CONTROL DATA 924 COMPUTER

INPUT/OUTPUT SPECIFICATIONS AND INSTALLATION

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INPUT/OUTPUT SPECIFICATIONS
AND INSTALLATION

RECORD OF CHANGE NOTICES

C. N. NO.	DATE ORIGINATED	DATE ENTERED	INITIALS	REMARKS

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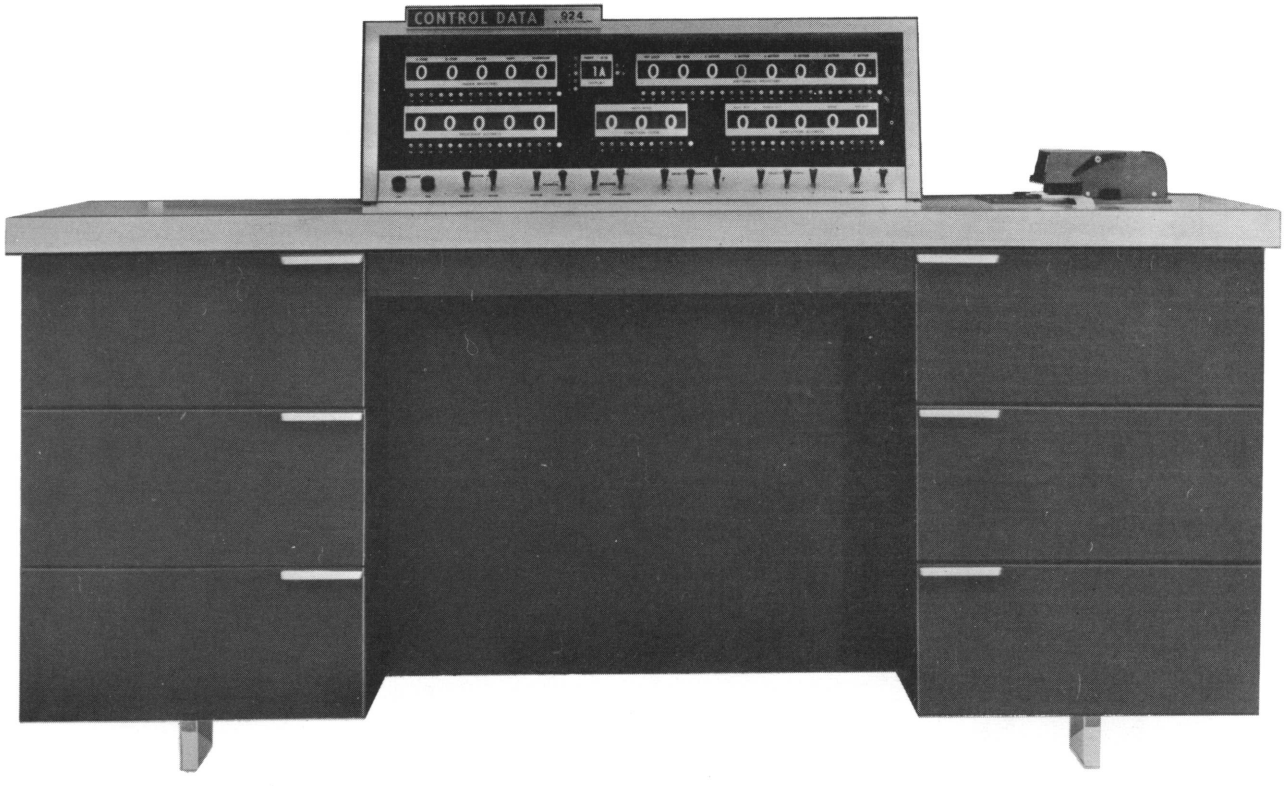
Section IV


CONTROL DATA
924
1A

This specification contains information necessary to attach external equipment to the Control Data Corporation 924 Computer.

The 924 computer has three modes of input/output operation. They are: (1) 1604 or 48-bit mode, (2) 24-bit mode, and (3) 160 mode. 48-bit and 24-bit mode are described in Section I; 160 mode is described in Section II. Section III describes the auxiliary scanner, the interrupt, cabling information and communication circuits. Unless stated differently, information describing one particular mode does not apply to other modes.

Section IV provides installation information for the 924 computer.

GENERAL DESCRIPTION

The 924 computer communicates with external equipment via 6 buffer channels. Exchange of data on buffer channels is program initiated but is carried out under control that is independent of the computer program.

Input buffer channels are numbered 1, 3, and 5. Output channels are numbered 2, 4, and 6.

SECTION I

48-BIT AND 24-BIT MODE

48-BIT MODE

In 48-bit mode the 924 can be used with any 1604 type external equipment. Two consecutive 24-bit words are assembled into one 48-bit word when buffering out to external equipment. One 48-bit word is disassembled into two consecutive 24-bit words when buffering into the 924. Assembly and disassembly are done by the 924.

24-BIT MODE

In 24-bit mode the 924 is used with external equipment made for the 924 such as the reader or punch. 24 bits are transferred in or out.

COMMUNICATION SIGNALS

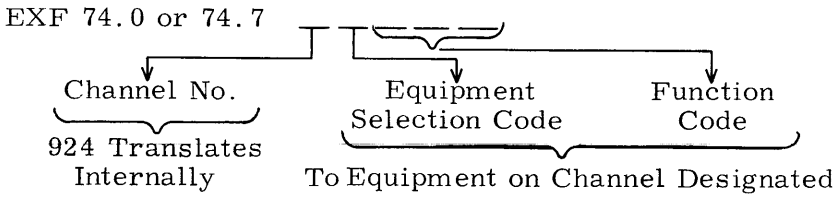
Communication with external equipment is established with function signals and data signals. The following applies to both 24-bit and 48-bit mode.

FUNCTION AND SENSE SIGNALS

The external function lines carry a 12-bit select or sense code to external equipment. This code is gated out by using an external function select or sense instruction (74.0 or 74.7).

EXF 74.0 ----- selects an external equipment and places it in a mode of operation.
EXF 74.7 ----- senses conditions in external equipment.

The five octal digits of the base execution address are interpreted as follows:



When an EXF select or sense instruction is programmed, the code is put on the function lines accompanied by a select or sense ready. If an EXF sense instruction is programmed and the sensed condition exists, a response is returned to the 924. This response must remain on until the sense ready drops. The function and sense ready timing is shown in figure 1.

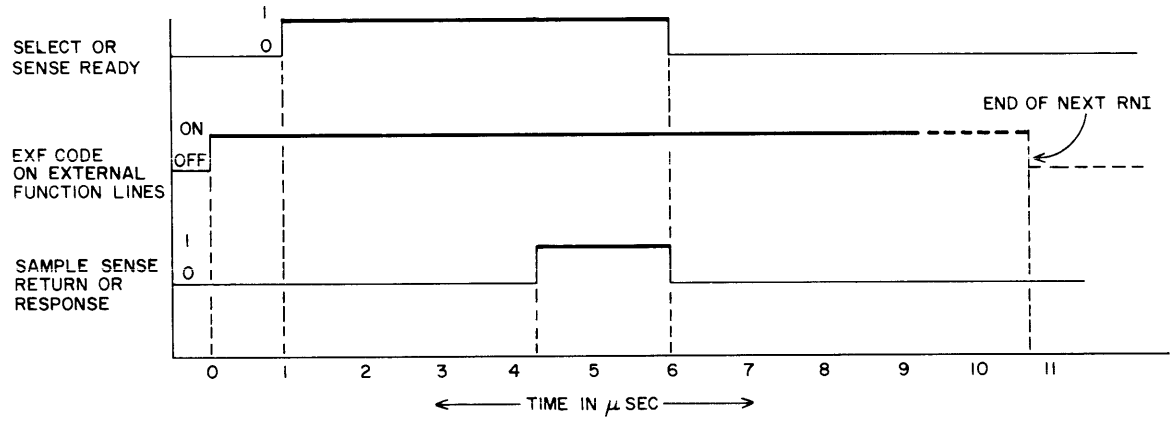


Figure 1. Function and Sense Ready Timing

An EXF 74.0 C0000 instruction (C = channel number) clears all equipment on channel C.

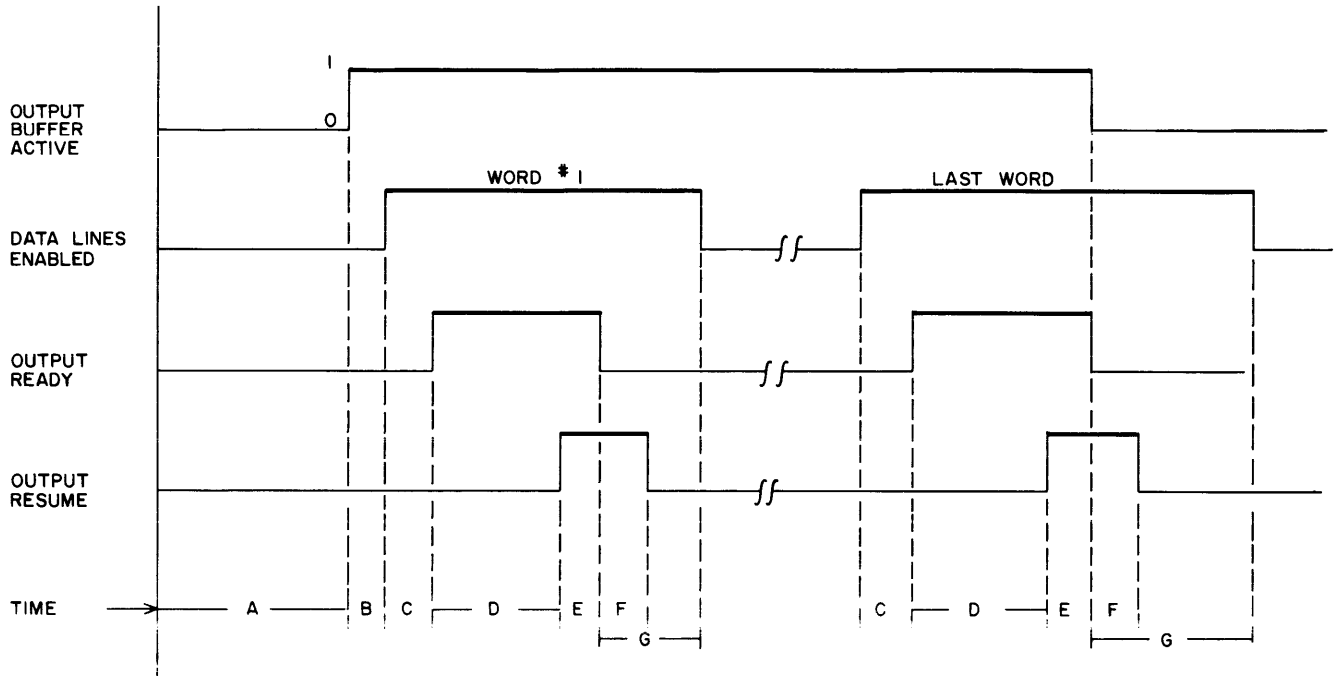
DATA SIGNALS

Each I/O channel on the 924 is connected to 48 lines for the transfer of data. In 48-bit mode, all 48 lines are used for the transfer of data (bits 0-47). For 24-bit mode, 24 of the 48 lines are used for the transfer of data (bits 0-23).

