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Operator's Guide for IBM 7040-7044 Systems

This publication is intended for personnel operating IBM 7040 and 7044 systems. It describes lights, switches, indicators, and keys of the systems, and of units within the systems. Instructions and operation code lists are included. The reader should be familiar with *IBM 7040-7044 Principles of Operation,* Form A22-6649.

This edition, Form A22-6741-1, obsoletes the preceding edition,
Form A22-6741.

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Contents

Figure 1. Operator's Console

The operator's console contains a program controlled console typewriter, keys, switches, and lights for communication between operator and computer (Figure 1). Two banks of entry keys and an enter keys computer instruction make possible the entry of a full data word or instruction into the computer. This entry may be either manual or program controlled.

Information is set into the keys in octal format. The contents of main processing unit registers and counters are displayed in lights on the console. Certain control and error indications also are displayed on the console for viewing and action.

The processing unit controls and supervises the entire computer system and performs the actual arithmetic and logical operations on data. From a functional viewpoint, the processing unit consists of two sections: control and arithmetic-logical.

The control section can start or stop an input-output device, turn a signal indicator on or off, rewind a tape reel, or direct some process of calculation.

The arithmetic-logical section contains the circuitry to perform arithmetic and logical operations. The arithmetic portion calculates, shifts numbers, sets the algebraic sign of results, compares, and so on. The logical portion carries out the decision-making operations to change the sequence of instruction execution.

Instructions and Data

Instructions are distinguished from data by the time at which they are brought into the processing unit from core storage. Information that is brought into the processing unit during an instruction (I) cycle is interpreted as an instruction. Information that is brought into the processing unit during any other computer cycle is treated as data. Consequently, the computer can readily operate on its own instructions, by bringing information into the processing unit during any cycle other than an I cycle. Also, the computer can be instructed to alter its own instructions according to conditions encountered during the handling of a procedure.

It is this ability to process instructions that provides the almost unlimited flexibility and the so-called logical ability of the stored program computer system.

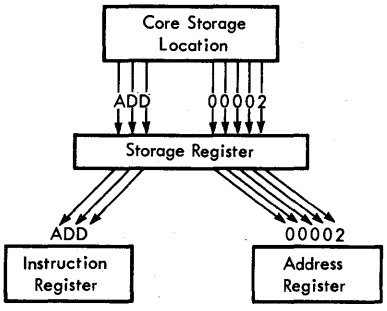


Figure 2. Register Nomenclature and Function

Register

The register is an electronic device capable of receiving and holding information, and transferring it as directed by control circuits. Functioning may depend upon magnetic cores, transistors, or similar components.

Registers are named according to function: an accumulator register accumulates results; a multiplier-quotient register holds either multiplier or quotient; a storage register contains information received from storage or to be sent to storage; an address register holds the address of a storage location or device; and an instruction register contains the instruction code (operation part) of an instruction being executed (Figure 2).

Registers differ in size, capacity, and use. Some registers contain extra positions to indicate overflow conditions during an arithmetic operation. The accumulator register has 39 positions; 36 for data, two (P and Q) to remember overflow conditions, and one (C) which holds a check bit for that word. If two 36-bit binary numbers are added, the result can be a 37-bit answer. In Figure 3, the accumulator register holds one number; the other number — from storage — is in the storage register. When the two numbers are added, and the result is placed back into the accumulator register, the overflow is indicated by the presence of a 1-bit in the first (P) overflow position. The ac-

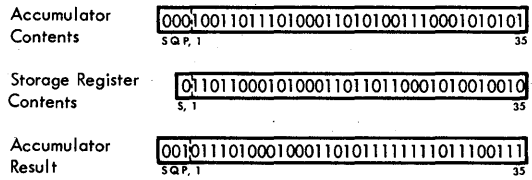


Figure 3. Overflow Condition Resulting from Addition

cumulator might then be shifted right one place and a record kept of the lost low-order bit.

With other registers, contents can be shifted right or left within the register and, in some cases, even between registers. When contents are shifted from one register to another, the two registers act as one large register. Figure 4 shows three types of shifting. With shifting involving a single register, data shifted out of the register may or may not be lost, depending on the instruction used. With double register shifting, data shifted out of the registers are lost, and vacated positions of the registers are filled with zeros.

In other uses, a register may hold data while associated circuits analyze the data. When an instruction is placed in a register, circuits can determine the operation to be performed and locate the data to be used. Data within specific registers can also be checked for validity.

The main registers of a system, particularly those involved in normal data flow and core storage addressing, display their contents by small lights located on the operator's console. A light ON indicates a 1-bit for that position: a light OFF indicates a 0-bit.

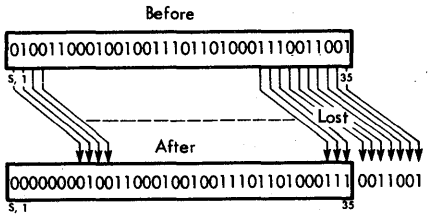
Counter

Counters are closely related to registers and usually perform the same functions. In addition, contents of a counter can be increased or decreased by some amount. The contents of a counter, as of a register, may be displayed in lights on the operator's console.

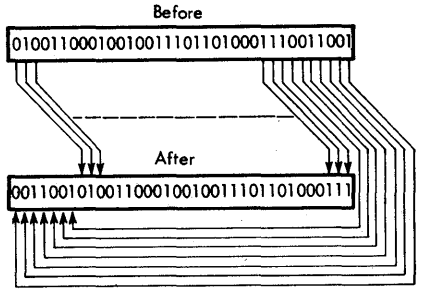
Adder

The adder receives data from two or more sources, performs addition, and sends the sum to a register. Figure 5 shows two positions of an adder circuit with inputs from an accumulator register and a storage register. The sum is developed in the adder. A carry from any position is sent to the next higher-order position. The final sum goes to corresponding positions of the receiving register.

Single Register Shifting:
(Shift right seven places)
Note: Left-hand positions are filled with zeros; data shifted out of position 35 are lost.



Single Register Shifting:
(Shift right seven places)
Note: Data are not lost when shifted out of position 35; the data are re-entered in position S.



Double Register Shifting:
(Shift right seven places)
Note: Data are shifted from position 35 of the first register into position S of the second register. Data shifted out of position 35 of the second register are lost. Vacated positions are filled with zeros.

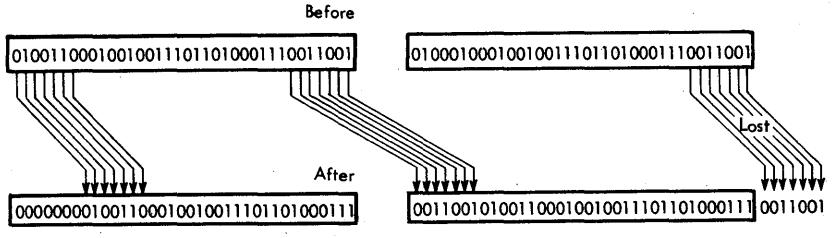


Figure 4. Types of Register Shifting

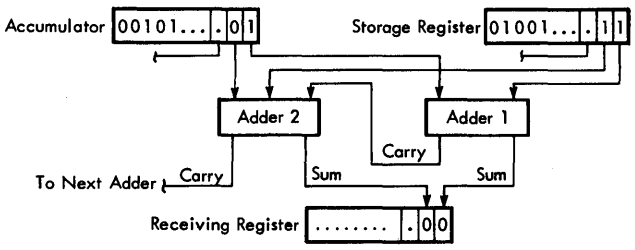


Figure 5. Adders in a Computer System

Machine Cycles

All computer operations take place in fixed intervals of time, determined by regular pulses emitted from an electronic clock at frequencies as high as millions per second. A fixed quantity of pulses determines the time of each basic machine cycle.

Within a machine cycle, the computer performs a specific machine operation. The quantity and kind of operations required to execute a single instruction depend on the instruction. Various machine operations are combined to execute each instruction.

An instruction consists of at least two parts, an operation and an operand. The operation tells the machine which function to perform: read, write, add, subtract, and so on. The operand can be the address of data or of an instruction, or of an input-output unit or other device. The operand can also specify a control function such as shifting a quantity in a register, or backspacing and rewinding a reel of tape.

To receive, interpret, and execute instructions, the central processing unit must operate in a prescribed sequence. The sequence is determined by the specific instruction and is carried out during a fixed interval of timed pulses.

All instructions have one instruction (I) cycle. Some instructions require only an I cycle for complete execution; other instructions require both an I and an execute (E) cycle.

Instruction Cycle

The first cycle required to execute an instruction is called the instruction (I) cycle. The time of this cycle is instruction or I-time. During I-time:

1. The instruction is taken from a main storage location and brought to the processing unit.
2. The operation part is decoded in an instruction register. This tells the machine what is to be done.
3. The operand is placed in an address register. This tells the machine what it is to work with.
4. The location of the next instruction to be executed is determined.

At the beginning of a program, the instruction counter is set to the address of the first program instruction. This instruction is brought from storage and, while it is being executed, the instruction counter automatically advances (steps) to the address of the location occupied by the next stored instruction. By the time one instruction is executed, the counter has located the next instruction in the program sequence. The stepping action of the counter is automatic: when the computer is directed to a series of instructions, it will execute these instructions one after another until instructed to do otherwise.

Assume that an instruction is given to add the contents of storage location 00002 to the contents of the accumulator register. Figure 6 shows the main registers involved and the information flow lines.

At the start of I-time, the instruction counter transfers the address of the instruction to the address register. The addressed instruction is selected from storage and placed in a storage register. From the storage register, the operation part is routed to the instruction register, and the operand to the address register. Operation decoders then condition circuit paths to perform the instruction, while the address register locates the operand.

