
|               | Tr | Cxm                                 | = EndGO $\overline{\text{Tsm}}(\text{Tr}+\text{Tp})$                       |  |            |
|               |    | sC(0-23)                            | = M(0-23)Cxm   | M $\rightarrow$ C (Fetch next instruction)       |            |
|               |    | rC( " )                             | = TrCxm  |  | Tr thru Tp |
|               |    | rIa                                 | = TrF1   |  |            |
|               |    | rIx                                 | = Tr( $\overline{\text{F}}\text{IF3}$ )( $\overline{\text{GO}}\text{Ht}$ ) |  |            |
|               | Tp | rA00                                | = TpEndGO  |  |            |
|               |    | rB00                                | = ( " )  |  |            |
|               |    | sCp                                 | = M24Cxm $\overline{\text{Ht}}\overline{\text{Ts}}\text{Tp}$               | Parity error                                     |            |
|               |    | rF(1-3)                             | = TpEndSk  | $\emptyset 0$ next clock (T8)                    |            |
|               |    | Oc                                  | = ( " )  |  |            |
|               |    | sO2                                 | = Oc   |  |            |
|               |    | rO(1,3,4,5,6)                       | = Oc   | NOP (20) $\rightarrow$ 0                         |            |

| 75 | LDB | Load B        | (M) → B                     | 2 Cycles                     |
|----|-----|---------------|-----------------------------|------------------------------|
| 00 | T8  | rCz           | = 00T8                      | Initialize carry             |
|    |     | sIx           | = 00T8C1G0                  | Initialize indexing          |
|    |     | Oxc           | = (00T8IaG0)C2              |                              |
|    |     | sO(1,3,4,5,6) | = C(3,5,6,7,8)Oxc           | Instruction → 0              |
|    |     | rO2           | = C4Oxc                     |                              |
| T7 |     | Ar3           | = (01020304)Q1              |                              |
|    |     | sA(0-2)       | = A(21-23)AnrAr3            |                              |
|    |     | rA( " )       | = A( " ) " "                | Recirculate A                |
|    |     | sA(3-23)      | = A(0-20)Ar3                |                              |
|    |     | rA( " )       | = A( " ) " "                |                              |
|    |     | sB(0-2)       | = B(21-23)BnrAr3            |                              |
|    |     | rB( " )       | = B( " ) " "                | Recirculate B                |
|    |     | sB(3-23)      | = B(0-20)Ar3                |                              |
|    |     | rB( " )       | = B( " ) " "                |                              |
|    |     | Cr3           | = F1F2(TsQ1)                |                              |
|    |     | sC(0-2)       | = Add(1-3)00JuTsCr3         |                              |
|    |     | rC( " )       | = Add( " ) " "              | C+X•Ix → C (Add=Xz+Yz)       |
|    |     | sC(3-23)      | = C(0-20)Cr3                |                              |
|    |     | rC( " )       | = C( " ) " "                |                              |
|    |     | Xz(1-3)       | = Xn(1-3)00•Ix              | Adder input if Ix (indexing) |
|    |     | Xz( " )       | = Xn( " )00Ix+Ix            |                              |
|    |     | Yz(1-3)       | = C(21-23)07                | Adder input (C)              |
|    |     | Yz( " )       | = C( " ) " "                |                              |
|    |     | sCz           | = KzQ1T007                  | Carry for Adder              |
|    |     | rCz           | = KzQ1                      |                              |
|    |     | sCp           | = (C2K0C220C23)CpTsHtQ1F1F2 | Check parity                 |
|    |     | rCp           | = ( " )Cp " "               |                              |
| T4 |     | Sc            | = T4F1F2Inr                 | Clear S                      |
|    |     | rS(1-14)      | = Sc                        |                              |
| T3 |     | Sxc           | = T3F1F2Ju                  |                              |
|    |     | sS(1,2)       | = Add(2,3)Sxc               |                              |
|    |     | sS(3-14)      | = C(0-11)Sxc                | C+X•Ix → S                   |
| T0 |     | rCz           | = F1T0                      |                              |
| Tr |     | Cxm           | = Ju00Tsm(Tr+Tp)            | M → C (Fetch Operand)        |
|    |     | sC(0-23)      | = M(0-23)Cxm                |                              |
|    |     | rC( " )       | = TrCxm                     |                              |
|    |     | sCz           | = (Tr00)0203                | Parity error                 |
|    |     | sHt           | = CpTrK0K002                |                              |
|    |     | rIx           | = Tr(F1F3)(G0Ht)            |                              |
|    |     | rK0           | = G0TrF2                    |                              |
| Tp |     | sCp           | = M24CxmHtTsTp              | Initiate parity              |
|    |     | sF1           | = (TpIa00)0304              |                              |
|    |     | sF2           | = ( " )0301                 | 06 next clock (T8)           |

|    |    |          |                                   |  |                                |
|----|----|----------|-----------------------------------|--|--------------------------------|
| 06 | T8 | Bnr      | = 01020304050606                  |  |                                |
|    |    | sIa      | = T8F1F3(06)                      |  | Initiate P register increment  |
|    |    | End      | = F1F2                            |  | Last cycle                     |
|    | T7 | Ar3      | = (01020304)Q1                    |  |                                |
|    |    | sA(0-2)  | = A(21-23)ArAr3                   |  |                                |
|    |    | rA( " )  | = A( " ) " "                      |  | Recirculate A                  |
|    |    | sA(3-23) | = A(0-20)Ar3                      |  | T7 thru T0                     |
|    |    | rA( " )  | = A( " ) " "                      |  |                                |
|    |    | sB(0-2)  | = 010203040506Ar306C(21-23)       |  |                                |
|    |    | rB( " )  | = " " " C( " )                    |  | (M) → B                        |
|    |    | sB(3-23) | = B(0-20)Ar3                      |  | T7 thru T0                     |
|    |    | rB( " )  | = B( " ) " "                      |  |                                |
|    |    | Cr3      | = F1F3(TsQ1)                      |  |                                |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                 |  |                                |
|    |    | rC( " )  | = Add( " ) " "                    |  | B + C → C                      |
|    |    | sC(3-23) | = C(0-20)Cr3                      |  | T7 thru T0                     |
|    |    | rC( " )  | = C( " ) " "                      |  |                                |
|    |    | Xz(1-3)  | = B(21-23)060204                  |  |                                |
|    |    | Xz( " )  | = B( " ) " "                      |  | Unused adder inputs            |
|    |    | Yz(1-3)  | = C(21-23)07                      |  | T7 thru T0                     |
|    |    | Yz( " )  | = C( " ) " "                      |  |                                |
|    |    | sCz      | = KzQ1F107                        |  | Carry logic                    |
|    |    | rCz      | = KzQ1                            |  | T7 thru T0                     |
|    |    | sCp      | = (C210C220C23)CpTsHtQ10603       |  | Check parity                   |
|    |    | rCp      | = ( " ) Cp " "                    |  | T7 thru T0                     |
|    |    | Pr3      | = (F1G0)Q2                        |  |                                |
|    |    | sP0      | = (P120P13P14Ia)F1G0(02040506)Pr3 |  |                                |
|    |    | rP0      | = ( " ) " "                       |  |                                |
|    |    | sP1      | = (P130P14Ia) " "                 |  |                                |
|    |    | rP1      | = ( " ) " "                       |  |                                |
|    |    | sP2      | = (P140Ia) " "                    |  | P + 1 → P                      |
|    |    | rP2      | = ( " ) " "                       |  | T7 thru T3                     |
|    |    | sP(3-14) | = P(0-11)Pr3                      |  |                                |
|    |    | rP( " )  | = P( " ) " "                      |  |                                |
|    |    | rIa      | = (P12P13P14)Q2F1                 |  |                                |
|    | T4 | Sc       | = T4EndInr                        |  | Clear S                        |
|    |    | rS(1-14) | = Sc                              |  |                                |
|    | T3 | Sxp      | = T3IntEndG0                      |  |                                |
|    |    | sS1      | = (P130P14Ia)F1G0(02040506)Sxp    |  |                                |
|    |    | rS1      | = ( " ) " "                       |  |                                |
|    |    | sS2      | = (P140Ia) " "                    |  | P + 1 → S                      |
|    |    | rS2      | = ( " ) " "                       |  |                                |
|    |    | sS(3-14) | = P(0-11)Sxp                      |  |                                |
|    |    | rS( " )  | = P( " ) " "                      |  |                                |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                 |  | M → C (Fetch next instruction) |
|    |    | sC(0-23) | = M(0-23)Cxm                      |  | Tr thru Tp                     |
|    |    | rC( " )  | = TrCxm                           |  |                                |
|    |    | sHt      | = CpTr(0002)                      |  | Parity error                   |

|    |               |                  |                    |
|----|---------------|------------------|--------------------|
|    | rLa           | = TrF1           |                    |
|    | rIx           | = Tr(F1F3)(GOHt) |                    |
| Tp | rA00          | = TpEndGO        |                    |
|    | rB00          | = ( " )          |                    |
|    | sCp           | = M24CxmHtTsTp   | Initiate parity    |
|    | rF(1,2)       | = TpEndSk        | ∅0 next clock (T8) |
|    | Oc            | = ( " )          |                    |
|    | sO2           | = Oc             |                    |
|    | rO(1,3,4,5,6) | = Oc             | NOP (20) → 0       |



| 76 | LDA      | Load A                          | (M) → A                      | 2 Cycles   |
|----|----------|---------------------------------|------------------------------|------------|
| 00 | T8       | rCz = 00T8                      | Initialize carry             |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing          |            |
|    |          | Oxc = (00T8IaG0)C2              |                              |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0              |            |
|    |          | rO2 = C4Oxc                     |                              |            |
| T7 | Ar3      | = (01020304)Q1                  |                              |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                              |            |
|    | rA( " )  | = A( " ) " "                    | Recirculate A                | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                              |            |
|    | rA( " )  | = A( " ) " "                    |                              |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                              |            |
|    | rB( " )  | = B( " ) " "                    | Recirculate B                | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                              |            |
|    | rB( " )  | = B( " ) " "                    |                              |            |
|    | Cr3      | = F1F2(TsQ1)                    |                              |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             |                              |            |
|    | rC( " )  | = Add( " ) " "                  | C+X•Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                              |            |
|    | rC( " )  | = C( " ) " "                    |                              |            |
|    | Xz(1-3)  | = Xn(1-3)00•Ix                  | Adder input if Ix (indexing) |            |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                              | T7 thru T0 |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input (C)              | T7 thru T0 |
|    | Yz( " )  | = C( " ) " "                    |                              |            |
|    | sCz      | = KzQ1T007                      | Carry for Adder              | T7 thru T1 |
|    | rCz      | = KzQ1                          |                              |            |
|    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2     | Check parity                 | T7 thru T0 |
|    | rCp      | = ( " )Cp " "                   |                              |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                      |            |
|    | rS(1-14) | = Sc                            |                              |            |
| T3 | Sxc      | = T3F1F2Ju                      |                              |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   | C+X•Ix → S                   |            |
|    | sS(3-14) | = C(0-11)Sxc                    |                              |            |
| T0 | rCz      | = F1T0                          |                              |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch Operand)        | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                              |            |
|    | rC( " )  | = TrCxm                         |                              |            |
|    | sCz      | = (Tr00)0203                    | Parity error                 |            |
|    | sHt      | = CpTrKpK002                    |                              |            |
|    | rIx      | = Tr(F1F3)(G0Ht)                |                              |            |
|    | rK0      | = G0TrF2                        |                              |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity              |            |
|    | sF1      | = (TpIa00)0304                  | 06 next clock (T8)           |            |
|    | sF2      | = ( " )0301                     |                              |            |

|    |    |          |                                   |                                |            |
|----|----|----------|-----------------------------------|--------------------------------|------------|
| 06 | T8 | Anr      | = 01020304050606                  |                                |            |
|    |    | sIa      | = T8F1F31K1                       | Initiate P register increment  |            |
|    |    | End      | = F1F2                            | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                    |                                |            |
|    |    | sA(0-2)  | = C(21-23)01020304050606          |                                |            |
|    |    | rA( " )  | = C( " ) " "                      | (M) → A                        | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |    | rA( " )  | = A( " ) " "                      |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |    | rB( " )  | = B( " ) " "                      | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |    | rB( " )  | = B( " ) " "                      |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                 |                                |            |
|    |    | rC( " )  | = Add( " ) " "                    | A + C → C                      | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |    | rC( " )  | = C( " ) " "                      |                                |            |
|    |    | Xz(1-3)  | = B(21-23)060204                  |                                |            |
|    |    | Xz( " )  | = B( " ) " "                      | Unused adder inputs            | T7 thru T0 |
|    |    | Yz(1-3)  | = C(21-23)07                      |                                |            |
|    |    | Yz( " )  | = C( " ) " "                      |                                |            |
|    |    | sCz      | = KzQ1F107                        |                                |            |
|    |    | rCz      | = KzQ1                            | Carry logic                    | T7 thru T0 |
|    |    | sCp      | = (C210C220C23)CpTsHtQ10603       |                                |            |
|    |    | rCp      | = ( " )Cp " "                     | Check parity                   | T7 thru T0 |
|    |    | Pr3      | = (F1G0)Q2                        |                                |            |
|    |    | sP0      | = (P120P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |    | rP0      | = ( " ) " "                       |                                |            |
|    |    | sP1      | = (P130P14Ia) " "                 |                                |            |
|    |    | rP1      | = ( " ) " "                       |                                |            |
|    |    | sP2      | = (P140Ia) " "                    | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) " "                       |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |    | rP( " )  | = P( " ) " "                      |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    | T4 | Sc       | = T4EndInr                        |                                |            |
|    |    | rS(1-14) | = Sc                              | Clear S                        |            |
|    | T3 | Sxp      | = T3IntEndG0                      |                                |            |
|    |    | sS1      | = (P130P14Ia)F1G0(02040506)Sxp    |                                |            |
|    |    | rS1      | = ( " ) " "                       |                                |            |
|    |    | sS2      | = (P140Ia) " "                    | P + 1 → S                      |            |
|    |    | rS2      | = ( " ) " "                       |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |    | rS( " )  | = P( " ) " "                      |                                |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                 |                                |            |
|    |    | sC(0-23) | = M(0-23)Cxm                      | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | rC( " )  | = TrCxm                           |                                |            |
|    |    | sHt      | = CpTr0K002                       | Parity error                   |            |

|    |               |                   |                    |
|----|---------------|-------------------|--------------------|
|    | rIa           | = TrF1            |                    |
|    | rIx           | = Tr(F1F3) (GOHt) |                    |
| Tp | rA00          | = TpEndGO         |                    |
|    | rB00          | = ( " )           |                    |
|    | sCp           | = M24CmHtTsTp     | Initiate parity    |
|    | rF(1,2)       | = TpEndSk         | 00 next clock (T8) |
|    | Oc            | = ( " )           |                    |
|    | sO2           | = Oc              |                    |
|    | rO(1,3,4,5,6) | = Oc              | NOP (20) → 0       |

|    |          |  |                                |            |
|----|----------|--|--------------------------------|------------|
| 77 | EAX      | Effective Address to X                                       | M → X                          | 2 Cycles   |
| 00 | T8       | rCz = 00T8   |                                |            |
|    |          | sEax = (00T8 $\overline{1aGO}$ )C3C4C5C6C7C8 $\overline{C9}$ |                                |            |
|    |          | sIx = 00T8C1G0   | Initialize indexing            |            |
|    |          | Oxc = (00T8 $\overline{1aGO}$ ) $\overline{C2}$              |                                |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc                              | Instruction ↔ 0                |            |
|    |          | rO2 = $\overline{C4Oxc}$                                     |                                |            |
| T7 | Ar3      | = (01020304)Q1   |                                |            |
|    | sA(0-2)  | = A(21-23)AnrAr3   |                                |            |
|    | rA( " )  | = $\overline{A( " )}$ " "                                    | Recirculate A                  | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3   |                                |            |
|    | rA( " )  | = $\overline{A( " )}$ " "                                    |                                |            |
|    | sB(0-2)  | = B(21-23)BnrAr3   |                                |            |
|    | rB( " )  | = $\overline{B( " )}$ " "                                    | Recirculate B                  | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3   |                                |            |
|    | rB( " )  | = $\overline{B( " )}$ " "                                    |                                |            |
|    | Cr3      | = F1F2(TsQ1)   |                                |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3  |                                |            |
|    | rC( " )  | = $\overline{Add( " )}$ " "                                  | C + X · Ix → C (Add = Xz + Yz) | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3   |                                |            |
|    | rC( " )  | = $\overline{C( " )}$ " "                                    |                                |            |
|    | Xz(1-3)  | = Xn(1-3)00 · Ix   |                                |            |
|    | Xz( " )  | = $\overline{Xn( " )}$ 00Ix + Ix                             | Adder input (XIx)              | T7 thru T0 |
|    | Yz(1-3)  | = C(21-23)07   |                                |            |
|    | Yz( " )  | = $\overline{C( " )}$ " "                                    | Adder input (C)                | T7 thru T0 |
|    | sCz      | = KzQ1T007   |                                |            |
|    | rCz      | = $\overline{KzQ1}$  | Carry logic                    | T7 thru T1 |
|    | sCp      | = (C21 ⊕ C22 ⊕ C23) Cp Ts Ht Q1 F1 F2                        |                                |            |
|    | rCp      | = ( " ) Cp " "   | Check parity                   | T7 thru T0 |
|    | Xnr      | = EaxJu  |                                |            |
|    | sX(0-2)  | = ( " )Add(1-3)Q6  |                                |            |
|    | rX( " )  | = ( " ) $\overline{Add( " )}$ " "                            | C + X · Ix → X                 | T7 thru T3 |
| T4 | Sc       | = T4F1F2Inr  |                                |            |
|    | rS(1-14) | = Sc   | Clear S                        |            |
| T3 | rEax     | = JuT3   |                                |            |
|    | Sxc      | = T3F1F2Ju   |                                |            |
|    | sS(1,2)  | = Add(2,3)Sxc  |                                |            |
|    | sS(3-14) | = C(0-11)Sxc   | C + X · Ix → S                 |            |
|    | sXw1     | = EaxQ6Xn1   |                                |            |
|    | rXw1     | = $\overline{EaxQ6Xn1}$                                      | Recirculate X10                |            |
| T2 | sXw(1-3) | = Xn(1-3)Xnr   |                                |            |
|    | rXw( " ) | = $\overline{Xn( " )}$ " "                                   | Recirculate X                  | T2 on      |
| T0 | rCz      | = F1T0   |                                |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)   |                                |            |
|    | sC(0-23) | = M(0-23)Cxm   | M → C (Fetch operand)          | Tr thru Tp |
|    | rC( " )  | = TrCxm  |                                |            |
|    | sCz      | = (Tr00)0203   |                                |            |

|    |     |                                  |                    |
|----|-----|----------------------------------|--------------------|
|    | sHt | = CpT $\overline{\text{KpK002}}$ | Parity error       |
|    | rIx | = Tr(F1F3) (G0Ht)                |                    |
|    | rK0 | = G0Tr                           |                    |
| Tp | sCp | = M24CxmHtTsTp                   | Initiate parity    |
|    | sF1 | = (TpIa0)0304                    |                    |
|    | sF2 | = ( " )0301                      | 06 next clock (T8) |

|    |    |          |                                   |                                |            |
|----|----|----------|-----------------------------------|--------------------------------|------------|
| 06 | T8 | sIa      | = T8F1F31 <del>Q</del> Cr         | Initiate P register increment  |            |
|    |    | End      | = F1F2                            | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                    |                                |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                  |                                |            |
|    |    | rA( " )  | = $\bar{A}$ ( " ) " "             | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |    | rA( " )  | = $\bar{A}$ ( " ) " "             |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |    | rB( " )  | = $\bar{B}$ ( " ) " "             | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |    | rB( " )  | = $\bar{B}$ ( " ) " "             |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                 | A + C → C                      | T7 thru T0 |
|    |    | rC( " )  | = $\bar{Add}$ ( " ) " "           |                                |            |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |    | rC( " )  | = $\bar{C}$ ( " ) " "             |                                |            |
|    |    | Xz(1-3)  | = A(21-23)060204                  |                                |            |
|    |    | Xz( " )  | = $\bar{A}$ ( " ) " "             | Unused adder inputs            | T7 thru T0 |
|    |    | Yz(1-3)  | = C(21-23)07                      |                                |            |
|    |    | Yz( " )  | = $\bar{C}$ ( " ) " "             |                                |            |
|    |    | sCz      | = KzQ1F107                        | Carry logic                    | T7 thru T0 |
|    |    | rCz      | = KzQ1                            |                                |            |
|    |    | sCp      | = (C210C220C23)CpTsHtQ10603       | Check parity                   | T7 thru T0 |
|    |    | rCp      | = ( " ) Cp " "                    |                                |            |
|    |    | Pr3      | = (F1G0)Q2                        |                                |            |
|    |    | sP0      | = (P120P13P14La)F1G0(02040506)Pr3 |                                |            |
|    |    | rP0      | = ( " ) " "                       |                                |            |
|    |    | sP1      | = (P130P14La) " "                 |                                |            |
|    |    | rP1      | = ( " ) " "                       |                                |            |
|    |    | sP2      | = (P140La) " "                    | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) " "                       |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |    | rP( " )  | = $\bar{P}$ ( " ) " "             |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    | T4 | Sc       | = T4EndInr                        | Clear S                        |            |
|    |    | rS(1-14) | = Sc                              |                                |            |
|    | T3 | Sxp      | = T3IntEndG0                      |                                |            |
|    |    | sS1      | = (P130P14La)F1G0(02040506)Sxp    |                                |            |
|    |    | rS1      | = ( " ) " "                       | P + 1 → S                      |            |
|    |    | sS2      | = (P140La) " "                    |                                |            |
|    |    | rS2      | = ( " ) " "                       |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |    | rS( " )  | = $\bar{P}$ ( " ) " "             |                                |            |
|    | Tr | Cxm      | = EndG0Tam(Tr+Tp)                 | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23) | = M(0-23)Cxm                      |                                |            |
|    |    | rC( " )  | = TrCxm                           |                                |            |
|    |    | sHt      | = CpTr0602                        | Parity error                   |            |

|    |               |                   |                    |
|----|---------------|-------------------|--------------------|
|    | rIa           | = TrF1            |                    |
|    | rIx           | = Tr(F1F3) (GOht) |                    |
| Tp | rA00          | = TpEndGO         |                    |
|    | rB00          | = ( " )           |                    |
|    | sCp           | = M24ComHtTsTp    | Initiate parity    |
|    | rF(1,2)       | = TpEndSk         | 00 next clock (T8) |
|    | Oc            | = ( " )           |                    |
|    | sO2           | = Oc              |                    |
|    | rO(1,3,4,5,6) | = Oc              | NOP (20) → 0       |

Programmed Operator (C2)