Output From 924

Control signals used for transmitting output data are shown in figures 2 and 3. The following sequence of events occurs when transmitting data from the 924:

1. The computer selects the equipment to which data is to be sent with the correct EXF select code.
2. The computer activates the output channel and turns on the output buffer active line. This line remains on until the final word is transmitted.
3. The computer places the word or words in the Output register. In 24-bit mode the word is placed in bits 0-23 of the Output register. In 48-bit mode the first word is put in bits 24-47 of the Output register and the next word is placed in bits 0-23 of the Output register. (An odd number of 24-bit words cannot be buffered out in 48-bit mode.) The Output register is connected to the output lines.
4. An output ready is sent after the Output register is filled and the output lines have stabilized. The output ready indicates that the output lines are ready for sampling.



Time A - Time before output channel is active.

B - 10.2 usec if word 1 is from the even memory, 14.6 usec if word 1 is from the odd memory.

C - 3.0 usec if word is from the odd memory, 6.6 usec if word is from the even memory.

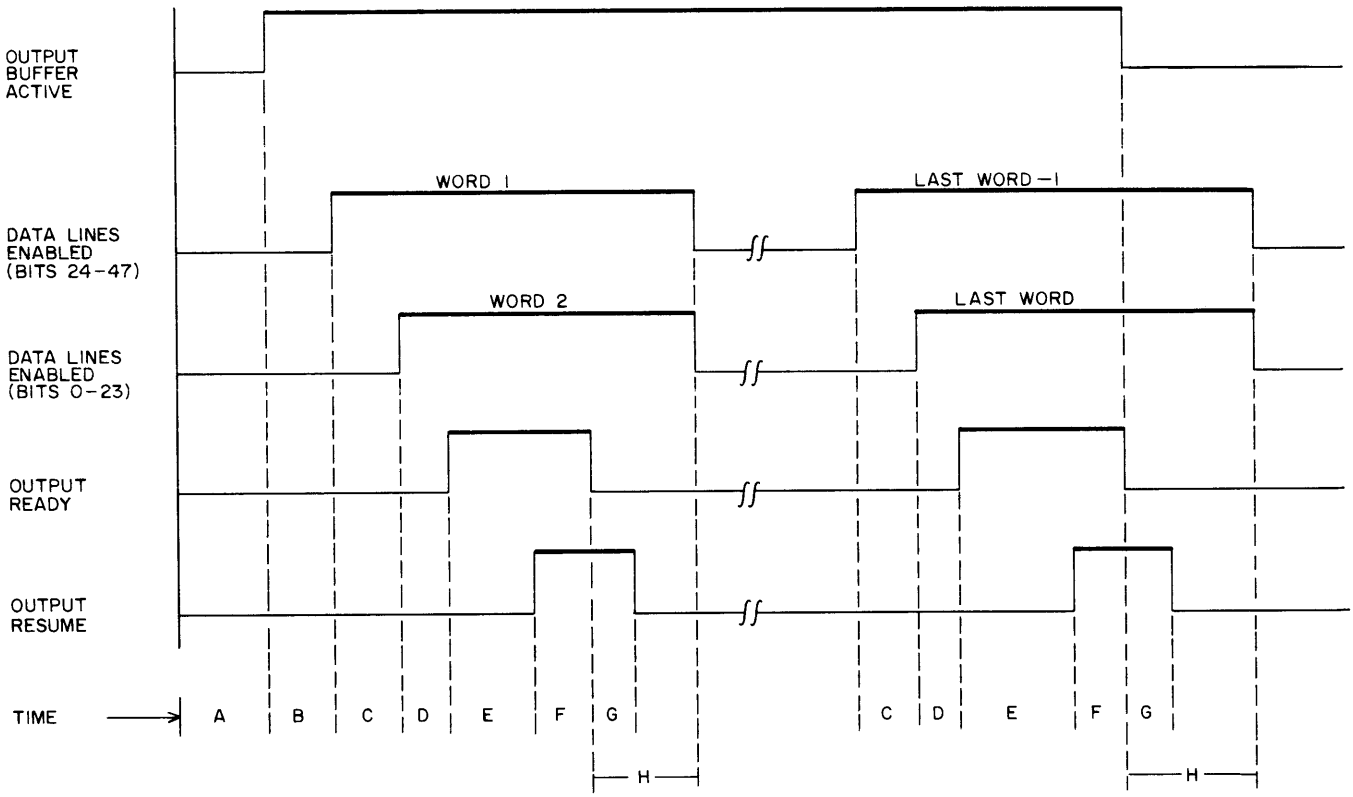
D - Determined by output equipment.

E - 1.4 usec to 2.8 usec.

F - Determined by output equipment.

G - Varies with computer instruction sequence.

Figure 2. Output Data Ready/Resume Timing
24-Bit Mode (One Output Channel Active)



Time A - Time before input channel is active.

B - 10.2 usec if word 1 is from the even memory, 14.6 usec if word 1 is from the odd memory.

C - 4.4 usec if word 1 is from the even memory, 2.8 usec if word 1 is from the odd memory.

D - 3.6 usec if word 1 is from the even memory. 7.0 usec if word 1 is from the odd memory.

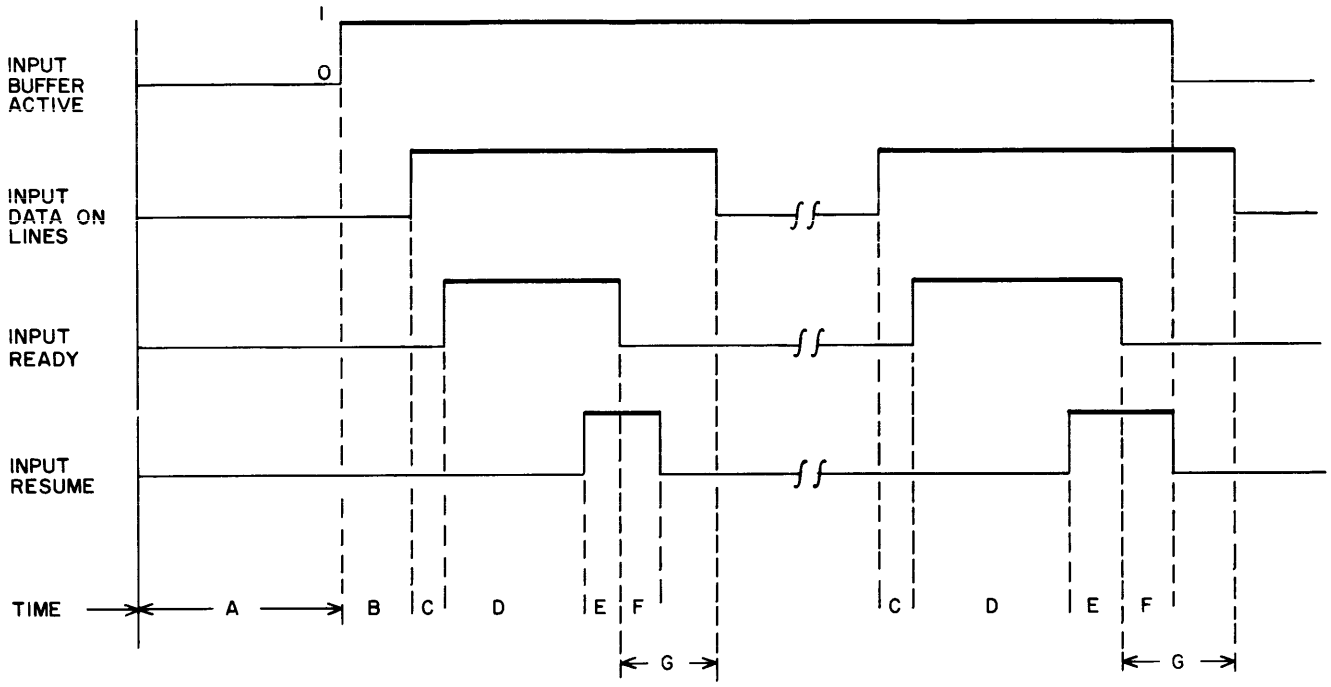
E - Determined by output equipment.

F - 1.4 usec to 2.8 usec.

G - Determined by output equipment.

H - Varies with computer instruction sequence.

Figure 3. Output Data Ready/Resume Timing
48-Bit Mode (One Output Channel Active)



Time A - Time before input channel is active.

B - Determined by input equipment.

C - Determined by input equipment. (Input data and input ready may be sent at the same time.)

D - Minimum time 9.4 usec (24-bit mode), 15.2 usec (48-bit mode). Maximum time 185 usec. The maximum time is based upon the following situation: (1) The computer has just entered the Read Next Instruction sequence when the input ready is sent. (2) The instruction that is read out of memory is a multiply (MUI). (3) All other channels demand processing and they all are in 48-bit mode. (4) The initial address was from the odd memory for all word blocks.

E - Determined by input equipment.

F - 1.4 usec to 2.8 usec.

G - Determined by input equipment. Input data and input ready may be turned off at the same time.

Figure 4. Input Data Ready/Resume Timing
24-Bit and 48-Bit Mode

5. After the external equipment has accepted the data, it returns an output resume signal to the computer.

6. The computer turns off the output ready signal.

7. The external equipment turns off the output resume signal.

8. Steps 3-7 are repeated until the entire block of information is transmitted, at which time the buffer active signal is dropped.

Input to Computer

Control signals for transmitting input data are shown in figure 4. The following sequence of events occurs when transmitting data to the 924:

1. The computer selects the equipment from which it is to receive information.

2. The computer activates the input channel and turns on the input buffer active line. This line remains on until the final word is transmitted.

3. The external equipment places a word on the lines and sends an input ready to the 924.

4. The computer accepts the word and then sends an input resume. In 24-bit mode the resume is sent back after the information contained in bits 0-23 on the input lines is stored in memory. In 48-bit mode the information contained in bits 24 to 47 is stored in memory and then the information in bits 0-23 is stored in the next consecutive address in memory before the resume is sent.

5. The input resume causes the external equipment to turn off the input ready.

6. The dropping of the input ready causes the computer to drop the resume.

7. Steps 3-6 are repeated until the entire block of information is transmitted, at which time the input active line is dropped.

SUMMARY

Each cable group contains one input channel, one output channel, one set of function lines, and one set of control lines. There are three such cable groups. They contain the pairs of input/output buffer channels 1 and 2, 3 and 4, 5 and 6. The six cables within a group are always used together and are not separable. The control signals necessary for communicating with the computer are defined below:

Input Data Ready

Originates in external equipment; terminates in computer.