Execution of instructions need not necessarily proceed sequentially. Certain instructions can alter the normal stepping of the instruction counter: the instruction brought from storage can cause the next execution to be not the next sequential instruction, but, instead, one located in another position. For instance, the instruction counter can be reset back to the beginning to repeat the entire program for another incoming group of data.

This transfer (branch) to alternative instructions also may be conditional. The computer can be directed first to examine some indicating device, and then transfer if the indicator is on, or off. An instruction can say, "Look at the sign of the quantity in the accumulator; if this sign is minus, take the next instruction from location 5000; if plus, proceed to the next instruction in sequence." The instruction counter is set according to the contents of one of two possible storage locations: 5000, or the location of the next instruction in sequence. The logical path — that is, the precise

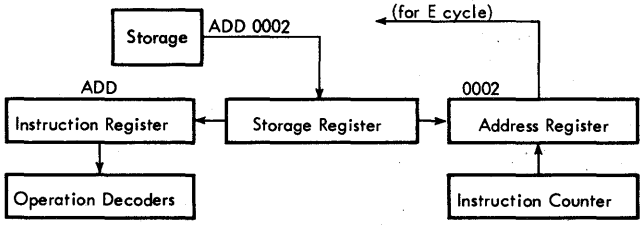


Figure 6. Computer I Cycle Flow Lines

sequence of instructions executed – may be controlled either by unconditional transfers, or by a series of conditional tests applied at various points in the program. Normally the storage arrangement of the stored instructions is not altered.

Execute Cycle

I-time is usually followed by one or more computer cycles which complete the operation being performed. Execution of an E cycle brings a word into the processing unit from core storage, or takes a word from the processing unit and places it in core storage. Any word brought into the processing unit during an E cycle is treated as data for the operation decoded by the previous I cycle. Figure 7 shows the data flow following the I-time illustrated by Figure 6.

The E-cycle (Figure 7) starts by removing from storage the information located at the address (00002) indicated by the address register. The information goes to the storage register, from which it is then moved to the adders together with the number from the accumulator. The contents of the storage register and accumulator are combined in the adders, and the sum is returned to the accumulator.

The address register may contain information other than the storage location of data. It can indicate the address of an input-output device, or a control function to be performed. The operation part of the instruction tells the computer how to interpret this information.

Buffer Cycle

Buffer cycles are used to transfer information between an overlap data channel (channels B through E) and an input-output device.

Use Cycle

Use cycles are used to transfer information between channel A and attached input-output devices.

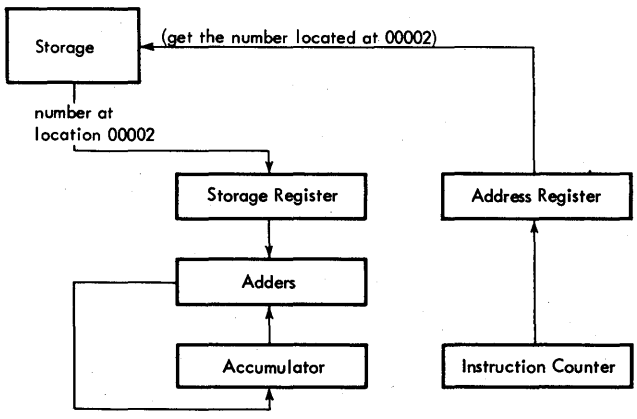


Figure 7. Computer E Cycle Following an I Cycle

Operator's Console

The operator's console has five panels (Figure 8) containing keys, lights, and switches that provide flexible, efficient communication between the computer and the operator. The following descriptions of console features start at the top left-hand corner of panel 1 and continue through panel 5.

Panel 1

Channel Bit Density: Five density switches are used, one for each possible data channel, to select the magnetic tape densities used for recording. Each switch has three positions: 556/200, 800/200, and 800/556. Thus, a magnetic tape unit whose *channel* bit density switch is in the 800/556 position would record at 800 bits per inch if operating at high density, at 556 bits per inch if operating at low density.

Storage Clock: With this switch in the ON position, core storage location 00005 is incremented (added to) 60 times a second. Incrementing is stopped by placing the switch in the OFF position or by removing power from the system.

Step Mode Selector: This three position rotary switch controls the operation mode when the single or multiple step keys are depressed. The three positions of the selector switch are: INSTRUCTION, CYCLE, PULSE. INSTRUCTION is the normal operation position and provides for execution of a single instruction at a time when the single step key is used. The CYCLE and PULSE positions are customer engineering aids and allow execution to be slowed to observe details of a single instruction.

Address Stop: This five-position switch is used in conjunction with the entry (location) switches and has these positions: OFF, I-Cycle, E-Store, Channel Store, and Any. The address at which the operator wishes to stop is first placed in the entry (location) switches. The operator then selects the type of cycle on which to stop. When a coincidence of the selected address and the cycle occurs, the computer stops.

Panel 2

CB Thermal: This light is turned ON whenever a circuit breaker, fuse, thermal, or airflow switch in the basic system or auxiliary equipment opens. Power is removed from the system if the opening switch is in the central processing unit (CPU). In auxiliary equipment, power is removed only from the unit.

Master Power Connect: When this switch is on (lit), power is supplied to the sequencing controls and the power-on and power-off switches are active.

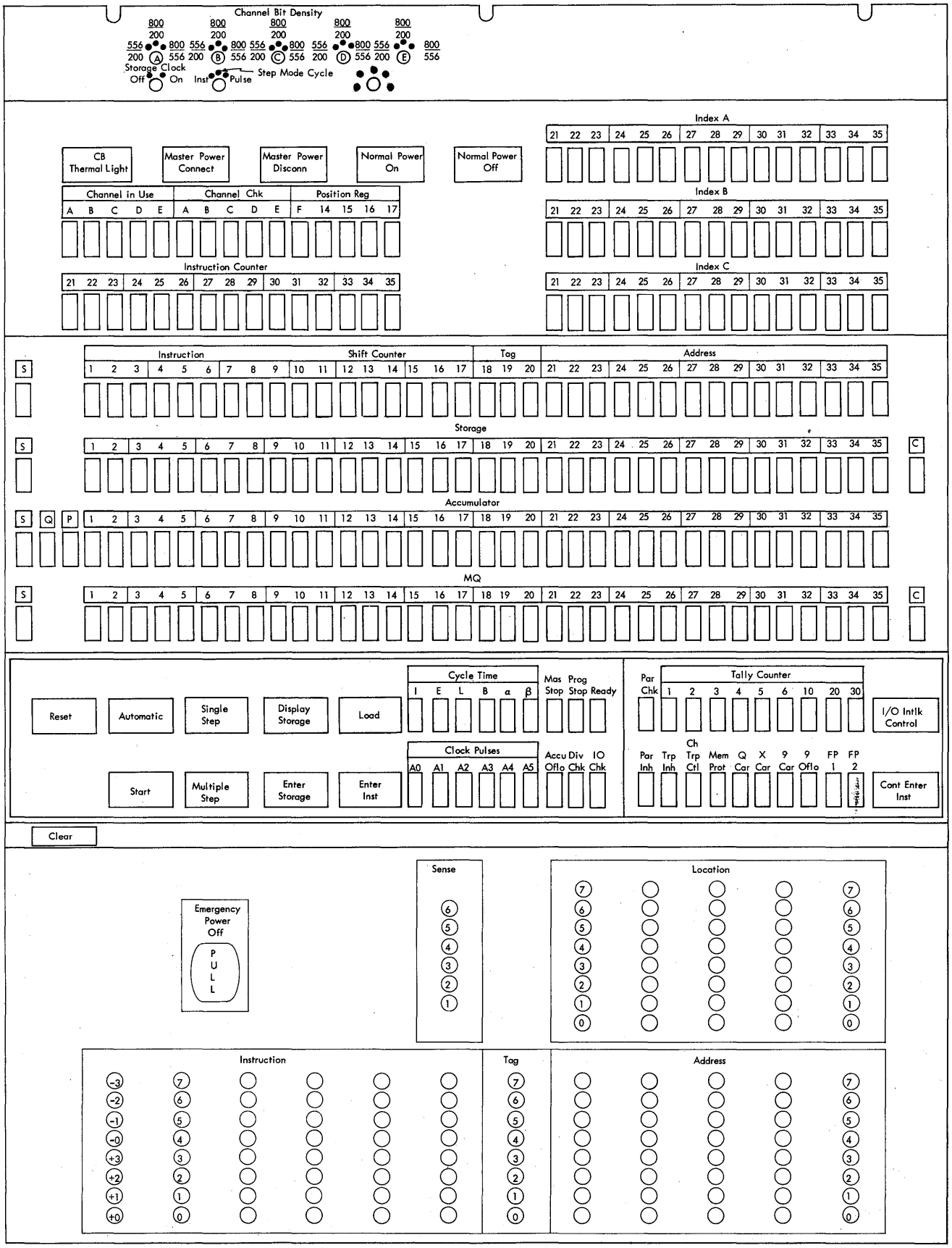


Figure 8. Operator's Console Panel

Master Power Disconnect: This switch controls power circuits and power applied to the sequencing controls. All power components under control of the system are disconnected from the line power. The power-on switch has no effect in this condition. Pressing this switch (with the system operating) results in a sequenced power-off operation.

Normal Power On: Pressing this switch starts a power-on sequence for the CPU and auxiliary equipment under control of the power distribution unit.

Normal Power Off: Depressing the power-off switch removes all DC voltages and air blower circuits in sequence. The —48 volts control voltage and convenience outlet power remain on.

Channel in Use (A through E): The channel in use indicators, one for each channel, are on for each data channel that is in operation.