P → Location 0  
C(2-8) → P

2 Cycles

|    |         |                      |   |                                      |            |
|----|---------|----------------------|---|--------------------------------------|------------|
| ∅0 | T8      | rCz                  | = ∅0T8  |                                      |            |
|    |         | sEax                 | = $\overline{IaGOC2\emptyset0T8}$                 |                                      |            |
|    |         | sJu                  | = "   |                                      |            |
| T7 | Ar3     |                      | = $(\overline{01020304})Q1$                       |                                      |            |
|    |         | sA(0-2)              | = $A(21-23)\overline{AnrAr3}$                     |                                      |            |
|    |         | rA( " )              | = $\overline{A( " ) "}$                           | Recirculate A                        | T7 thru T0 |
|    |         | sA(3-23)             | = $A(0-20)Ar3$                                    |                                      |            |
|    |         | rA( " )              | = $\overline{A( " ) "}$                           |                                      |            |
|    |         | sB(0-2)              | = $B(21-23)\overline{BnrAr3}$                     |                                      |            |
|    |         | rB( " )              | = $\overline{B( " ) "}$                           | Recirculate B                        | T7 thru T0 |
|    |         | sB(3-23)             | = $B(0-20)Ar3$                                    |                                      |            |
|    |         | rB( " )              | = $\overline{B( " ) "}$                           |                                      |            |
|    |         | Cr3                  | = $\overline{FlF2TsQ1}$                           |                                      |            |
|    |         | sC0                  | = $(P12)Ju\overline{TsCr3Q6}$                     |                                      |            |
|    |         | rC0                  | = $(\overline{P12}) " "$                          |                                      |            |
|    |         | sC(1,2)              | = $P(13,14)Ju\overline{TsCr3Q2}$                  | P(1-14) → C(10-23)                   | T7 thru T3 |
|    |         | rC( " )              | = $\overline{P( " ) "}$                           |                                      |            |
|    |         | sC(3-23)             | = $C(0-20)Cr3$                                    |                                      |            |
|    |         | rC( " )              | = $\overline{C( " ) "}$                           |                                      |            |
|    |         | $\overline{Xz}(1-3)$ | = $\overline{Ix}$                                 |                                      |            |
|    |         | Yz(1-3)              | = $C(21-23)\overline{\emptyset7}$                 | Adder input (C)                      |            |
|    |         | $\overline{Yz}( " )$ | = $\overline{C( " ) "}$                           |                                      |            |
|    |         | sCz                  | = $Kz\overline{\emptyset7Q1T0}$                   | Carry logic                          | T7 thru T1 |
|    |         | rCz                  | = $\overline{KzQ1}$                               |                                      |            |
|    |         | sCp                  | = $(C21\overline{C22}C23)\overline{CpTsHtFlF2Q1}$ | Check parity                         | T7 thru T0 |
|    |         | rCp                  | = $( " )Cp " "$                                   |                                      |            |
|    |         | Mxc                  | = $Eax\overline{Tsm}$                             |                                      | T7 thru Tp |
|    |         | Pr3                  | = $JuQ2$  |                                      |            |
|    |         | sP(0-2)              | = $C(6-8)Eax(T6+T7)Pr3$                           |                                      |            |
|    |         | rP( " )              | = $\overline{C( " ) "}$                           | C(3-8) → P                           | T7 thru T6 |
|    |         | sP(3-14)             | = $P(0-11)Pr3$                                    |                                      |            |
|    |         | rP( " )              | = $\overline{P( " ) "}$                           |                                      |            |
| T5 | sP2     |                      | = $EaxT5$   | C2 → P                               |            |
| T4 | Sc      |                      | = $\overline{InrFlF2T4}$                          | Clear S                              |            |
|    |         | rS(1-14)             | = $Sc$  |                                      |            |
| T3 | sC0     |                      | = $\overline{TsEaxCr3T3}$                         | C9 set                               |            |
|    |         | rM(0-24)             | = $T3$  |                                      |            |
| T2 | sC(0-2) |                      | = $E2m(0-2)(Ju\overline{TsCr3})T2$                | Contents of Bank Register 2 → C(6-8) |            |
|    |         | rC( " )              | = $\overline{E2m( " ) ( " ) "}$                   |                                      |            |
| T1 | sC(0-2) |                      | = $E3m(0-2)(Ju\overline{TsCr3})T1$                | Contents of Bank Register 3 → C(3-5) |            |
|    |         | rC( " )              | = $\overline{E3m( " ) ( " ) "}$                   |                                      |            |
| T0 | rCz     |                      | = $\overline{FlT0}$                               |                                      |            |
|    |         | sC0                  | = $Of(Ju\overline{TsCr3})T0$                      | Sign of C = Of                       |            |
|    |         | rC0                  | = $\overline{Of( " ) "}$                          | No input to Cl, 2                    |            |
|    |         | rC(1,2)              | = $(Ju\overline{TsCr3})T0$                        | Parity error                         |            |
| Tr | sHt     |                      | = $CpT\overline{KpK002}$                          |                                      |            |
| Tp | rEax    |                      | = $Tp$  |                                      |            |
|    |         | sF(1-3)              | = $EaxTp$   | $\emptyset7$ next cycle (T8)         |            |
|    |         | rJu                  | = $Tp$  |                                      |            |
|    |         | sM(0-24)             | = $C(0-24)MxcTp$                                  | C → M(P → Location 0)                |            |



|    |    |               |                               |                                |            |
|----|----|---------------|-------------------------------|--------------------------------|------------|
| 07 | T8 | End           | = F1F2                        | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                |                                |            |
|    |    | sA(0-2)       | = A(21-23)ArAr3               |                                |            |
|    |    | rA( " )       | = A( " ) " "                  | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                  |                                |            |
|    |    | rA( " )       | = A( " ) " "                  |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3              |                                |            |
|    |    | rB( " )       | = B( " ) " "                  | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                  |                                |            |
|    |    | rB( " )       | = B( " ) " "                  |                                |            |
|    |    | Pr3           | = F1GOQ2                      |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3 |                                |            |
|    |    | rP( " )       | = P( " ) " ( " ) "            | Recirculate P                  | T7 thru T3 |
|    |    | sP(3-14)      | = P(0-11)Pr3                  |                                |            |
|    |    | rP( " )       | = P( " ) " "                  |                                |            |
|    | T4 | Sc            | = T4EndInr                    |                                |            |
|    |    | rS(1-14)      | = Sc                          | Clear S                        |            |
|    | T3 | Sxp           | = T3IntEndGO                  |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = P( " ) " ( " ) "            | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                  |                                |            |
|    |    | rS( " )       | = P( " ) " "                  |                                |            |
|    | T0 | rSk           | = 07T0                        |                                |            |
|    | Tr | Cxm           | = EndGOTsm(Tr+Tp)             | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                  |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCxm                       |                                |            |
|    |    | rIa           | = F1Tr                        |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)              |                                |            |
|    | Ip | rA00          | = TpEndGO                     |                                |            |
|    |    | rB00          | = TpEndGO                     |                                |            |
|    |    | sCp           | = M24CxmHtTsTp                | Initiate parity                |            |
|    |    | rF(1-3)       | = TpEndSk                     | 00 next                        |            |
|    |    | Oc            | = TpEndSk                     |                                |            |
|    |    | sO2           | = Oc                          |                                |            |
|    |    | rO(1,3,4,5,6) | = Oc                          | NOP (20) → 0                   |            |

Indirect Addressing, 1 Level (Ia)

(M) → P

1 Cycle

|    |     |                      |  |                                      |            |
|----|-----|----------------------|--|--------------------------------------|------------|
| ∅0 | T8  | rCz                  | = ∅0T8   |                                      |            |
|    |     | sHz                  | = T8   |                                      |            |
|    |     | sIa                  | = $\overline{C2}C9(C5+C8+C3C4)\emptyset0T8$  |                                      |            |
|    |     | sIx                  | = $\overline{C1}G\emptyset0T8$   | Initialize indexing                  |            |
|    |     | Oxc                  | = $\overline{Ia}G\overline{C2}\emptyset0T8$  |                                      |            |
|    |     | sO(1,3,4,5,6)        | = C(3,5,6,7,8)Oxc  | C(3-8) → 0 instruction to 0 register |            |
|    |     | rO2                  | = $\overline{Oxc}C4$   |                                      |            |
| T7 | Ar3 |                      | = $(\overline{O5F1F2} + (\overline{O1020304}))Q1$  | (All instructions except 66 & 67)    |            |
|    |     | sA(0-2)              | = $\overline{A}(21-23)AnrAr3$  |                                      |            |
|    |     | rA( " )              | = $\overline{A}( " ) " "$  | Recirculate A                        | T7 thru T0 |
|    |     | sA(3-23)             | = $\overline{A}(0-20)Ar3$  |                                      |            |
|    |     | rA( " )              | = $\overline{A}( " ) " "$  |                                      |            |
|    |     | sB(0-2)              | = $\overline{B}(21-23)BnrAr3$  |                                      |            |
|    |     | rB( " )              | = $\overline{B}( " ) " "$  | Recirculate B                        | T7 thru T0 |
|    |     | sB(3-23)             | = $\overline{B}(0-20)Ar3$  |                                      |            |
|    |     | rB( " )              | = $\overline{B}( " ) " "$  |                                      |            |
|    |     | Cr3                  | = $\overline{Ts}\emptyset0Q1$  |                                      |            |
|    |     | sC(0-2)              | = $\overline{Add}(1-3)Cr3\overline{JuTs}$  | C + X·Ix → C                         | T7 thru T0 |
|    |     | rC( " )              | = $\overline{Add}( " ) " "$  |                                      |            |
|    |     | sC(3-23)             | = $\overline{C}(0-20)Cr3$  |                                      |            |
|    |     | rC( " )              | = $\overline{C}( " ) " "$  |                                      |            |
|    |     | sCp                  | = $(\overline{C21} \oplus \overline{C22} \oplus \overline{C23})\overline{CpTsHt}Q1\overline{F1F2}$ | Parity check                         | T7 thru T0 |
|    |     | rCp                  | = ( " ) Cp " "   |                                      |            |
|    |     | Xz(1-3)              | = $\overline{Xn}(1-3)\emptyset0Ix$   | Xz input to adder (X·Ix)             |            |
|    |     | $\overline{Xz}( " )$ | = $\overline{Xn}( " )\emptyset0Ix + \overline{Ix}$   |                                      | T7 thru Tp |
|    |     | Yz(1-3)              | = $\overline{C}(21-23)\emptyset7$  | Yz input to adder (C)                | T7 thru Tp |
|    |     | $\overline{Yz}( " )$ | = $\overline{C}( " ) " "$  |                                      |            |
|    |     | sCz                  | = $\overline{Kz}Q1\overline{T0}$   |                                      |            |
|    |     | rCz                  | = $\overline{Kz}Q1$  | Carry logic                          | T7 thru T1 |
| T4 | Sc  |                      | = $\overline{Inr}F1F2T4$   |                                      |            |
|    |     | rS(1-14)             | = Sc   | Clear S                              |            |
| T3 | Sxc |                      | = $\overline{Ju}T3$  |                                      |            |
|    |     | sS(1,2)              | = $\overline{Add}(2,3)Sxc$   |                                      |            |
|    |     | sS(3-14)             | = $\overline{C}(0-11)Sxc$  | C(10-23) → S                         |            |
| T0 | rCz |                      | = $\overline{F1}T0$  |                                      |            |
| Tr | Cxm |                      | = $\overline{Ju}Tsm(Tr+Tp)$  |                                      |            |
|    |     | sC(0-23)             | = $\overline{M}(0-23)Cxm$  | M → C (Fetch operand)                | Tr thru Tp |
|    |     | rC( " )              | = $\overline{Cxm}Tr$   |                                      |            |
|    |     | sHt                  | = $\overline{CpTr}Kp\overline{K0}\overline{02}$  | Parity error                         |            |
|    |     | rIx                  | = $(\overline{F1F3})(\overline{GOHt})Tr$   |                                      |            |
|    |     | rRc                  | = Tr   |                                      |            |
| Tp | sCp |                      | = $\overline{M24}Cxm\overline{Ht}T5Tp$   | Initiate parity                      |            |

Oxc is inhibited for next cycle because the instruction is already in the 0 register and is now ready to be executed.

Indirect Addressing, 2 Levels (Ia) ((M)) → P

2 Cycles

|    |     |                      |  |                                      |            |
|----|-----|----------------------|--|--------------------------------------|------------|
| ∅0 | T8  | rCz                  | = ∅0T8   |                                      |            |
|    |     | sHz                  | = T8   |                                      |            |
|    |     | sIa                  | = $\overline{C2}C9(C5+C8+C3C4)\emptyset0T8$  |                                      |            |
|    |     | sIx                  | = $C1G0\emptyset0T8$   | Initialize indexing                  |            |
|    |     | Oxc                  | = $\overline{Ia}G0\overline{C2}\emptyset0T8$   |                                      |            |
|    |     | sO(1,3,4,5,6)        | = C(3,5,6,7,8)Oxc  | C(3-8) → 0 instruction to 0 register |            |
|    |     | rO2                  | = $Oxc\overline{C4}$   |                                      |            |
| T7 | Ar3 |                      | = $(\overline{O5}\overline{F1}\overline{F2}+(\overline{O1020304}))Q1$                            | (All instructions except 66 & 67)    |            |
|    |     | sA(0-2)              | = $A(21-23)\overline{Anr}Ar3$  |                                      |            |
|    |     | rA( " )              | = $\overline{A}( " ) " "$  | Recirculate A                        | T7 thru T0 |
|    |     | sA(3-23)             | = $A(0-20)Ar3$   |                                      |            |
|    |     | rA( " )              | = $\overline{A}( " ) " "$  |                                      |            |
|    |     | sB(0-2)              | = $B(21-23)\overline{Bnr}Ar3$  |                                      |            |
|    |     | rB( " )              | = $\overline{B}( " ) " "$  | Recirculate B                        | T7 thru T0 |
|    |     | sB(3-23)             | = $B(0-20)Ar3$   |                                      |            |
|    |     | rB( " )              | = $\overline{B}( " ) " "$  |                                      |            |
|    |     | Cr3                  | = $\overline{Ts}\emptyset0Q1$  |                                      |            |
|    |     | sC(0-2)              | = $Add(1-3)Cr3\overline{Ju}\overline{Ts}$  |                                      |            |
|    |     | rC( " )              | = $\overline{Add}( " ) " "$  | C + X·Ix → C                         | T7 thru T0 |
|    |     | sC(3-23)             | = $C(0-20)Cr3$   |                                      |            |
|    |     | rC( " )              | = $\overline{C}( " ) " "$  |                                      |            |
|    |     | sCp                  | = $(C21\oplus C22\oplus C23)\overline{Cp}\overline{Ts}\overline{Ht}Q1\overline{F1}\overline{F2}$ | Parity check                         | T7 thru T0 |
|    |     | rCp                  | = ( " ) Cp " "   |                                      |            |
|    |     | Xz(1-3)              | = $Xn(1-3)\emptyset0Ix$  | Xz input to adder (X·Ix)             |            |
|    |     | $\overline{Xz}( " )$ | = $\overline{Xn}( " )\emptyset0Ix+\overline{Ix}$   |                                      | T7 thru Tp |
|    |     | Yz(1-3)              | = $C(21-23)\emptyset7$   | Yz input to adder (C)                | T7 thru Tp |
|    |     | $\overline{Yz}( " )$ | = $\overline{C}( " ) " "$  |                                      |            |
|    |     | sCz                  | = $KzQ1\overline{T0}$  |                                      |            |
|    |     | rCz                  | = $\overline{Kz}Q1$  | Carry logic                          | T7 thru T1 |
| T4 | Sc  |                      | = $\overline{Inr}\overline{F1}\overline{F2}T4$   |                                      |            |
|    |     | rS(1-14)             | = Sc   | Clear S                              |            |
| T3 | Sxc |                      | = $\overline{Ju}T3$  |                                      |            |
|    |     | sS(1,2)              | = $Add(2,3)Sxc$  |                                      |            |
|    |     | sS(3-14)             | = $C(0-11)Sxc$   | C(10-23) → S                         |            |
| T0 | rCz |                      | = $\overline{Fl}T0$  |                                      |            |
| Tr | Cxm |                      | = $\overline{Ju}\overline{Ts}m(Tr+Tp)$   |                                      |            |
|    |     | sC(0-23)             | = $M(0-23)Cxm$   | M → C (Fetch operand)                | Tr thru Tp |
|    |     | rC( " )              | = $Cxm\overline{Tr}$   |                                      |            |
|    |     | sHt                  | = $Cp\overline{Tr}\overline{Kp}\overline{K0}\overline{02}$                                       | Parity error                         |            |
|    |     | rIx                  | = $(\overline{Fl}\overline{F3})(\overline{G0}\overline{Ht})\overline{Tr}$                        |                                      |            |
|    |     | rRc                  | = Tr   |                                      |            |
| Tp | sCp |                      | = $M24Cxm\overline{Ht}\overline{Ts}Tp$   | Initiate parity                      |            |

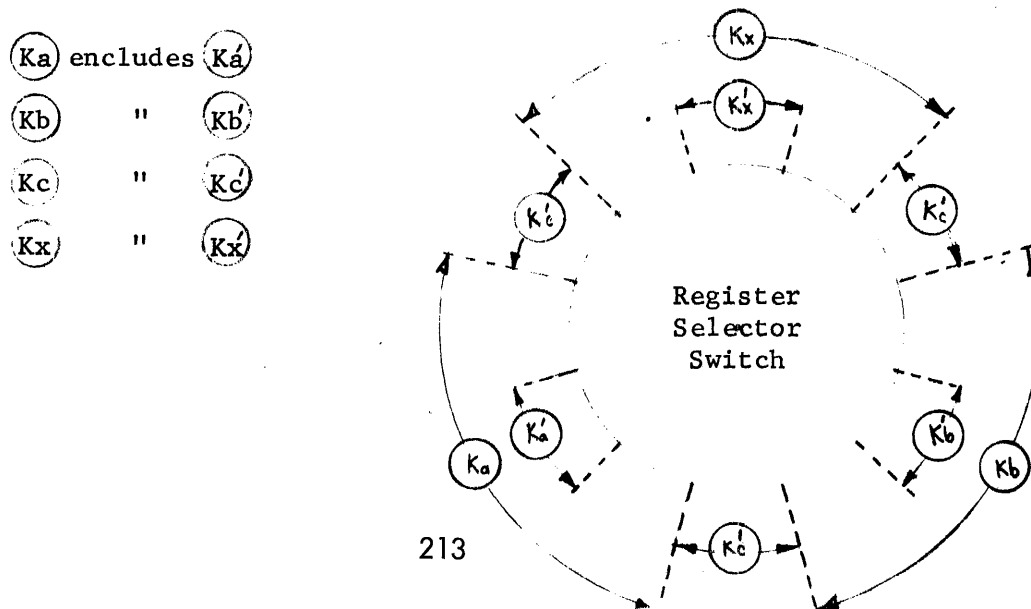
|    |     |          |   |                           |                                   |            |
|----|-----|----------|---|---------------------------|-----------------------------------|------------|
| 00 | T8  | rCz      | = | 00T8                      |                                   |            |
|    |     | sHz      | = | T8                        |                                   |            |
|    |     | sIa      | = | C2C9(C5+C8+C3C4)00T8      |                                   |            |
|    |     | rIa      | = | 00T8C9Ia                  |                                   |            |
|    |     | sIx      | = | C1G00T8                   | Initialize indexing               |            |
| T7 | Ar3 |          | = | (05F1F2+(01020304))Q1     | (All instructions except 66 & 67) |            |
|    |     | sA(0-2)  | = | A(21-23)AnrAr3            |                                   |            |
|    |     | rA( " )  | = | A( " ) " "                | Recirculate A                     | T7 thru T0 |
|    |     | sA(3-23) | = | A(0-20)Ar3                |                                   |            |
|    |     | rA( " )  | = | A( " ) " "                |                                   |            |
|    |     | sB(0-2)  | = | B(21-23)BnrAr3            |                                   |            |
|    |     | rB( " )  | = | B( " ) " "                | Recirculate B                     | T7 thru T0 |
|    |     | sB(3-23) | = | B(0-20)Ar3                |                                   |            |
|    |     | rB( " )  | = | B( " ) " "                |                                   |            |
|    |     | Cr3      | = | Ts00Q1                    |                                   |            |
|    |     | sC(0-2)  | = | Add(1-3)Cr3JuTs           | C + X·Ix → C                      | T7 thru T0 |
|    |     | rC( " )  | = | Add( " ) " "              |                                   |            |
|    |     | sC(3-23) | = | C(0-20)Cr3                |                                   |            |
|    |     | rC( " )  | = | C( " ) " "                |                                   |            |
|    |     | sCp      | = | (C21⊕C22⊕C23)CpTsHtQ1F1F2 | Parity check                      | T7 thru T0 |
|    |     | rCp      | = | ( " ) Cp " "              | Xz input to adder (X·Ix)          | T7 thru Tp |
|    |     | Xz(1-3)  | = | Xn(1-3)00Ix               | Yz input to adder (C)             | T7 thru Tp |
|    |     | Xz( " )  | = | Xn( " )00Ix+Ix            |                                   |            |
|    |     | Yz(1-3)  | = | C(21-23)07                | Carry logic                       | T7 thru T1 |
|    |     | Yz( " )  | = | C( " ) " "                |                                   |            |
|    |     | sCz      | = | KzQ1T0                    |                                   |            |
|    |     | rCz      | = | KzQ1                      |                                   |            |
| T4 | Sc  |          | = | InrF1F2T4                 | Clear S                           |            |
|    |     | rS(1-14) | = | Sc                        |                                   |            |
| T3 | Sxc |          | = | JuT3                      |                                   |            |
|    |     | sS(1,2)  | = | Add(2,3)Sxc               | C(10-23) → S                      |            |
|    |     | sS(3-14) | = | C(0-11)Sxc                |                                   |            |
| T0 | rCz |          | = | FIT0                      |                                   |            |
| Tr | Cxm |          | = | JuTsm(Tr+Tp)              | M → C (Fetch operand)             | Tr thru Tp |
|    |     | sC(0-23) | = | M(0-23)Cxm                | Parity error                      |            |
|    |     | rC( " )  | = | CxmTr                     |                                   |            |
|    |     | sHt      | = | CpTrKpK002                |                                   |            |
|    |     | rIx      | = | (FIF3)(G0Ht)Tr            |                                   |            |
|    |     | rRc      | = | Tr                        |                                   |            |
| Tp | sCp |          | = | M24CxmHtTsTp              | Initiate parity                   |            |

Oxc is inhibited for next cycle because the instruction is already in the 0 register and is now ready to be executed.