A static "1" signal is produced on this line when information is present in the output register of the external equipment which the computer may sample. The external equipment drops this signal when the input data resume signal is received from the computer.

Input Data Resume

Originates in computer; terminates in external equipment.

A static "1" signal is produced on this line by the computer when it accepts the input word. When an input data resume signal is received from the computer, the input data ready signal is terminated in the external equipment. Dropping the input data ready signal from the external equipment turns off the input data resume signal at the computer.

Output Data Ready

Originates in computer; terminates in external equipment.

A static "1" signal on this line accompanies each word of output information. This signal is turned off by the output data resume signal from the external equipment.

Output Data Resume

Originates in external equipment; terminates in computer.

A static "1" signal on this line indicates that the external equipment has accepted the word of information and will turn off the output data ready signal at the computer; this causes the external equipment to drop the output data resume.

Input Buffer Active

Originates in computer; terminates in external equipment.

A static "1" signal is produced on this line whenever the input buffer channel of the cable group is activated. The signal remains on until the final word of the block is entered in computer storage and the last input data resume has dropped.

Output Buffer Active

Originates in computer; terminates in external equipment.
A static "1" signal is produced on this line whenever the output buffer channel of the cable group is activated. This signal remains on until the final word of the block is buffered to the external equipment and the output data resume signal is returned to the computer.

External Master Clear

Originates in computer; terminates in external equipment.
A static "1" signal appears on this line whenever the Clear switch at the 924 console is moved to UP position. This signal clears the control functions of all external equipment attached to the cable group.

Input Function Ready

Originates in computer; terminates in external equipment.
A static "1" signal is produced on this line when an external function code is present on the external function lines for translation by the external equipment. A signal on this line selects input conditions within the external equipments. This signal is automatically dropped after 5 microseconds.

Input Sense Ready

Originates in computer; terminates in external equipment.
A static "1" signal is produced on this line whenever the computer is ready to sense the existence of an input condition within the external equipment. The signal is automatically dropped after 5 microseconds.

Output Function Ready

Originates in computer; terminates in external equipment.
A static "1" signal is produced on this line whenever an external function code is present on the external function lines for translation by the external equipment. This line selects output conditions within the external equipment. This signal is automatically dropped after 5 microseconds.

Output Sense Ready

Originates in computer; terminates in external equipment.

A static "1" signal is produced whenever an external function code is present on the line to sense the existence of an output condition within the external equipment. This signal is automatically dropped after 5 microseconds.

Sense Response

Originates in external equipment; terminates in computer.

A static "1" signal on this line indicates to the computer the presence of the condition specified by the upper 11 bits of the 12-bit code sent to external equipment on external function lines. The sense response line is sampled by the computer at the end of the input/output sense ready signal (the computer interprets the inverse of the sense response received from the external equipment when it sends a code with a "1" in the low order bit position to the external equipment).

External Function Lines

These lines originate in the computer and must be continuously monitored by the external equipment. Only the presence of the proper function or sense ready signal enables the sampling of these lines by the external equipment as an external function code.

SECTION II

160 MODE

In 160 mode the 924 can be used with most 160 and 160-A external equipment. Possible exceptions are explained in the 160 mode summary. The 160 mode input and output lines contain 12 bits each. The output lines are used for both data and external function information.

COMMUNICATION SIGNALS

Communication with external equipment is accomplished with function signals and data signals.

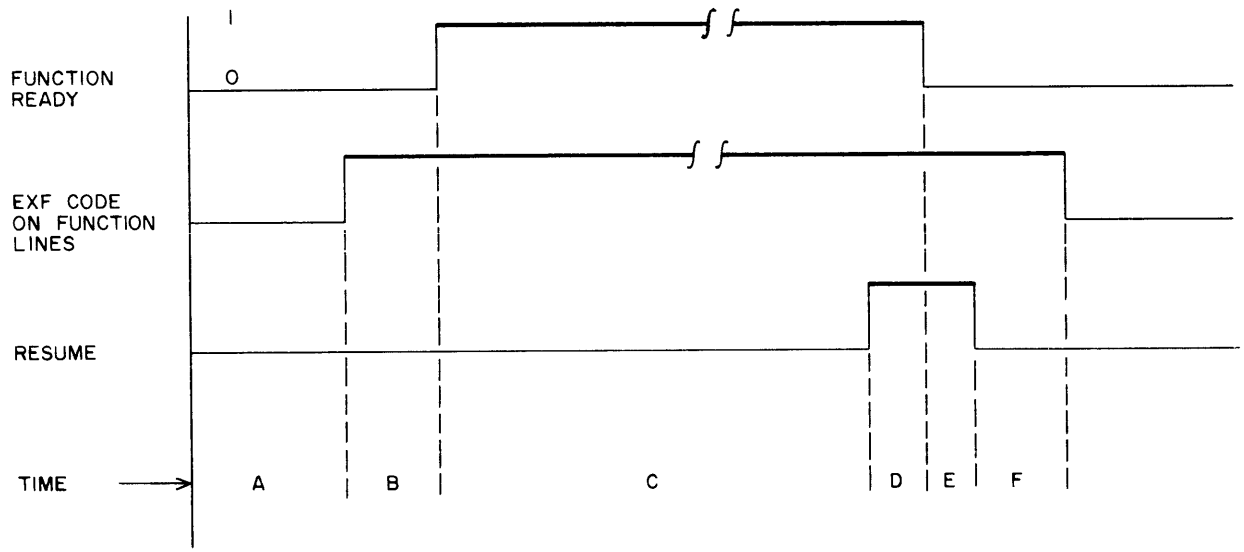
FUNCTION SIGNALS

160 mode must be selected in the 924 for a particular channel before that channel can be used to select 160 or 160-A equipment. Selection of equipment is accomplished by programming an EXF instruction. If status of equipment is desired, an EXF instruction with the correct status code is used. The equipment will then put the status response on the input lines accompanied by an input ready.

The sequence of events that occurs when selecting equipment or requesting status is as follows:

1. 160 mode is selected for the particular channel that is to be used.
2. An EXF 740C---- instruction is programmed where C is the channel and bits 0-11 contain the equipment select code or equipment status request code.
3. The select or status request code is put on the output lines. (The output lines are used for both data and function codes.)
4. An output function ready is sent out. The output function ready and function code stay on the lines until a resume is returned to the computer.
5. After the external equipment has accepted or recognized the code, a resume is sent back to the computer.
6. The 924 drops the function ready.
7. The external equipment drops the resume.

Timing for the above is shown in figure 5.



Time A - Time before EXF instruction

B - 1 usec

C - Determined by external equipment

D - 1.4 usec to 2.8 usec

E - 1.4 usec to 2.8 usec

F - Minimum time 4.0 usec, maximum time 9.8 usec

Figure 5. Function Ready/Resume Timing

DATA SIGNALS

Data is transmitted to and from the 924 via 12 input and 12 output lines. Output data is buffered from bits 0-11 of memory. Input data is stored in bits 0-11 in memory. Input lines that are not connected to external equipment will cause zeros to be stored. Because bits 12-23 are not connected, zeros will be stored at these bit positions.

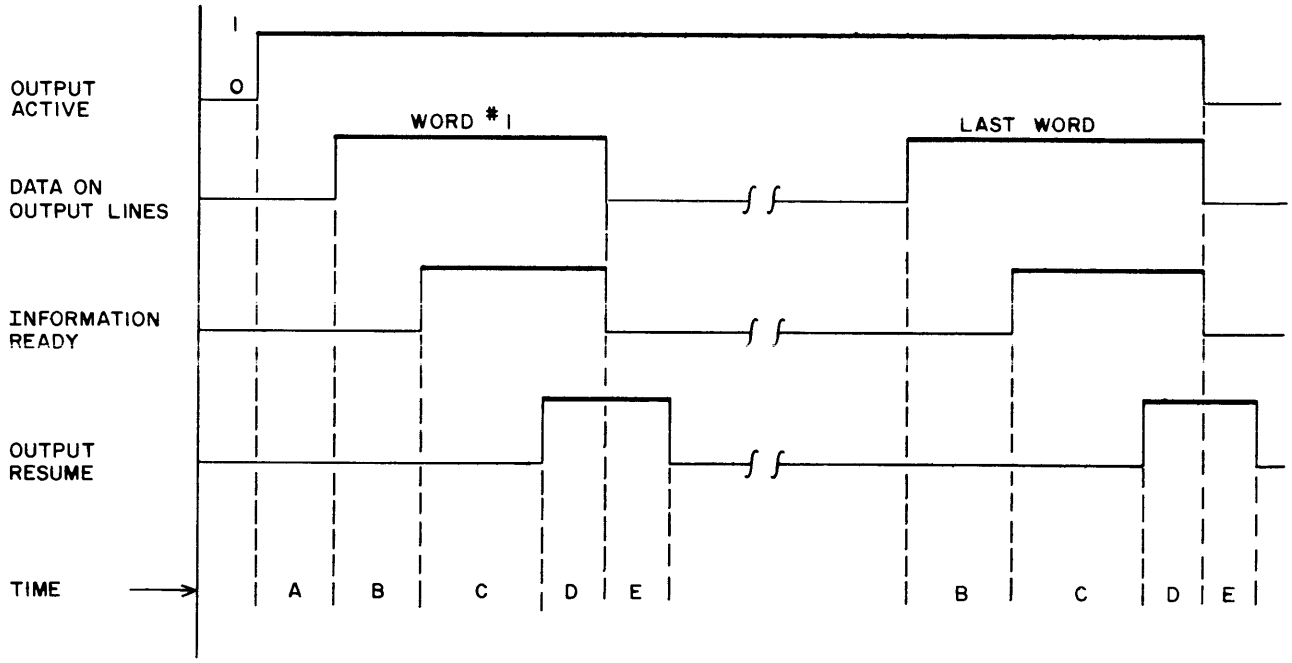
Output From Computer

The sequence of events and control signals that occur when transmitting words from the 924 to external equipment are as follows:

1. The computer selects the external equipment.
2. The computer determines status if necessary. Status is requested and the response appears on the input lines accompanied by an input ready. The response has to be buffered in (a one word input buffer) and examined.
3. The computer turns on the output active line.

4. The computer places the word in the output register.
5. After the output lines have stabilized, the computer sends an information ready.
6. The external equipment sends an output resume after it has accepted the data.
7. Steps 4-6 are repeated until the entire block of information is transmitted. After the entire block is transmitted, the output active line is dropped.

Figure 6 shows the ready/resume timing for the above.



Time A - 10.2 usec if word 1 is from the even memory, 14.6 usec if word 1 is from the odd memory.

B - 3.0 usec if word is from the odd memory, 6.6 usec if word is from the even memory.

C - Determined by external equipment.

D - 1.4 usec to 2.8 usec.

E - Determined by output equipment.