Channel Check (A through E): The channel check indicators, one for each channel, are on when a byte or word redundancy has been detected.

Position Register: These five lights reflect the contents of the indirect address trigger (F) and positions 14-17 of the instruction being executed. Positions 15-17 indicate which adapter is being used on a select instruction and the character selected on character-handling instructions.

Instruction Counter: These lights reflect the contents of the instruction counter.

Index A, B, and C: These lights, one for each position of each index register, reflect the contents of the index registers.

Panel 3

Internal CPU Registers: The contents of the instruction register, shift counter, tag register, address counter, storage register, accumulator register, and multiplier-quotient register are reflected by these lights.

Storage Register C: This light reflects the contents of the 37th bit of the word in the storage register.

MQ Register C: This light reflects the parity bit contents of the word being used in an input-output operation on data channel A.

Panel 4

Reset: Pressing this key resets all registers and indicators in the logic section of the processing unit. Core storage is not affected by the reset key, but all data channel registers and indicators are reset.

Automatic: This switch is lit when in AUTOMATIC position. Placing this switch in the MANUAL position stops the processing unit after it has completed execution of the instruction being processed, unless an input-output device is in use. In this case, the computer continues execution of instructions and remains in automatic status until all input-output devices have been disconnected. When the processing unit stops (with this switch in manual) the computer is in manual status. The storage clock continues to run.

Single Step/Multiple Step: When the CPU is in manual status, these keys enable the operator to proceed with his program either one step at a time or at a slow automatic speed. If the computer executes an instruction that causes an input-output unit to be selected, the computer operates in automatic mode until the input-output unit is disconnected. When the disconnect occurs, the computer returns to manual status.

Display Storage: With the CPU in manual status, pressing the display storage key displays the contents of the core storage location addressed by the entry keys of panel 5. The contents are displayed by the lights associated with the storage register. If the storage clock optional feature is installed, the storage clock switch must be turned off to maintain the displayed word in the storage register.

Load: This key is active in automatic when the CPU is stopped and no channels are in operation. It is also operative as a program reset any time the automatic key is on. The following occurs when the load key is depressed.

When the automatic key is not on (manual mode):

1. If an instruction is in process it is given a brief period of time to complete.
2. At the end of this time, an interlock reset occurs even if the present instruction has not completed. The interlock and all other possible resets are described at the end of this section.

When the automatic key is on (automatic mode):

1. The instruction set up in the entry keys is executed.
2. The instruction set up in the keys should select a channel and put the channel in use. A channel command with maximum word count and an address of 00100 is loaded into the selected channel. When the channel in use indicator is turned off, the computer transfers control to location 00101 and continues instruction execution from there.

Start: Pressing the start key continues operation at high speed if the computer has stopped at a program stop, or if the CPU has been returned to automatic after having been in manual status. The start key resets the program stop light, and operations start at the address specified by the contents of the instruction counter.

Enter Storage: With the CPU in manual status, pressing this key places the word in the word bank of the entry keys in core storage at the location set up in the location bank of the entry keys.

Enter Instruction: Pressing this key executes the instruction set up in the word bank of the entry keys. The CPU must be in manual status.

Cycle Timer (I, E, L, B, α, β): The cycle timer lights reflect the current machine cycle being executed. Status of the alpha and beta triggers are also reflected for a 7106 CPU.

Master Stop: This light is on whenever the master stop trigger is on (CPU is logically stopped).

Program Stop: This light is on whenever the computer executes a halt instruction.

Ready: This light is ON after power is applied to the computer and remains on except when the computer is in automatic status and the continuous enter-instruction switch is on or the I-O interlock switch is in MANUAL.

Clock Pulses (A0 through A5): These lights reflect the state of the timing ring.

Accumulator Overflow: This light is on during any fixed-point or shifting operation that gives a carry out of position 1 of the accumulator. The light is turned off by execution of a TOV instruction or depression of the reset key.

Divide Check: This light is turned on in fixed-point division if the dividend (accumulator contents) is greater than or equal to the divisor (storage register contents). In floating-point operation, the light is on if the magnitude of the fraction of the dividend is greater than or equal to twice the magnitude of the divisor fraction. The light is tested and turned off by execution of the DCT instruction.

I-O Check: The I-O check light may be turned on by any of the following conditions:

1. If an RCH instruction is decoded and the specified data channel has not been selected.
2. If, during writing, a channel data register has not been loaded with a word from storage by the time its contents are to be sent to the output unit.
3. If, during reading, a channel data register has not transmitted its contents to storage by the time that new data are to be loaded into it from an input unit. This is not true during a tape operation when an RCH (following an RDS) is given too late.

The I-O check light may be turned off by execution of an IOT instruction.

Parity Check: This light is turned on when the parity circuits detect an error. It will be on when the CPU stops on error during storage test operations.

Tally Counter (1, 2, 3, 4, 5, 6, 10, 20, 30): The tally counter differentiates between the L cycles of a floating-point instruction and provides gating for their different operational steps. The counter is divided into two stages. Lights on the console reflect which stage the CPU is currently operating in. Positions 1 through 6 indicate the flow of single precision floating point and positions 10, 20, and 30 together with positions 1 through 6 indicate the flow of double precision floating point.

I-O Interlock Control: When the light in this switch is on, the switch is in MANUAL position; when the light is off the switch is in automatic position. The switch is used with the auto-manual switch as an aid in locating I-O problems. The switch functions as follows:

1. If an I-O unit is selected with the I-O interlock light off, system operation reverts to automatic status even though the auto-manual switch is in MANUAL.
2. If the I-O interlock light is on and the CPU is in manual status when an I-O unit is selected, the CPU executes the select and remains in manual status.

Parity Inhibit: This light is on whenever parity traps are inhibited as a result of a previous parity trap. The light is turned off by execution of a TRP instruction or a machine reset.

Trap Inhibit: This light is on when all interrupt traps are inhibited as a result of a parity or interval timer reset trap. The light is turned off with execution of the TRT or TRP instructions or a machine reset.

Channel Trap Control: This light is off when channel traps are inhibited as a result of a trap or ICT instruction or a machine reset. It is turned on by execution of an RCT or ENB instruction.

Memory Protect: This light is on whenever the machine is operating in the memory protect mode.

Q Carry: This light reflects the condition of the Q-carry trigger. The trigger is turned on whenever a carry out of adder Q position occurs.

X Carry: This light is on when the X-carry trigger is on as a result of a carry out of adder position 21.

9 Carry: This light is on whenever a carry occurs out of adder position 9.

9 Overflow: This light is on whenever accumulator position 9 equals 1 in an accumulator left shift or during a 9 carry in an adder to accumulator operation.

FP1 and FP2: The floating point (FP) 1 and 2 lights reflect the condition of floating-point 1 and 2 triggers. The triggers are used to store certain conditions throughout floating-point operations. The lights are customer engineering aids.

Continuous Enter Instruction: When the light in this switch is on, indicating continuous enter instruction mode, the CPU is forced continuously to execute the instruction set up in the entry keys in panel 5 if the CPU is in automatic status and the start key is depressed. It is a customer engineering aid.

Clear: With the computer in automatic status, pressing the clear key resets all areas of core storage to

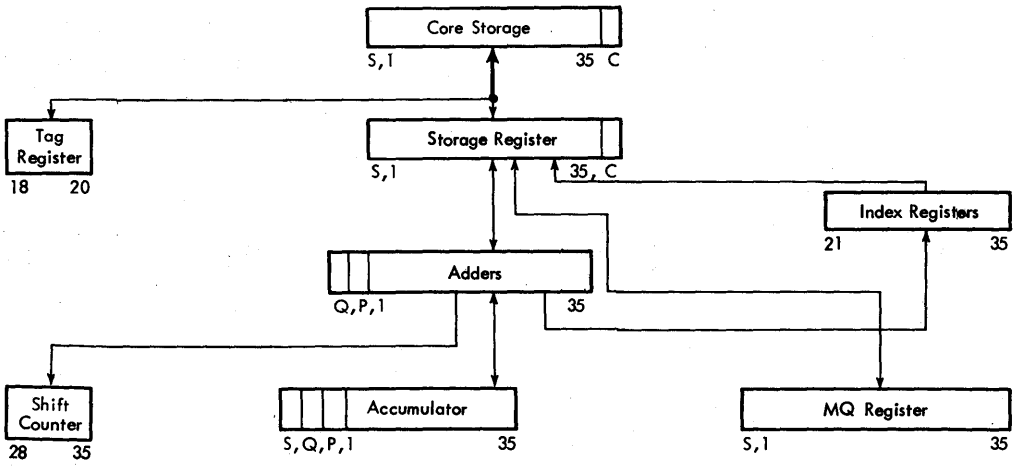


Figure 9. Simplified Processing Unit Data Flow

zeros and all registers in the CPU. The clear key also resets all channel registers and indicators. The key is inoperative when the computer is in true manual status.

Panel 5

Emergency Power Off: When this pull type switch is actuated, all power on the system and all auxiliary power are immediately removed. The switch must be mechanically restored. The on-line 1401 and its attached I-O equipment are not affected.

Sense: Six sense switches give the operator manual control over the program while it is being executed at high speed. At various points in the program, executing a sense switch test instruction causes the computer program to follow one of two courses, depending on whether the sense switch tested is depressed. The sense switches are also effective while the computer is in manual status.