A Register Selection - Computer in "IDLE" ( $\overline{GOHT}$ ) with C Register Selected  $\textcircled{Kc'}$

|               |               |          |   |                                       |
|---------------|---------------|----------|---|---------------------------------------|
| $\emptyset 0$ | T8            | rC24     | = T8( $\overline{TsTsr}$ )                      |                                       |
|               |               | rCz      | = $\emptyset 0T8$                               |                                       |
|               |               | sF1      | = T8 $\overline{GO}$                            | $\emptyset 5$ next (T7)               |
|               |               | sF3      | = T8 $\overline{GO}$                            |                                       |
|               |               | rHt      | = T8 $\overline{KsKgCpGO}$                      | initiate idle (also reset halt light) |
|               |               | sHz      | = T8  |                                       |
| $\emptyset 5$ | T7            | Ar3      | = (01020304)Q1                                  |                                       |
|               |               | sA(0-2)  | = A(21-23) $\overline{AnrAr3}$                  |                                       |
|               |               | rA( " )  | = $\overline{A( " ) "}$                         | Recirculate A                         |
|               |               | sA(3-23) | = A(0-20)Ar3                                    | T7 thru T0                            |
|               |               | rA( " )  | = $\overline{A( " ) "}$                         |                                       |
|               |               | sB(0-2)  | = B(21-23) $\overline{BnrAr3}$                  |                                       |
|               |               | rB( " )  | = $\overline{B( " ) "}$                         | Recirculate B                         |
|               |               | sB(3-23) | = B(0-20)Ar3                                    | T7 thru T0                            |
|               |               | rB( " )  | = $\overline{B( " ) "}$                         |                                       |
|               |               | End      | = $\emptyset 5(A00+GO)$                         | last cycle                            |
|               |               | sXw(1-3) | = Xn(1-3) $\overline{Xnr}$                      |                                       |
|               |               | rXw( " ) | = $\overline{Xn( " ) "}$                        | Recirculate X                         |
| T4            | Sc            |          | = T4(End+F1F2) $\overline{Inr}$                 |                                       |
|               |               | rS(1-14) | = Sc  | Clear S                               |
| Tr            | rIa           |          | = TrF1  |                                       |
|               | rIx           |          | = Tr( $\overline{F1F3}$ ) ( $\overline{GOHT}$ ) |                                       |
|               | rRc           |          | = Tr  |                                       |
| Tp            | rF1           |          | = TpEndSk                                       | $\emptyset 0$ next clock (T8)         |
|               | rF3           |          | = ( " )   |                                       |
|               | rRf           |          | = Tp $\emptyset 1$ ( $\overline{GOHT}$ )        |                                       |
|               | rJu           |          | = Tp  |                                       |
|               | Oc            |          | = TpEndSk                                       |                                       |
|               | rO(1,3,4,5,6) |          | = Oc  | NOP (20) $\rightarrow 0$              |
|               | sO2           |          | = Oc  |                                       |

The C register is being displayed. The following shows what takes place when the Register Selector Switch is placed on A.



|    |    |               |   |                                       |
|----|----|---------------|---|---------------------------------------|
| Ø0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )   |                                       |
|    |    | rCz           | = Ø0T8  |                                       |
|    |    | sF1           | = T8 $\overline{\text{GO}}$   | Ø5 next (T7)                          |
|    |    | sF3           | = T8 $\overline{\text{GO}}$   |                                       |
|    |    | rHt           | = T8( $\overline{\text{Sk}}\overline{\text{g}}\overline{\text{CpGO}}$ )                           | initiate idle (also reset halt light) |
|    |    | sHz           | = T8  |                                       |
| Ø5 | T7 | Ar3           | = (Ø1020304)Q1  |                                       |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$   |                                       |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "   | Recirculate A T7 thru T0              |
|    |    | sA(3-23)      | = A(0-20)Ar3  |                                       |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "   |                                       |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$   |                                       |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "   | Recirculate B T7 thru T0              |
|    |    | sB(3-23)      | = B(0-20)Ar3  |                                       |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "   |                                       |
|    |    | End           | = Ø5(A00+GO)  | last cycle                            |
|    |    | sXw(1-3)      | = Xn(1-3) $\overline{\text{Xnr}}$   | Recirculate X                         |
|    |    | rXw( " )      | = $\overline{\text{Xn}}$ ( " ) " "  |                                       |
| T4 |    | Sc            | = T4(End+ $\overline{\text{FlF2}}$ ) $\overline{\text{Inr}}$                                      | Clear S                               |
|    |    | rS(1-14)      | = Sc  |                                       |
| Tr |    | rIa           | = Tr $\overline{\text{Fl}}$   |                                       |
|    |    | rIx           | = Tr( $\overline{\text{FlF3}}$ )( $\overline{\text{GOHt}}$ )                                      |                                       |
|    |    | rRc           | = Tr  |                                       |
| Tp |    | sEx           | = ( $\overline{\text{TsTpGOHt}}$ ) $\overline{\text{AOK}}\overline{\text{sk}}\overline{\text{g}}$ | initiate exchange between A and C     |
|    |    | rF1           | = TpEnd $\overline{\text{Sk}}$  | Ø0 next clock (T8)                    |
|    |    | rF3           | = ( " )   |                                       |
|    |    | rRf           | = TpØ1( $\overline{\text{GOHt}}$ )  |                                       |
|    |    | rJu           | = Tp  |                                       |
|    |    | Oc            | = TpEnd $\overline{\text{Sk}}$  |                                       |
|    |    | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                          |
|    |    | sO2           | = Oc  |                                       |

|    |    |               |  |                    |                                       |
|----|----|---------------|--|--------------------|---------------------------------------|
| ∅0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                            |                    |                                       |
|    |    | rCz           | = $\overline{\text{∅0T8}}$                                   |                    |                                       |
|    |    | sF1           | = T8 $\overline{\text{G0}}$                                  |                    |                                       |
|    |    | sF3           | = T8 $\overline{\text{G0}}$                                  | ∅5 next (T7)       |                                       |
|    |    | rHt           | = T8( $\overline{\text{KsKgCpG0}}$ )                         |                    | initiate idle (also reset halt light) |
|    |    | sHz           | = T8   |                    |                                       |
| ∅5 | T7 | Ar3           | = (01020304)Q1   |                    |                                       |
|    |    | Anr           | = Ex( $\overline{\text{Ka}}$ )                               |                    |                                       |
|    |    | sA(0-2)       | = C(21-23)Ex( $\overline{\text{Ka}}$ )Ar3                    | C → A              | T7 thru T0                            |
|    |    | rA( " )       | = $\overline{\text{C}}$ ( " ) " "                            |                    |                                       |
|    |    | sA(3-23)      | = A(0-20)Ar3   |                    |                                       |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "                            |                    |                                       |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{Bnr}}$ Ar3                       |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "                            | Recirculate B      | T7 thru T0                            |
|    |    | sB(3-23)      | = B(0-20)Ar3   |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "                            |                    |                                       |
|    |    | Cr3           | = Ex( $\overline{\text{TsQ1}}$ )                             |                    |                                       |
|    |    | sC(0-2)       | = A(21-23)Ex( $\overline{\text{KgTs}}$ )Cr3                  | A → C              | T7 thru T0                            |
|    |    | rC( " )       | = $\overline{\text{A}}$ ( " ) " "                            |                    |                                       |
|    |    | sC(3-23)      | = C(0-20)Cr3   |                    |                                       |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) " "                            |                    |                                       |
|    |    | End           | = $\overline{\text{∅5(A00+G0)}}$                             | last cycle         |                                       |
|    |    | sXw(1-3)      | = Xn(1-3) $\overline{\text{Xnr}}$                            | Recirculate X      |                                       |
|    |    | rXw( " )      | = $\overline{\text{Xn}}$ ( " ) " "                           |                    |                                       |
| T4 |    | Sc            | = T4(End+ $\overline{\text{F1F2}}$ ) $\overline{\text{Inr}}$ | Clear S            |                                       |
|    |    | rS(1-14)      | = Sc   |                    |                                       |
| T0 |    | sA00          | = ExT0A00( $\overline{\text{Ka}}$ )                          |                    |                                       |
| Tr |    | rIa           | = Tr $\overline{\text{F1}}$                                  |                    |                                       |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ )( $\overline{\text{G0Ht}}$ ) |                    |                                       |
|    |    | rRc           | = Tr   |                    |                                       |
| Tp |    | rEx           | = ExTp   |                    |                                       |
|    |    | rF1           | = TpEnd $\overline{\text{Sk}}$                               |                    |                                       |
|    |    | rF3           | = ( " )  | ∅0 next clock (T8) |                                       |
|    |    | rRf           | = Tp $\overline{\text{∅1}}$ ( $\overline{\text{G0Ht}}$ )     |                    |                                       |
|    |    | rJu           | = Tp   |                    |                                       |
|    |    | Oc            | = TpEnd $\overline{\text{Sk}}$                               |                    |                                       |
|    |    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0       |                                       |
|    |    | sO2           | = Oc   |                    |                                       |

|    |               |          |   |                                       |            |
|----|---------------|----------|---|---------------------------------------|------------|
| 00 | T8            | rC24     | = T8( $\overline{\text{TsTsr}}$ )                             |                                       |            |
|    |               | rCz      | = $\overline{\text{0T8}}$                                     |                                       |            |
|    |               | sF1      | = T8G0  |                                       |            |
|    |               | sF3      | = T8G0  | 05 next (T7)                          |            |
|    |               | rHt      | = T8( $\overline{\text{CsCpG0}}$ )                            | initiate idle (also reset halt light) |            |
|    |               | sHz      | = T8  |                                       |            |
| 05 | T7            | Ar3      | = (01020304)Q1  |                                       |            |
|    |               | sA(0-2)  | = A(21-23) $\overline{\text{AnrAr3}}$                         |                                       |            |
|    |               | rA( " )  | = $\overline{\text{A( " ) "}}$                                | Recirculate A                         | T7 thru T0 |
|    |               | sA(3-23) | = A(0-20)Ar3  |                                       |            |
|    |               | rA( " )  | = $\overline{\text{A( " ) "}}$                                |                                       |            |
|    |               | sB(0-2)  | = B(21-23) $\overline{\text{BnrAr3}}$                         |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B( " ) "}}$                                | Recirculate B                         | T7 thru T0 |
|    |               | sB(3-23) | = B(0-20)Ar3  |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B( " ) "}}$                                |                                       |            |
|    |               | End      | = $\overline{\text{05(A00+G0)}}$                              | last cycle                            |            |
|    |               | sXw(1-3) | = Xn(1-3) $\overline{\text{Xnr}}$                             |                                       |            |
|    |               | rXw( " ) | = $\overline{\text{Xn( " ) "}}$                               | Recirculate X                         |            |
| T4 | Sc            |          | = T4( $\overline{\text{End+F1F2}})$ $\overline{\text{Inr}}$   | Clear S                               |            |
|    |               | rS(1-14) | = Sc  |                                       |            |
| Tr | rIa           |          | = TrF1  |                                       |            |
|    | rIx           |          | = Tr( $\overline{\text{F1F3}}$ ) ( $\overline{\text{GOHt}}$ ) |                                       |            |
|    | rRc           |          | = Tr  |                                       |            |
| Tp | rF1           |          | = TpEnd $\overline{\text{Sk}}$                                |                                       |            |
|    | rF3           |          | = ( " )   | 00 next clock (T8)                    |            |
|    | rRf           |          | = Tp01( $\overline{\text{GOHt}}$ )                            |                                       |            |
|    | rJu           |          | = Tp  |                                       |            |
|    | Oc            |          | = TpEnd $\overline{\text{Sk}}$                                |                                       |            |
|    | rO(1,3,4,5,6) |          | = Oc  | NOP (20) → 0                          |            |
|    | sO2           |          | = Oc  |                                       |            |

The A register is now being displayed. The following shows what takes place when the Register Selector Switch is returned to C.



|    |               |          |   |                                       |            |
|----|---------------|----------|---|---------------------------------------|------------|
| Ø0 | T8            | rC24     | = T8(TsTsr)                             |                                       |            |
|    |               | rCz      | = Ø0T8                                  |                                       |            |
|    |               | sF1      | = T8GØ                                  |                                       |            |
|    |               | sF3      | = T8GØ                                  | Ø5 next (T7)                          |            |
|    |               | rHt      | = T8( <del>Ks</del> <del>Kp</del> CpGØ) | initiate idle (also reset halt light) |            |
|    |               | sHz      | = T8                                    |                                       |            |
| Ø5 | T7            | Ar3      | = (Ø1Ø2Ø3Ø4)Q1                          |                                       |            |
|    |               | sA(0-2)  | = A(21-23)AnrAr3                        |                                       |            |
|    |               | rA( " )  | = A( " ) " "                            | Recirculate A                         | T7 thru T0 |
|    |               | sA(3-23) | = A(0-20)Ar3                            |                                       |            |
|    |               | rA( " )  | = A( " ) " "                            |                                       |            |
|    |               | sB(0-2)  | = B(21-23)BnrAr3                        | Recirculate B                         | T7 thru T0 |
|    |               | rB( " )  | = B( " ) " "                            |                                       |            |
|    |               | sB(3-23) | = B(0-20)Ar3                            |                                       |            |
|    |               | rB( " )  | = B( " ) " "                            |                                       |            |
|    |               | End      | = Ø5(AØØ+GØ)                            | last cycle                            |            |
|    |               | sXw(1-3) | = Xn(1-3)Xnr                            | Recirculate X                         |            |
|    |               | rXw( " ) | = Xn( " ) " "                           |                                       |            |
| T4 | Sc            |          | = T4(End+F1F2)Inr                       | Clear S                               |            |
|    | rS(1-14)      |          | = Sc                                    |                                       |            |
| Tr | rIa           |          | = TrF1                                  |                                       |            |
|    | rIx           |          | = Tr(F1F3)(GØHt)                        |                                       |            |
|    | rRc           |          | = Tr                                    |                                       |            |
| Tp | sEx           |          | = (TsTpGØHt)(AØØBØØ)Ⓚ                   | initiate exchange between A and C.    |            |
|    | rF1           |          | = TpEndSk                               | Ø0 next clock (T8)                    |            |
|    | rF3           |          | = ( " )                                 |                                       |            |
|    | rRf           |          | = TpØ1(GØHt)                            |                                       |            |
|    | rJu           |          | = Tp                                    |                                       |            |
|    | Oc            |          | = TpEndSk                               |                                       |            |
|    | rO(1,3,4,5,6) |          | = Oc                                    | NOP (20) → 0                          |            |
|    | sO2           |          | = Oc                                    |                                       |            |

|    |               |          |  |                                       |            |
|----|---------------|----------|--|---------------------------------------|------------|
| Ø0 | T8            | rC24     | = T8( $\overline{\text{TsTsr}}$ )                            |                                       |            |
|    |               | rCz      | = $\overline{\text{Ø0T8}}$                                   |                                       |            |
|    |               | sF1      | = T8 $\overline{\text{GO}}$                                  |                                       |            |
|    |               | sF3      | = T8 $\overline{\text{GO}}$                                  | Ø5 next (T7)                          |            |
|    |               | rHt      | = T8( $\overline{\text{KsKpCpGO}}$ )                         | initiate idle (also reset halt light) |            |
|    |               | sHz      | = T8   |                                       |            |
| Ø5 | T7            | Ar3      | = (01020304)Q1   |                                       |            |
|    |               | Anr      | = ExA00B00   |                                       |            |
|    |               | sA(0-2)  | = C(21-23)ExA00B00Ar3  |                                       |            |
|    |               | rA( " )  | = $\overline{\text{C}}$ ( " ) " "                            | C → A                                 | T7 thru T0 |
|    |               | sA(3-23) | = A(0-20)Ar3   |                                       |            |
|    |               | rA( " )  | = $\overline{\text{A}}$ ( " ) " "                            |                                       |            |
|    |               | sB(0-2)  | = B(21-23) $\overline{\text{Bnr}}$ Ar3                       |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B}}$ ( " ) " "                            | Recirculate B                         | T7 thru T0 |
|    |               | sB(3-23) | = B(0-20)Ar3   |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B}}$ ( " ) " "                            |                                       |            |
|    |               | Cr3      | = Ex( $\overline{\text{TsQ1}}$ )                             |                                       |            |
|    |               | sC(0-2)  | = A(21-23)ExA00B00 $\overline{\text{Ts}}$ Cr3                |                                       |            |
|    |               | rC( " )  | = $\overline{\text{A}}$ ( " ) " "                            | A → C                                 | T7 thru T0 |
|    |               | sC(3-23) | = C(0-20)Cr3   |                                       |            |
|    |               | rC( " )  | = $\overline{\text{C}}$ ( " ) " "                            |                                       |            |
|    |               | End      | = Ø5( $\overline{\text{A00+GO}}$ )                           | last cycle                            |            |
|    |               | sXw(1-3) | = Xn(1-3)Xnr   |                                       |            |
|    |               | rXw( " ) | = $\overline{\text{Xn}}$ ( " ) " "                           | Recirculate X                         |            |
| T4 | Sc            |          | = T4(End+ $\overline{\text{F1F2}}$ ) $\overline{\text{Inr}}$ |                                       |            |
|    |               | rS(1-14) | = Sc   | Clear S                               |            |
| T0 | rA00          |          | = $\overline{\text{ExT0A00}}$                                |                                       |            |
| Tr | rIa           |          | = TrF1   |                                       |            |
|    | rIx           |          | = Tr( $\overline{\text{F1F3}}$ )( $\overline{\text{GOHt}}$ ) |                                       |            |
|    | rRc           |          | = Tr   |                                       |            |
| Tp | rEx           |          | = ExTp   |                                       |            |
|    | rF1           |          | = TpEnd $\overline{\text{Sk}}$                               |                                       |            |
|    | rF3           |          | = ( " )  | Ø0 next clock (T8)                    |            |
|    | rRf           |          | = TpØ1( $\overline{\text{GOHt}}$ )                           |                                       |            |
|    | rJu           |          | = Tp   |                                       |            |
|    | Oc            |          | = TpEnd $\overline{\text{Sk}}$                               |                                       |            |
|    | rO(1,3,4,5,6) |          | = Oc   | NOP (20) → 0                          |            |
|    | sO2           |          | = Oc   |                                       |            |

|    |    |               |  |                                       |            |
|----|----|---------------|--|---------------------------------------|------------|
| Ø0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                            |                                       |            |
|    |    | rCz           | = Ø0T8   |                                       |            |
|    |    | sF1           | = T8 $\overline{\text{GO}}$                                  |                                       |            |
|    |    | sF3           | = T8 $\overline{\text{GO}}$                                  | Ø5 next (T7)                          |            |
|    |    | rHt           | = T8 $\overline{\text{KsgCpGO}}$                             | initiate idle (also reset halt light) |            |
|    |    | sHz           | = T8   |                                       |            |
| Ø5 | T7 | Ar3           | = (01020304)Q1   |                                       |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                        |                                       |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              | Recirculate A                         | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3   |                                       |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                              |                                       |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                        |                                       |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              | Recirculate B                         | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3   |                                       |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                              |                                       |            |
|    |    | End           | = Ø5(A00+GO)   | last cycle                            |            |
|    |    | sXw(1-3)      | = Xn(1-3) $\overline{\text{Xnr}}$                            |                                       |            |
|    |    | rXw( " )      | = $\overline{\text{Xn}}$ ( " ) "                             | Recirculate X                         |            |
| T4 |    | Sc            | = T4(End+ $\overline{\text{FlF2}}$ ) $\overline{\text{Inr}}$ |                                       |            |
|    |    | rS(1-14)      | = Sc   | Clear S                               |            |
| Tr |    | rIa           | = Tr $\overline{\text{Fl}}$                                  |                                       |            |
|    |    | rIx           | = Tr( $\overline{\text{FlF3}}$ )( $\overline{\text{GOHt}}$ ) |                                       |            |
|    |    | rRc           | = Tr   |                                       |            |
| Tp |    | rF1           | = TpEnd $\overline{\text{Sk}}$                               |                                       |            |
|    |    | rF3           | = ( " )  | Ø0 next clock (T8)                    |            |
|    |    | rRf           | = Tp $\overline{\text{Fl}}$ ( $\overline{\text{GOHt}}$ )     |                                       |            |
|    |    | rJu           | = Tp   |                                       |            |
|    |    | Oc            | = TpEnd $\overline{\text{Sk}}$                               |                                       |            |
|    |    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0                          |            |
|    |    | sO2           | = Oc   |                                       |            |

The computer is now in normal "IDLE" mode with C being displayed.

B Register Selection - Computer in "IDLE" ( $\overline{GOHt}$ ) with C Register Selected  $\textcircled{Kc}$ .

|               |               |          |  |                                       |            |
|---------------|---------------|----------|--|---------------------------------------|------------|
| $\emptyset 0$ | T8            | rC24     | = T8( $\overline{TsTsr}$ )                                   |                                       |            |
|               |               | rCz      | = $\emptyset 0T8$  |                                       |            |
|               |               | sF1      | = T8 $\overline{GO}$   | $\emptyset 5$ next (T7)               |            |
|               |               | sF3      | = T8 $\overline{GO}$   |                                       |            |
|               |               | rHt      | = T8 $\textcircled{Ks}$ $\textcircled{Kg}$ $\overline{CpGO}$ | initiate idle (also reset halt light) |            |
|               |               | sHz      | = T8   |                                       |            |
| $\emptyset 5$ | T7            | Ar3      | = (01020304)Q1   |                                       |            |
|               |               | sA(0-2)  | = A(21-23) $\overline{AnrAr3}$                               |                                       |            |
|               |               | rA( " )  | = $\overline{A}$ ( " ) "                                     | Recirculate A                         | T7 thru T0 |
|               |               | sA(3-23) | = A(0-20)Ar3   |                                       |            |
|               |               | rA( " )  | = $\overline{A}$ ( " ) "                                     |                                       |            |
|               |               | sB(0-2)  | = B(21-23) $\overline{BnrAr3}$                               |                                       |            |
|               |               | rB( " )  | = $\overline{B}$ ( " ) "                                     | Recirculate B                         | T7 thru T0 |
|               |               | sB(3-23) | = B(0-20)Ar3   |                                       |            |
|               |               | rB( " )  | = $\overline{B}$ ( " ) "                                     |                                       |            |
|               |               | End      | = $\emptyset 5(\overline{A00+GO})$                           | last cycle                            |            |
|               |               | sXw(1-3) | = Xn(1-3) $\overline{Xnr}$                                   | Recirculate X                         |            |
|               |               | rXw( " ) | = $\overline{Xn}$ ( " ) "                                    |                                       |            |
| T4            | Sc            |          | = T4(End+ $\overline{FlF2}$ ) $\overline{Inr}$               |                                       |            |
|               |               | rS(1-14) | = Sc   | Clear S                               |            |
| Tr            | rIa           |          | = TrF1   |                                       |            |
|               | rIx           |          | = Tr( $\overline{FlF3}$ ) ( $\overline{GOHt}$ )              |                                       |            |
|               | rRc           |          | = Tr   |                                       |            |
| Tp            | rF1           |          | = TpEnd $\overline{Sk}$                                      | $\emptyset 0$ next clock (T8)         |            |
|               | rF3           |          | = ( " )  |                                       |            |
|               | rRf           |          | = Tp $\emptyset 1$ ( $\overline{GOHt}$ )                     |                                       |            |
|               | rJu           |          | = Tp   |                                       |            |
|               | Oc            |          | = TpEnd $\overline{Sk}$                                      |                                       |            |
|               | rO(1,3,4,5,6) |          | = Oc   | NOP (20) $\rightarrow 0$              |            |
|               | sO2           |          | = Oc   |                                       |            |

The C register is being displayed. The following shows what takes place when the Register Selector Switch is placed on B.