Figure 6. Information Ready/Resume Timing

Input to Computer

The sequence of events and control signals that occur when transmitting data from external equipment to the 924 are as follows:

1. The computer selects the external equipment.
2. The computer determines status if necessary.
3. The computer turns on the input active line and sends an input request to the external equipment.
4. The external equipment places the data on the input lines and sends an input ready to the computer.
5. The 924 drops the input request after it has stored the word in memory.
6. The dropping of the input request causes the external equipment to drop the input ready.
7. If the buffer is completed the computer drops the input active line. If not, the computer sends another input request and steps 4-6 are repeated.

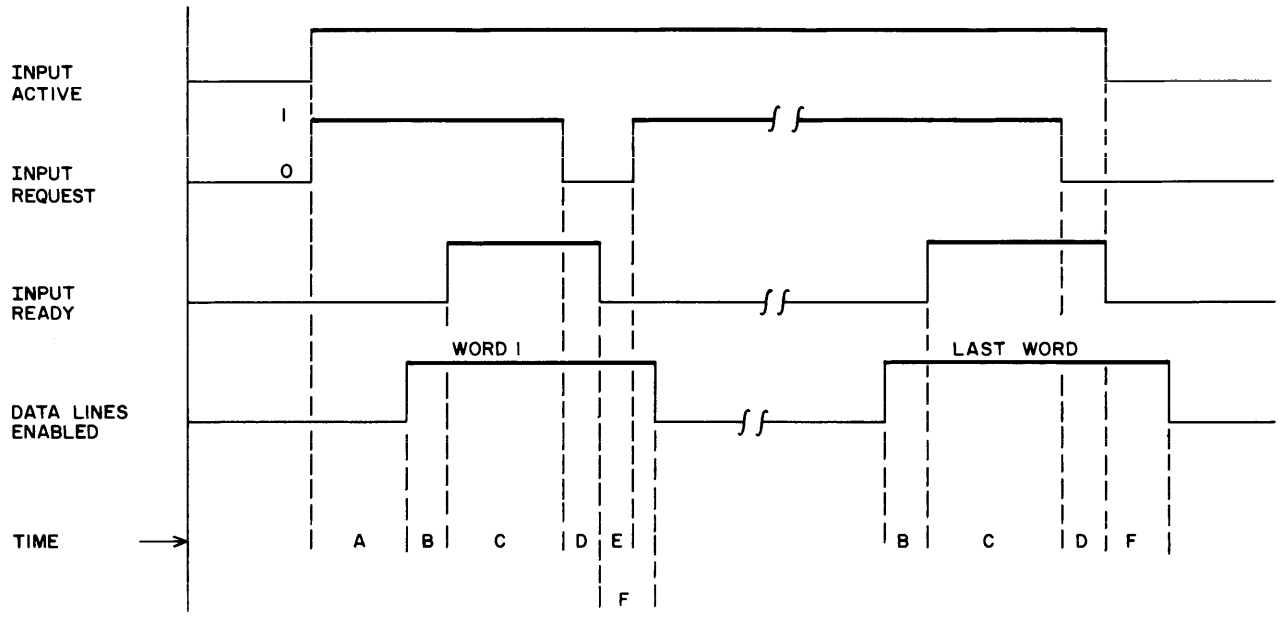
Figure 7 shows the ready/resume timing for the above.

A disconnect line is used to terminate an input buffer. If the input device has transmitted the final word, a disconnect signal is sent and the buffer is terminated. This will happen even if the computer is programmed to receive a longer block of data.

SUMMARY

The 924 has instructions that take up to 45 usec to execute (MUI). If the external equipment to be used requires an output ready or input request within a fixed period of time, difficulty could arise. The computer may not be able to recognize an input ready or output resume in time if it is in the process of executing an instruction that takes a long period of time.

Each cable group contains one input channel and one output channel. There are three such cable groups. They contain the pairs of input/output buffer channels 1 and 2, 3 and 4, 5 and 6. The two cables within a group are always used together and are not separable. The control signals necessary for communicating with the computer are defined on pages 22 and 23.



Time A - Determined by external equipment.

B - Determined by external equipment. The data lines may be enabled at the same time the input ready is sent.

C - Minimum time 9.4 usec, maximum time 180 usec. The maximum time is based upon the following:

1. The computer has just entered the RNI sequence when the input ready is sent.
2. The instruction that the computer reads out of memory is a MUI (Multiply).
3. All other channels demand processing.

D - Determined by external equipment.

E - 1.4 to 2.8 usec.

F - Determined by external equipment. Data may be removed from the lines at the same time the input ready drops.

Figure 7. Input Data Ready/Resume Timing

SUMMARY

Computer to External Equipment	
External Master Clear	Static "1" signal appears on the line whenever External Master Clear switch on the 924 console is set to CLEAR. Signal is available to clear external equipments attached to the computer.
Function Ready	Static "1" signal is produced on the line when function code is present on output data lines for examination and translation by external equipment. Signal is removed by output resume signal from external equipment.
Information Ready	Static "1" signal accompanies each word of output information. Signal is turned off by output resume signal from external equipment.
External Equipment to Computer	
Output Resume	Static "1" indicates external equipment has accepted word of information or external function code. Signal turns off information ready or function ready signal at computer. Output resume drops when function ready or information ready drops.
Output Active	Static "1" is produced when the computer is engaged in a block output operation. Signal drops when the last word of the block has been sent.
Interrupt 30, 40	Static "1" signal notifies computer that interrupt is generated. Computer enters interrupt routine and sends status request which is a signal to turn off interrupt.
Output Data and External Function Lines	The 12 lines carry output data and external function information.

Computer to External Equipment	
Input Request	Static "1" signal is produced when computer is ready to receive an input word. Signal drops when computer has accepted word.
External Equipment to Computer	
Input Ready	Static "1" signal produced when information, in a state which computer may sample, is present in input register of external equipment. Signal is dropped when computer drops input request signal.
Input Active	Static "1" signal is produced when the computer is engaged in a block input operation. Signal drops when the last word of the block has been accepted.
Disconnect	Short "1" signal indicates to computer that input device has transmitted final word of input data transmission. Upon receipt of signal, computer resumes main program with no further delay. (Generally, input instruction establishes a storage block of greater capacity than the actual input data block.)
Input Data and Status Lines	The 12 lines which carry input data status information perform as follows: 1) Following a normal input selection, lines hold content of external equipment input register which computer samples. Data is removed from lines when input request is dropped from computer. 2) Following request for status from computer, lines contain external equipment response. (A one word input buffer is programmed to ascertain status response.)

SECTION III

AUXILIARY SCANNER
924 INTERRUPT
CABLING INFORMATION
COMMUNICATION CIRCUITS

AUXILIARY SCANNER

The 924 computer has an auxiliary scanner which controls the input/output buffer operation and the interrupt. The scanner continually interrogates each channel for action requests and the interrupt system for an interrupt request. An input action request occurs when an active input channel has input data on the lines and has sent an input ready. An output action request occurs when an active output channel has received a resume from external equipment indicating that the external equipment is ready is receive more data. When an action request or interrupt request occurs the scanner will stop. If the computer is in the RNI or executing an instruction, this operation will be completed. The exception to this is a search instruction. If the computer is in the search sequence an exit will be taken. The computer will exchange an input/output data word or enter the interrupt routine. The computer upon completing the word exchange or exiting from the interrupt routine will return to the main program. If a search instruction has not been completed the computer will continue with the search sequence.

The scanner scans all six channels and the interrupt request line once every 1.6 usec. The order of scan is: channel 1, channel 3, channel 2, channel 6, interrupt request line, channel 5, channel 4.

924 INTERRUPT

The 924 computer can be interrupted by internal or external conditions. All internal interrupts originating in the computer cause the computer to do a return jump to address 16. Each cable group of 48-bit cables has one interrupt line for receiving external interrupts. An interrupt on any one of these three lines will cause the computer to do a return jump to address 16.

Each cable group of 160 mode cables has two interrupt lines. One is the interrupt 30 line and the other is the interrupt 40 line.

When the interrupt 30 line is activated the 924 does a return jump to address 30. When the interrupt 40 line is activated the 924 does a return jump to address 40. The computer does a return jump to address 16 when an interrupt occurs from any other source. This will be designated as interrupt 16.

The interrupt signals are recognized by the computer on a priority basis. If more than one type of interrupt occurs simultaneously, the lower numbered interrupt will be recognized first.

When an interrupt is recognized by the computer the interrupt lockout is set to prevent recognition of other interrupts. Clearing of the interrupt lockout does not depend upon which interrupt the computer has recognized (16, 30, or 40). The only condition that clears the interrupt lockout is when the computer does a RNI (Read Next Instruction) from address 16, 30 or 40.

The sampling of the interrupt lines is done when the scanner is set at the Interrupt position. It is at this time that priority is established if more than one interrupt line is active.

In the interrupt routine the source of interrupt has to be recognized and a status request or select code sent to clear the source of interrupt. If more than one interrupt line is active, the one with higher priority will be recognized by the computer. If this line of higher priority again becomes active before the interrupt lockout is cleared, the computer will again recognize it and not the line of lower priority. In other words one interrupt line could permanently lock out other interrupt lines of lower priority under certain conditions.

The 924 has a real-time clock interrupt. Selection of this interrupt causes the computer to be interrupted once every 100 milliseconds. In the interrupt routine the computer must either reselect the real-time clock interrupt or clear it. The reason for this is that in all cases the interrupt must stay on until the computer recognizes it. Reselecting the real-time clock in the interrupt routine turns the interrupt off and enables another real-time clock interrupt (in 100 milliseconds).

CABLING INFORMATION

Table 1 - Lists the jack connections on the computer for each channel pair in 48-bit or 160 mode (see page 45).

Table 2 - Lists the pin assignments for the 48-bit (1604) cables (see page 46).

Table 3 - Lists the pin assignments for the 160 and 160-A input/output cables (see page 47).

COMMUNICATION CIRCUITS

An output amplifier circuit in the computer converts the low level internal logic voltages to high level voltages necessary for transmission by cable to external equipment. An input amplifier circuit converts the high level cable voltages to the low level internal logic voltages. Although each circuit produces a 180^{o} phase shift, it does not function as a logical inverter. Instead, the two circuits are generally used together (figure 8, part c) so that the total phase shift is 360^{o} and the initial and final voltage levels are identical.

OUTPUT AMPLIFIER

A schematic diagram of the output amplifier is shown in figure 8, part a. Resistor R01 and the -20v supply hold the input to the circuit (point a) at binary "1" (-3v) when no input signal is applied to the circuit or when no data or control line is tied to the circuit. The collectors of transistors Q01 and Q02 are connected to the base of Q01 through 150 uuf capacitor C01 which integrates the collector signal. Assuming that a binary "1" is supplied to the circuit, Q01 and Q02 turn on, placing a low impedance between ground and the output line. The output of the circuit is effectively held to -0.5v. Capacitor C01 tends to oppose the initial conduction of Q01 and Q02 by feeding back a less negative signal than was initially placed on the base. When C01 approaches full charge, Q01 and Q02 approach full conduction and the output rises to -0.5v. Full saturation is prevented by feedback diode CR02. If a binary "0" (-0.5v) is applied to the circuit, the voltage divider action of the circuit causes Q01 and Q02 to turn off. No feedback is applied to prevent cutoff so the output voltage rises toward -20v; the actual voltage is determined by the driven output circuit.