Entry Switches: There are two banks of entry switches. The first is an 8 × 5 matrix of switches that allow the operator to enter a location into core storage in octal format. The second bank is an 8 × 12 matrix of switches that enable the operator to insert a word into the computer using octal format. This word is divided into sign, instruction, tag, and address. To enter a word into core storage, the octal representation of the location in core storage to be used is first placed into the location bank switches. Next, the octal representation of the actual word to be entered is placed in the word bank switches. The enter storage key is then pressed, which automatically stores the desired word in the desired location in core storage. These switches are active only when the computer is in manual status.

Processing Unit Data Flow

Instruction flow charts accompany many of the instruction descriptions of this publication. To aid understanding the flow of data and instructions through the processing unit, Figure 9 shows a simplified processing unit data flow; the positions of the word that are placed in an individual register or counter are shown below each component.

Input-Output Devices

The following sections describe the operation of input-output devices that may be attached to the system. In addition to the information about operation of keys and lights, general information about magnetic tape and basic card machine features is included.

These devices are inherently mechanical and, once started in motion, will continue to move for a predetermined time. The tape unit moves tape from record gap to record gap, file gap to file gap, record gap to file gap, file gap to record gap, or from record or file gaps to the load point. The card equipment (card reader and card punch) motion is from card to card. Printer motion is from line to line. These motions, once started, cannot normally be stopped.

Magnetic Tape Handling

DUST PREVENTION

Foreign particles on tape can reduce the intensity of reading and recording pulses by increasing the distance between the tape and the read-write head. Be extremely careful to protect magnetic tape from dust and dirt.

Keep the tape in a dust proof container whenever the tape is not in use on a tape unit. When a reel of tape is removed from a tape unit, immediately place it in a container. Always place sponge rubber grommets or special clips on the reels as they are stored, to prevent the free end from unwinding in the container.

When tape is removed from the container, close the container and place it where it is not exposed to dust and dirt.

Store tapes in a cabinet elevated from the floor and away from sources of paper or card dust. This should minimize the transfer of dust from the outside of the container to the reel during loading or unloading operations.

Never use the top of a tape unit as a working area. Placing materials on top of the units exposes them to heat and dust from the blowers in the unit. It might also interfere with the cooling of the tape unit.

To label a reel of tape for identification, other than by means of the provided card holder, use a material that can be removed without leaving a residue. Adhesive stickers that can be applied and removed easily are satisfactory. Never use an eraser to alter the identification on a label.

DAMAGE PREVENTION

Information is recorded within .020 inch of the edge of the tape. Proper operation requires that the edge of the tape be free from nicks and kinks.

Handle reels near the hub whenever possible. In picking up reels, grip the reel between the center hole and the outer edge. Gripping the reel so as to compress its outer edges pinches the few turns of the tape near the outer edge of the reel. Persons handling tape reels inside and outside the machine room should be instructed to avoid pinching the reels or contacting the exposed edges of the tape.

Dropping a reel of tape can easily damage both the reel and the tape. Never throw or mishandle reels even while they are protected in their containers.

CLEANING TAPE AND TAPE CONTAINERS

To clean a tape, gently wipe the tape with a clean, lint-free cloth moistened with an IBM recommended tape transport cleaner.

Inspect containers periodically. Remove any accumulation of dust by washing with a regular household detergent.

TAPE BREAK

If a tape break occurs, divide the reel into two smaller reels. It may be necessary to make a temporary splice in order to recover information; however, splicing is not recommended as a permanent correction procedure. In making a temporary splice, be sure to use the special low-cold-flowing splicing tape.

DROPPED-TAPE INSPECTION

If a reel of tape has been dropped, the reel may be broken or bent. Bending is less likely, as a strain sufficient to bend a reel usually breaks it. The edge of the tape may be crimped, and the tape may be soiled. To test for and remedy these defects, proceed as follows:

1. Inspect the tape reel immediately. Breaking or bending of the reel can usually be found by visual inspection. In addition, check the reel for bending by mounting it on the hub of a tape unit. If the reel has been bent or broken, it obviously should not be used again; but the tape may be serviceable.
2. Inspect the tape itself.

a. If there is no evidence of crimping or other tape damage, and the reel is undamaged, thoroughly clean the tape (exposed or unwound) and reel. The tape is then in good operating condition. If at all possible, test to verify that the tape operates properly before using it on subsequent runs.

b. If there is no evidence of tape damage, but the reel is damaged, thoroughly clean the tape (exposed or unwound) and rewind it on another reel. If possible, test to verify that the tape operates properly.

c. If the edge of the tape is crimped, the action to be taken depends on whether the tape contains essential information. If the tape does not contain essential information, discard the crimped footage. If the tape contains essential information, thoroughly clean the tape and attempt to reconstruct this information through a tape-to-printer or other machine operation. Should reconstruction fail, the records in question must be rewritten from cards or from another source.

Manual Operation of the Tape Units

On each tape unit, manual operations are performed by using the keys and lights appearing in Figure 10.

The tape address selector switch determines which one of the tape addresses may select this unit. If the switch is set to 1, the unit may be addressed by 201 in the BCD mode or 221 in the binary mode. This switch should not be rotated during any tape operation.

The select light is turned on only when the computer selects the tape unit. The ready light is on (the tape unit is in ready status), provided the tape is loaded into the columns, the reel door interlock is closed, and the tape unit is not in the process of finding the load point (rewind or load operation). Manual control is indicated when the ready light is off, provided the tape unit is not rewinding or loading and the reel door is closed.

Pressing the start key places the tape unit under control of the computer and causes the ready light to be turned on, provided the tape unit is in ready status. Pressing the reset key removes the tape unit from computer control, turns off the ready light, and resets all controls to their normal positions. It also stops any tape operation that has been initiated, except high speed rewind, which reverts to low speed rewind. After the tape is loaded into the vacuum columns and low-speed rewind is in progress, press the reset key again to stop the low-speed rewind.

When the door is open, the reel door interlock prevents operation of the reel drive motors. If the reel door is closed and the ready light is off, pressing the load rewind key causes a fast rewind (if the tape is more than 450 feet from its load point) at the end of which the tape is loaded into the vacuum columns and searched in a backward direction for the load point. Pressing the unload key causes the tape unit to remove the tape from the vacuum columns and raise the head cover, regardless of the distribution of the tape on the two reels. If tape is not at the load point when the operator wishes to change it, the operator starts a load point search by pressing the load-rewind key.

The EOT indicators in the channel and tape unit are turned on when the tape breaks or when the physical end of tape is reached during a write operation. The end of tape test (ETT) may be used in a program to interrogate the status of the end-of-tape indicator in a data channel. The status of the EOT indicator has no effect upon tape operation.

The end-of-tape indicator and light may be turned off by pressing the reset key on the tape unit and then pressing the unload key on the tape unit. Execution of the ETT instruction will turn off the EOT indicator in the data channel.

The change density key changes the density mode (high or low) when depressed if the tape unit is not ready. The stored program instruction can accomplish the same density setting. The density mode in which the tape unit is operating is indicated by the high or the low density light.

The plastic tape reels are $10\frac{1}{2}$ inches in diameter and are designed so that the front and back sides of the reel are different (Figure 11). In normal operation, a special ring is inserted in a groove in the back side of the reel to depress a pin which is then under spring tension. If the special ring is removed from the reel, the pin rides freely in the groove and a writing inter-

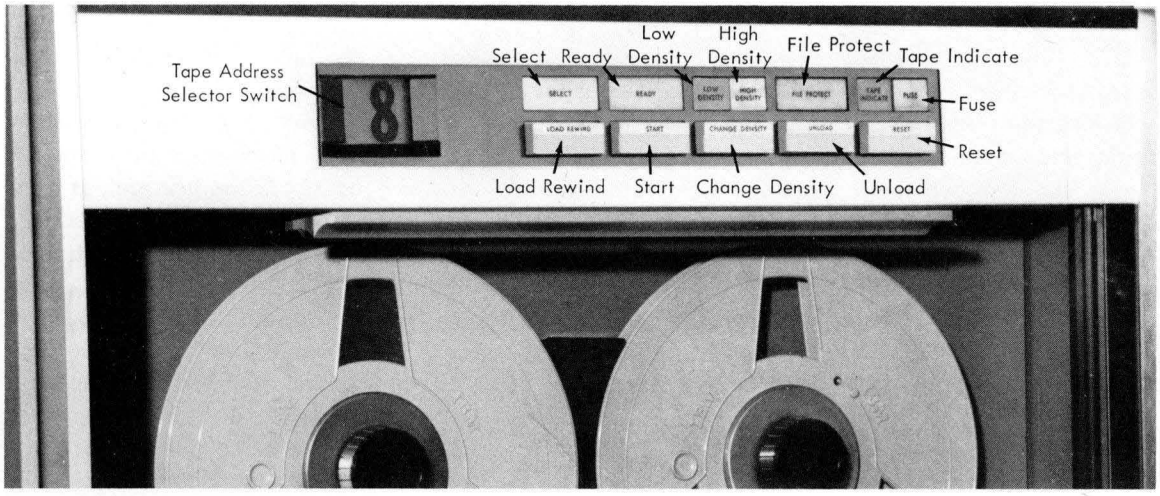


Figure 10. IBM 729 II and IV Keys and Lights

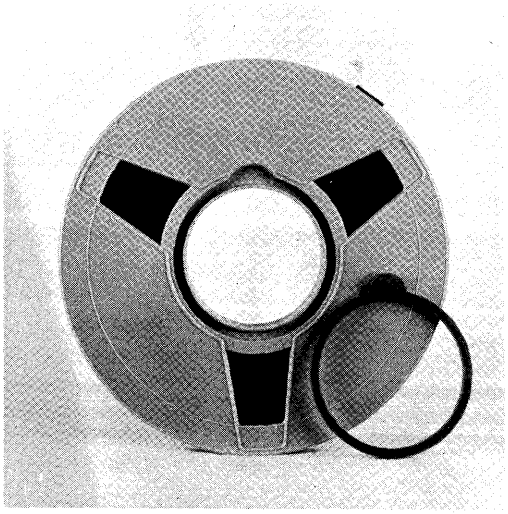


Figure 11. Protect Ring

lock is automatically set. Also, the file protect light is turned on to inform the program that it is impossible for the program to write on tape. However, tape may be read, backspaced, or rewound freely when the file protect light is on.