$\textcircled{Ka}$  enclodes  $\textcircled{Ka'}$   
 $\textcircled{Kb}$  "  $\textcircled{Kb'}$   
 $\textcircled{Kc}$  "  $\textcircled{Kc'}$   
 $\textcircled{Kx}$  "  $\textcircled{Kx'}$

|    |               |          |  |                                       |            |
|----|---------------|----------|--|---------------------------------------|------------|
| ∅0 | T8            | rC24     | = T8( $\overline{\text{TsTsr}}$ )                              |                                       |            |
|    |               | rCz      | = $\overline{\text{∅0T8}}$                                     |                                       |            |
|    |               | sF1      | = $\overline{\text{T8G0}}$                                     |                                       |            |
|    |               | sF3      | = $\overline{\text{T8G0}}$                                     | ∅5 next (T7)                          |            |
|    |               | rHt      | = $\overline{\text{T8KsKgCpG0}}$                               | initiate idle (also reset halt light) |            |
|    |               | sHz      | = T8   |                                       |            |
| ∅5 | T7            | Ar3      | = (01020304)Q1   |                                       |            |
|    |               | sA(0-2)  | = A(21-23) $\overline{\text{AnrAr3}}$                          |                                       |            |
|    |               | rA( " )  | = $\overline{\text{A( " )}}$ "                                 | Recirculate A                         | T7 thru T0 |
|    |               | sA(3-23) | = A(0-20)Ar3   |                                       |            |
|    |               | rA( " )  | = $\overline{\text{A( " )}}$ "                                 |                                       |            |
|    |               | sB(0-2)  | = B(21-23) $\overline{\text{BnrAr3}}$                          |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B( " )}}$ "                                 | Recirculate B                         | T7 thru T0 |
|    |               | sB(3-23) | = B(0-20)Ar3   |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B( " )}}$ "                                 |                                       |            |
|    |               | End      | = $\overline{\text{∅5(A00+G0)}}$                               | last cycle                            |            |
|    |               | sXw(1-3) | = Xn(1-3) $\overline{\text{Xnr}}$                              | Recirculate X                         |            |
|    |               | rXw(1-3) | = $\overline{\text{Xn( " )}}$ "                                |                                       |            |
| T4 | Sc            |          | = T4(End+ $\overline{\text{FlF2}}$ ) $\overline{\text{Inr}}$   | Clear S                               |            |
|    |               | rS(1-14) | = Sc   |                                       |            |
| Tr | rIa           |          | = TrFl   |                                       |            |
|    | rIx           |          | = Tr( $\overline{\text{FlF3}}$ ) ( $\overline{\text{GOHt}}$ )  |                                       |            |
|    | rRc           |          | = Tr   |                                       |            |
| Tp | sEx           |          | = ( $\overline{\text{TsTpGOHt}}$ ) $\overline{\text{B00KsKg}}$ | initiate exchange between B and C     |            |
|    | rF1           |          | = TpEndSk  |                                       |            |
|    | rF3           |          | = ( " )  | ∅0 next clock (T8)                    |            |
|    | rRf           |          | = Tp∅1 ( $\overline{\text{GOHt}}$ )                            |                                       |            |
|    | rJu           |          | = Tp   |                                       |            |
|    | Oc            |          | = TpEndSk  |                                       |            |
|    | rO(1,3,4,5,6) |          | = Oc   | NOP (20) → 0                          |            |
|    | sO2           |          | = Oc   |                                       |            |

|    |    |               |  |                    |                                       |
|----|----|---------------|--|--------------------|---------------------------------------|
| ∅0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                            |                    |                                       |
|    |    | rCz           | = ∅0T8   |                    |                                       |
|    |    | sF1           | = T8 $\overline{\text{G0}}$                                  |                    |                                       |
|    |    | sF3           | = T8 $\overline{\text{G0}}$                                  | ∅5 next (T7)       |                                       |
|    |    | rHt           | = T8( $\overline{\text{G0}} \oplus \overline{\text{CpG0}}$ ) |                    | initiate idle (also reset halt light) |
|    |    | sHz           | = T8   |                    |                                       |
| ∅5 | T7 | Ar3           | = (01020304)Q1   |                    |                                       |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                        |                    |                                       |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "                            |                    |                                       |
|    |    | sA(3-23)      | = A(0-20)Ar3   | Recirculate A      | T7 thru T0                            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "                            |                    |                                       |
|    |    | Bnr           | = Ex <b>Kb</b>   |                    |                                       |
|    |    | sB(0-2)       | = C(21-23)Ex <b>Kb</b> Ar3                                   |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{C}}$ ( " ) " "                            | C → B              | T7 thru T0                            |
|    |    | sB(3-23)      | = B(0-20)Ar3   |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "                            |                    |                                       |
|    |    | Cr3           | = Ex( $\overline{\text{TsQ1}}$ )                             |                    |                                       |
|    |    | sC(0-2)       | = B(21-23)Ex <b>Kb</b> $\overline{\text{TsCr3}}$             |                    |                                       |
|    |    | rC( " )       | = $\overline{\text{B}}$ ( " ) " "                            | B → C              | T7 thru T0                            |
|    |    | sC(3-23)      | = C(0-20)Cr3   |                    |                                       |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) " "                            |                    |                                       |
|    |    | End           | = ∅5(A00+G0)   | last cycle         |                                       |
|    |    | sXw(1-3)      | = Xn(1-3) $\overline{\text{Xnr}}$                            | Recirculate X      |                                       |
|    |    | rXw( " )      | = $\overline{\text{Xn}}$ ( " ) " "                           |                    |                                       |
| T4 |    | Sc            | = T4(End+ $\overline{\text{FlF2}}$ ) $\overline{\text{Inr}}$ | Clear S            |                                       |
|    |    | rS(1-14)      | = Sc   |                    |                                       |
| T0 |    | sB00          | = ExT0B00 <b>Kb</b> Ar3                                      |                    |                                       |
| Tr |    | rIa           | = TrF1   |                    |                                       |
|    |    | rIx           | = Tr( $\overline{\text{FlF3}}$ )( $\overline{\text{GOHt}}$ ) |                    |                                       |
|    |    | rRc           | = Tr   |                    |                                       |
| Tp |    | rEx           | = ExTp   |                    |                                       |
|    |    | rF1           | = TpEndSk  |                    |                                       |
|    |    | rF3           | = ( " )  | ∅0 next clock (T8) |                                       |
|    |    | rRf           | = Tp∅1( $\overline{\text{GOHt}}$ )                           |                    |                                       |
|    |    | rJu           | = Tp   |                    |                                       |
|    |    | Oc            | = TpEndSk  |                    |                                       |
|    |    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0       |                                       |
|    |    | sO2           | = Oc   |                    |                                       |

|    |    |               |   |                                       |            |
|----|----|---------------|---|---------------------------------------|------------|
| 00 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                             |                                       |            |
|    |    | rCz           | = 0T8   |                                       |            |
|    |    | sF1           | = T8 $\overline{\text{GO}}$                                   | 05 next (T7)                          |            |
|    |    | sF3           | = T8 $\overline{\text{GO}}$                                   |                                       |            |
|    |    | rHt           | = T8( $\overline{\text{KsKgCpGO}}$ )                          | initiate idle (also reset halt light) |            |
|    |    | sHz           | = T8  |                                       |            |
| 05 | T7 | Ar3           | = (01020304)Q1  |                                       |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                         |                                       |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                               | Recirculate A                         | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3  |                                       |            |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) "                               |                                       |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                         |                                       |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                               | Recirculate B                         | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3  |                                       |            |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) "                               |                                       |            |
|    |    | End           | = 05( $\overline{\text{A00+GO}}$ )                            | last cycle                            |            |
|    |    | sXw(1-3)      | = $\overline{\text{Xn}}$ (1-3) $\overline{\text{Xnr}}$        |                                       |            |
|    |    | rXw( " )      | = $\overline{\text{Xn}}$ ( " ) "                              | Recirculate X                         |            |
| T4 |    | Sc            | = T4( $\overline{\text{End+F1F2}}$ ) $\overline{\text{Inr}}$  |                                       |            |
|    |    | rS(1-14)      | = Sc  | Clear S                               |            |
| Tr |    | rIa           | = TrF1  |                                       |            |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ ) ( $\overline{\text{GOHt}}$ ) |                                       |            |
|    |    | rRc           | = Tr  |                                       |            |
| Tp |    | rF1           | = TpEndSk   |                                       |            |
|    |    | rF3           | = ( " )   | 00 next clock (T8)                    |            |
|    |    | rRf           | = Tp01 ( $\overline{\text{GOHt}}$ )                           |                                       |            |
|    |    | rJu           | = Tp  |                                       |            |
|    |    | Oc            | = TpEndSk   |                                       |            |
|    |    | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                          |            |
|    |    | sO2           | = Oc  |                                       |            |

The B register is now being displayed. The following shows what takes place when the Register Selector Switch is returned to C.

|    |    |               |                                      |               |                                       |
|----|----|---------------|--------------------------------------|---------------|---------------------------------------|
| Ø0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )    |               |                                       |
|    |    | rCz           | = Ø0T8                               |               |                                       |
|    |    | sF1           | = T8GØ                               |               |                                       |
|    |    | sF3           | = T8GØ                               |               | Ø5 next (T7)                          |
|    |    | rHt           | = T8( $\overline{\text{KsKpCpGØ}}$ ) |               | initiate idle (also reset halt light) |
|    |    | sHz           | = T8                                 |               |                                       |
| Ø5 | T7 | Ar3           | = (Ø1Ø2Ø3Ø4)Q1                       |               |                                       |
|    |    | sA(0-2)       | = A(21-23)AnrAr3                     |               |                                       |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "       | Recirculate A | T7 thru T0                            |
|    |    | sA(3-23)      | = A(0-20)Ar3                         |               |                                       |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "       |               |                                       |
|    |    | sB(0-2)       | = B(21-23)BnrAr3                     |               |                                       |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "       | Recirculate B | T7 thru T0                            |
|    |    | sB(3-23)      | = B(0-20)Ar3                         |               |                                       |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "       |               |                                       |
|    |    | End           | = Ø5(AØØ+GØ)                         |               | last cycle                            |
|    |    | sXw(1-3)      | = Xn(1-3)Xnr                         |               | Recirculate X                         |
|    |    | rXw( " )      | = $\overline{\text{Xn( " )}}$ "      |               |                                       |
| T4 |    | Sc            | = T4(End+F1F2)Inr                    |               | Clear S                               |
|    |    | rS(1-14)      | = Sc                                 |               |                                       |
| Tr |    | rIa           | = TrF1                               |               |                                       |
|    |    | rIx           | = Tr(F1F3)(GØHt)                     |               |                                       |
|    |    | rRc           | = Tr                                 |               |                                       |
| Tp |    | sEx           | = (TsTpGØHt)(AØØBØØ)(KØ)             |               | initiate exchange between B and C.    |
|    |    | rF1           | = TpEndSk                            |               |                                       |
|    |    | rF3           | = ( " )                              |               | Ø0 next clock (T8)                    |
|    |    | rRf           | = TpØ1(GØHt)                         |               |                                       |
|    |    | rJu           | = Tp                                 |               |                                       |
|    |    | Oc            | = TpEndSk                            |               |                                       |
|    |    | rØ(1,3,4,5,6) | = Oc                                 |               | NØP (20) → 0                          |
|    |    | sØ2           | = Oc                                 |               |                                       |



|    |    |               |                         |                    |                                       |
|----|----|---------------|-------------------------|--------------------|---------------------------------------|
| ∅0 | T8 | rC24          | = T8(TsTsr)             |                    |                                       |
|    |    | rCz           | = ∅0T8                  |                    |                                       |
|    |    | sF1           | = T8G0                  |                    |                                       |
|    |    | sF3           | = T8G0                  |                    | ∅5 next (T7)                          |
|    |    | rHt           | = T8KsKpG0              |                    | initiate idle (also reset halt light) |
|    |    | sHz           | = T8                    |                    |                                       |
| ∅5 | T7 | Ar3           | = (01020304)Q1          |                    |                                       |
|    |    | sA(0-2)       | = A(21-23)AnrAr3        |                    |                                       |
|    |    | rA( " )       | = A( " ) " "            | Recirculate A      | T7 thru T0                            |
|    |    | sA(3-23)      | = A(0-20)Ar3            |                    |                                       |
|    |    | rA( " )       | = A( " ) " "            |                    |                                       |
|    |    | Bnr           | = ExA00B00              |                    |                                       |
|    |    | sB(0-2)       | = C(21-23)ExA00B00Ar3   |                    |                                       |
|    |    | rB( " )       | = C( " ) " "            | C → B              | T7 thru T0                            |
|    |    | Cr3           | = Ex(TsQ1)              |                    |                                       |
|    |    | sC(0-2)       | = B(21-23)ExA00B00TsCr3 |                    |                                       |
|    |    | rC( " )       | = B( " ) " "            | B → C              | T7 thru T0                            |
|    |    | sC(3-23)      | = C(0-20)Cr3            |                    |                                       |
|    |    | rC( " )       | = C( " ) " "            |                    |                                       |
|    |    | End           | = ∅5(A00+G0)            |                    | last cycle                            |
|    |    | sXw(1-3)      | = Xn(1-3)Xnr            |                    |                                       |
|    |    | rXw( " )      | = Xn( " ) " "           | Recirculate X      |                                       |
| T4 |    | Sc            | = T4(End+F1F2)Inr       |                    |                                       |
|    |    | rS(1-14)      | = Sc                    | Clear S            |                                       |
| T0 |    | rB00          | = ExT0B00               |                    |                                       |
| Tr |    | rIa           | = TrF1                  |                    |                                       |
|    |    | rIx           | = Tr(F1F3)(GOHt)        |                    |                                       |
|    |    | rRc           | = Tr                    |                    |                                       |
| Tp |    | rEx           | = ExTp                  |                    |                                       |
|    |    | rF1           | = TpEndSk               |                    |                                       |
|    |    | rF3           | = ( " )                 | ∅0 next clock (T8) |                                       |
|    |    | rRf           | = Tp∅1(GOHT)            |                    |                                       |
|    |    | rJu           | = Tp                    |                    |                                       |
|    |    | Oc            | = TpEndSk               |                    |                                       |
|    |    | rO(1,3,4,5,6) | = Oc                    |                    |                                       |
|    |    | sO2           | = Oc                    | NOP (20) → 0       |                                       |

|    |    |               |   |                    |                                       |
|----|----|---------------|---|--------------------|---------------------------------------|
| ∅0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                             |                    |                                       |
|    |    | rCz           | = $\overline{\text{∅0T8}}$                                    |                    |                                       |
|    |    | sF1           | = T8 $\overline{\text{GO}}$                                   |                    |                                       |
|    |    | sF3           | = T8 $\overline{\text{GO}}$                                   | ∅5 next (T7)       |                                       |
|    |    | rHt           | = T8( $\overline{\text{skgCpGO}}$ )                           |                    | initiate idle (also reset halt light) |
|    |    | sHz           | = T8  |                    |                                       |
| ∅5 | T7 | Ar3           | = $(\overline{01020304})\overline{\text{Q1}}$                 |                    |                                       |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                         |                    |                                       |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "                                | Recirculate A      | T7 thru T0                            |
|    |    | sA(3-23)      | = A(0-20)Ar3  |                    |                                       |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "                                |                    |                                       |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                         |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "                                | Recirculate B      | T7 thru T0                            |
|    |    | sB(3-23)      | = B(0-20)Ar3  |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "                                |                    |                                       |
|    |    | End           | = $\overline{\text{∅5(A00+GO)}}$                              |                    | last cycle                            |
|    |    | sXw(1-3)      | = Xn(1-3) $\overline{\text{Xnr}}$                             |                    |                                       |
|    |    | rXw( " )      | = $\overline{\text{Xn( " )}}$ "                               | Recirculate X      |                                       |
| T4 |    | Sc            | = T4( $\overline{\text{End+F1F2}}\overline{\text{Inr}}$ )     |                    |                                       |
|    |    | rS(1-14)      | = Sc  |                    | Clear S                               |
| Tr |    | rIa           | = Tr $\overline{\text{F1}}$                                   |                    |                                       |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ ) ( $\overline{\text{GOHt}}$ ) |                    |                                       |
|    |    | rRc           | = Tr  |                    |                                       |
| Tp |    | rF1           | = Tp $\overline{\text{EndSk}}$                                |                    |                                       |
|    |    | rF3           | = ( " )   | ∅0 next clock (T8) |                                       |
|    |    | rRf           | = Tp $\overline{\text{∅1}}$ ( $\overline{\text{GOHt}}$ )      |                    |                                       |
|    |    | rJu           | = Tp  |                    |                                       |
|    |    | Oc            | = Tp $\overline{\text{EndSk}}$                                |                    |                                       |
|    |    | rO(1,3,4,5,6) | = Oc  |                    | NOP (20) → 0                          |
|    |    | sO2           | = Oc  |                    |                                       |

The Computer is now in normal "IDLE" mode with C being displayed.

X Register Selection - Computer in "IDLE" ( $\overline{GOHt}$ ) with C Register Selected  $\textcircled{K}$ .

|               |               |          |   |                               |                                       |
|---------------|---------------|----------|---|-------------------------------|---------------------------------------|
| $\emptyset 0$ | T8            | rC24     | = T8( $\overline{TsTsr}$ )                      |                               |                                       |
|               |               | rCz      | = $\emptyset 0T8$                               |                               |                                       |
|               |               | sF1      | = T8 $\overline{GO}$                            |                               |                                       |
|               |               | sF3      | = T8 $\overline{GO}$                            | $\emptyset 5$ next (T7)       |                                       |
|               |               | rHt      | = T8 $\textcircled{KsKp}$ $\overline{CpGO}$     |                               | initiate idle (also reset halt light) |
|               |               | sHz      | = T8  |                               |                                       |
| $\emptyset 5$ | T7            | Ar3      | = (01020304)Q1                                  |                               |                                       |
|               |               | sA(0-2)  | = A(21-23) $\overline{AnrAr3}$                  |                               |                                       |
|               |               | rA( " )  | = $\overline{A}$ ( " ) "                        | Recirculate A                 | T7 thru T0                            |
|               |               | sA(3-23) | = A(0-20)Ar3                                    |                               |                                       |
|               |               | rA( " )  | = $\overline{A}$ ( " ) "                        |                               |                                       |
|               |               | sB(0-2)  | = B(21-23) $\overline{BnrAr3}$                  |                               |                                       |
|               |               | rB( " )  | = $\overline{B}$ ( " ) "                        | Recirculate B                 | T7 thru T0                            |
|               |               | sB(3-23) | = B(0-20)Ar3                                    |                               |                                       |
|               |               | rB( " )  | = $\overline{B}$ ( " ) "                        |                               |                                       |
|               |               | End      | = $\emptyset 5(\overline{A00+GO})$              |                               | last cycle                            |
|               |               | sXw(1-3) | = Xn(1-3) $\overline{Xnr}$                      | Recirculate X                 |                                       |
|               |               | rXw( " ) | = $\overline{Xn}$ ( " ) "                       |                               |                                       |
| T4            | Sc            |          | = T4( $\overline{End+F1F2}$ ) $\overline{Inr}$  |                               |                                       |
|               |               | rS(1-14) | = Sc  | Clear S                       |                                       |
| Tr            | rIa           |          | = TrF1  |                               |                                       |
|               | rIx           |          | = Tr( $\overline{F1F3}$ ) ( $\overline{GOHt}$ ) |                               |                                       |
|               | rRc           |          | = Tr  |                               |                                       |
| Tp            | rF1           |          | = TpEnd $\overline{Sk}$                         | $\emptyset 0$ next clock (T8) |                                       |
|               | rF3           |          | = ( " )   |                               |                                       |
|               | rRf           |          | = Tp $\emptyset 1$ ( $\overline{GOHt}$ )        |                               |                                       |
|               | rJu           |          | = Tp  |                               |                                       |
|               | Oc            |          | = TpEnd $\overline{Sk}$                         |                               |                                       |
|               | rO(1,3,4,5,6) |          | = Oc  | NOP (20) $\rightarrow 0$      |                                       |
|               | sO2           |          | = Oc  |                               |                                       |

The C register is being displayed. The following shows what takes place when the Register Selector Switch is placed on X.

$\textcircled{Ka}$  enclodes  $\textcircled{Ka'}$   
 $\textcircled{Kb}$  "  $\textcircled{Kb'}$   
 $\textcircled{Kc}$  "  $\textcircled{Kc'}$   
 $\textcircled{Kx}$  "  $\textcircled{Kx'}$

|    |               |          |  |                                       |            |
|----|---------------|----------|--|---------------------------------------|------------|
| Ø0 | T8            | rC24     | = T8( $\overline{\text{TsTsr}}$ )                              |                                       |            |
|    |               | rCz      | = Ø0T8   |                                       |            |
|    |               | sF1      | = T8GØ   |                                       |            |
|    |               | sF3      | = T8GØ   | Ø5 next (T7)                          |            |
|    |               | rHt      | = T8( $\overline{\text{KsKgCpGØ}}$ )                           | initiate idle (also reset halt light) |            |
|    |               | sHz      | = T8   |                                       |            |
| Ø5 | T7            | Ar3      | = (01020304)Q1   |                                       |            |
|    |               | sA(0-2)  | = A(21-23) $\overline{\text{AnrAr3}}$                          |                                       |            |
|    |               | rA( " )  | = $\overline{\text{A}}$ ( " ) " "                              | Recirculate A                         | T7 thru T0 |
|    |               | sA(3-23) | = A(0-20)Ar3   |                                       |            |
|    |               | rA( " )  | = $\overline{\text{A}}$ ( " ) " "                              |                                       |            |
|    |               | sB(0-2)  | = B(21-23) $\overline{\text{BnrAr3}}$                          |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B}}$ ( " ) " "                              | Recirculate B                         | T7 thru T0 |
|    |               | sB(3-23) | = B(0-20)Ar3   |                                       |            |
|    |               | rB( " )  | = $\overline{\text{B}}$ ( " ) " "                              |                                       |            |
|    |               | End      | = Ø5( $\overline{\text{AØØ+GØ}}$ )                             | last cycle                            |            |
|    |               | sXw(1-3) | = Xn(1-3) $\overline{\text{Xnr}}$                              |                                       |            |
|    |               | rXw( " ) | = $\overline{\text{Xn}}$ ( " ) " "                             | Recirculate X                         |            |
| T4 | Sc            |          | = T4( $\overline{\text{End+F1F2}}$ ) $\overline{\text{Inr}}$   |                                       |            |
|    |               | rS(1-14) | = Sc   | Clear S                               |            |
| Tr | rIa           |          | = TrF1   |                                       |            |
|    | rIx           |          | = Tr( $\overline{\text{F1F3}}$ ) ( $\overline{\text{GOHt}}$ )  |                                       |            |
|    | rRc           |          | = Tr   |                                       |            |
| Tp | sEx           |          | = ( $\overline{\text{TsTpGOHt}}$ ) $\overline{\text{BØØKsKg}}$ | initiate exchange between X and C     |            |
|    | rF1           |          | = TpEndSk  |                                       |            |
|    | rF3           |          | = ( " )  | Ø0 next clock (T8)                    |            |
|    | rRf           |          | = TpØ1 ( $\overline{\text{GOHt}}$ )                            |                                       |            |
|    | rJu           |          | = Tp   |                                       |            |
|    | Oc            |          | = TpEndSk  |                                       |            |
|    | rØ(1,3,4,5,6) |          | = Oc   | NØP (20) → 0                          |            |
|    | sØ2           |          | = Oc   |                                       |            |

|    |    |               |                    |               |                                       |
|----|----|---------------|--------------------|---------------|---------------------------------------|
| Ø0 | T8 | rC24          | = T8(TsTsr)        |               |                                       |
|    |    | rCz           | = Ø0T8             |               |                                       |
|    |    | sF1           | = T8G0             |               |                                       |
|    |    | sF3           | = T8G0             |               | Ø5 next (T7)                          |
|    |    | rHt           | = T8KsKpCpG0       |               | initiate idle (also reset halt light) |
|    |    | sHz           | = T8               |               |                                       |
| Ø5 | T7 | Ar3           | = (01020304)Q1     |               |                                       |
|    |    | sA(0-2)       | = A(21-23)AnrAr3   |               |                                       |
|    |    | rA( " )       | = A( " ) " "       | Recirculate A | T7 thru T0                            |
|    |    | sA(3-23)      | = A(0-20)Ar3       |               |                                       |
|    |    | rA( " )       | = A( " ) " "       |               |                                       |
|    |    | sB(0-2)       | = B(21-23)BnrAr3   |               |                                       |
|    |    | rB( " )       | = B( " ) " "       | Recirculate B | T7 thru T0                            |
|    |    | sB(3-23)      | = B(0-20)Ar3       |               |                                       |
|    |    | rB( " )       | = B( " ) " "       |               |                                       |
|    |    | Cr3           | = Ex(TsQ1)         |               |                                       |
|    |    | sC(0-2)       | = Xn(1-3)ExKsTsCr3 |               |                                       |
|    |    | rC( " )       | = Xn( " ) " "      | X → C         | T7 thru T0                            |
|    |    | sC(3-23)      | = C(0-20)Cr3       |               |                                       |
|    |    | rC( " )       | = C( " ) " "       |               |                                       |
|    |    | End           | = Ø5(A00+G0)       |               | last cycle                            |
|    |    | Xnr           | = ExKs             |               |                                       |
|    |    | sXw(1-3)      | = C(21-23)ExKsTs   |               |                                       |
|    |    | rXw( " )      | = C( " ) " "       | C → X         | T7 thru T0                            |
| T4 |    | Sc            | = T4(End+F1F2)Inr  |               |                                       |
|    |    | rS(1-14)      | = Sc               | Clear S       |                                       |
| T0 |    | sA00          | = T0ExA00Ks        |               |                                       |
|    |    | sB00          | = Ar3T0ExB00Ks     |               |                                       |
| Tr |    | rIa           | = TrF1             |               |                                       |
|    |    | rIx           | = Tr(F1F3)(GOHt)   |               |                                       |
|    |    | rRc           | = Tr               |               |                                       |
| Tp |    | rEx           | = ExTp             |               |                                       |
|    |    | rF1           | = TpEndSk          |               |                                       |
|    |    | rF3           | = ( " )            |               | Ø0 next clock (T8)                    |
|    |    | rRf           | = TpØ1(GOHt)       |               |                                       |
|    |    | rJu           | = Tp               |               |                                       |
|    |    | Oc            | = TpEndSk          |               |                                       |
|    |    | rO(1,3,4,5,6) | = Oc               |               | NOP (20) → 0                          |
|    |    | sO2           | = Oc               |               |                                       |

|    |    |               |   |                                       |            |
|----|----|---------------|---|---------------------------------------|------------|
| Ø0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                             | Ø5 next (T7)                          |            |
|    |    | rCz           | = Ø0T8  |                                       |            |
|    |    | sF1           | = T8GO  |                                       |            |
|    |    | sF3           | = T8GO  |                                       |            |
|    |    | rHt           | = T8K <del>sk</del> gCpGO                                     | initiate idle (also reset halt light) |            |
|    |    | sHz           | = T8  |                                       |            |
| Ø5 | T7 | Ar3           | = (01020304)Q1  |                                       |            |
|    |    | sA(0-2)       | = A(21-23) $\overline{\text{AnrAr3}}$                         |                                       |            |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "                                | Recirculate A                         | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3  |                                       |            |
|    |    | rA( " )       | = $\overline{\text{A( " )}}$ "                                |                                       |            |
|    |    | sB(0-2)       | = B(21-23) $\overline{\text{BnrAr3}}$                         |                                       |            |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "                                | Recirculate B                         | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3  |                                       |            |
|    |    | rB( " )       | = $\overline{\text{B( " )}}$ "                                |                                       |            |
|    |    | End           | = Ø5( $\overline{\text{A00+G0}}$ )                            | last cycle                            |            |
|    |    | sXw(1-3)      | = Xn(1-3) $\overline{\text{Xnr}}$                             |                                       |            |
|    |    | rXw( " )      | = $\overline{\text{Xn( " )}}$ "                               | Recirculate X                         |            |
| T4 |    | Sc            | = T4( $\overline{\text{End+F1F2}}$ ) $\overline{\text{Inr}}$  |                                       |            |
|    |    | rS(1-14)      | = Sc  | Clear S                               |            |
| Tr |    | rIa           | = TrF1  |                                       |            |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ ) ( $\overline{\text{GOHt}}$ ) |                                       |            |
|    |    | rRc           | = Tr  |                                       |            |
| Tp |    | rF1           | = TpEndSk   |                                       |            |
|    |    | rF3           | = ( " )   | Ø0 next clock (T8)                    |            |
|    |    | rRf           | = TpØ1( $\overline{\text{GOHt}}$ )                            |                                       |            |
|    |    | rJu           | = Tp  |                                       |            |
|    |    | Oc            | = TpEndSk   |                                       |            |
|    |    | rO(1,3,4,5,6) | = Oc  | NOP (20) → 0                          |            |
|    |    | sO2           | = Oc  |                                       |            |