The binary "1" state of the output amplifier circuit is -0.5v (± 0.3v) at the terminals of external equipments or computer under all conditions.

The binary "0" state of the output amplifier is -16v (± 3v) at the terminals of the external equipments under all conditions.

In the binary "1" or "0" state an output amplifier circuit (whether located in the computer or in an external equipment) need supply no more than 10 ma to any single input amplifier circuit in another equipment.

The output amplifier circuit can drive a maximum of five input amplifier circuits (50 ma maximum available current from output amplifier circuit).

Waveform characteristics of the signal from the output amplifier:

No transition with slope greater than 8v per usec for a 30 foot cable
Minimum transition time 2 usec
Maximum transition time 4 usec

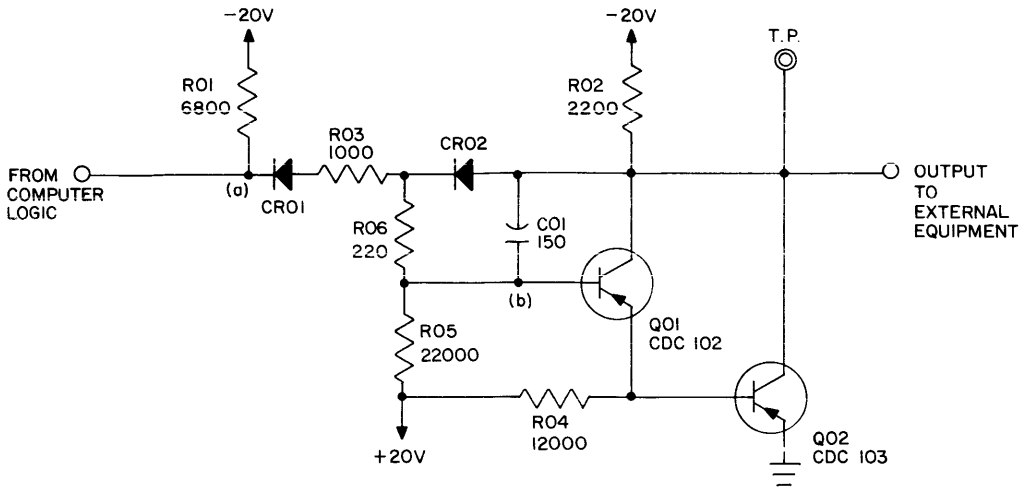
The circuit is capable of driving a total wiring capacity which can vary between 0 and 0.002 uuf.

INPUT AMPLIFIER

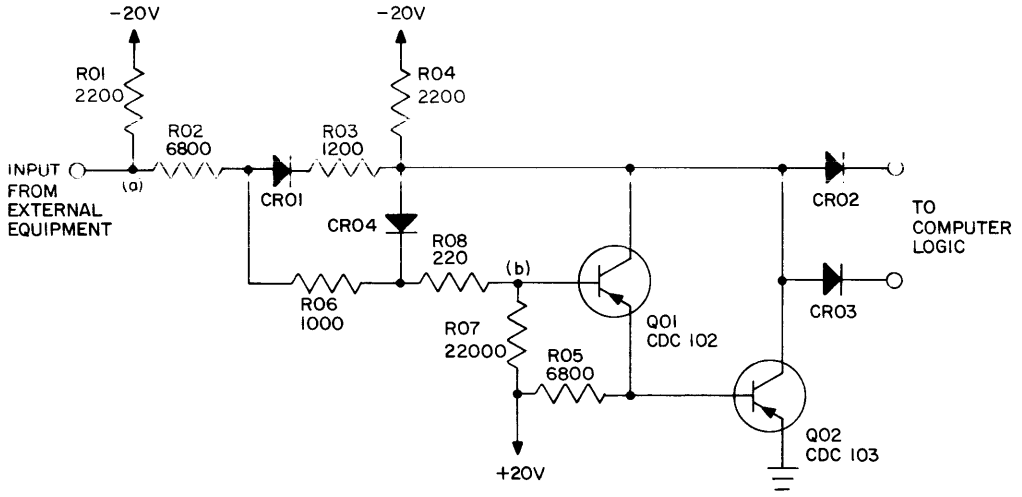
A schematic diagram of the input amplifier circuit used in the computer is given in figure 8, part b. Resistor R01 and the -20v supply hold the input to the circuit (point a) at binary "0" (-16v) when no input signal is supplied to the circuit or when no data or control line is connected to the circuit. Assuming a binary "1" (-0.5v) input to the circuit, the base of Q01 (point b) rises positive due to the voltage divider action of R02, R06, R07, and R08. The collectors of Q01 and Q02 then move in a negative direction. A feedback network including R03 and CR01 limits the negative potential of the collectors so that a binary "1" (-3v) is presented to the computer logic circuits. Conversely, if a binary "0" (-16v) input is applied to the circuit, the voltage divider action causes the transistors to increase conduction. The feedback network of R08 and CR04 limits conduction so that the output to the computer logic circuits approaches -0.5v or binary "0".

The maximum steady-state current drawn from a line by an input circuit does not exceed 10 ma. The circuit is designed so that if the input wire is disconnected the effect will be as though a binary "0" were present at the input.

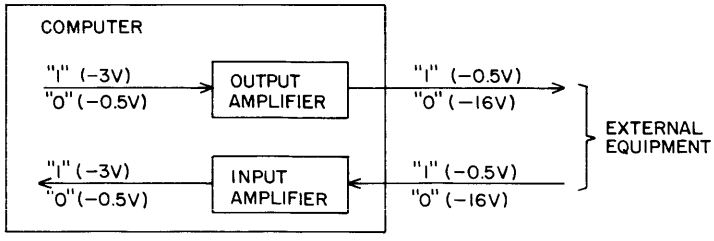
The waveshape of the current drawn from a line by an input circuit has a slope which does not exceed 5 ma per usec.



a. OUTPUT AMPLIFIER



b. INPUT AMPLIFIER



c. AMPLIFIER CONVERSIONS

Figure 8. Communication Circuits

SECTION IV

924 INSTALLATION

GENERAL PROCEDURES

The area selected for installation of a computer system must meet the conditions necessary for efficient operation. This section provides information on power requirements, equipment sizes, and cabling to aid in the preparation of a suitable site for the system.

Two months before the system is shipped, a detailed floor layout should be submitted to Control Data Corporation so that cable requirements may be determined. Control Data will furnish recommendations for a floor layout if desired. If required, one month before shipment, the Control Data engineer responsible for delivery and installation of the equipment will visit the site to discuss unloading and placement. At this time, area specifications and final modifications will be reviewed.

SPACE AND LAYOUT REQUIREMENTS

The size and shape of the installation area will partially determine positioning of the various equipment cabinets (figure 9). The operator seated at the console should be able to view the tape handlers and any other equipment with moving parts. Cabinets should be easily accessible to the operator and to maintenance personnel and equipment.

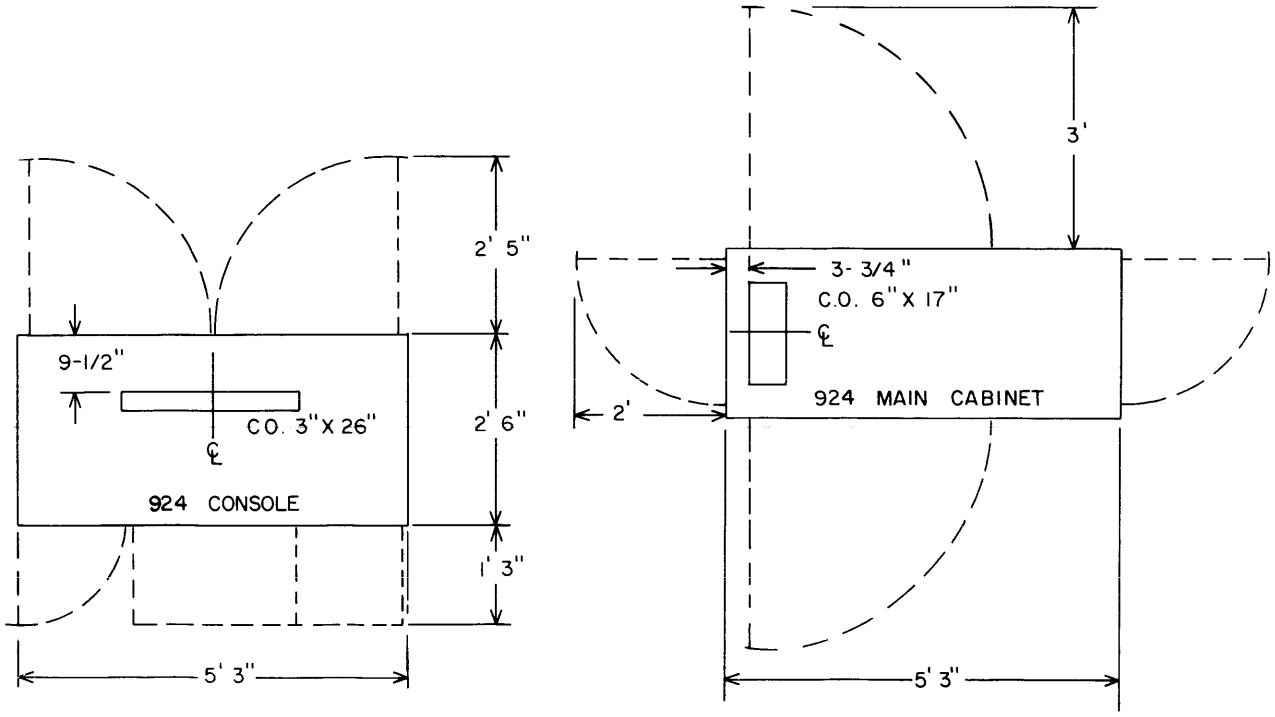


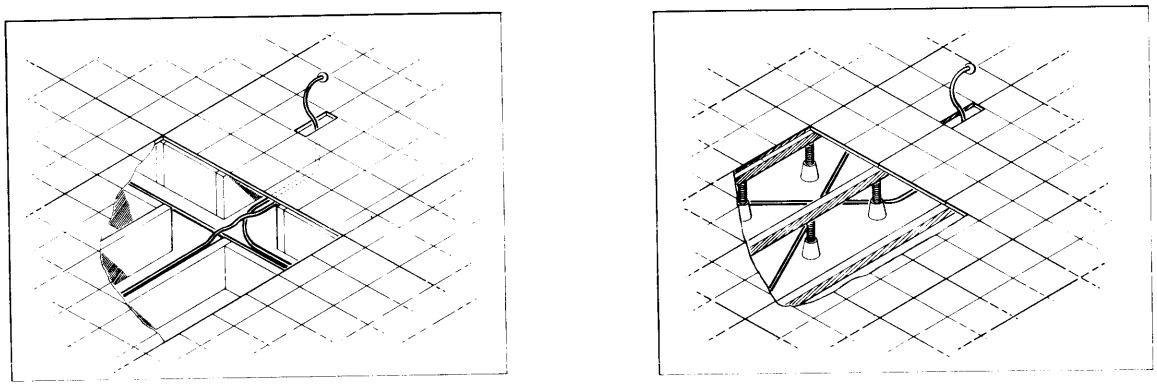
Figure 9. Console and Main Cabinet Templates

Plastic templates of equipments may be obtained from Control Data Corporation, 924 Product Department.