The fuse light indicates that a fuse has burned out. Notify a customer engineer of this condition.

The tape transport mechanism of the 729II and 729IV tape units is shown in Figure 12.

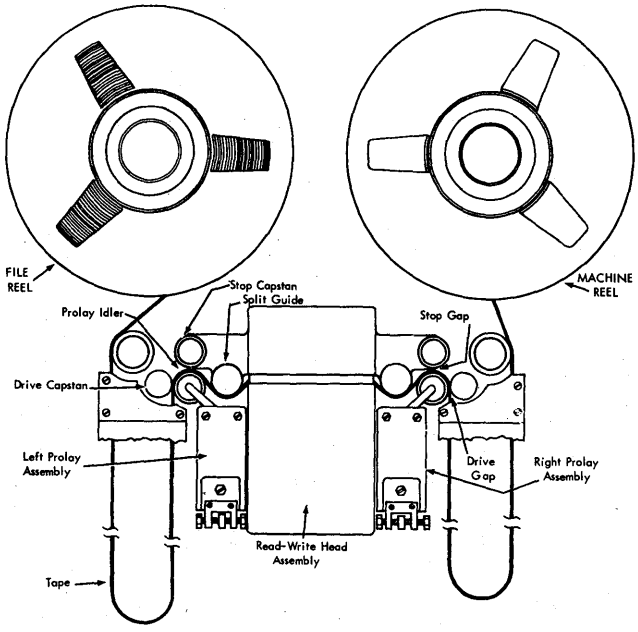


Figure 12. Schematic, Tape Feed

Tape Unload Procedures

To unload tape, use the following procedure:

1. Depress the reset key (tape unit) to turn off the ready light. Depressing the reset key is necessary only if the ready light is on.
2. Depress the load rewind key to rewind the tape.
3. When the load point has been reached, depress the unload key.
4. Open the reel door when the head cover is fully raised, the tape is out of the columns, and the load point is under the photoelectric cell. Do not open the door of the tape unit until the tape drive mechanism has completed the unloading sequence.
5. Hold the reel release key depressed and manually rewind the file reel by turning it in a counterclock-wise direction with the finger pressed in the finger hole of the reel.
6. When the tape has been completely rewound, loosen the hub knob and remove the reel. If resistance is encountered in removing a reel, exert pressure from the rear of the reel with the hands as near the hub as possible. Never rock a reel by grasping it near the outer periphery in such a way as to pinch the edges of the outer turns of tape.
7. Check the removed reel to determine whether it is to be file protected and whether it has been labeled correctly. Place the reel in the container. If the file protection ring has been removed and the file protect light fails to go on, notify the customer engineer immediately.

Tape Load Procedures

Before the following tape load procedure is initiated, the tape unit should be in an unload condition and tape removed from the machine.

1. Check the reel that is to be loaded, to determine if if should have the file protection ring inserted or removed. The file protection ring must be inserted for card-to-tape operation. Mount the reel to be loaded on the left mounting hub and tighten the hub knob (Figure 8). Place an empty reel on the right mounting hub and tighten the hub knob. The hub contains a rubber rim that grips the reel tightly when the knob in the center of the hub is tightened. When mounting, push the reels firmly against the stop on the mounting hub to insure proper alignment. Always make sure that the hub knobs have been tightened during loading. However, do not use excessive force when tightening the hub knobs, for this tends to strip the threads.
2. Hold the reel release key depressed and rotate the file reel in a clockwise direction, unwinding about four feet of tape.

3. Place the tape over the left roller through the read-write head assembly and over the right roller (Figure 8). Place and hold the end of the tape between the index finger and the hub of the machine reel. Depressing the reel release key, wind the tape on the machine reel in a clockwise direction for at least two turns beyond the load point marker. When placing tape on the machine reel, align it carefully to prevent damage to the edge on the first few turns. When winding the tape to load point, rotate the machine reel with the finger in the reel finger hole or near the hub and on the reel. Rotating the reel with the finger in the cutout can result in nicking or curling the edge of the tape..

4. Close the reel door. Make sure that the door interlock switch is closed.

5. Set the address selector switch to the correct address position.

6. Depress the load rewind key to (1) load tape into the vacuum columns, (2) lower the head assembly, and (3) rewind the tape to the load point.

7. Depress the start key. This places the tape unit under automatic control and turns on the ready light.

NOTE: Do not turn power off with the tape unit in a load status because the head assembly must be up for removal of tape. If power is turned off after leaving load point, it will be necessary to begin a new start procedure to resume operation.

IBM 7330 Magnetic Tape Unit Keys and Lights

Figure 13 shows keys and lights of the 7330, described as follows. Figure 14 shows both the IBM 729 II and the IBM 7330 Magnetic Tape Units.

Address Selection Switch sets a tape unit to any one of ten possible tape unit addresses.

Select Light turns on when the computer executes a tape control instruction that contains the tape address corresponding to the setting of the address selection switch of a unit that is ready.

Ready Light indicates that tape unit is in operation or is ready for operation. The reel door should not be opened when the ready light is on.

Tape Indicate Light turns on when the unit detects a tape mark when reading, or an end-of-reel reflective spot when writing. The light turns off after an unload operation and by instruction.

Fuse Light indicates that a protective device has interrupted an excessive flow of current; operation cannot be resumed until the condition has been corrected by a customer engineer.

File Protection Light is turned on if the file reel is mounted without a file protection ring in it or if the unit is not ready or is rewinding. Writing on tape cannot occur when the file protection light is on.

Low Density Light turns on when density selection switch is manually set to low density. It must be on when the unit is reading or writing low-density tape.

High Density Light is turned on when the density selection switch is manually set to high density; it must be on when the unit is reading or writing high-density tape.

Reset Key resets the tape unit to manual control and stops any tape operation previously initiated; it does not change status of the tape indicate light.

Start Key turns on the ready light and places the tape unit in ready status. The start key is pressed only after tape has been positioned with the load-rewind key.

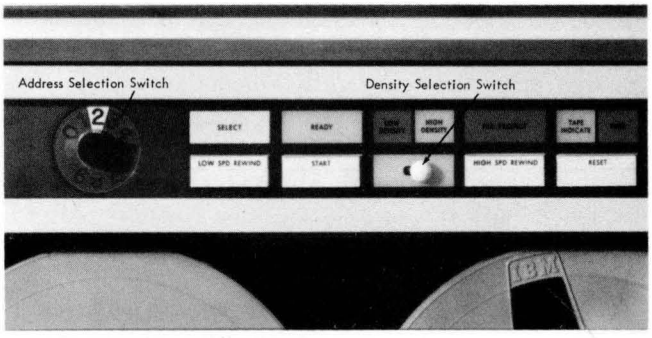


Figure 13. IBM 7330 Operating Keys and Lights

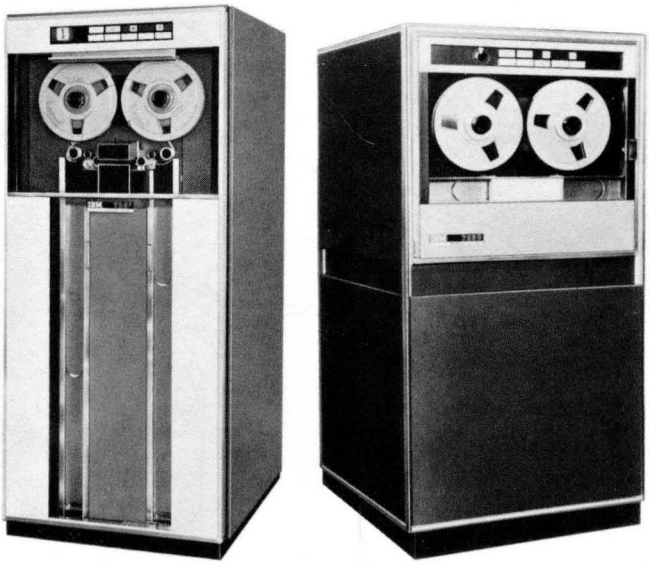


Figure 14. IBM 729 and 7330 Tape Units

Low-Speed Rewind Key positions tape at the load point by causing a slow-speed (in-column) rewind until the load point marker is sensed. The low-speed rewind key is effective only if the load arm is positioned, tape is in the vacuum columns, the reel door is closed, and the ready light is off.

High-Speed Rewind Key removes tape from the vacuum columns, raises the upper read-write head assembly, and rewinds tape at high speed. Tape must be in the columns, the reel door must be closed, and the ready light must be off for the high-speed rewind key to be effective. The tape indicate light is turned off at the end of the operation.

Density Selection Switch places the tape unit in low-density mode when the toggle is moved to the left and in high-density mode when the toggle is moved to the right. The appropriate density light turns on.

Reel Release Key is depressed to permit manually turning the reels for threading tape when the reel door is open.

Steps required to place a 7330 tape unit in ready status after a high-speed rewind are:

1. Open the reel door.
2. Press the reel release button and hold it pressed through step 5.
3. Manually rotate the take-up reel for a few times until the load point is on the reel.
4. Move the read-write head lever to a vertical position. This will lower the head.
5. Rotate each reel, as necessary, to move the tape into the vacuum columns properly.
6. Close the reel door.
7. Press the low-speed rewind and start keys.