The X register is now being displayed. The following shows what takes place when the Register Selector Switch is returned to C.

|    |    |               |                        |  |                                       |
|----|----|---------------|------------------------|--|---------------------------------------|
| Ø0 | T8 | rC24          | = T8(TsTsr)            |  |                                       |
|    |    | rCz           | = Ø0T8                 |  |                                       |
|    |    | sF1           | = T8GØ                 |  |                                       |
|    |    | sF3           | = T8GØ                 |  | Ø5 next (T7)                          |
|    |    | rHt           | = T8KsKgCpGØ           |  | initiate idle (also reset halt light) |
|    |    | sHz           | = T8                   |  |                                       |
| Ø5 | T7 | Ar3           | = (01020304)Q1         |  |                                       |
|    |    | sA(0-2)       | = A(21-23)AnrAr3       |  |                                       |
|    |    | rA( " )       | = A( " ) "             |  | Recirculate A                         |
|    |    | sA(3-23)      | = A(0-20)Ar3           |  | T7 thru T0                            |
|    |    | rA( " )       | = A( " ) "             |  |                                       |
|    |    | sB(0-2)       | = B(21-23)BnrAr3       |  |                                       |
|    |    | rB( " )       | = B( " ) "             |  | Recirculate B                         |
|    |    | sB(3-23)      | = B(0-20)Ar3           |  | T7 thru T0                            |
|    |    | rB( " )       | = B( " ) "             |  |                                       |
|    |    | End           | = Ø5(AØØ+GØ)           |  | last cycle                            |
|    |    | sXw(1-3)      | = Xn(1-3)Xnr           |  | Recirculate X                         |
|    |    | rXw( " )      | = Xn( " ) "            |  |                                       |
| T4 |    | Sc            | = T4(End+F1F2)Inr      |  | Clear S                               |
|    |    | rS(1-14)      | = Sc                   |  |                                       |
| Tr |    | rIa           | = TrF1                 |  |                                       |
|    |    | rIx           | = Tr(F1F3)(GØHt)       |  |                                       |
|    |    | rRc           | = Tr                   |  |                                       |
| Ø5 | Ø0 | sEx           | = (TsTpGØHt)(AØØBØØ)KØ |  | initiate exchange between X and C.    |
|    |    | rF1           | = TpEndSk              |  |                                       |
|    |    | rF3           | = ( " )                |  | Ø0 next clock (T8)                    |
|    |    | rRf           | = TpØ1(GØHt)           |  |                                       |
|    |    | rJu           | = Tp                   |  |                                       |
|    |    | Oc            | = TpEndSk              |  |                                       |
|    |    | rO(1,3,4,5,6) | = Oc                   |  | NOP (20) → 0                          |
|    |    | sO2           | = Oc                   |  |                                       |

|    |    |               |   |                    |                                       |
|----|----|---------------|---|--------------------|---------------------------------------|
| Ø0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                             |                    |                                       |
|    |    | rCz           | = Ø0T8  |                    |                                       |
|    |    | sF1           | = T8GØ  |                    |                                       |
|    |    | sF3           | = T8GØ  |                    | Ø5 next (T7)                          |
|    |    | rHt           | = T8KsKpGpGØ  |                    | initiate idle (also reset halt light) |
|    |    | sHz           | = T8  |                    |                                       |
| Ø5 | T7 | Ar3           | = (01020304)Q1  |                    |                                       |
|    |    | sA(0-2)       | = A(21-23)AnrAr3  |                    |                                       |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "                             | Recirculate A      | T7 thru T0                            |
|    |    | sA(3-23)      | = A(0-20)Ar3  |                    |                                       |
|    |    | rA( " )       | = $\overline{\text{A}}$ ( " ) " "                             |                    |                                       |
|    |    | sB(0-2)       | = B(21-23)BnrAr3  |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "                             | Recirculate B      | T7 thru T0                            |
|    |    | sB(3-23)      | = B(0-20)Ar3  |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B}}$ ( " ) " "                             |                    |                                       |
|    |    | Cr3           | = Ex( $\overline{\text{TsQ1}}$ )                              |                    |                                       |
|    |    | sC(0-2)       | = Xn(1-3)ExA00B00 $\overline{\text{TsCr3}}$                   |                    |                                       |
|    |    | rC( " )       | = $\overline{\text{Xn}}$ ( " ) " "                            | X → C              | T7 thru T0                            |
|    |    | sC(3-23)      | = C(0-20)Cr3  |                    |                                       |
|    |    | rC( " )       | = $\overline{\text{C}}$ ( " ) " "                             |                    |                                       |
|    |    | End           | = Ø5(A00+GØ)  | last cycle         |                                       |
|    |    | Xnr           | = A00B00Ex  |                    |                                       |
|    |    | sXw(1-3)      | = C(21-23)A00B00Ex  |                    |                                       |
|    |    | rXw( " )      | = $\overline{\text{C}}$ ( " ) " "                             | C → X              | T7 thru T0                            |
| T4 |    | Sc            | = T4(End+ $\overline{\text{F1F2}}$ ) $\overline{\text{Inr}}$  |                    |                                       |
|    |    | rS(1-14)      | = Sc  | Clear S            |                                       |
| T0 |    | rA00          | = ExT0A00   |                    |                                       |
|    |    | rB00          | = ExT0B00Ar3  |                    |                                       |
| Tr |    | rIa           | = TrF1  |                    |                                       |
|    |    | rIx           | = Tr( $\overline{\text{F1F3}}$ ) ( $\overline{\text{GOHt}}$ ) |                    |                                       |
|    |    | rRc           | = Tr  |                    |                                       |
| Tp |    | rEx           | = ExTp  |                    |                                       |
|    |    | rF1           | = TpEnd $\overline{\text{Sk}}$                                |                    |                                       |
|    |    | rF3           | = ( " )   | Ø0 next clock (T8) |                                       |
|    |    | rRf           | = TpØ1 ( $\overline{\text{GOHt}}$ )                           |                    |                                       |
|    |    | rJu           | = Tp  |                    |                                       |
|    |    | Oc            | = TpEnd $\overline{\text{Sk}}$                                |                    |                                       |
|    |    | r0(1,3,4,5,6) | = Oc  | NOP (20) → 0       |                                       |
|    |    | s02           | = Oc  |                    |                                       |



|    |    |               |  |                    |                                       |
|----|----|---------------|--|--------------------|---------------------------------------|
| ∅0 | T8 | rC24          | = T8( $\overline{\text{TsTsr}}$ )                    |                    |                                       |
|    |    | rCz           | = $\overline{\text{∅0T8}}$                           |                    |                                       |
|    |    | sF1           | = $\overline{\text{T8G0}}$                           |                    |                                       |
|    |    | sF3           | = $\overline{\text{T8G0}}$                           |                    | ∅5 next (T7)                          |
|    |    | rHt           | = $\overline{\text{T8KsKpCpG0}}$                     |                    | initiate idle (also reset halt light) |
|    |    | sHz           | = T8   |                    |                                       |
| ∅5 | T7 | Ar3           | = $(\overline{\text{01020304}})\overline{\text{Q1}}$ |                    |                                       |
|    |    | sA(0-2)       | = $\overline{\text{A(21-23)AnrAr3}}$                 |                    |                                       |
|    |    | rA( " )       | = $\overline{\text{A( " ) "}}$                       |                    |                                       |
|    |    | sA(3-23)      | = $\overline{\text{A(0-20)Ar3}}$                     | Recirculate A      | T7 thru T0                            |
|    |    | rA( " )       | = $\overline{\text{A( " ) "}}$                       |                    |                                       |
|    |    | sB(0-2)       | = $\overline{\text{B(21-23)BnrAr3}}$                 |                    |                                       |
|    |    | rB( " )       | = $\overline{\text{B( " ) "}}$                       |                    |                                       |
|    |    | sB(3-23)      | = $\overline{\text{B(0-20)Ar3}}$                     | Recirculate B      | T7 thru T0                            |
|    |    | rB( " )       | = $\overline{\text{B( " ) "}}$                       |                    |                                       |
|    |    | End           | = $\overline{\text{∅5(A00+G0)}}$                     |                    | last cycle                            |
|    |    | sXw(1-3)      | = $\overline{\text{Xn(1-3)Xnr}}$                     |                    |                                       |
|    |    | rXw( " )      | = $\overline{\text{Xn( " ) "}}$                      | Recirculate X      |                                       |
| T4 |    | Sc            | = $\overline{\text{T4(End+F1F2)Inr}}$                |                    |                                       |
|    |    | rS(1-14)      | = Sc   | Clear S            |                                       |
| Tr |    | rIa           | = TrF1   |                    |                                       |
|    |    | rIx           | = $\overline{\text{Tr(F1F3)(GOht)}}$                 |                    |                                       |
|    |    | rRc           | = Tr   |                    |                                       |
| Tp |    | rF1           | = $\overline{\text{TpEndSk}}$                        |                    |                                       |
|    |    | rF3           | = ( " )  | ∅0 next clock (T8) |                                       |
|    |    | rRf           | = $\overline{\text{Tp∅1(GOht)}}$                     |                    |                                       |
|    |    | rJu           | = Tp   |                    |                                       |
|    |    | Oc            | = $\overline{\text{TpEndSk}}$                        |                    |                                       |
|    |    | rO(1,3,4,5,6) | = Oc   | NOP (20) → 0       |                                       |
|    |    | sO2           | = Oc   |                    |                                       |

The Computer is now in normal "IDLE" mode with C being displayed.

|    |     |                              |
|----|-----|------------------------------|
| 03 | UDI | Same as Unconditional Branch |
| 04 | UDI | Same as Halt                 |

|               |     |  |   |                          |
|---------------|-----|--|---|--------------------------|
| 05            | UDI | Branch to Address Plus One, A,B,C Registers Change as in Divide ( $\emptyset 1$ ).   | 5 Cycles  |                          |
| $\emptyset 0$ | T8  | rCz = $\emptyset 0T8$<br>sHz = T8<br>sIx = $C1G0\emptyset 0T8$<br>sJu = $\overline{1aGOC4C5C8C9}T8$<br>Oxc = $\overline{1aGOC2\emptyset 0}T8$<br>sO(1,3,4,5,6) = $C(3,5,6,7,8)Oxc$<br>rO2 = $\overline{C4}Oxc$   | Initialize indexing<br>Instruction to 0 register  |                          |
|               | T7  | sA00 = $\emptyset 0T7A0$<br>Ar3 = $\overline{F1F2O5}Q1$<br>sA(0-2) = $\overline{A(21-23)Anr}Ar3$<br>rA( " ) = $\overline{A( " ) "}$<br>sA(3-23) = $\overline{A(0-20)Ar3}$<br>rA( " ) = $\overline{A( " ) "}$<br>sB(0-2) = $\overline{B(21-23)Bnr}Ar3$<br>rB( " ) = $\overline{B( " ) "}$<br>sB(3-23) = $\overline{B(0-20)Ar3}$<br>rB( " ) = $\overline{B( " ) "}$<br>End = $\overline{JuEaxO1}$<br>Cr3 = $\overline{F1F2(Ts)Q1}$<br>sC0 = $(P12)JuTsCr3Q6$<br>rC0 = $( " ) " "$<br>sC(1,2) = $P(13,14)JuTsCr3Q2$<br>rC( " ) = $\overline{P( " ) "}$<br>sC(3-23) = $\overline{C(0-20)Cr3}$<br>rC( " ) = $\overline{C( " ) "}$<br>sCp = $(C21OC22OC23)CpTsHtQ1F1F2$<br>rCp = $( " ) Cp " "$<br>Pr3 = $JuQ2$<br>sP(0-2) = $\overline{Add(1-3)JuEaxPr3}$<br>rP( " ) = $\overline{Add( " ) "}$<br>sP(3-14) = $\overline{P(0-11)Pr3}$<br>rP( " ) = $\overline{P( " ) "}$<br>Xz(1-3) = $\overline{Xn(1-3)\emptyset 0Ix}$<br>Xz( " ) = $\overline{Xn( " )\emptyset 0Ix+Ix}$<br>Yz(1-3) = $\overline{C(21-23)\emptyset 7}$<br>Yz( " ) = $\overline{C( " ) "}$<br>sCz = $\overline{KzQ1T0}$<br>rCz = $\overline{KzQ1}$ | Set A00 = sign of A<br>Recirculate A<br>Recirculate B<br>Last cycle<br>P(1-14) $\rightarrow$ C(10-23)<br>Parity check<br>C + X·Ix $\rightarrow$ P<br>Input to adder (X·Ix)<br>Input to adder (C)<br>Carry logic | T7 thru T0<br>T7 thru T0 |
|               | T4  | Sc = $\overline{InrF1F2T4}$<br>rS(1-14) = Sc   | Clear S   |                          |
|               | T3  | rC0 = $(JuTsCr3)Q4Q6$<br>Sxp = $\overline{IntEndGOT3}$<br>sS(1,2) = $\overline{Add(2,3)(JuEax)Sxp}$<br>sS(3-14) = $\overline{P(0-11)Sxp}$  | No input to C3, C6, C9<br>P $\rightarrow$ S   | T3 thru T1               |
|               | T2  | rC(1,2) = $(JuTsCr3)T2$  | No input to C7, C8  |                          |
|               | T1  | sC(1,2) = $(JuTsCr3)Em(1,2)T1$<br>rC( " ) = $( " ) Em( " ) "$  | (C1,C2) is (C4,C5) at T1  |                          |
|               | T0  | rCz = $\overline{F1T0}$<br>sC0 = $\overline{Of(JuTsCr3)T0}$<br>rC0 = $\overline{Of( " ) "}$<br>rC(1,2) = $(JuTsCr3)T0$   | Set C0 if overflow<br>No input to C1, C2  |                          |

|    |               |                    |                                |
|----|---------------|--------------------|--------------------------------|
| Tr | Cxm           | = EndGOTsm(Tr+Tp)  |                                |
|    | sC(0-23)      | = M(0-23) Cxm      | M → C (Fetch next instruction) |
|    | rC( " )       | = CxmTr            | Tr thru Tp                     |
|    | sHt           | = CpTrKpK002       | Parity error                   |
|    | rIx           | = (F1F3)(GOHt)Tr   |                                |
|    | rRc           | = Tr               |                                |
| Tp | rA00          | = EndGOTp          |                                |
|    | rB00          | = ( " )            |                                |
|    | sCp           | = M24CxmHtTsTp     | Initiate parity                |
|    | sF3           | = Ia030400Tp       | 01 next clock (T8)             |
|    | rJu           | = Tp               |                                |
|    | Oc            | = (O103Ia+EndSk)Tp |                                |
|    | rO(1,3,4,5,6) | = Oc               |                                |
|    | sO2           | = Oc               | NOP (20) → 0                   |

|    |    |          |                                   |  |                             |
|----|----|----------|-----------------------------------|--|-----------------------------|
| Ø1 | T8 | Anr      | = Ø1Ø5                            |  |                             |
|    |    | Bnr      | = Ø1Ø5                            |  |                             |
|    |    | Ck       | = Ø1T8CØTs                        |  |                             |
|    |    | sC(0-23) | = C(0-23)Ck                       |  |                             |
|    |    | rC( " )  | = C( " ) "                        |  | Invert C if C > 0           |
|    |    | sCz      | = Ø1T8CØ                          |  |                             |
|    |    | sHz      | = T8                              |  | Initiate -B if A-           |
|    |    | sIx      | = Ø1T8CØ                          |  | Set Ix = sign of (M)        |
|    | T7 | Ar3      | = F1F2Ø5Q1                        |  |                             |
|    |    | sA(0-2)  | = (Ha(1-3)AØØ+B(21-23)AØØ)Ø1Ø5Ar3 |  |                             |
|    |    | rA( " )  | = (Ha( " ) " +B( " ) " ) "        |  | B → A if A ≥ 0              |
|    |    | sA(3-23) | = A(0-20)Ar3                      |  | B + 1 → A if A < 0          |
|    |    | rA( " )  | = A( " ) "                        |  | T7 thru TØ                  |
|    |    | Hx(1-3)  | = B(21-23)Ø1                      |  |                             |
|    |    | Hx( " )  | = B( " ) "                        |  | Half adder inputs (B+1)     |
|    |    | sB(0-2)  | = Add(1-3)Ø1Ø5Ar3                 |  | T7 thru TØ                  |
|    |    | rB( " )  | = Add( " ) "                      |  |                             |
|    |    | sB(3-23) | = B(0-20)Ar3                      |  | A  -  C  → B                |
|    |    | rB( " )  | = B( " ) "                        |  | T7 thru TØ                  |
|    |    | Xz(1-3)  | = (A(21-23)AØØ+A(21-23)AØØ)Ø1     |  | Adder input ( A )           |
|    |    | Xz( " )  | = (A( " ) " +A( " ) " ) "         |  | T7 thru TØ                  |
|    |    | Yz(1-3)  | = C(21-23)Ø7                      |  | Adder input ( C )           |
|    |    | Yz( " )  | = C( " ) "                        |  | T7 thru TØ                  |
|    |    | Cr3      | = F1F2(TsQ1)                      |  |                             |
|    |    | sC(0-2)  | = C(21-23)F1F2F3TsCr3             |  |                             |
|    |    | rC( " )  | = C( " ) "                        |  | Recirculate C               |
|    |    | sC(3-23) | = C(0-20)Cr3                      |  | T7 thru TØ                  |
|    |    | rC( " )  | = C( " ) "                        |  |                             |
|    |    | sCp      | = (C21⊕C22⊕C23)CpTsHtQ1F1F2       |  | Check parity                |
|    |    | rCp      | = ( " )Cp "                       |  | T7 thru TØ                  |
|    | T6 | sRf      | = Ø1(Q3Q6)(BØB1B2AØA1A2Bc23)      |  | Rf means 0 ≤ A, B =  C      |
|    | T4 | Sc       | = T4F1F2Inr                       |  | T6 thru Tp                  |
|    |    | rS(1-14) | = Sc                              |  | Clear S                     |
|    | T3 | Sxc      | = T3F1F2Ju                        |  |                             |
|    |    | sS(1,2)  | = Add(2,3)Sxc                     |  |                             |
|    |    | rS( " )  | = Add( " ) "                      |  | Junk input to C             |
|    |    | sS(3-14) | = C(0-11)Sxc                      |  |                             |
|    |    | rS( " )  | = C( " ) "                        |  |                             |
|    | Tr | sBc23    | = Ø1TrHzAØØ                       |  | Set Bc23 if B = 0 and A < 0 |
|    |    | sHt      | = CpTrKØKØØ2                      |  | Parity error                |
|    | Tp | sF2      | = Ø1Tp                            |  | Ø3 next                     |
|    |    | Sc       | = Ø1Tp                            |  |                             |
|    |    | rS(1-14) | = Sc                              |  | Clear S                     |

Ø1 same as for a Divide instruction.