FLOOR

The weight of a cabinet is distributed over its entire base with a maximum load of 150 lbs. /ft.^{2} The leveling pads in each cabinet are not normally used for support but are provided to level the cabinet on uneven floors. If leveling pads are used, the floor must be able to withstand a concentrated load of 150 lbs. /in.^{2}

Connecting cables in the computer system enter the cabinets through openings in the bottom. Raceways may be built into the floor or a raised floor may be laid above the room floor (figure 10). If a raised floor is used, cables may be routed without restriction and addition or rearrangement of equipment is simplified. A raised floor can be used to provide an underfloor plenum cooling system instead of the blowers in the cabinet. When used as a plenum, the minimum underspace clearance is eight inches.



A. Raceway Type B. Pedestal Type

Figure 10. Raised Floors

AREA CLEANLINESS

Clean the computer site regularly to avoid dust accumulation. Static electricity on magnetic tape attracts dust and cigarette ashes. Smoking should be avoided when handling tapes. The cabinets of the system contain permanent filters which should be removed, cleaned, and replaced weekly.

FIRE PRECAUTIONS

Locate fire extinguishing equipment near the system; observe normal fire precautions.

TEMPERATURE AND HUMIDITY CONTROL

The computer main cabinet and magnetic tape units are cooled by blowers that circulate ambient room air through the cabinets or by underfloor pressure plenums.

Plenum cooling is preferred because it reduces the over-all noise level and allows a higher room temperature (78°F, 40 to 60% relative humidity). The plenum system requires an underfloor clearance of eight inches, air circulation through the main cabinet equal to 1600 cfm, and 0.5 inch static pressure in the plenum (after allowance for losses through the floor seams). Plenum air temperature at the main cabinet should be no higher than 68°F.

All other equipment is cooled by self contained blowers (and/or fans) or free air convection through the unit. In most equipment air is drawn through filters at the bottom of each cabinet and forced up and out through louvres near the top. The 606 tape unit is cooled by air drawn through the top and forced out the bottom.

Room air conditioning requirements without a plenum system are 70°F at 40 to 60% relative humidity. Relative humidity below 40% can cause static electricity to build up on the magnetic tapes. Humidity above 60% can cause errors in paper tape, card reader and punch operations.

Heat generated by the equipment should be quickly removed from the vicinity of the cabinets by circulation of the room air. Additional factors which will aid in determining over-all cooling requirements are:

one ton of air conditioning = 12,000 BTU/hr.
heat generated by one person = 500 BTU/hr. (approx.)

POWER REQUIREMENTS

The computing system operates from a 120/208, 60 ~, 3ϕ, 4-wire service and 120/208 vac, 400 ~, 3ϕ, 4-wire service. The 60 ~ power is taken directly from the main power service lines and is used to operate the motor-generator and items such as utility outlets, blower motors, punch motor, etc. Power for the motor-generator sets

may be either 220 or 440 vac. Figure 13 shows power requirements for a typical installation.

The output of the motor-generator supplies the 120/208 vac, 400 ~ , 3ϕ, 4-wire service. 400 ~ service is used for the computers because it is relatively free from power surges occurring on the input to the motor and is more easily filtered after rectification.

The motor-generator (MG) and its control cabinet (figure 11) should be loacated in a ventilated site remote from the computing area. The MG (figure 12) and control unit should be installed and wired prior to the time of computer delivery. A spare MG will also be installed to provide for a minimum of interruption in the event of generator failure. Control and switchover gear for the two MGs are included in a single cabinet.

CUSTOMER WIRING

Four 400 ~ wires and two control wires from the MG control cabinet to the computer area breaker panels are to be installed by the customer prior to shipment of the computing system. These wires may be routed in the same raceway. If a remote control unit for the MG control cabinet is specified, four additional control wires must be installed in the above raceway.

The output of each MG is 10 KW, 208 vac, 400 ~ , 3ϕ. The four wires carrying the 400 ~ power should be sized to allow no more than 2% voltage drop over the entire length of the run. The control wires should be sized, in accordance with codes for control circuits, to handle a pushbutton station operating a magnetic contactor.

Two circuit breaker panels provided by the customer are to be mounted side by side on a wall in the computing room with a common raceway across the bottom. Figure 10 shows a sample arrangement of the circuit breaker panels and the MG installation.

One panel distributes the 208 vac, 400 ~ , 4-wire power from the motor generator. This panel needs no main breaker, but one 3-phase breaker for each piece of equipment in the system must be provided.

The other panel distributes the 308 vac, 60 ~ , 4-wire power for the various equipments in the system. It requires a magnetic contactor for the main disconnect. The

size of this contactor will depend upon the amount of power used in the system. This panel should contain one 3-phase or 1-phase breaker for each equipment in the system. Breaker specifications for the equipments are listed in table 4.

CABLES

Control Data Corporation will wire the output side of the breakers at the time of installation. However, site preparation is the customers responsibility and should conform to local electrical codes. If the codes require conduits or special raceways for cabling, these must be supplied and installed by the customer. Space should be allowed on both panels for the installation of additional breakers at a later date.

Cables supplying power to the cabinets should originate at the breaker panel where they are permanently installed. Sufficient spare cable should be allowed to accommodate minor changes in location of equipment. The power cable should not exceed 100 feet in length. Local codes will determine exact requirements.

To ease routing and connection of the power cables, locate the breaker panels in line with available floor raceways and in an area central to all equipment in the system.

The information cables (tables 1, 2, and 3) which connect the various units of the computer system will be delivered at the time of installation. Prior to delivery, the customer should determine the length of the cables. Equipment layout should be revised if the total length of any cable exceeds 50 feet.*

Except for variation in cable length, all information cables are identical. Detailed cable makeup and interconnection data are found in the maintenance volume. All cables used in the computer system (except those previously listed under Customer Wiring) are supplied by Control Data Corporation at the time of delivery of the system.

When submitting the final equipment configuration, the customer should advise Control Data Corporation of any unusual cabling requirements or obstructions beneath the floor that would interfere with the cables. This should be done no later than two months prior to shipment.

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* The total length of a cable includes all the individual cables connected to any one channel even when jumpering is accomplished within I/O equipment.