TAPE LOADING PROCEDURE

Proper tape loading minimizes tape damage, tape contamination, and insures correct seating of the rewind arm:

1. Check for removal or insertion of file protection ring.
2. Place file reel firmly on machine mounting hub and tighten the hub knob.
3. Press reel release key and unwind about 18 inches of tape.
4. Open center cover and right column door.
5. Thread tape through tape transport as indicated on inside of center cover.
6. Close right column door.
7. Turn machine reel clockwise to move load point marker past the transport area; avoid slack in the tape.
8. Press reel release key and lower the rewind arm.
9. Remove pressure from reel release key for a few seconds.
10. After vacuum comes up, press reel release key and load tape into columns by turning the left reel clockwise and the right reel counterclockwise.
11. Seat rewind arm; close center cover and tape unit door.
12. Set the address selector switch to the correct address position.
13. Depress low-speed rewind and start keys.

7330 OPERATING PRECAUTIONS

High-Speed Rewind: To prevent damage to tape, never press the reset key or open the tape unit door during normal high-speed rewind.

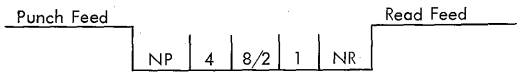
If an emergency forces a violation of this rule, take steps afterward to remove undesirable tension from the tape on the file reel. Press the reel release key and manually wind at least 200 feet of tape from the file reel to the machine reel; then close the door and resume high-speed rewind.

High-Speed Rewind Arm: After tape is removed from the 7330, the high-speed rewind arm is in the up position; leave it in the up position. An arm that is in the down position when power is turned off may cause fuses to blow when power is turned on.

IBM 1622 Card Read Punch

The IBM 1622 Card Read Punch reads 250 cards per minute and punches 125 cards per minute. Cards are read 9-edge first, face down, past two reading stations: check and read. The read buffer is initially loaded with 80 columns of card data during a start or load run-in operation. Thereafter, each card feed cycle is under program control. The reader can accept and translate card codes equivalent to the 64 combinations of six bits (with optional feature).

The read and punch feed units are separate and functionally independent; each has its individual switches, lights, checking circuits, and buffer storage. Two stackers are provided for each feed unit: one for normal stacking, the other for error selected stacking (Figure 15).



Pocket	Use
NP	Normal Punch
4	Error Punch
8/2	Not Used
1	Error Read
NR	Normal Read

Figure 15. 1622 Card Read Punch Stacker Pockets

For the punch operation, cards are fed 12-edge first, face down, past the punch and check stations. All of the 64 combinations of six bits (with optional feature) can be translated and punched.

Card Read And Card Punch Keys and Lights (Figure 16)

The following lights are common to both the read and punch feeds:

Stacker Light is turned on when a stacker is full. Both feeds are stopped and removed from ready status. Operation resumes after the stacker is emptied.

Fuse Light is turned on to indicate a blown fuse in the 1622.

Transport Light is turned on when a card in either feed unit does not feed properly. Both feeds are stopped and removed from ready status. Both start keys must be pressed to resume operation after the feed condition is corrected.

Thermal Light is turned on if the internal temperature of the 1622 becomes excessive.

CARD READER

Reader On/Off Switch supplies power to the unit. The computer power-on switch must be on to make this 1622 switch active.

Nonprocess Runout Key is used to run out cards after a reader check error, or after the reader stop key

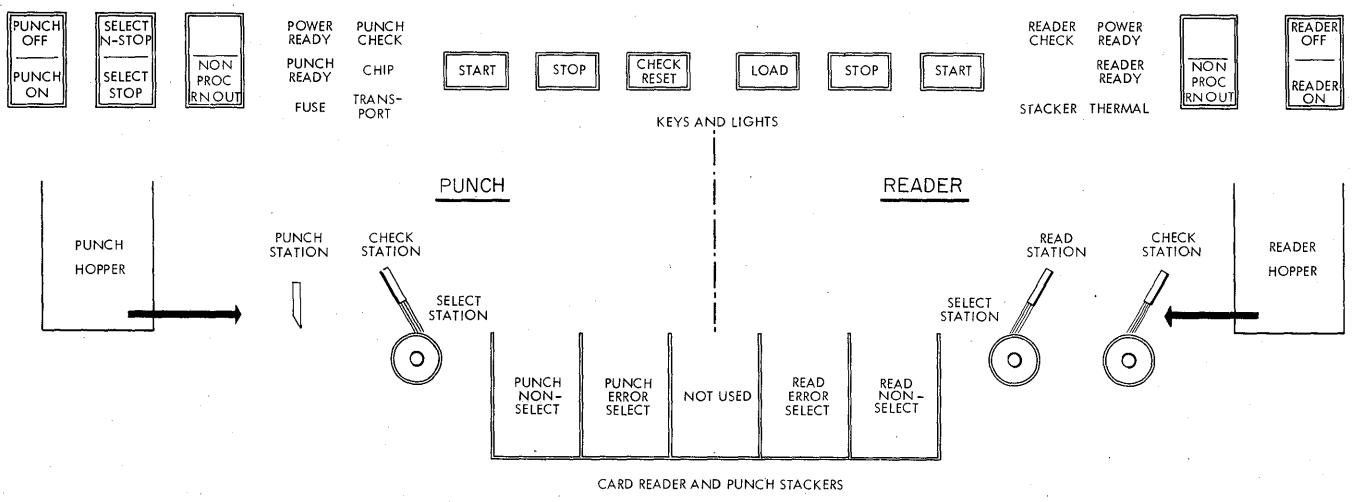


Figure 16. 1622 Operating Keys and Lights

has been pressed. The cards are placed in the read select stacker without a buffer storage-to-core storage transfer. The reader check light and check circuits are turned off. Cards must be removed from the hopper to make this key active.

Power Ready Light is on when power in the 1622 is at an operating level.

Reader Ready Light is turned on to indicate that the first card has been loaded into buffer storage with the start key, without a reader check error. It remains on until: stop key is pressed, a reader check error, a transport jam, a misfeed, or an empty hopper.

Reader Check Light is turned on by an unequal comparison between the read and check stations and by incorrect parity detected in buffer storage during a card read. With an unequal comparison, the reader is stopped, ready status is terminated, and the buffer storage data just read cannot be transferred to core storage on the next read operation.

Start Key is used (1) to run in cards which are then placed under program control (data from the first card is checked and loaded in input buffer storage); (2) to set up a runout condition, which permits programmed reading of the cards remaining in the feed when the hopper becomes empty; and (3) to restore ready status after the reader has been stopped by either the stop key, an empty hopper, an error, a misfeed, or a transport jam.

Stop Key is used to stop the read feed at the end of the card cycle in progress, and to remove the reader from ready status. Data that is entered into buffer storage during the read cycle in progress is transferred to core storage. The computer continues processing until the next read instruction causes a reader-no-feed stop.

Load Key causes data from the first card to be read into buffer storage and to be checked. Thereafter, each card feed cycle is under program control.

CARD PUNCH

Punch On/Off Switch supplies power to the unit. The computer power-on switch must be on to make this 1622 switch active.

Select N-Stop – Select Stop Switch controls stopping of the punch when error cards are selected into the punch error select stacker. With the switch on STOP, the punch feed stops with the error card in the select stacker.

Nonprocess Runout Key is pressed, after a punch check error and machine stop, to reset the error circuits and to run out the card (B) following next behind the error card (A). Card B has passed the punch station and is stopped between the punch and the punch check stations. Card B may have been the subject of a punch error at approximately the same time as the punch check error on card A; if so, card B will follow card A into the select stacker and the punch check light will be turned on again. The next following two cards will be blank and will go into the nonselect pocket; these two cards should be removed before further processing.

Punch Ready Light is turned on when the 1622 has a card in punching position and will respond to a write instruction. The light is turned off by a punch check error, an empty hopper, a full chip box, a stop key depression, a transport jam, or a misfeed.

Power Ready Light is on when power in the 1622 is at an operating level.

Punch Check Light is turned on by an unequal comparison between data read at the check station, and data punched on the preceding card feed cycle; or when, with the select stop switch set to stop, a 1622 parity error occurs during punching. The punch stops and ready status is terminated.

Start Key is used to feed cards to the punch station initially or after an error and nonprocess runout; and to establish ready status after an empty hopper, a misfeed, a transport jam, or a stop key depression.

Stop Key is used to stop the punch feed at the end of the card cycle in progress, and to remove the punch from ready status.

Check Reset Key is used to reset error circuits and turn off the punch check light. A start key or nonprocess runout key depression must follow.

IBM 1402 Card Read Punch, Model 2

The 1402, Model 2, reads 800 cards per minute and punches 250 cards per minute. The read and feed units are separate as with the 1622, and the same stacker pocket names are used. The 8/2 pocket, used only on the 1402, holds selected punched cards. Cards are read and punched in the same manner as with the 1622.

Card Read Punch Lights (Figure 17)

The 1402, Model 2, has four lights that refer to the machine rather than to one of the two units:

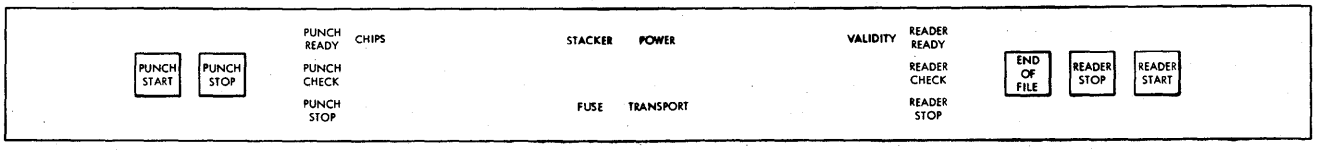


Figure 17. IBM 1402 Keys and Lights (Model 2)

Stacker indicates that one or more pockets are full. Both the reader and punch units stop.