|    |    |          |   |                    |            |
|----|----|----------|---|--------------------|------------|
| Ø3 | T7 | Ar3      | = $\overline{(01020304)}Q1$                         |                    |            |
|    |    | sA(0-2)  | = A(21-23) $\overline{Ar}Ar3$                       |                    |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "                            |                    |            |
|    |    | sA(3-23) | = A(0-20)Ar3  | Recirculate A      | T7 thru T0 |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "                            |                    |            |
|    |    | sB(0-2)  | = B(21-23) $\overline{Br}Ar3$                       |                    |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "                            |                    |            |
|    |    | sB(3-23) | = B(0-20)Ar3  | Recirculate B      | T7 thru T0 |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "                            |                    |            |
| T0 |    | rCp      | = $\overline{TsHtK0}(F1+F2)(\overline{07040602})T0$ |                    |            |
|    |    | rCz      | = $\overline{Fl}T0$                                 |                    |            |
| Tp |    | sSk      | = $\overline{030506}Tp$                             |                    |            |
|    |    | sFl      | = TpSk  | Ø7 next clock (T8) |            |

|    |    |          |                                  |                                |            |
|----|----|----------|----------------------------------|--------------------------------|------------|
| Ø7 | T8 | Ck       | = Ø7T8Ts                         |                                |            |
|    |    | sC(0-23) | = C(0-23)Ck                      | Invert C                       |            |
|    |    | rC( " )  | = C( " ) "                       |                                |            |
|    |    | End      | = F1F2                           | Last cycle                     |            |
|    |    | sIa      | = T8Ø7SkIjKr                     | Initiate P register increment  |            |
| T7 |    | Cr3      | = Ø7Ø5TsQ1                       |                                |            |
|    |    | rC(0-2)  | = "                              |                                |            |
|    |    | sC(3-23) | = C(0-20)Cr3                     | 0 → C                          | T7 thru T0 |
|    |    | rC( " )  | = C( " ) "                       |                                |            |
|    |    | Pr3      | = (F1G0)Q2                       |                                |            |
|    |    | sP0      | = (P12P13P14Ia)F1G0(Ø2Ø4Ø5Ø6)Pr3 |                                |            |
|    |    | rP0      | = ( " ) "                        |                                |            |
|    |    | sP1      | = (P13P14Ia) "                   |                                |            |
|    |    | rP1      | = ( " ) "                        |                                |            |
|    |    | sP2      | = (P14Ia) "                      | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) "                        |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                     |                                |            |
|    |    | rP( " )  | = P( " ) "                       |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                |                                |            |
| T6 |    | Xz(1-3)  | = B(21-23)Ø7Ø5Ø6                 | Adder input (B)                | T6 thru Tr |
|    |    | Xz( " )  | = B( " ) "                       |                                |            |
|    |    | Yz3      | = Ø7Bc23                         |                                |            |
|    |    | rYz1     | = Ø7RF                           | Adder input (Bc)               | T6 thru Tr |
|    |    | rYz2     | = Ø7KØ                           |                                |            |
|    |    | rYz3     | = Ø7Bc23                         |                                |            |
| T4 |    | Sc       | = T4EndInr                       |                                |            |
|    |    | rS(1-14) | = Sc                             | Clear S                        |            |
| T3 |    | Sxp      | = T3IntEndGO                     |                                |            |
|    |    | sS(1,2)  | = P(13,14)IaF1G0(Ø2Ø4Ø5Ø6)Sxp    | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )  | = P( " ) " ( " ) "               | P → S                          |            |
|    |    | sS(3-14) | = P(0-11)Sxp                     |                                |            |
|    |    | rS( " )  | = P( " ) "                       |                                |            |
| T0 |    | rSk      | = Ø7T0                           |                                |            |
| Tr |    | Cxm      | = EndGO $\overline{Tsm}(Tr+Tp)$  | M → C (Fetch next instruction) | Tr thru Tp |
|    |    | sC(0-23) | = M(0-23)Cxm                     |                                |            |
|    |    | rC( " )  | = TrCxm                          |                                |            |
|    |    | sHt      | = CpTrKpKØØ2                     | Parity error                   |            |
|    |    | rIa      | = F1Tr                           |                                |            |
|    |    | rIx      | = Tr(F1F3)(GOHt)                 |                                |            |
| Tp |    | rA00     | = TpEndGO                        |                                |            |
|    |    | rB00     | = TpEndGO                        |                                |            |
|    |    | sCp      | = M24CxmHtTsTp                   | Initiate parity                |            |
|    |    | rF(1-3)  | = TpEndSk                        | Ø0 next                        |            |

|               |     |   |  |
|---------------|-----|---|--|
| 07            | UDI | Branch to Address Plus One. (Phasing Similar to Left Shift, May Hang-up in $\emptyset 3$ if Sk Doesn't Set) (Shift May Occur But it May be Dependent Upon Contents of P Register) |  |
| $\emptyset 0$ | T8  | rCz   | = $\emptyset 0T8$  |
|               |     | sIx   | = $C1G0\emptyset 0T8$ Initialize indexing  |
|               |     | sJu   | = $\overline{C4C5C8C9}IaG0\emptyset 0T8$   |
|               |     | Oxc   | = $\overline{C2}IaG0\emptyset 0T8$   |
|               |     | sO(1,3,4,5,6)   | = $C(3,5,6,7,8)Oxc$ C(3-8) $\rightarrow$ 0 if not indirect addressi  |
|               |     | rO2   | = $\overline{C4}Oxc$   |
| T7            |     | sA00  | = $A0\emptyset 0T7$ Save sign of A   |
|               |     | Ar3   | = $(01020304)Q1$   |
|               |     | sA(0-2)   | = $A(21-23)\overline{Anr}Ar3$  |
|               |     | rA( " )   | = $\overline{A( " ) "}$  |
|               |     | sA(3-23)  | = $A(0-20)Ar3$ Recirculate A T7 thru T0  |
|               |     | rA( " )   | = $\overline{A( " ) "}$  |
|               |     | sB(0-2)   | = $B(21-23)\overline{Bnr}Ar3$  |
|               |     | rB( " )   | = $\overline{B( " ) "}$  |
|               |     | sB(3-23)  | = $B(0-20)Ar3$ Recirculate B T7 thru T0  |
|               |     | rB( " )   | = $\overline{B( " ) "}$  |
|               |     | Cr3   | = $\overline{F1F2}(TsQ1)$ T7 thru T2   |
|               |     | sC0   | = $(P12)JuTsCr3Q6$   |
|               |     | rC0   | = $( " ) " " " " " "$  |
|               |     | sC(1,2)   | = $P(13,14)JuTsCr3Q2$  |
|               |     | rC( " )   | = $\overline{P( " ) "}$ P(6-14) $\rightarrow$ C(15-23) T7 thru T5  |
|               |     | sC(3-23)  | = $C(0-20)Cr3$   |
|               |     | rC( " )   | = $\overline{C( " ) "}$  |
|               |     | End   | = $JuEax0I$  |
|               |     | Xz(1-3)   | = $Xn(1-3)\emptyset 0Ix$ Adder input if Ix(indexing)   |
|               |     | $\overline{Xz}( " )$  | = $\overline{Xn( " ) " +Ix}$ T7 thru T0  |
|               |     | Yz(1-3)   | = $C(21-23)\emptyset 7$  |
|               |     | $\overline{Yz}( " )$  | = $\overline{C( " ) "}$ Adder input (C) T7 thru T0   |
|               |     | sCz   | = $Kz\emptyset 7Q1T0$  |
|               |     | rCz   | = $\overline{Kz}Q1$ Carry logic T7 thru T0   |
|               |     | sCp   | = $(C21\oplus C22\oplus C23)\overline{Cp}TsHtQ1F1F2$   |
|               |     | rCp   | = $( " " )Cp " "$ Check parity T7 thru T0  |
|               |     | Pr3   | = $JuQ2$   |
|               |     | sP(0-2)   | = $Add(1-3)JuEaxPr3$   |
|               |     | rP( " )   | = $Add( " ) " " "$   |
|               |     | sP(3-14)  | = $P(0-11)Pr3$ C + X·Ix $\rightarrow$ P T7 thru T3   |
|               |     | rP( " )   | = $\overline{P( " ) "}$  |
| $\emptyset 1$ | T5  | sF3   | = $Ia030405\emptyset 0Q4$ $\emptyset 1$ next clock (T8)  |
|               | T4  | sC0   | = $(C21F1F2F3+P12JuQ6)\overline{Ts}Cr3$ Merge (P4+C12 $\rightarrow$ C15) T4 only   |
|               |     | rC0   | = $(C21 " +P12 " ) " "$ C(6,9) $\rightarrow$ C(9,12) T3 thru T2  |
|               |     | sC(1,2)   | = $(C(22,23)F1F2F3+P(13,14)JuQ2)\overline{Ts}Cr3$ Merge (P(2,3,5,6)+C(10,11,13,14) $\rightarrow$ C(13,14,16,17) T4 thru T3 |
|               |     | rC( " )   | = $(\overline{C( " ) " +P( " ) " } " " "$ C(7,8) $\rightarrow$ C(10,11) T2 only  |
|               |     | sC  | = $\overline{Inr}F1F2T4$   |
|               |     | rS(1-14)  | = $Sc$ Clear S   |
| T3            |     | rC0   | = $JuTsCr3Q4Q6$ No inputs to C6,C9 T3 thru T2  |



|       |               |                            |                                       |
|-------|---------------|----------------------------|---------------------------------------|
|       | Sxp           | = (End+JuEax)IntT3         |                                       |
|       | sS(1,2)       | = Add(2,3)JuEaxSxp         |                                       |
|       | rS( " )       | = Add( " ) " "             |                                       |
|       | sS(3-14)      | = P(0-11)Sxp               | P → S                                 |
|       | rS( " )       | = P( " ) " "               |                                       |
| T2    | rC(1,2)       | = JuTsCr3T2                | No input C7,C8                        |
|       | sF2           | = 050102                   | 03 next clock (T8)                    |
|       | Sx48          | = (S6S7S8+S9S10)0501T2     | Shift > 48 bits                       |
|       | rS(1-8)       | = 0501T2                   | Zero → S(1-8)                         |
|       | sS(9,10)      | = Sx48                     | Set count = 48 if shift ≥ 48          |
|       | rS(11-14)     | = Sx48                     | Leave count alone if shift < 48       |
|       | sSk           | = (0501T2)(S6S7...S14)     | Count = zero                          |
|       | sSk           | = ( " ) (A0A1)C2           | A,B normalized C2=C11(norm.bit) at T2 |
|       | rS14          | = ( " ) ( " )C2            | Avoid clean up shift.                 |
| 03 T1 | AL2           | = 0506Sk03                 | See instruction 67 (03 T1)            |
|       | sB(22,23)     | = A(0,1)AL2C405            | " " " "                               |
|       | rB( " )       | = A( " ) " "               | " " " "                               |
|       | Sd2           | = 0506Sk03                 | " " " "                               |
|       | sSk           | = 05Sk(S9S10S11S12)S1303   | " " " "                               |
|       | sSk           | = 0506Sk(S9S10S11S12)S1403 |                                       |
| T0    | rCz           | = FIT0                     |                                       |
|       | sC0           | = Of(JuTsCr3)T0            |                                       |
|       | rC0           | = Of( " )T0                |                                       |
|       | rC(1,2)       | = (JuTsCr3)T0              | No input to C1,C2                     |
|       | rCp           | = TsTOHtK0(F2070406)02     | Avoid erroneous parity error          |
|       | (refer 03 T1) |                            |                                       |
| Tr    | sHt           | = CpTrKpK002               | Parity error                          |
|       | (refer 03 T1) |                            |                                       |

If Sk is not set ( $\overline{Sk}$ ) the Computer will hang up in 03. If Sk sets before Tp, the Computer will remain in a dynamic halt until Tp occurs.

|    |               |                   |                                 |
|----|---------------|-------------------|---------------------------------|
| Tp | Arl           | = (0506SkS14)03Tp | See instruction 67 (03 Tp)      |
|    | Brl           | = ( " ) " "       | " " " "                         |
|    | sFl           | = TpSk            | 07 next clock (T8)              |
|    | rJu           | = Tp              |                                 |
|    | Oc            | = EndSkTp         |                                 |
|    | rO(1,3,4,5,6) | = Oc              | NOP (20) → 0 if $\overline{Sk}$ |
|    | sO2           | = Oc              |                                 |
|    | rRf           | = (GOHt)01Tp      | Clear Rf                        |

If 07 occurs Sk must be set and the instruction (07) is still in 0.

|       |          |                                      |                                     |            |
|-------|----------|--------------------------------------|-------------------------------------|------------|
| Ø7 T8 | Ck       | = Ø7T8Ts                             |                                     |            |
|       | sC(0-23) | = C(0-23)Ck                          | Invert C                            |            |
|       | rC( " )  | = C( " )Ck                           |                                     |            |
|       | End      | = F1F2                               |                                     |            |
|       | sIa      | = SkT8Ø7IaKr                         | Initiate P register increment       |            |
|       | sBc23    | = (Ø705T8)S14                        | Rf, K0, Bc23 form an Octal input to |            |
|       | sK0      | = ( " )S7                            | Yz(1-3) from T8 thru T6 which       |            |
|       | sRf      | = ( " )S6                            | represent the negative number of    |            |
|       |          |                                      | shifts during normalize.            |            |
| T7    | Ar3      | = Ø706Q1                             |                                     |            |
|       | sA(0-2)  | = A(21-23)ArAr3                      |                                     |            |
|       | rA( " )  | = A( " ) "                           | Recirculate A                       | T7 thru T0 |
|       | sA(3-23) | = A(0-20)Ar3                         |                                     |            |
|       | rA( " )  | = A( " ) "                           |                                     |            |
|       | sB(0-2)  | = B(21-23)BrAr3                      |                                     |            |
|       | rB( " )  | = B( " ) "                           | Recirculate B                       | T7 thru T0 |
|       | sB(3-23) | = B(0-20)Ar3                         |                                     |            |
|       | rB( " )  | = B( " ) "                           |                                     |            |
|       | Pr3      | = (F1G0)Q2                           |                                     |            |
|       | sP0      | = ( " ) (Ø2040506) (P12P13P14Ia) Pr3 |                                     |            |
|       | rP0      | = ( " ) ( " ) (P12P13P14Ia) "        |                                     |            |
|       | sP1      | = ( " ) ( " ) (P13P14Ia) Pr3         |                                     |            |
|       | rP1      | = ( " ) ( " ) (P13P14Ia) "           | P → S                               | T7 thru T3 |
|       | sP2      | = ( " ) ( " ) (P14Ia) Pr3            |                                     |            |
|       | rP2      | = ( " ) ( " ) (P14Ia) "              |                                     |            |
|       | rIa      | = P12P13P14Q2F1                      |                                     |            |
|       | sP(3-14) | = P(0-11)Pr3                         |                                     |            |
|       | rP( " )  | = P( " ) "                           |                                     |            |
|       | Xnr      | = Ø3(040506)C5Ø7                     |                                     |            |
|       | sXw(1-3) | = Add(1-3)Ø3(040506)C5Ø7F1           | X+S(2-7)+S14 → X                    |            |
|       | rXw( " ) | = Add( " ) "                         | (X=number of shifts → X)            | T7 thru T0 |
|       | Xz(1-3)  | = Xn(1-3)IxØ705                      | Adder input (X)                     | T7 thru T0 |
|       | Xz( " )  | = Xn( " ) "                          |                                     |            |
|       | Yz1      | = RfØ7                               | Adder input (S)                     |            |
|       | Yz1      | = RfØ7                               | Bits S3 thru S7 contains            |            |
|       | Yz2      | = K0Ø7                               | a negative count of the             |            |
|       | Yz2      | = K0Ø7                               | AL2's during normalize.             |            |
|       | Yz3      | = Bc23Ø7                             | S14 contains the clean up.          |            |
|       | Yz3      | = Bc23Ø7                             |                                     |            |
|       | sBc23    | = (Ø705T7)S5                         |                                     |            |
|       | rBc23    | = ( " )S5                            |                                     |            |
|       | sK0      | = ( " )S4                            | Rf, K0 and Bc23 must                |            |
|       | rK0      | = ( " )S4                            | be set for the next                 |            |
|       | sRf      | = ( " )S3                            | clock                               |            |
|       | rRf      | = ( " )S3                            |                                     |            |

|    |               |                                    |                               |            |
|----|---------------|------------------------------------|-------------------------------|------------|
| T6 | sBc23         | = ( $\emptyset 705T6$ )S2          |                               |            |
|    | sK0           | = ( " )S2                          | Extend minus sign for         | T5 thru T0 |
|    | sRf           | = ( " )S2                          | negative count to Yz          |            |
| T4 | Sc            | = T4EndInr                         |                               |            |
|    | rS(1-14)      | = Sc                               | Clear S                       |            |
| T3 | Sxp           | = T3IntEndGO                       |                               |            |
|    | sS1           | = (F1GO) (02040506) (P13P14Ia) Sxp |                               |            |
|    | sS2           | = ( " ) ( " ) (P14Ia) Sxp          | P → S                         |            |
|    | sS(3-14)      | = P(0-11) Sxp                      |                               |            |
| T0 | rSk           | = $\emptyset 7T0$                  |                               |            |
| Tr | Cxm           | = EndGO $\overline{Tsm}(Tr+Tp)$    | M → C(Fetch next instruction) |            |
|    | sC(0-23)      | = M(0-23) Cxm                      |                               | Tr thru Tp |
|    | rC( " )       | = CxmTr                            |                               |            |
|    | rIa           | = TrF1                             |                               |            |
|    | rIx           | = Tr(F1F3) (GOht)                  |                               |            |
|    | rK0           | = $\emptyset 7Tr$                  |                               |            |
|    | rA00          | = TpEndGO                          |                               |            |
| Tp | sCp           | = M24CxmTp $\overline{HtTs}$       | Initiate parity               |            |
|    | rF(1-3)       | = TpEndSK                          | $\emptyset 0$ next clock (T8) |            |
|    | rRf           | = Tp $\overline{OI}(GOht)$         |                               |            |
|    | Oc            | = TpEndSK                          |                               |            |
|    | sO2           | = Oc                               |                               |            |
|    | rO(1,3,4,5,6) | = Oc                               | NOP (20) → 0                  |            |

|    |     |   |   |  |
|----|-----|---|---|--|
| 11 | UDI | Similar to Parallel Output When Ready (Next instruction is found in location designated by operand)   | (M) → Output Device   | 3 Cycles + Wait  |
| 00 | T8  | rCz = 0T8<br>sIx = 0T8C1GO<br>Oxc = (0T8IaGO)C2<br>sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc<br>rO2 = C4Oxc   | Initialize indexing<br>Instruction → 0  |  |
|    | T7  | Ar3 = (01020304)Q1<br>sA(0-2) = A(21-23)AnrAr3<br>rA( " ) = A( " ) "<br>sA(3-23) = A(0-20)Ar3<br>rA( " ) = A( " ) "<br>sB(0-2) = B(21-23)BnrAr3<br>rB( " ) = B( " ) "<br>sB(3-23) = B(0-20)Ar3<br>rB( " ) = B( " ) "<br>Cr3 = F1F2(TsQ1)<br>sC(0-2) = Add(1-3)0JuTsCr3<br>rC( " ) = Add( " ) "<br>sC(3-23) = C(0-20)Cr3<br>rC( " ) = C( " ) "<br>Xz(1-3) = Xn(1-3)0·Ix<br>Xz( " ) = Xn( " )0Ix+Ix<br>Yz(1-3) = C(21-23)07<br>Yz( " ) = C( " ) "<br>sCz = KzQ1T007<br>rCz = KzQ1<br>sCp = (C210C220C23)CpTsHtQ1F1F2<br>rCp = ( " )Cp " | Recirculate A<br>Recirculate B<br>C+X·Ix → C (Add=Xz+Yz)<br>Adder input (XIx)<br>Adder input (C)<br>Carry logic<br>Check parity | T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T0<br>T7 thru T1<br>T7 thru T0 |
|    | T4  | Sc = T4F1F2Inr  | Clear S   |  |
|    | T3  | Sxc = T3F1F2Ju<br>sS(1,2) = Add(2,3)Sxc<br>sS(3-14) = C(0-11)Sxc  | C + X·Ix → S  |  |
|    | T0  | rCz = F1T0  |   |  |
|    | Tr  | Cxm = Ju0Tsm(Tr+Tp)<br>sC(0-23) = M(0-23)Cxm<br>rC( " ) = TrCxm<br>sHt = CpTrK002<br>rIx = Tr(F1F3)(GOHt)<br>rK0 = GOTrF2   | M → C (Fetch operand)<br>Parity error   | Tr thru Tp   |
|    | Tp  | sCp = M24CxmHtTsTp<br>sF2 = (TpIa00)0302  | Initiate parity<br>02 next clock (T8)   |  |

|               |    |          |  |                                       |                    |
|---------------|----|----------|--|---------------------------------------|--------------------|
| $\emptyset 2$ | T7 | Ar3      | = $(01020\overline{304})Q1$                  |                                       |                    |
|               |    | sA(0-2)  | = $A(21-23)\overline{Ar}Ar3$                 |                                       |                    |
|               |    | rA( " )  | = $\overline{A( " ) "}$                      |                                       |                    |
|               |    | sA(3-23) | = $A(0-20)Ar3$                               | Recirculate A                         | T7 thru T0         |
|               |    | rA( " )  | = $\overline{A( " ) "}$                      |                                       |                    |
|               |    | sB(0-2)  | = $B(21-23)\overline{Br}Ar3$                 |                                       |                    |
|               |    | rB( " )  | = $\overline{B( " ) "}$                      |                                       |                    |
|               |    | sB(3-23) | = $B(0-20)Ar3$                               | Recirculate B                         | T7 thru T0         |
|               |    | rB( " )  | = $\overline{B( " ) "}$                      |                                       |                    |
|               |    | sRf      | = $Q2\overline{F306}F2Rt$                    | External Device is ready (Rt)         | T7 thru T3         |
|               |    |          |  | to receive information                | from the computer. |
| T0            |    | rCz      | = $\overline{F1}T0$                          |                                       |                    |
| Tp            |    | sF1      | = $Tp(F1\overline{F3010304})\overline{Ia}Rf$ | $\emptyset 6$ next if Rf              |                    |
|               |    |          |  | $\emptyset 2$ next if $\overline{Rf}$ |                    |
|               |    | rRf      | = $Tp\overline{01}(\overline{GOHt})$         |                                       |                    |

The Computer will continue to repeat  $\emptyset 2$  until the External Device becomes ready, at which time the data will be transferred in parallel from the C register to the device. At Tp time, following the transfer,  $\emptyset 6$  will occur.