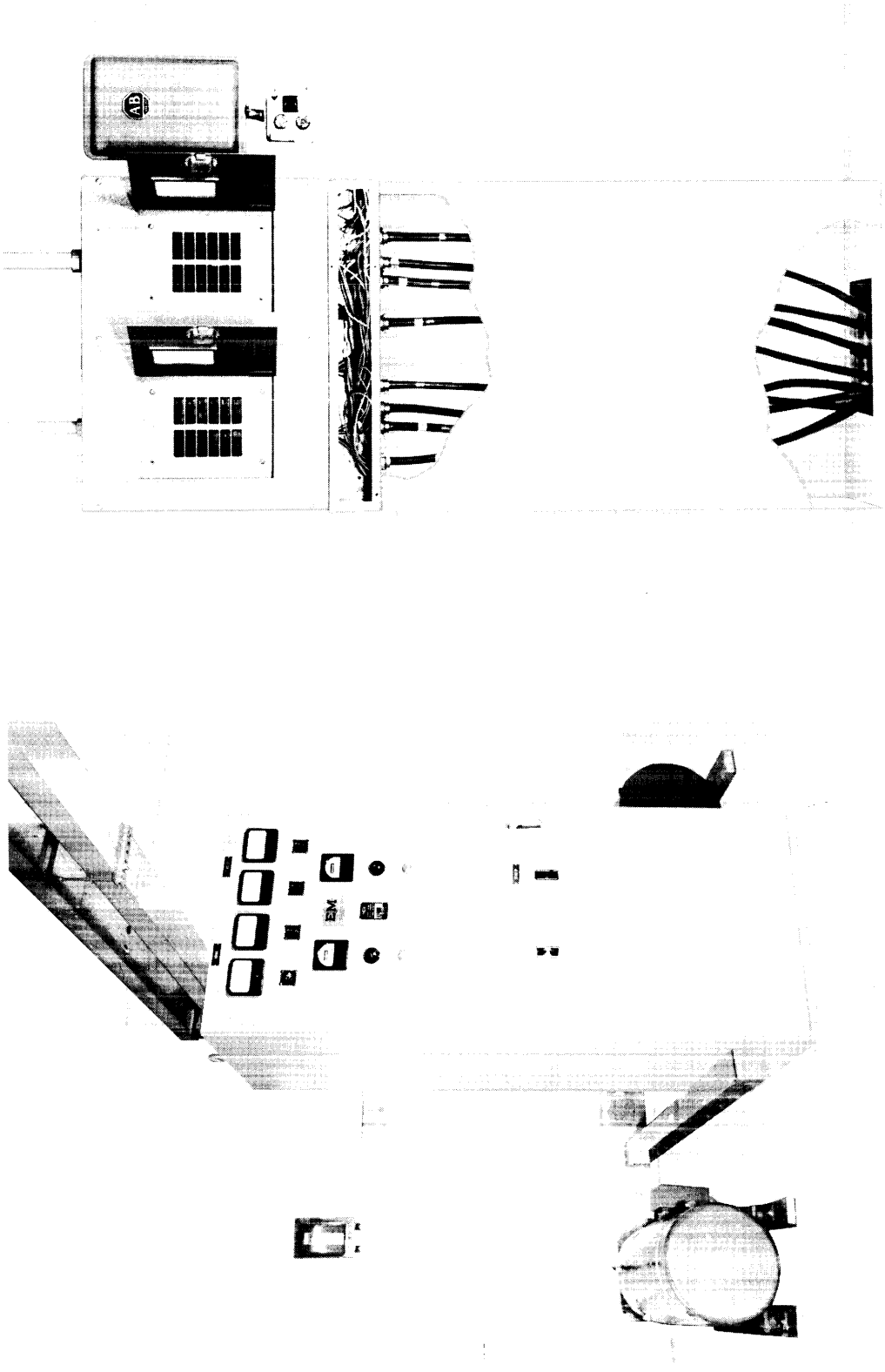


Figure 11a. Typical Power Installation

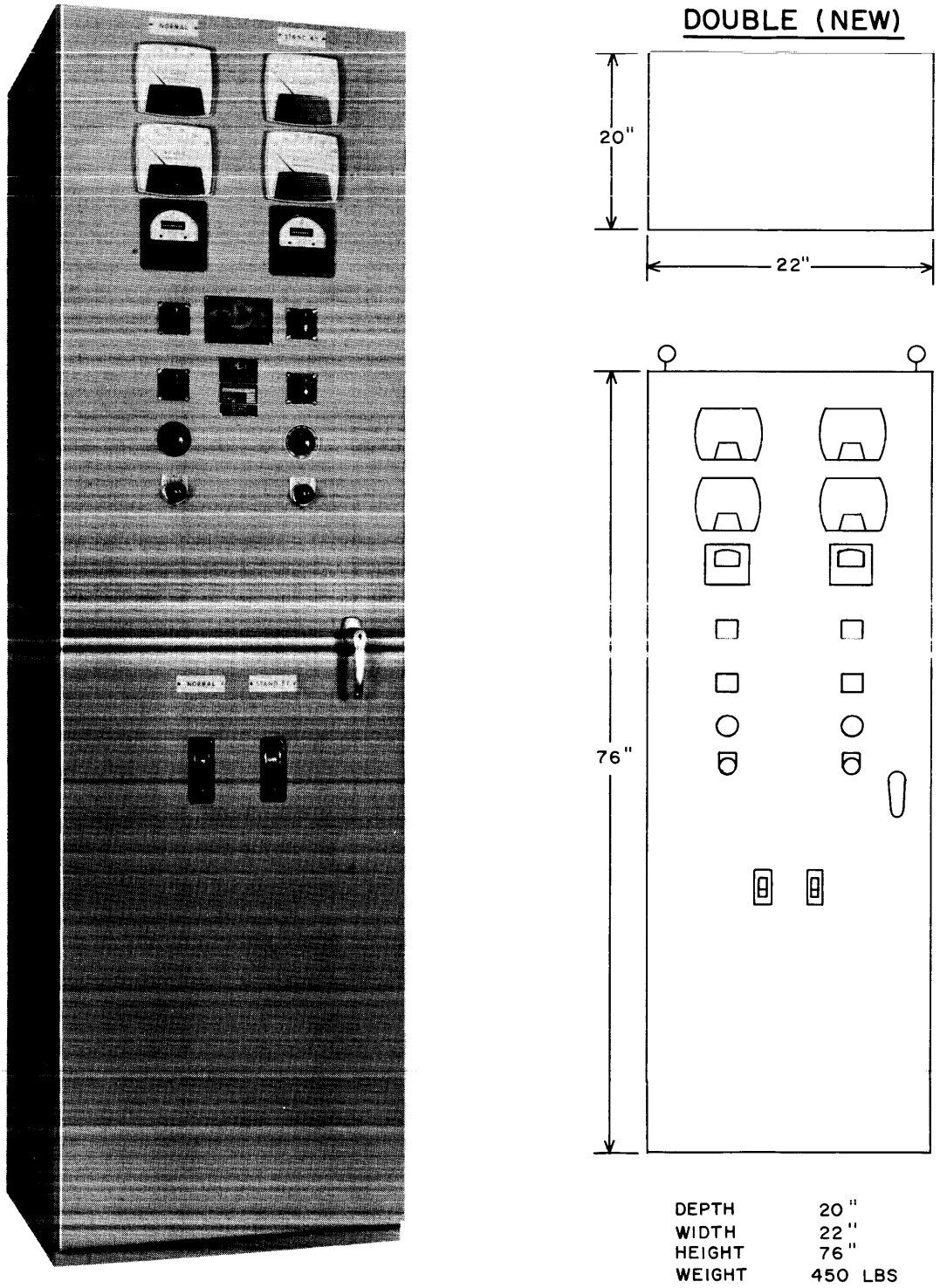
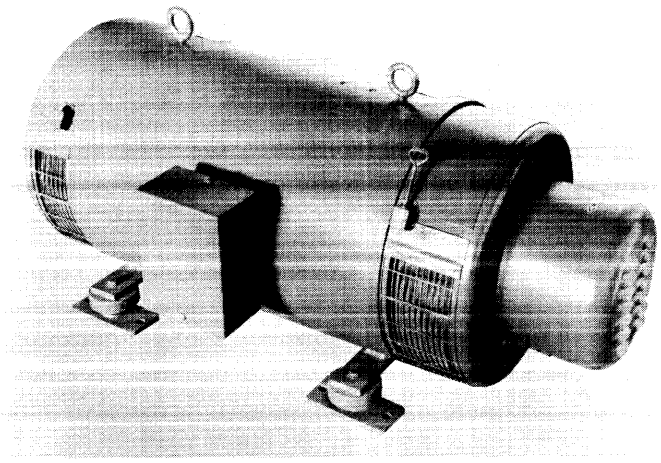


Figure 11b. Motor Generator Control Cabinet (Double - New)



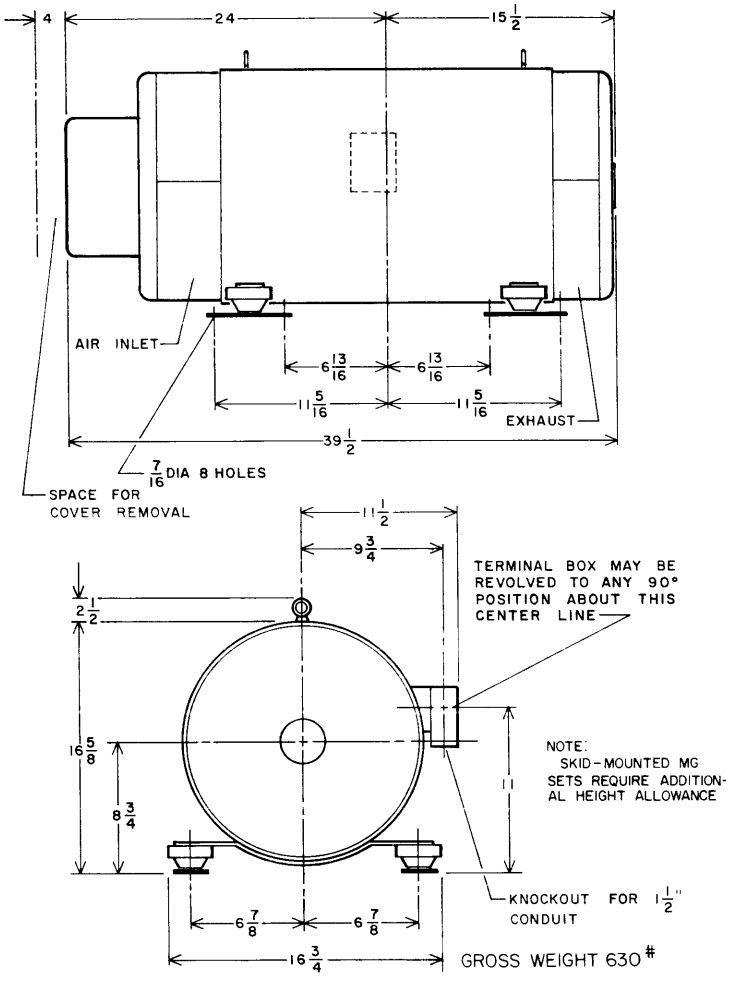
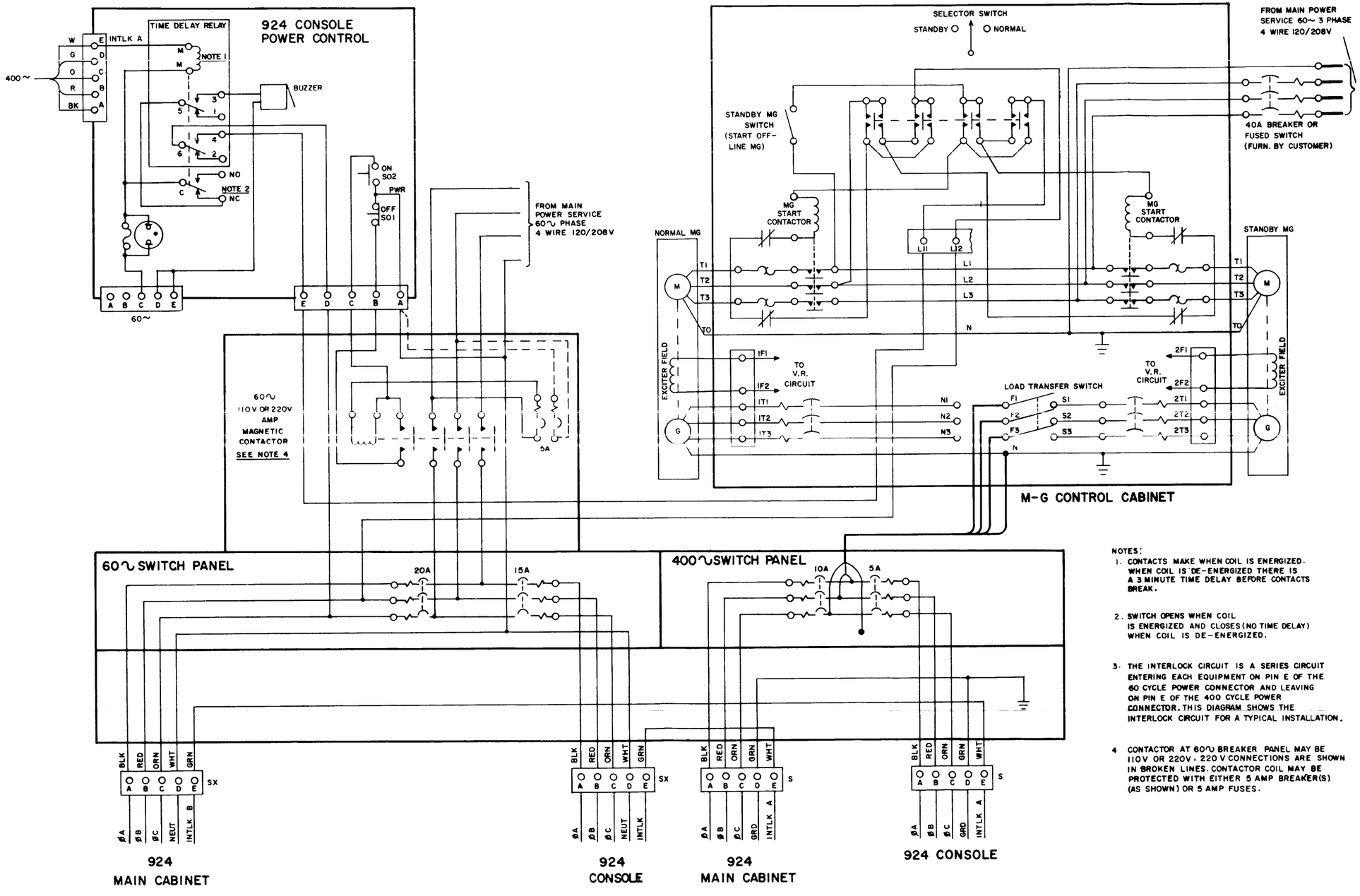


Figure 12. 10 KW Motor Generator Set



NOTES:

1. CONTACTS MAKE WHEN COIL IS ENERGIZED. WHEN COIL IS DE-ENERGIZED THERE IS A 3 MINUTE TIME DELAY BEFORE CONTACTS BREAK.
2. SWITCH OPENS WHEN COIL IS ENERGIZED AND CLOSES (NO TIME DELAY) WHEN COIL IS DE-ENERGIZED.
3. THE INTERLOCK CIRCUIT IS A SERIES CIRCUIT ENTERING EACH EQUIPMENT ON PIN E OF THE 60 CYCLE POWER CONNECTOR AND LEAVING ON PIN E OF THE 400 CYCLE POWER CONNECTOR. THIS DIAGRAM SHOWS THE INTERLOCK CIRCUIT FOR A TYPICAL INSTALLATION.
4. CONTACTOR AT 60~ BREAKER PANEL MAY BE 110V OR 220V. 220 V CONNECTIONS ARE SHOWN IN BROKEN LINES. CONTACTOR COIL MAY BE PROTECTED WITH EITHER 5 AMP BREAKER(S) (AS SHOWN) OR 5 AMP FUSES.