Fuse indicates that a fuse has blown in the reader or punch unit.

Power indicates that power is being supplied to the 1402.

Transport indicates that a card jam has occurred in the stacker transport area. Card feeding is stopped in both feeds until the jam is cleared.

Reader Keys and Lights

READER START

Operating this key feeds three cards into the read feed, fills the reader synchronizer with the contents of the first card, and turns on the reader ready light.

When the reader has been stopped, pressing the start key turns on the reader ready light, and allows the cards to continue feeding under program control.

When the cards are removed from the read feed hopper and the end-of-file key is not operated, pressing the start key moves the remaining two or three cards to the NR stacker pocket unprocessed (Figure 18).

READER STOP

Operating this key stops the reader at the end of the feed cycle in progress and turns off the reader ready light.

END-OF-FILE (EOF)

Operation of this key activates circuits that signal a last card condition in the central processing unit. The last card condition can be used by the stored program to initiate an end-of-file routine. The end-of-file latch is turned on following the data transfer of the last card. The EOF key lights when it is pressed.

The end-of-file key, which can be pressed at any time, causes the card reader to operate in one of these ways:

1. With four or more cards in the read hopper, all the cards are processed and run into a stacker. Operating the stop key or processing the last card causes the end-of-file condition to be reset.
2. With three cards remaining in the feed, a card read instruction before the operation of the end-of-file key causes the program to hang-up. Pressing the end-of-file key and *then* the start key allows the last three cards to be processed and run into a stacker. Operating the stop key or processing the last card causes the end-of-file condition to be reset.
3. With the one, two, or three cards to be processed in the read hopper, pressing the end-of-file key and then the start key feeds the card or cards and turns on the reader ready light after the first card passes the second read station. The card or cards are processed and run into a stacker. Operating the stop key or processing the last card causes the end-of-file condition to be reset.

READER READY

This light indicates that the reader is ready to be used by the CPU.

VALIDITY

This light indicates than an invalid character has been detected during a feed operation. The light remains ON until the next feed instruction is started. During the read instruction, the invalid character is transferred from synchronizer to storage.

READER STOP

This light indicates that a feed failure or card jam has occurred during a feed operation, stopping the reader and turning off the reader ready light.

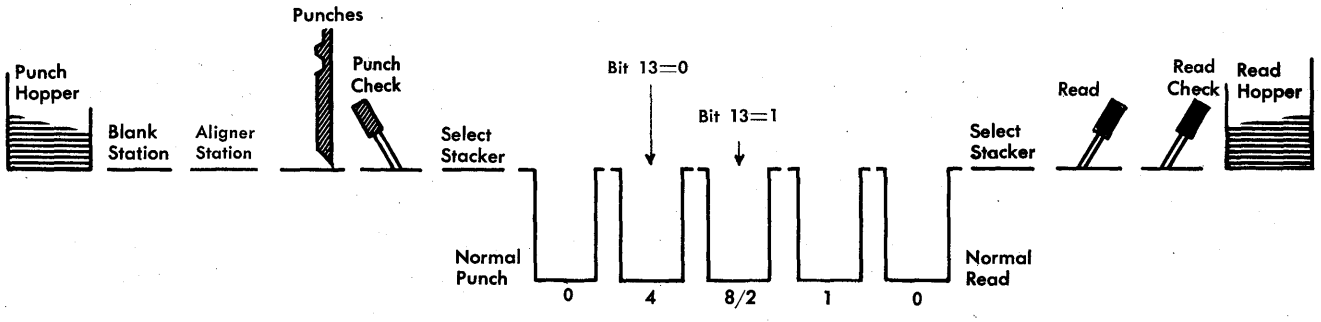


Figure 18. 1402 Card Transport Schematic

READER CHECK

This light indicates the detection of a hole count error, parity error, or synchronizer timing error during a feed operation. The light remains ON until the next feed instruction is started. During the read instruction, the data are transferred from synchronizer to storage, and the channel A redundancy check indicator is turned on.

Punch Unit Keys and Lights

PUNCH START

Operating this key feeds two cards into the punch feed and turns on the punch ready light.

When the punch has been stopped, pressing the start key turns on the punch ready light, and allows card punching to resume under program control.

When the cards have been removed from the punch feed hopper, pressing the start key moves the three cards remaining in the punch feed to the normal punch pocket. The first card that enters the normal punch pocket is unchecked.

PUNCH STOP

Operating this key stops the punch at the end of the feed cycle in progress and turns off the punch ready light.

PUNCH READY

This light indicates that the punch is ready to be used by the CPU.

PUNCH STOP

This light indicates that a feed failure or card jam has occurred during a punch operation, stopping the punch and turning off the punch ready light.

PUNCH CHECK

This light indicates the detection of a hole count error, parity error, or synchronizer timing error during a punch operation.

CHIPS

This light indicates that the chip receptacle is full or not in place. The punch cannot operate while the chips light is on.

NOTE: Cards in either the punch or reader which result in validity errors or a hole count check are *automatically* stacked in the NP or NR pocket.

Printer

IBM 1403 Printer, Models 1 and 2

The 1403, Model 1 or 2, is an output unit for IBM 7040 and 7044 systems. The standard printing capacity is 100 positions, with an additional 32 positions available on the Model 2. Each position can print 48 different characters: 26 alphabetic, 10 numeric, and 12 special characters. For information pertaining to the numeric print feature, refer to "Special Features" at end of this section.

METHOD OF PRINTING

The alphabetic, numeric, and special characters are assembled in a chain (Figure 19). As the chain travels in a horizontal plane, each character is printed when it is positioned opposite a magnet-driven hammer that presses the form against the chain.

When each character is printed, it is checked against the corresponding position in the print synchronizer to insure that printed output is accurate. Also, the machine checks to insure that the character is printed in the correct print position, that only valid characters are printed, and that over-printing does not occur.

1403 Printer Keys and Lights (Figures 20 and 21)

PRINT START (FRONT AND BACK)

Operating this key turns on the ready light.

PRINT STOP (FRONT AND BACK)

Operating the stop key turns off the ready light. If the stored program attempts to execute a WRS instruction with the printer specified, the CPU will hang up.

CHECK RESET

This key resets a printer error indication. The print-start key is then pressed to resume operation.

PRINT READY

This light indicates that the printer is ready to print.

END-OF-FORMS

This light indicates an end-of-forms condition (the machine stops).

FORMS CHECK

This light indicates paper feed trouble in the forms tractor, or that the carriage stop has been used. This

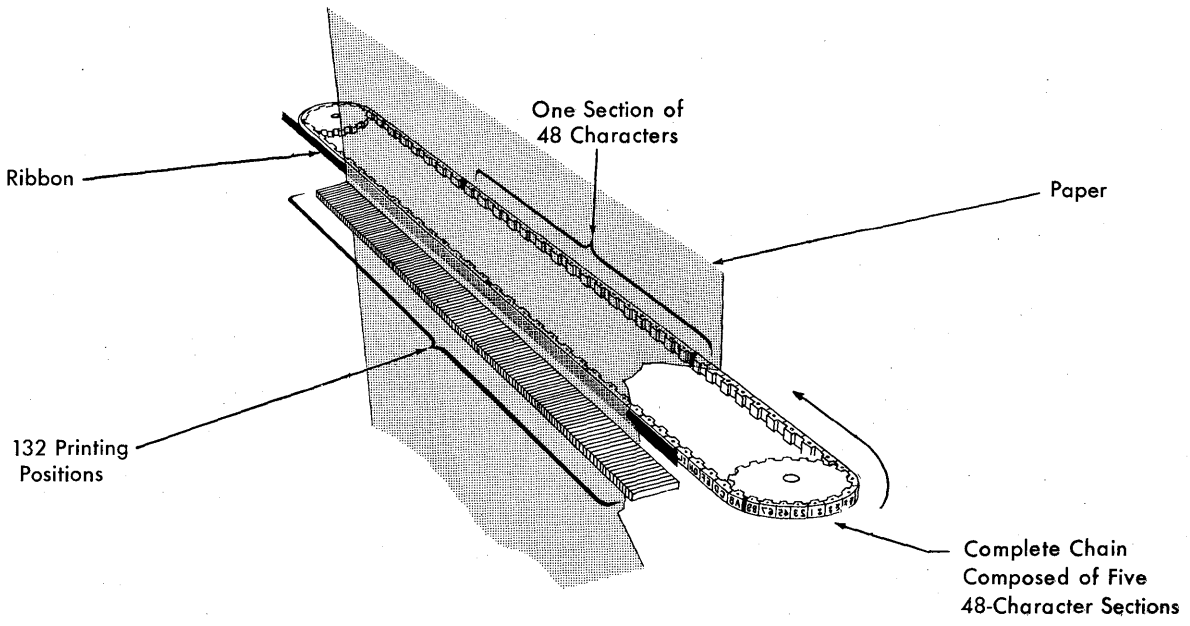


Figure 19. Printing Mechanism, Schematic

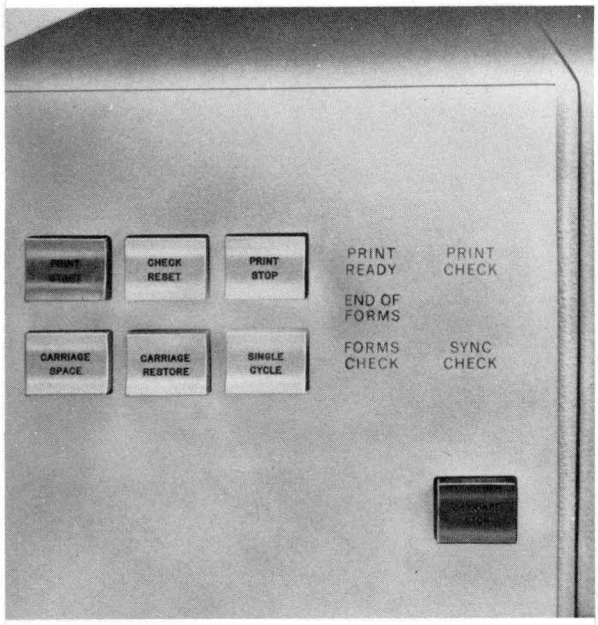


Figure 20. 1403 Operating Keys and Lights

Figure 21. 1403 Printer Keys (Rear)

light must be cleared by the check reset key before the print start key is effective.