|    |    |          |                                  |                                       |            |
|----|----|----------|----------------------------------|---------------------------------------|------------|
| 06 | T8 | sIa      | = T8F1F3(1)Kr                    | Has no effect                         |            |
|    |    | End      | = F1F2                           | Last cycle                            |            |
|    | T7 | Ar3      | = (01020304)Q1                   |                                       |            |
|    |    | sA(0-2)  | = A(21-23)ArAr3                  |                                       |            |
|    |    | rA( " )  | = A( " ) " "                     | Recirculate A                         | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                     |                                       |            |
|    |    | rA( " )  | = A( " ) " "                     |                                       |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                 |                                       |            |
|    |    | rB( " )  | = B( " ) " "                     | Recirculate B                         | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                     |                                       |            |
|    |    | rB( " )  | = B( " ) " "                     |                                       |            |
|    |    | Cr3      | = F1F3(TsQ1)                     |                                       |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                |                                       |            |
|    |    | rC( " )  | = Add( " ) " "                   | A + C → C                             | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                     |                                       |            |
|    |    | rC( " )  | = C( " ) " "                     |                                       |            |
|    |    | XZ(1-3)  | = X                              |                                       |            |
|    |    | Yz(1-3)  | = C(21-23)07                     | Adder input (C)                       |            |
|    |    | YZ( " )  | = C( " ) " "                     |                                       |            |
|    |    | sCz      | = KzQ1F107                       |                                       |            |
|    |    | rCz      | = KzQ1                           | Carry logic                           | T7 thru T0 |
|    |    | sCp      | = (C21 ⊕ C22 ⊕ C23) CpTsHtQ10603 |                                       |            |
|    |    | rCp      | = ( " ) Cp " "                   | Check parity                          | T7 thru T0 |
|    |    | Pr3      | = (F1G0)Q2                       |                                       |            |
|    |    | sP(0-2)  | = Add(1-3)02040506Pr3            | C(10-23) → P                          | T7 thru T3 |
|    |    | rP( " )  | = Add( " ) " "                   | C contains operand (bits 14-23 of     |            |
|    |    | sP(3-14) | = P(0-11)Pr3                     | which represent I/O starting address) |            |
|    |    | rP( " )  | = P( " ) " "                     |                                       |            |
|    |    | rIa      | = (P12P13P14)Q2F1                | Has no effect                         |            |
|    | T4 | Sc       | = T4EndInr                       | Clear S                               |            |
|    |    | rS(1-14) | = Sc                             |                                       |            |
|    | T3 | Sxp      | = T3IntEndG0                     |                                       |            |
|    |    | sS1      | = Add(2,3)02040506Sxp            |                                       |            |
|    |    | rS1      | = Add( " ) " "                   | C(10-23) + A(10-23) → S               |            |
|    |    | sS(3-14) | = P(0-11)Sxp                     |                                       |            |
|    |    | rS( " )  | = P( " ) " "                     |                                       |            |
|    | Tr | Cxm      | = EndG0Tsm(Tr+Tp)                | M → C (Fetch next instruction)        |            |
|    |    | sC(0-23) | = M(0-23)Cxm                     |                                       | Tr thru Tp |
|    |    | rC( " )  | = CxmTr                          |                                       |            |
|    |    | sHt      | = CpTrKpK002                     | Parity error                          |            |

|    |               |                   |                   |
|----|---------------|-------------------|-------------------|
|    | rIa           | = TrF1            |                   |
|    | rIx           | = Tr(F1F3) (GOHt) |                   |
| Tp | rA00          | = TpEndGO         |                   |
|    | rB00          | = ( " )           |                   |
|    | sCp           | = M24CxmHtTsTp    | Initiate parity   |
|    | rF(1,2)       | = TpEndSk         | 0 next clock (T8) |
|    | Oc            | = ( " )           |                   |
|    | sO2           | = Oc              |                   |
|    | rO(1,3,4,5,6) | = Oc              | NOP (20) → 0      |

|    |          |                                 |                              |            |
|----|----------|---------------------------------|------------------------------|------------|
| 15 | UDI      | Two Cycle NOP                   |                              | 2 Cycles   |
| 00 | T8       | rCz = 00T8                      | Initialize carry             |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing          |            |
|    |          | Oxc = (00T8IaG0)C2              |                              |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0              |            |
|    |          | rO2 = C4Oxc                     |                              |            |
| T7 | Ar3      | = (01020304)Q1                  |                              |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                | Recirculate A                | T7 thru T0 |
|    | rA( " )  | = A( " ) "                      |                              |            |
|    | sA(3-23) | = A(0-20)Ar3                    |                              |            |
|    | rA( " )  | = A( " ) "                      |                              |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                | Recirculate B                | T7 thru T0 |
|    | rB( " )  | = B( " ) "                      |                              |            |
|    | sB(3-23) | = B(0-20)Ar3                    |                              |            |
|    | rB( " )  | = B( " ) "                      |                              |            |
|    | Cr3      | = F1F2(TsQ1)                    |                              |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             | C+X·Ix → C (Add=Xz+Yz)       | T7 thru T0 |
|    | rC( " )  | = Add( " ) "                    |                              |            |
|    | sC(3-23) | = C(0-20)Cr3                    |                              |            |
|    | rC( " )  | = C( " ) "                      |                              |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input if Ix (indexing) |            |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                              | T7 thru T0 |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input C register       | T7 thru T0 |
|    | Yz( " )  | = C( " ) "                      |                              |            |
|    | sCz      | = KzQ1T007                      | Carry for Adder              | T7 thru T1 |
|    | rCz      | = KzQ1                          |                              |            |
|    | sCp      | = (G210C220C23)CpTsHtQ1F1F2     | Check parity                 | T7 thru T0 |
|    | rCp      | = ( " )Cp "                     |                              |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                      |            |
|    | rS(1-14) | = Sc                            |                              |            |
| T3 | Sxc      | = T3F1F2Ju                      |                              |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   | C + X·Ix → S                 |            |
|    | sS(3-14) | = C(0-11)Sxc                    |                              |            |
| T0 | rCz      | = F1T0                          |                              |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch operand)        | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                              |            |
|    | rC( " )  | = TrCxm                         |                              |            |
|    | sHt      | = CpTrKpK002                    | Parity error                 |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                              |            |
|    | rK0      | = GOTrF2                        |                              |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity              |            |
|    | sF1      | = (TpIa00)0304                  |                              |            |
|    | sF2      | = ( " )0302                     | 06 next clock (T8)           |            |



|    |    |          |                                   |                                |            |
|----|----|----------|-----------------------------------|--------------------------------|------------|
| 06 | T8 | sIa      | = T8F1F31 <del>1</del> Cr         | Initiate P register increment  |            |
|    |    | End      | = F1F2                            | Last cycle                     |            |
|    | T7 | Ar3      | = (01020304)Q1                    |                                |            |
|    |    | sA(0-2)  | = A(21-23)AnrAr3                  |                                |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "          | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23) | = A(0-20)Ar3                      |                                |            |
|    |    | rA( " )  | = $\overline{A}$ ( " ) "          |                                |            |
|    |    | sB(0-2)  | = B(21-23)BnrAr3                  |                                |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "          | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23) | = B(0-20)Ar3                      |                                |            |
|    |    | rB( " )  | = $\overline{B}$ ( " ) "          |                                |            |
|    |    | Cr3      | = F1F3(TsQ1)                      |                                |            |
|    |    | sC(0-2)  | = Add(1-3)06TsCr3                 |                                |            |
|    |    | rC( " )  | = $\overline{Add}$ ( " ) "        | A + C → C                      | T7 thru T0 |
|    |    | sC(3-23) | = C(0-20)Cr3                      |                                |            |
|    |    | rC( " )  | = $\overline{C}$ ( " ) "          |                                |            |
|    |    | Xz(1-3)  | = A(21-23)060204                  |                                |            |
|    |    | Xz( " )  | = $\overline{A}$ ( " ) "          | Unused adder inputs            | T7 thru T0 |
|    |    | Yz(1-3)  | = C(21-23)07                      |                                |            |
|    |    | Yz( " )  | = $\overline{C}$ ( " ) "          |                                |            |
|    |    | sCz      | = KzQ1F107                        |                                |            |
|    |    | rCz      | = KzQ1                            | Carry logic                    | T7 thru T0 |
|    |    | sCp      | = (C210C220C23)CpTsHtQ10603       |                                |            |
|    |    | rCp      | = ( " ) Cp "                      | Check parity                   | T7 thru T0 |
|    |    | Pr3      | = (F1G0)Q2                        |                                |            |
|    |    | sP0      | = (P120P13P14Ia)F1G0(02040506)Pr3 |                                |            |
|    |    | rP0      | = ( " ) "                         |                                |            |
|    |    | sP1      | = (P130P14Ia) " "                 |                                |            |
|    |    | rP1      | = ( " ) "                         |                                |            |
|    |    | sP2      | = (P140Ia) " "                    | P + 1 → P                      | T7 thru T3 |
|    |    | rP2      | = ( " ) "                         |                                |            |
|    |    | sP(3-14) | = P(0-11)Pr3                      |                                |            |
|    |    | rP( " )  | = $\overline{P}$ ( " ) "          |                                |            |
|    |    | rIa      | = (P12P13P14)Q2F1                 |                                |            |
|    | T4 | Sc       | = T4EndInr                        |                                |            |
|    |    | rS(1-14) | = Sc                              | Clear S                        |            |
|    | T3 | Sxp      | = T3IntEndGO                      |                                |            |
|    |    | sS1      | = (P130P14Ia)F1G0(02040506)Sxp    |                                |            |
|    |    | rS1      | = ( " ) "                         |                                |            |
|    |    | sS2      | = (P140Ia) " "                    | P + 1 → S                      |            |
|    |    | rS2      | = ( " ) "                         |                                |            |
|    |    | sS(3-14) | = P(0-11)Sxp                      |                                |            |
|    |    | rS( " )  | = $\overline{P}$ ( " ) "          |                                |            |
|    | Tr | Cxm      | = EndGOIsm(Tr+Tp)                 |                                |            |
|    |    | sC(0-23) | = M(0-23)Cxm                      | M → C (Fetch next instruction) |            |
|    |    | rC( " )  | = TrCxm                           |                                | Tr thru Tp |
|    |    | sHt      | = CpTrCp002                       | Parity error                   |            |

|    |               |                  |                    |
|----|---------------|------------------|--------------------|
|    | rIa           | = TrF1           |                    |
|    | rIx           | = Tr(FIF3)(GOHt) |                    |
| Tp | rA00          | = TpEndGO        |                    |
|    | rB00          | = ( " )          |                    |
|    | sCp           | = M24CcmHtTsTp   | Initiate parity    |
|    | rF(1,2)       | = TpEndSk        | 00 next clock (T8) |
|    | Oc            | = ( " )          |                    |
|    | sO2           | = Oc             |                    |
|    | rO(1,3,4,5,6) | = Oc             | NOP (20) → 0       |

UDI 21  
UDI 22  
UDI 24  
UDI 25  
UDI 26  
UDI 27

21 UDI Same as Execute  
22 UDI Same as EOM 2000(1,2,4,10)-(See EOM for specific EOM instruction)  
24 UDI Same as No Operation  
25 UDI Same as Execute  
26 UDI Same as EOD 200(30,21,12,3)-(See EOD for specific EOD instruction)  
27 UDI Same as Execute

|    |     |   |                        |
|----|-----|---|------------------------|
| 31 | UDI | M → C (00), C → M (04), No Other Registers Affected | 3 Cycles               |
| 00 | T8  | rCz = 00T8  |                        |
|    |     | sIx = 00T8C1G0                                      | Initialize indexing    |
|    |     | Oxc = (00T8IaG0)C2                                  |                        |
|    |     | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc                     | Instruction → 0        |
|    |     | rO2 = C4Oxc   |                        |
|    | T7  | Ar3 = (01020304)Q1                                  |                        |
|    |     | sA(0-2) = A(21-23)AnrAr3                            |                        |
|    |     | rA( " ) = A( " ) "                                  | Recirculate A          |
|    |     | sA(3-23) = A(0-20)Ar3                               |                        |
|    |     | rA( " ) = A( " ) "                                  |                        |
|    |     | sB(0-2) = B(21-23)BnrAr3                            |                        |
|    |     | rB( " ) = B( " ) "                                  | Recirculate B          |
|    |     | sB(3-23) = B(0-20)Ar3                               |                        |
|    |     | rB( " ) = B( " ) "                                  |                        |
|    |     | Cr3 = F1F2(TsQ1)                                    |                        |
|    |     | sC(0-2) = Add(1-3)00JuTsCr3                         |                        |
|    |     | rC( " ) = Add( " ) "                                | C+X·Ix → C (Add=Xz+Yz) |
|    |     | sC(3-23) = C(0-20)Cr3                               |                        |
|    |     | rC( " ) = C( " ) "                                  |                        |
|    |     | Xz(1-3) = Xn(1-3)00·Ix                              | Adder input (XIx)      |
|    |     | Xz( " ) = Xn( " )00Ix+Ix                            |                        |
|    |     | Yz(1-3) = C(21-23)07                                | Adder input (C)        |
|    |     | Yz( " ) = C( " ) "                                  |                        |
|    |     | sGz = KzQ1T007                                      | Carry logic            |
|    |     | rCz = KzQ1  |                        |
|    |     | sCp = (C210C220C23)CpTsHtQ1F1F2                     | Check parity           |
|    |     | rCp = ( " )Cp "                                     |                        |
|    | T4  | Sc = T4F1F2Inr                                      | Clear S                |
|    |     | rS(1-14) = Sc                                       |                        |
|    | T3  | Sxc = T3F1F2Ju                                      |                        |
|    |     | sS(1,2) = Add(2,3)Sxc                               |                        |
|    |     | sS(3-14) = C(0-11)Sxc                               | C + X·Ix → S           |
|    | T0  | rCz = F1T0  |                        |
|    |     | sRf = 05F3T0  | No input to Y buffer   |
|    | Tr  | Cxm = Ju00Tsm(Tr+Tp)                                |                        |
|    |     | sC(0-23) = M(0-23)Cxm                               | M → C (Fetch operand)  |
|    |     | rC( " ) = TrCxm                                     |                        |
|    |     | sHt = CpTrKpK002                                    | Parity error           |
|    |     | rIx = Tr(F1F3)(GOHt)                                |                        |
|    |     | rK0 = GOTrF2  |                        |
|    | TP  | sCp = M24CxmHtTsTp                                  | Initiate parity        |
|    |     | sF1 = 010304IaRfF1F3Tp                              | 04 next clock (T8)     |

|    |          |                             |                                  |                                 |            |
|----|----------|-----------------------------|----------------------------------|---------------------------------|------------|
| 04 | T8       | rC24                        | = T8(TsTsr)                      | Initialize parity generation    |            |
|    |          | sIa                         | = F1F3(Q1)K                      | Initialize P register increment |            |
|    |          | Mxc                         | = 04Tsm                          |                                 | T8 thru Tp |
|    | T7       | Ar3                         | = (01020304)Q1                   |                                 |            |
|    |          | sA(0-2)                     | = A(21-23)AnrAr3                 |                                 |            |
|    |          | rA( " )                     | = A( " ) " "                     | Recirculate A                   | T7 thru T0 |
|    |          | sA(3-23)                    | = A(0-20)Ar3                     |                                 |            |
|    |          | rA( " )                     | = A( " ) " "                     |                                 |            |
|    |          | sB(0-2)                     | = B(21-23)BnrAr3                 |                                 |            |
|    |          | rB( " )                     | = B( " ) " "                     | Recirculate B                   | T7 thru T0 |
|    |          | sB(3-23)                    | = B(0-20)Ar3                     |                                 |            |
|    |          | rB( " )                     | = B( " ) " "                     |                                 |            |
|    |          | Cr3                         | = F1F3(TsQ1)                     |                                 |            |
|    |          | sC(0-2)                     | = C(21-23)010406Ts04             |                                 |            |
|    |          | rC( " )                     | = C( " ) " "                     | Recirculate C                   | T7 thru T0 |
|    |          | sC(3-23)                    | = C(0-20)Cr3                     |                                 |            |
|    |          | rC( " )                     | = C( " ) " "                     |                                 |            |
|    |          | Pr3                         | = (F1G0)Q2                       |                                 |            |
|    |          | sP0                         | = (P12P13P14Ia)F1G0(02040506)Pr3 |                                 |            |
|    |          | rP0                         | = ( " ) " "                      |                                 |            |
|    |          | sP1                         | = (P13P14Ia)                     |                                 |            |
|    |          | rP1                         | = ( " ) " "                      |                                 |            |
|    |          | sP2                         | = (P14Ia)                        | P + 1 → P                       | T7 thru T3 |
|    |          | rP2                         | = ( " ) " "                      |                                 |            |
|    |          | sP(3-14)                    | = P(0-11)Pr3                     |                                 |            |
|    |          | rP( " )                     | = P( " ) " "                     |                                 |            |
|    |          | rIa                         | = (P12P13P14)Q2F1                |                                 |            |
| T6 | sC24     | = (C0C1C2)C24(TsTsr)(Q3+Q5) | Generate parity                  | T6 thru Tr                      |            |
|    | rC24     | = ( " )C24( " )( " )        |                                  |                                 |            |
| T3 | rM(0-24) | = T3                        | Clear M                          |                                 |            |
| T0 | rCp      | = TsTOHtk0(F1070106)02      |                                  |                                 |            |
| Tr | sHt      | = CpTnkPk002                | Parity error                     |                                 |            |
|    | rIa      | = TrF1                      |                                  |                                 |            |
|    | rK0      | = TrGOF2                    |                                  |                                 |            |
| Tp | sF(2,3)  | = Tp04                      | 07 next clock (T8)               |                                 |            |
|    | sM(0-24) | = C(0-24)MxcTp              | C → M (Store operand)            |                                 |            |
|    | rM( " )  | = C( " ) " "                |                                  |                                 |            |

|    |    |               |   |                                |            |
|----|----|---------------|---|--------------------------------|------------|
| Ø7 | T8 | End           | = $\overline{F1F2}$                                   | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1  |                                |            |
|    |    | sA(0-2)       | = $\overline{A(21-23)}\overline{ArAr3}$               | Recirculate A                  | T7 thru T0 |
|    |    | rA(")         | = $\overline{A(")}"$                                  |                                |            |
|    |    | sA(3-23)      | = $\overline{A(0-20)}Ar3$                             |                                |            |
|    |    | rA(")         | = $\overline{A(")}"$                                  |                                |            |
|    |    | sB(0-2)       | = $\overline{B(21-23)}\overline{BnrAr3}$              | Recirculate B                  | T7 thru T0 |
|    |    | rB(")         | = $\overline{B(")}"$                                  |                                |            |
|    |    | sB(3-23)      | = $\overline{B(0-20)}Ar3$                             |                                |            |
|    |    | rB(")         | = $\overline{B(")}"$                                  |                                |            |
|    |    | Pr3           | = F1GOQ2  |                                |            |
|    |    | sP(0-2)       | = $\overline{P(12-14)}\overline{IaF1GO(02040506)}Pr3$ | Recirculate P                  | T7 thru T3 |
|    |    | rP(")         | = $\overline{P(")}"$ ( " ) "                          |                                |            |
|    |    | sP(3-14)      | = $\overline{P(0-11)}Pr3$                             |                                |            |
|    |    | rP(")         | = $\overline{P(")}"$                                  |                                |            |
|    | T4 | Sc            | = $\overline{T4EndInr}$                               | Clear S                        |            |
|    |    | rS(1-14)      | = Sc  |                                |            |
|    | T3 | Sxp           | = $\overline{T3IntEndGO}$                             | P(13,14) contains P(1,2) at T3 |            |
|    |    | sS(1,2)       | = $\overline{P(13,14)}\overline{IaF1GO(02040506)}Sxp$ | P → S                          |            |
|    |    | rS(")         | = $\overline{P(")}"$ ( " ) "                          |                                |            |
|    |    | sS(3-14)      | = $\overline{P(0-11)}Sxp$                             |                                |            |
|    |    | rS(")         | = $\overline{P(")}"$                                  |                                |            |
|    | T0 | rSk           | = Ø7T0  |                                |            |
|    | Tr | Cxm           | = $\overline{EndGOTsm(Tr+Tp)}$                        | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = $\overline{M(0-23)}Cxm$                             |                                | Tr thru Tp |
|    |    | rC(")         | = $\overline{TrCxm}$                                  |                                |            |
|    |    | rIa           | = $\overline{F1Tr}$                                   |                                |            |
|    |    | rIx           | = $\overline{Tr(F1F3)}(\overline{GOHt})$              |                                |            |
|    | Tp | rA00          | = $\overline{TpEndGO}$                                | Initiate parity                |            |
|    |    | rB00          | = $\overline{TpEndGO}$                                | Ø0 next                        |            |
|    |    | sCp           | = $\overline{M24CxmHtTsTp}$                           |                                |            |
|    |    | rF(1-3)       | = $\overline{TpEndSk}$                                |                                |            |
|    |    | Oc            | = $\overline{TpEndSk}$                                |                                |            |
|    |    | sO2           | = Oc  | NOP (20) → 0                   |            |
|    |    | rO(1,3,4,5,6) | = Oc  |                                |            |

|    |          |                                 |                        |            |
|----|----------|---------------------------------|------------------------|------------|
| 34 | UDI      | Merge A + B and Store           | A + B → (M)            | 3 Cycles   |
| 00 | T8       | rCz = 00T8                      |                        |            |
|    |          | sIx = 00T8C1G0                  | Initialize indexing    |            |
|    |          | Oxc = (00T8IaG0)C2              |                        |            |
|    |          | sO(1,3,4,5,6) = C(3,5,6,7,8)Oxc | Instruction → 0        |            |
|    |          | rO2 = C4Oxc                     |                        |            |
| T7 | Ar3      | = (01020304)Q1                  |                        |            |
|    | sA(0-2)  | = A(21-23)AnrAr3                |                        |            |
|    | rA( " )  | = A( " ) " "                    | Recirculate A          | T7 thru T0 |
|    | sA(3-23) | = A(0-20)Ar3                    |                        |            |
|    | rA( " )  | = A( " ) " "                    |                        |            |
|    | sB(0-2)  | = B(21-23)BnrAr3                |                        |            |
|    | rB( " )  | = B( " ) " "                    | Recirculate B          | T7 thru T0 |
|    | sB(3-23) | = B(0-20)Ar3                    |                        |            |
|    | rB( " )  | = B( " ) " "                    |                        |            |
|    | Cr3      | = F1F2(TsQ1)                    |                        |            |
|    | sC(0-2)  | = Add(1-3)00JuTsCr3             |                        |            |
|    | rC( " )  | = Add( " ) " "                  | C+X·Ix → C (Add=Xz+Yz) | T7 thru T0 |
|    | sC(3-23) | = C(0-20)Cr3                    |                        |            |
|    | rC( " )  | = C( " ) " "                    |                        |            |
|    | Xz(1-3)  | = Xn(1-3)00·Ix                  | Adder input (XIx)      | T7 thru T0 |
|    | Xz( " )  | = Xn( " )00Ix+Ix                |                        |            |
|    | Yz(1-3)  | = C(21-23)07                    | Adder input (C)        | T7 thru T0 |
|    | Yz( " )  | = C( " ) " "                    |                        |            |
|    | sCz      | = KzQ1T007                      | Carry logic            | T7 thru T1 |
|    | rCz      | = KzQ1                          |                        |            |
|    | sCp      | = (C21C22C23)CpTsHtQ1F1F2       | Check parity           | T7 thru T0 |
|    | rCp      | = ( " )Cp " "                   |                        |            |
| T4 | Sc       | = T4F1F2Inr                     | Clear S                |            |
|    | rS(1-14) | = Sc                            |                        |            |
| T3 | Sxc      | = T3F1F2Ju                      |                        |            |
|    | sS(1,2)  | = Add(2,3)Sxc                   |                        |            |
|    | sS(3-14) | = C(0-11)Sxc                    | C + X·Ix → S           |            |
| T0 | rCz      | = F1T0                          |                        |            |
| Tr | Cxm      | = Ju00Tsm(Tr+Tp)                | M → C (Fetch operand)  | Tr thru Tp |
|    | sC(0-23) | = M(0-23)Cxm                    |                        |            |
|    | rC( " )  | = TrCxm                         |                        |            |
|    | sHt      | = CpTrK007                      | Parity error           |            |
|    | rIx      | = Tr(F1F3)(GOHt)                |                        |            |
|    | rK0      | = GOTrF2                        |                        |            |
| Tp | sCp      | = M24CxmHtTsTp                  | Initiate parity        |            |
|    | sF1      | = (TpIa00)0304                  | 04 next clock (T8)     |            |