Figure 13. Main Power Distribution

TABLE 1. CABLE IDENTIFICATION

Cable Group 1	A/3A2 CH 1-2 B/3B1 CH 1-2 C/4M1 CH 1-2 D/1A2 CH 1-2 E/1B1 CH 1-2 F/4K2 CH 1-2 160 MODE/1D2 Output Cable 160 MODE/3D2 Input Cable
Cable Group 2	A/3B2 CH 3-4 B/3C1 CH 3-4 C/4M2 CH 3-4 D/1B2 CH 3-4 E/1C1 CH 3-4 F/4L1 CH 3-4 160 MODE/1E1 Output Cable 160 MODE/3E1 Input Cable
Cable Group 3	A/3C2 CH 5-6 B/3D1 CH 5-6 C/4N1 CH 5-6 D/1C2 CH 5-6 E/1D1 CH 5-6 F/4L2 CH 5-6 160 MODE/1E2 Output Cable 160 MODE/3E2 Input Cable
	Group 1: Channel 1 - buffer input Channel 2 - buffer output Group 2: Channel 3 - buffer input Channel 4 - buffer output Group 3: Channel 5 - buffer input Channel 6 - buffer output

NOTE: Each label indicates cable by a prefix letter. The expression following the slash gives the computer connector for the cable.

TABLE 2. CONNECTOR PIN NUMBER ASSIGNMENTS (1604)

Pin No.	Input Buffer Channel			Output Buffer Channel		
	Cable A	Cable B	Cable C	Cable D	Cable E	Cable F
A	bit 47	bit 24	bit 01	bit 00	bit 23	bit 46
B	46	23	00	01	24	47
C	45	22	Input Ready	02	25	Output Ready
D	44	21	Input Resume	03	26	Output Resume
E	43	20	Input Buffer Active	04	27	Interrupt Function
F	42	19	External Master Clear	05	28	Input Function Ready
H	41	18	Not Used	06	29	Input Sense Ready
J	40	17		07	30	Output Function Ready
K	39	16		08	31	Output Sense Ready
L	38	15		09	32	Sense Response
M	37	14		10	33	Output Buffer Active
N	36	13		11	34	Function Bit 00
P	35	12		12	35	01
R	34	11		13	36	02
S	33	10		14	37	03
T	32	09		15	38	04
U	31	08		16	39	05
V	30	07		17	40	06
W	29	06		18	41	07
X	28	05		19	42	08
Y	27	04		20	43	09
Z	26	03		21	44	10
a	25	02		22	45	11
b	GRD	GRD	GRD	GRD	GRD	GRD

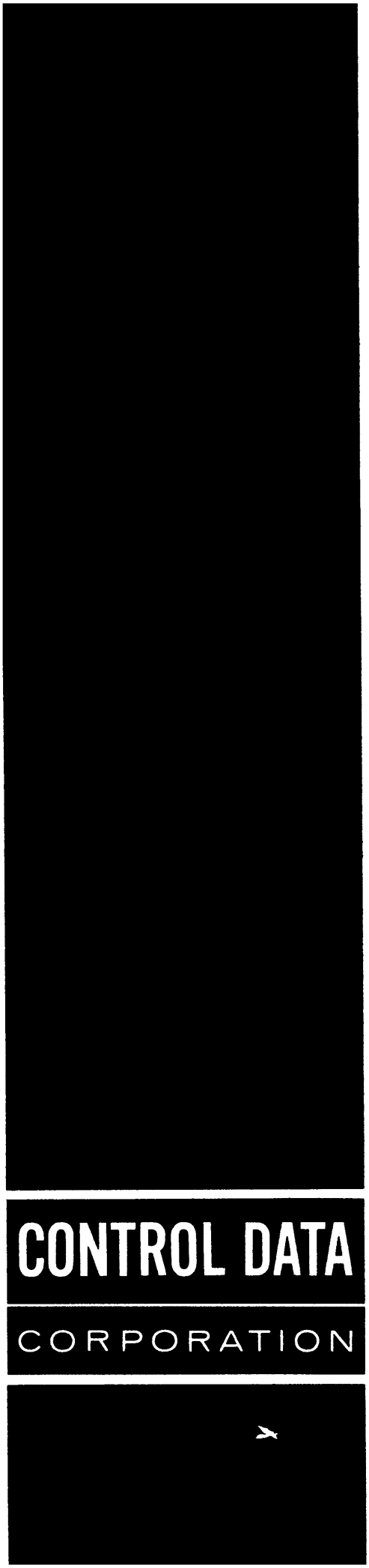
TABLE 3. PIN ASSIGNMENTS, INPUT/OUTPUT CABLES (160)

Normal Input and Buffer Input Cable	Pin	Normal Output and Buffer Output Cable
Bit 0 input status and information	A	Bit 0 output function and information
1	B	1
2	C	2
3	D	3
4	E	4
5	F	5
6	H	6
7	J	7
8	K	8
9	L	9
10	M	10
11	N	11
	P	
Input Ready	R	Information Ready
Input Request	S	Output Resume
Input Active	T	Function Ready
	U	Master Clear
Input Disconnect	V	Output Active
	W	
	X	
	Y	Interrupt 30
	Z	Interrupt 40
	a	
Ground	b	Ground

TABLE 4. ELECTRICAL AND PHYSICAL DATA

Equipment	Dimensions (Inches)			Weight	Air Circul.	Heat Generated	Power	Breaker Spec. amps		Measured Amperage						
										208v - 400 ∿			208v - 60 ∿			115v-60∿
	Width	Depth	Height	Lbs.	CFM	BTU/Hr.	KVA	400∿	60∿	ϕA	ϕB	ϕC	ϕA	ϕB	ϕC	1ϕ
1604 (With Blowers)	89-1/8	27-1/2	67-7/8	3070	3000	22, 500	6.6	20	20	14.0	14.0	14.0	7.5	7.5	0	--
1604 (W/O Blowers)	89-1/8	27-1/2	67-7/8	2950	3000	17, 000	5.0	20	20	14.0	14.0	14.0	--	--	--	--
1604 Console	157-3/4	64-1/2	42-5/8	870	--	2, 200	.65	5	15	0.25	0.25	0	2.5	0	2.4	--
1605 Adaptor	47-3/4	20-1/4	43	550	800	3, 000	.88	5	15	1.6	1.6	1.6	2.6	0	0	--
1606 Adaptor	47-3/4	20-1/4	43	470	800	3, 100	.91	5	15	1.6	1.6	1.6	2.8	0	0	--
1607 MTS (With Blowers)	88-1/2	27-1/2	67-3/4	2610	2500	30, 000	8.8	5	40	2.8	2.8	2.8	20	20	24	--
1607 MTS (W/O Blowers)	88-1/2	27-1/2	67-3/4	2560	3000	27, 000	7.9	5	40	2.8	2.8	2.8	20	20	20	--
1608 Control Unit	47-3/4	20-1/4	43	545	800	3, 800	1.1	5	15	2.2	2.2	2.2	2.8	0	0	--
1609 Adaptor	47-3/4	20-1/4	43	480	800	2, 500	.73	5	15	.75	.75	.75	0	0	0	4.0
1609 Card Unit	39-5/8	25-3/8	51-1/8	755	400	5, 700	1.7	--	15	0	0	0	7.75	5.0	0	1.7
1610 Control Unit (400 ∿)	47-3/4	20-1/4	43	550	800	2, 400	0.7	5	15	.75	.75	.75	--	--	--	3.8
1610 Control Unit (60 ∿)	47-3/4	20-1/4	43	525	800	3, 400	1.6	--	20	--	--	--	--	--	--	8.5
1612 Line Printer	71	30-3/8	55-3/8	1235	--	7, 700	2.3	--	30	--	--	--	--	--	--	19.5
1617 Card Reader	30	18-9/16	41 *	210**	100	950	.28	--	15	--	--	--	--	--	--	2.4
151 Card Tester	11-3/4	15	10-7/8	32	--	200	.06	--	--	--	--	--	--	--	--	0.3
7.5 KW Motor Generator	37-1/2	19-7/8	19-1/8	630	--	12, 500	3.6	--	--	--	--	--	10.0	10.0	10.0	--
M-G Control Cabinet (Single Controller)	22	30	76 ***	450	--	--	--	--	--	--	--	--	--	--	--	--
M-G Control Cabinet (Dual Controller - old)	32	31-5/8	76 ***	670	--	--	--	--	--	--	--	--	--	--	--	--
M-G Control Cabinet (Dual Controller - new)	22	20	76 ***	450	--	--	--	--	--	--	--	--	--	--	--	--
Display Unit (dd 51)	22-1/8	30	40-1/2	225	--	2, 900	--	--	--	--	--	--	--	--	--	--
Display Unit (dd 51a)	22-1/9	30	40-1/2	325	--	2, 900	--	--	--	--	--	--	--	--	--	--
924 Console	61-1/4	30-1/4	39-7/8	485	--	2, 000	0.59	10A-3P	15A-3P	0.5	0.5	0.5	3.2			
924 Computer (B)	62	27-1/2	67-7/8	1720	1600	13, 500	4.0	10A-3P	20A-3P	6.5	6.5	6.5	13.5			
924 Computer (NB)	62	27-1/2	67-7/8	1600	1600	8, 000	2.40	10A-3P	15A-3P	6.5	6.5	6.5				

* 41 total, 27-3/8 table only
** Table = 90 lbs.
***Add 3-1/2" for eyehook clearance



CONTROL DATA

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