|    |    |          |   |   |            |
|----|----|----------|---|---|------------|
| 04 | T8 | rC24     | = T8( $\overline{\text{TsTsr}}$ )   | Initialize parity generation                |            |
|    |    | sIa      | = $\overline{\text{FlF3I1Kr}}$  | Initialize P register increment             |            |
|    |    | Mxc      | = $\overline{\text{04Tsm}}$   |   | T8 thru Tp |
| T7 |    | Ar3      | = $\overline{(\text{01020304})}\text{Q1}$   |   |            |
|    |    | sA(0-2)  | = $\overline{\text{A}(21-23)\text{AnrAr3}}$   |   |            |
|    |    | rA( " )  | = $\overline{\text{A}( " ) "}$  | Recirculate A                               | T7 thru T0 |
|    |    | sA(3-23) | = $\overline{\text{A}(0-20)\text{Ar3}}$   |   |            |
|    |    | rA( " )  | = $\overline{\text{A}( " ) "}$  |   |            |
|    |    | sB(0-2)  | = $\overline{\text{B}(21-23)\text{BnrAr3}}$   |   |            |
|    |    | rB( " )  | = $\overline{\text{B}( " ) "}$  | Recirculate B                               | T7 thru T0 |
|    |    | sB(3-23) | = $\overline{\text{B}(0-20)\text{Ar3}}$   |   |            |
|    |    | rB( " )  | = $\overline{\text{B}( " ) "}$  |   |            |
|    |    | Cr3      | = $\overline{\text{FlF3}(\text{TsQ1})}$   |   |            |
|    |    | sC(0-2)  | = $\overline{(\text{B}(21-23)\overline{\text{06}}+\text{A}(21-23)\overline{\text{05}})\text{04TsCr304}}$  | A+B → C (Merge of A and B with result in C) | T7 thru T0 |
|    |    | rC( " )  | = $\overline{(\text{B}( " ) "}$   |   |            |
|    |    | sC(3-23) | = $\overline{\text{C}(0-20)\text{Cr3}}$   |   |            |
|    |    | rC( " )  | = $\overline{\text{C}( " ) "}$  |   |            |
|    |    | Pr3      | = $\overline{(\text{FlGO})}\text{Q2}$   |   |            |
|    |    | sP0      | = $\overline{(\text{Pl2}\oplus\text{Pl3Pl4Ia})\text{FlGO}(\overline{\text{02040506}})\text{Pr3}}$         |   |            |
|    |    | rP0      | = $\overline{(\text{ " } "}$  |   |            |
|    |    | sP1      | = $\overline{(\text{Pl3}\oplus\text{Pl4Ia})}$   |   |            |
|    |    | rP1      | = $\overline{(\text{ " } "}$  |   |            |
|    |    | sP2      | = $\overline{(\text{Pl4}\oplus\text{Ia})}$  | P + 1 → P                                   | T7 thru B  |
|    |    | rP2      | = $\overline{(\text{ " } "}$  |   |            |
|    |    | sP(3-14) | = $\overline{\text{P}(0-11)\text{Pr3}}$   |   |            |
|    |    | rP( " )  | = $\overline{\text{P}( " ) "}$  |   |            |
|    |    | rIa      | = $\overline{(\overline{\text{Pl2Pl3Pl4}})\text{Q2Fl}}$   |   |            |
| T6 |    | sC24     | = $\overline{(\text{C0}\oplus\text{C1}\oplus\text{C2})\text{C24}(\overline{\text{TsTsr}})(\text{Q3+Q5})}$ | Generate parity                             | T6 thru Tr |
|    |    | rC24     | = $\overline{(\text{ " } " )\text{C24}(\text{ " })(\text{ " } )}$   |   |            |
| T3 |    | rM(0-24) | = T3  | Clear M                                     |            |
| T0 |    | rCp      | = $\overline{\text{TsTOHtK0}(\text{Fl}\overline{\text{070106}})\overline{\text{02}}}$                     |   |            |
| Tr |    | sHt      | = $\overline{\text{CpTrKpK002}}$  | Parity error                                |            |
|    |    | rIa      | = $\overline{\text{TrFl}}$  |   |            |
|    |    | rK0      | = $\overline{\text{TrGOF2}}$  |   |            |
| Tp |    | sF(1-3)  | = $\overline{\text{Tp04}}$  | 07 next clock (T8)                          |            |
|    |    | sM(0-24) | = $\overline{\text{C}(0-24)\text{MxcTp}}$   | C → M (Store operand)                       |            |
|    |    | rM( " )  | = $\overline{\text{C}( " ) "}$  |   |            |



|    |    |               |                               |                                |            |
|----|----|---------------|-------------------------------|--------------------------------|------------|
| 07 | T8 | End           | = F1F2                        | Last cycle                     |            |
|    | T7 | Ar3           | = (01020304)Q1                |                                |            |
|    |    | sA(0-2)       | = A(21-23)AnrAr3              |                                |            |
|    |    | rA( " )       | = A( " ) " "                  | Recirculate A                  | T7 thru T0 |
|    |    | sA(3-23)      | = A(0-20)Ar3                  |                                |            |
|    |    | rA( " )       | = A( " ) " "                  |                                |            |
|    |    | sB(0-2)       | = B(21-23)BnrAr3              |                                |            |
|    |    | rB( " )       | = B( " ) " "                  | Recirculate B                  | T7 thru T0 |
|    |    | sB(3-23)      | = B(0-20)Ar3                  |                                |            |
|    |    | rB( " )       | = B( " ) " "                  |                                |            |
|    |    | Pr3           | = F1GOQ2                      |                                |            |
|    |    | sP(0-2)       | = P(12-14)IaF1GO(02040506)Pr3 |                                |            |
|    |    | rP( " )       | = P( " ) " ( " ) "            | Recirculate P                  | T7 thru T3 |
|    |    | sP(3-14)      | = P(0-11)Pr3                  |                                |            |
|    |    | rP( " )       | = P( " ) " "                  |                                |            |
|    | T4 | Sc            | = T4EndInr                    | Clear S                        |            |
|    |    | rS(1-14)      | = Sc                          |                                |            |
|    | T3 | Sxp           | = T3IntEndGO                  |                                |            |
|    |    | sS(1,2)       | = P(13,14)IaF1GO(02040506)Sxp | P(13,14) contains P(1,2) at T3 |            |
|    |    | rS( " )       | = P( " ) " ( " ) "            | P → S                          |            |
|    |    | sS(3-14)      | = P(0-11)Sxp                  |                                |            |
|    |    | rS( " )       | = P( " ) " "                  |                                |            |
|    | T0 | rSk           | = 07T0                        |                                |            |
|    | Tr | Cxm           | = EndGOTsm(Tr+Tp)             | M → C (Fetch next instruction) |            |
|    |    | sC(0-23)      | = M(0-23)Cxm                  |                                | Tr thru Tp |
|    |    | rC( " )       | = TrCxm                       |                                |            |
|    |    | rIa           | = F1Tr                        |                                |            |
|    |    | rIx           | = Tr(F1F3)(GOHt)              |                                |            |
|    | Tp | rA00          | = TpEndGO                     |                                |            |
|    |    | rB00          | = TpEndGO                     |                                |            |
|    |    | sCp           | = M24CxmHtTsTp                | Initiate parity                |            |
|    |    | rF(1-3)       | = TpEndSk                     | 00 next                        |            |
|    |    | Oc            | = TpEndSk                     |                                |            |
|    |    | sO2           | = Oc                          | NOP (20) → 0                   |            |
|    |    | rO(1,3,4,5,6) | = Oc                          |                                |            |

UDI 42  
UDI 44-1  
UDI 44-2  
UDI 44-3  
UDI 44-4  
UDI 44-5  
UDI 44-6  
UDI 44-7  
UDI 44-8  
UDI 44-9  
UDI 44-10  
UDI 44-11

|    |             |   |
|----|-------------|---|
| 42 | UDI         | Same as No Operation  |
| 44 | UDI 00000,2 | Same as Clear X   |
| 44 | UDI 00001   | Same as Clear A   |
| 44 | UDI 00002   | Same as Clear B   |
| 44 | UDI 00004   | Same as Copy A into B   |
| 44 | UDI 00010   | Same as Copy B into A   |
| 44 | UDI 00020   | Same as Copy B into X   |
| 44 | UDI 00040   | Same as Copy X into B   |
| 44 | UDI 00100   | Same as Copy least significant 9 bits only extend bit 15 throughout X when X is designation register. |
| 44 | UDI 00200   | Same as Copy X into A   |
| 44 | UDI 00400   | Same as Copy A into X   |
| 44 | UDI 01000   | Same as Copy Negative of A into A   |



|    |         |  |                               |
|----|---------|--|-------------------------------|
| T0 | rCz     | = $\overline{Fl}T0$                      |                               |
|    | sC0     | = $Of(JuTsCr3T0)$                        |                               |
|    | rC0     | = $\overline{Of}(\quad " \quad)$         | Set C0 if overflow.           |
|    | rC(1,2) | = $JuTsCr3T0$                            | No input to C1, C2            |
| Tr | sHt     | = $\overline{CpTrKpK002}$                | Parity error                  |
|    | rIx     | = $(\overline{FlF3})(\overline{COHt})Tr$ |                               |
|    | rRc     | = Tr                                     |                               |
| Tp | sF2     | = $\overline{02Ia0100Tp}$                |                               |
|    | sF3     | = $\overline{0304Ia00Tp}$                | $\emptyset 3$ next clock (T8) |
|    | rJu     | = Tp                                     |                               |

The C register at Tp contains the following information:

|              |                                       |
|--------------|---------------------------------------|
| C0           | = State of the Overflow Flip-Flop     |
| C1 thru C3   | = $\emptyset$                         |
| C4           | = State of the Em1 Flip-Flop          |
| C5           | = State of the Em2 Flip-Flop          |
| C6 thru C9   | = $\emptyset$                         |
| C10 thru C23 | = Original contents of the P register |

Rc is set at T8 which allows register change activity to go on during  $\emptyset 0$  of this instruction. See RCH (46) instruction for details on what effect indexing and the address configuration of a UDI (45) instruction will have in regard to register changes.

|    |    |          |   |                    |            |
|----|----|----------|---|--------------------|------------|
| Ø3 | T7 | Ar3      | = $\overline{(01020304)}Q1$                                 |                    |            |
|    |    | sA(0-2)  | = $\overline{A(21-23)ArAr3}$                                |                    |            |
|    |    | rA( " )  | = $\overline{A( " ) "}$                                     |                    |            |
|    |    | sA(3-23) | = $\overline{A(0-20)Ar3}$                                   | Recirculate A      | T7 thru T0 |
|    |    | rA( " )  | = $\overline{A( " ) "}$                                     |                    |            |
|    |    | sB(0-2)  | = $\overline{B(21-23)BrAr3}$                                |                    |            |
|    |    | rB( " )  | = $\overline{B( " ) "}$                                     |                    |            |
|    |    | sB(3-23) | = $\overline{B(0-20)Ar3}$                                   | Recirculate B      | T7 thru T0 |
|    |    | rB( " )  | = $\overline{B( " ) "}$                                     |                    |            |
|    |    | sOf      | = $\overline{(S9S10S11S12)(Bz0+B0)(RfB0+(A00+Lx))050603T7}$ |                    |            |
| T5 |    | sSk      | = $\overline{0506S11S12S1303T5}$                            |                    |            |
| T0 |    | rCp      | = $\overline{TSHtK0(F1+F2)(07040602)T0}$                    |                    |            |
|    |    | rCz      | = $\overline{FIT0}$   |                    |            |
| Tp |    | sF1      | = SkTp  | Ø7 next clock (T8) |            |
|    |    | Sd2      | = $\overline{0506Sk03Tp}$                                   |                    |            |
|    |    | sS11     | = $\overline{S11S12S13Sd2}$                                 |                    |            |
|    |    | rS11     | = $\overline{S11S12S13Sd2}$                                 |                    |            |
|    |    | sS12     | = $\overline{S12S13Sd2}$                                    |                    |            |
|    |    | rS12     | = $\overline{S12S13Sd2}$                                    | Counter for divide |            |
|    |    | sS13     | = $\overline{S13Sd2}$                                       |                    |            |
|    |    | rS13     | = $\overline{S13Sd2}$                                       |                    |            |

The Computer will continue to repeat Ø3 until Sk is set. The Computer may hang-up in Ø3 as much as eight cycles; the following is a sequence of combinations of S11, S12, S13 and number of cycles required before Ø7 is encountered:

| <u>S11</u> | <u>S12</u> | <u>S13</u> | <u>Number of Cycles</u> |
|------------|------------|------------|-------------------------|
| 0          | 0          | 1          | 8                       |
| 0          | 0          | 0          | 7                       |
| 1          | 1          | 1          | 6                       |
| 1          | 1          | 0          | 5                       |
| 1          | 0          | 1          | 4                       |
| 1          | 0          | 0          | 3                       |
| 0          | 1          | 1          | 2                       |
| 0          | 1          | 0          | 1                       |

This method of counting is the same as the one for a Divide instruction.

|    |    |               |  |   |                                 |
|----|----|---------------|--|---|---------------------------------|
| 07 | T8 | End           | = F1F2   |   |                                 |
|    |    | Ck            | = $\overline{\text{Ts}}\emptyset 7\text{T8}$   |   |                                 |
|    |    | sC(0-23)      | = $\overline{\text{C}}(0-23)\text{Ck}$   |   |                                 |
|    |    | rC( " )       | = C( " ) "   |   | Ones complement of C → C        |
|    |    | sIa           | = $\overline{\text{Tr}}\text{Sk}\emptyset 7\text{T8}$  |   | Initialize P register increment |
| T7 |    | Ar3           | = (01020304)Q1   |   |                                 |
|    |    | sA(0-2)       | = $\overline{\text{A}}(21-23)\overline{\text{Ar}}\text{Ar3}$   |   |                                 |
|    |    | rA( " )       | = $\overline{\text{A}}( " ) "$   |   | Recirculate A                   |
|    |    | sA(3-23)      | = $\overline{\text{A}}(0-20)\text{Ar3}$  |   | T7 thru T0                      |
|    |    | rA( " )       | = $\overline{\text{A}}( " ) "$   |   |                                 |
|    |    | sB(0-2)       | = $\overline{\text{B}}(21-23)\overline{\text{Br}}\text{Ar3}$   |   |                                 |
|    |    | rB( " )       | = $\overline{\text{B}}( " ) "$   |   | Recirculate B                   |
|    |    | sB(3-23)      | = $\overline{\text{B}}(0-20)\text{Ar3}$  |   | T7 thru T0                      |
|    |    | rB( " )       | = $\overline{\text{B}}( " ) "$   |   |                                 |
|    |    | Cr3           | = $\overline{\text{O5}}\text{Ts}\emptyset 7\text{Q1}$  |   |                                 |
|    |    | sC(3-23)      | = $\overline{\text{C}}(0-20)\text{Cr3}$  |   | Zero → C (No input to C(0-23))  |
|    |    | rC( " )       | = $\overline{\text{C}}( " ) "$   |   | T7 thru T0                      |
|    |    | Pr3           | = F1GOQ2   |   |                                 |
|    |    | sP0           | = $(\text{P12} \oplus \text{P13} \oplus \text{P14} \oplus \text{Ia})\text{F1GO}(\overline{\text{O2040506}})\text{Pr3}$       |   |                                 |
|    |    | rP0           | = ( " ) "  |   |                                 |
|    |    | sP1           | = $(\text{P13} \oplus \text{P14} \oplus \text{Ia})$  | " | P + 1 → P (P contains           |
|    |    | rP1           | = ( " ) "  | " | original contents of            |
|    |    | sP2           | = $(\text{P14} \oplus \text{Ia})$  | " | T7 thru T0                      |
|    |    | rP2           | = ( " ) "  | " | the C register,)                |
|    |    | sP(3-14)      | = P(0-11)Pr3   |   |                                 |
|    |    | rP( " )       | = $\overline{\text{P}}( " ) "$   |   |                                 |
|    |    | rIa           | = $(\text{P12} \oplus \text{P13} \oplus \text{P14})\text{F1Q2}$  |   |                                 |
| T6 |    | sC24          | = $(\text{C0} \oplus \text{C1} \oplus \text{C2})\overline{\text{C24}}(\text{Ts}\overline{\text{Tr}})(\text{Q3} + \text{Q5})$ |   |                                 |
|    |    | rC24          | = ( " ) C24( " )( " )  |   | Generate parity                 |
| T4 |    | Sc            | = End $\overline{\text{Inr}}\text{T4}$   |   | T6 thru Tr                      |
|    |    | rS(1-14)      | = Sc   |   | Clear S                         |
| T3 |    | Sxp           | = End $\overline{\text{Int}}\text{GOT3}$   |   |                                 |
|    |    | sS(1,2)       | = P(13,14)IaF1GO( $\overline{\text{O2040506}}$ )Sxp  |   | P(13,14) contains P(1,2) at T3  |
|    |    | sS(3-14)      | = P(0-11)Sxp   |   | P → S                           |
|    |    | rS( " )       | = $\overline{\text{P}}( " ) "$   |   |                                 |
| T0 |    | rSk           | = $\emptyset 7\text{T0}$   |   |                                 |
| Tr |    | Cxm           | = End $\overline{\text{GOT}}\text{sm}(\text{Tr} + \text{Tp})$  |   | M → C (Fetch next instruction)  |
|    |    | sC(0-23)      | = M(0-23)Cxm   |   | Tr thru Tp                      |
|    |    | rC( " )       | = TrCxm  |   |                                 |
|    |    | rIa           | = F1Tr   |   |                                 |
|    |    | rIx           | = $(\overline{\text{F1F3}})(\overline{\text{GO}}\text{Ht})\text{Tr}$   |   |                                 |
| Tp |    | rA00          | = End $\overline{\text{GOT}}\text{p}$  |   |                                 |
|    |    | rB00          | = "  |   |                                 |
|    |    | sCp           | = M24Cxm $\overline{\text{Ht}}\text{TsTp}$   |   | Initiate parity check           |
|    |    | rF(1-3)       | = End $\overline{\text{GOS}}\text{k}$  |   | $\emptyset 0$ next clock (T8)   |
|    |    | Oc            | = "  |   |                                 |
|    |    | s02           | = Oc   |   |                                 |
|    |    | rO(1,3,4,5,6) | = Oc   |   | NOP (20) → 0                    |

## UDI 47

This UDI is quite complex in its operation. The phases encountered are those of shift instructions. However both Ju, a flip-flop that controls branching, and Rc, a flip-flop that is true during the register change instructions, are set at  $\emptyset 0$  T8 time.

The effect of Ju is that the next instruction will be designated by the address of the instruction plus one. The effect of Rc is not predictable unless the address of the instruction and the contents of bit 10 are known. The contents of the P-register also affect the instruction in that a transfer of the contents of P(6-14) to C(15-23) is made during  $\emptyset 0$  (T7-T5). Since register change instructions employ the address portion of the instruction the contents of the P-register will be interpreted as part of the instruction.





## APPENDIX A



B Register Right Shift Add (Rsa)

$$\begin{aligned}
 B00 &= C0 \\
 B0 &= B00 \oplus C0 \oplus \{B0C1 + (B0 \oplus C1)[B1C2 + (B1 \oplus C2)B2Bc2]\} \\
 B1 &= B0 \oplus C1 \oplus [B1C2 + (B1 \oplus C2)B2Bc2] \\
 B2 &= B1 \oplus C2 \oplus B2Bc2 \\
 Bc2 &= (B2 \oplus Bc2)C3 + (B2 \oplus Bc2 \oplus C3)\{B3C4 + (B3 \oplus C4)[B4C5 + (B4 \oplus C5)B5Bc5]\} \\
 B3 &= (B2 \oplus Bc2) \oplus C3 \oplus \{B3C4 + (B3 \oplus C4)[B4C5 + (B4 \oplus C5)B5Bc5]\} \\
 B4 &= (B3 \oplus C4) \oplus [B4C5 + (B4 \oplus C5)B5Bc5] \\
 B5 &= B4 \oplus C5 \oplus B5Bc5 \\
 Bc5 &= (B5 \oplus Bc5)C6 + (B5 \oplus Bc5 \oplus C6)\{B6C7 + (B6 \oplus C7)[B7C8 + (B7 \oplus C8)B8Bc8]\} \\
 B6 &= (B5 \oplus Bc5) \oplus C6 \oplus \{B6C7 + (B6 \oplus C7)[B7C8 + (B7 \oplus C8)B8Bc8]\} \\
 B7 &= B6 \oplus C7 \oplus [B7C8 + (B7 \oplus C8)B8Bc8] \\
 B8 &= B7 \oplus C8 \oplus B8Bc8 \\
 Bc8 &= (B8 \oplus Bc8)C9 + (B8 \oplus Bc8 \oplus C9)\{B9C10 + (B9 \oplus C10)[B10C11 + (B10 \oplus C11)B11Bc11]\} \\
 B9 &= (B8 \oplus Bc8) \oplus C9 \oplus \{B9C10 + (B9 \oplus C10)[B10C11 + (B10 \oplus C11)B11Bc11]\} \\
 B10 &= B9 \oplus C10 \oplus [B10C11 + (B10 \oplus C11)B11Bc11] \\
 B11 &= B10 \oplus C11 \oplus B11Bc11 \\
 Bc11 &= (B11 \oplus Bc11)C12 + (B11 \oplus Bc11 \oplus C12)\{B12C13 + (B12 \oplus C13)[B13C14 + (B13 \oplus C14)B14Bc14]\} \\
 B12 &= (B11 \oplus Bc11) \oplus C12 \oplus \{B12C13 + (B12 \oplus C13)[B13C14 + (B13 \oplus C14)B14Bc14]\} \\
 B13 &= B12 \oplus C13 \oplus [B13C14 + (B13 \oplus C14)B14Bc14] \\
 B14 &= B13 \oplus C14 \oplus B14Bc14 \\
 Bc14 &= (B14 \oplus Bc14)C15 + (B14 \oplus Bc14 \oplus C15)\{B15C16 + (B15 \oplus C16)[B16C17 + (B16 \oplus C17)B17Bc17]\} \\
 B15 &= (B14 \oplus Bc14) \oplus C15 \oplus \{B15C16 + (B15 \oplus C16)[B16C17 + (B16 \oplus C17)B17Bc17]\} \\
 B16 &= B15 \oplus C16 \oplus [B16C17 + (B16 \oplus C17)B17Bc17] \\
 B17 &= B16 \oplus C17 \oplus B17Bc17 \\
 Bc17 &= (B17 \oplus Bc17)C18 + (B17 \oplus Bc17 \oplus C18)\{B18C19 + (B18 \oplus C19)[B19C20 + (B19 \oplus C20)B20Bc20]\} \\
 B18 &= (B17 \oplus Bc17) \oplus C18 \oplus \{B18C19 + (B18 \oplus C19)[B19C20 + (B19 \oplus C20)B20Bc20]\} \\
 B19 &= B18 \oplus C19 \oplus [B19C20 + (B19 \oplus C20)B20Bc20] \\
 B20 &= B19 \oplus C20 \oplus B20Bc20 \\
 Bc20 &= (B20 \oplus Bc20)C21 + (B20 \oplus Bc20 \oplus C21)\{B21C22 + (B21 \oplus C22)[B22C23 + (B22 \oplus C23)B23Bc23]\} \\
 B21 &= (B20 \oplus Bc20) \oplus C21 \oplus \{B21C22 + (B21 \oplus C22)[B22C23 + (B22 \oplus C23)B23Bc23]\} \\
 B22 &= B21 \oplus C22 \oplus [B22C23 + (B22 \oplus C23)B23Bc23] \\
 B23 &= B22 \oplus C23 \oplus B23Bc23 \\
 Bc23 &= B23Bc23
 \end{aligned}$$

## B Register Right One (Br1)

B0 = B00  
B1 = B0  
B2 = B1  
Bc2 = B2Bc2

B3 = B2 ⊕ Bc2  
B4 = B3  
B5 = B4  
Bc5 = B5Bc5

B6 = B5 ⊕ Bc5  
B7 = B6  
B8 = B7  
Bc8 = B8Bc8

B9 = B8 ⊕ Bc8  
B10 = B9  
B11 = B10  
Bc11 = B11Bc11

B12 = B11 ⊕ Bc11  
B13 = B12  
B14 = B13  
Bc14 = B14Bc14

B15 = B14 ⊕ Bc14  
B16 = B15  
B17 = B16  
Bc17 = B17Bc17

B18 = B17 ⊕ Bc17  
B19 = B18  
B20 = B19  
Bc20 = B20Bc20

B21 = B20 ⊕ Bc20  
B22 = B21  
B23 = B22  
Bc23 = B23Bc23

## A Left Two (AL2) B Register

B0 = B2 ⊕ Bc2  
B1 = B3  
B2 = B4  
Bc2 = B5Bc5

B3 = B5 ⊕ Bc5  
B4 = B6  
B5 = B7  
Bc5 = B8Bc8

B6 = B8 ⊕ Bc8  
B7 = B9  
B8 = B10  
Bc8 = B11Bc11

B9 = B11 ⊕ Bc11  
B10 = B12  
B11 = B13  
Bc11 = B14Bc14

B12 = B14 ⊕ Bc14  
B13 = B15  
B14 = B16  
Bc14 = B17Bc17

B15 = B17 ⊕ Bc17  
B16 = B18  
B17 = B19  
Bc17 = B20Bc20

B18 = B20 ⊕ Bc20  
B19 = B21  
B20 = B22  
Bc20 = B23Bc23

B21 = B23 ⊕ Bc23  
B22 = A0  
B23 = A1  
Bc23 = 0