PRINT CHECK

This light indicates a print error.

SYNC CHECK

This light comes ON to show that the chain was not in synchronism with the printer compare counter. The timing is automatically corrected. The light is extinguished by operating the print start key.

1403 Carriage Controls

CARRIAGE RESTORE

Pressing this key positions the carriage at channel 1 (home position). If the carriage feed clutch is disengaged, the form does not move. If it is engaged, the form moves in synchronization with the control tape.

CARRIAGE STOP

Pressing this key stops carriage operation and turns ON the forms check light.

CARRIAGE SPACE

Each time this key is pressed, it causes carriage tape and the form to advance one space.

SINGLE CYCLE

This key initiates the operation of the printer for one print cycle on each pressing of the key when the end-of-form light is ON and no paper jam exists. This allows printing of the last line of a form.

1403 Manual Controls (Figure 22)

FEED CLUTCH

The feed clutch controls the carriage tape drive and form feeding mechanism. If it is set to neutral, automatic form feeding cannot take place. It is also used to select spacing of six or eight lines to the inch.

PAPER ADVANCE KNOB

This knob positions the form vertically. It can be used only when the feed clutch is disengaged.

VERTICAL PRINT ADJUSTMENT

This knob makes possible fine spacing adjustments of forms at the print line. Carriage tape is not affected by this knob.

LATERAL PRINT VERNIER

This knob obtains fine horizontal positioning.

PRINT DENSITY CONTROL LEVER

As many as six forms can be printed at one time, and the print hammer unit is designed to adjust automatically for different thicknesses of forms. However, to provide a vernier control for print impression, a print density control lever is used. When this lever is set at position E, print impression is lightest; at position A, print impression is darkest. Between these two settings are intermediate settings. Position C is considered the normal setting. The lever moves the type chain closer to or farther from the hammer unit.

The setting of this lever must be considered together with the forms thickness, to determine the normal set-

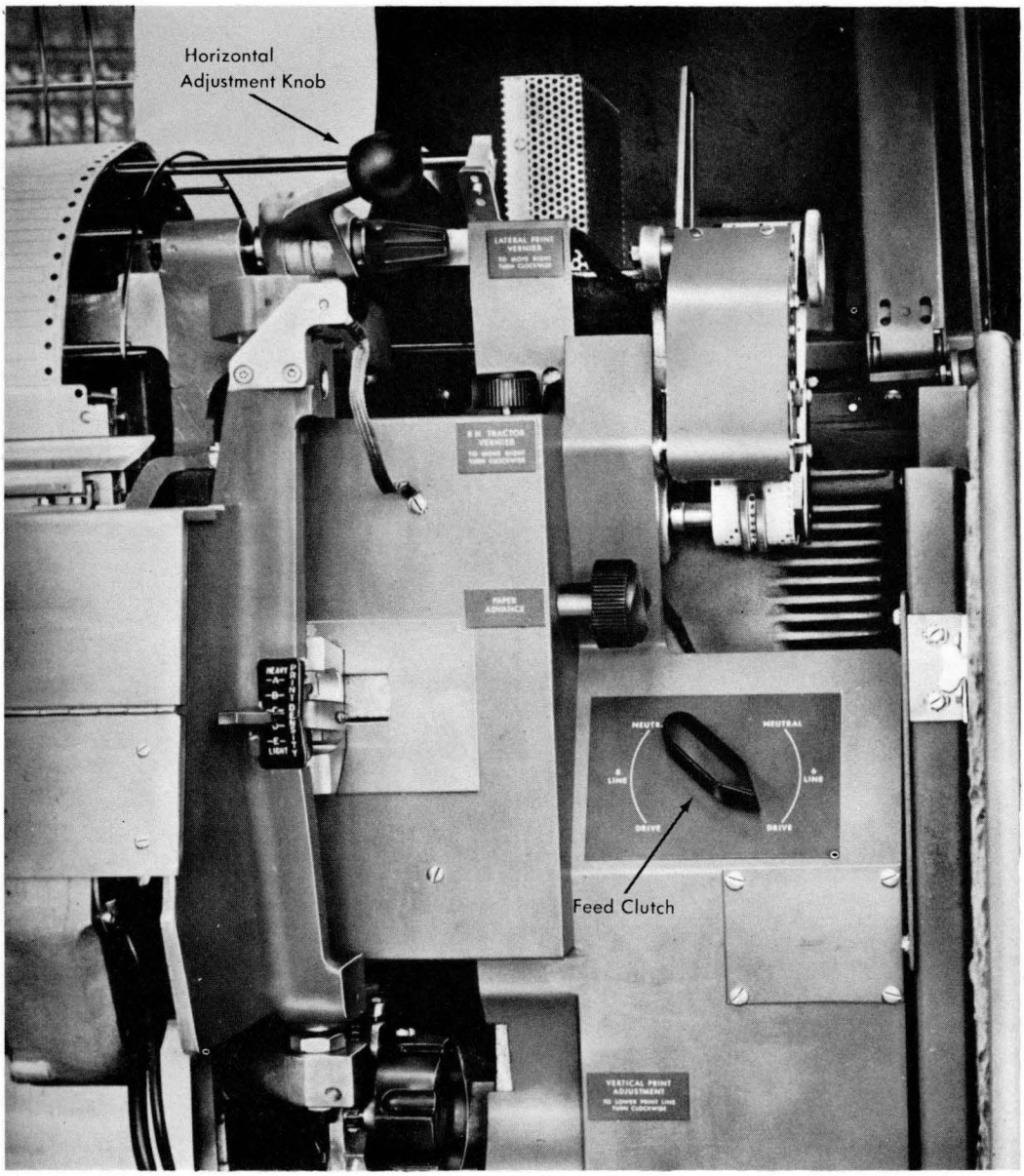


Figure 22. Carriage Controls

ting of the print timing dial (Figure 23). A chart is provided to determine the normal setting (Figure 24).

PRINT TIMING DIAL

A movable dial is set to a fixed indicator. Numbers around the dial provide a means of setting the print timing for a specific operation. The setting of the print density control lever must be set before the print timing dial is set. The nominal setting is read from a chart.

The chart should give the correct setting of the print timing dial. However, this setting can be checked by rotating the dial slowly in each direction from the normal setting, to determine the limits of good print quality.

PRINT UNIT RELEASE LEVER

This lever permits access to the form transport area (Figure 23).

PRINT LINE INDICATOR AND RIBBON SHIELD

The lower ribbon shield is also used as a print line indicator. It pivots with the ribbon mechanism. The front side of this shield is marked to show print position location (Figure 25).

When used as a print line indicator, the shield indicates where the lower edge of characters will print.

When the printer frame is open, the indicator pivots against the forms so that the print line may be set with respect to the forms.

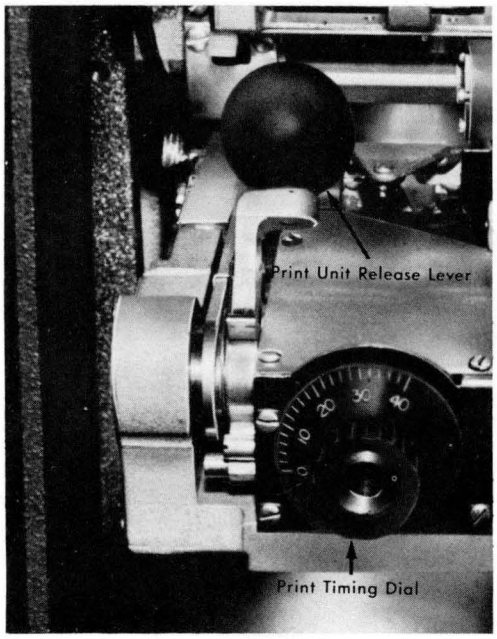


Figure 23. Print Timing Dial and Print Unit Release Lever

PRINT TIMING DIAL SETTING

PRINT DENSITY	FORM THICKNESS .003	.006	.009	.012	.015	.018	.021	.024
A	21	18	15	12	9	6	3	0
B	25	22	19	16	13	10	7	4
C	29	26	23	20	17	14	11	8
D	33	30	27	24	21	18	15	12
E	37	34	31	28	25	22	19	16

OBTAIN DIAL SETTING BY MATCHING "FORM THICKNESS" TO "PRINT DENSITY"

Figure 24. Print Timing Dial Chart

HORIZONTAL ADJUSTMENT

This device (Figure 22) positions the printing mechanism horizontally. When the lever is raised, the mechanism unlocks, and can be positioned horizontally within its 2.4-inch travel.

RH TRACTOR VERNIER

This knob allows fine adjustments in paper tension. It can be used for adjustments of up to one-half inch. There are two tractor slide bars, upper and lower. The

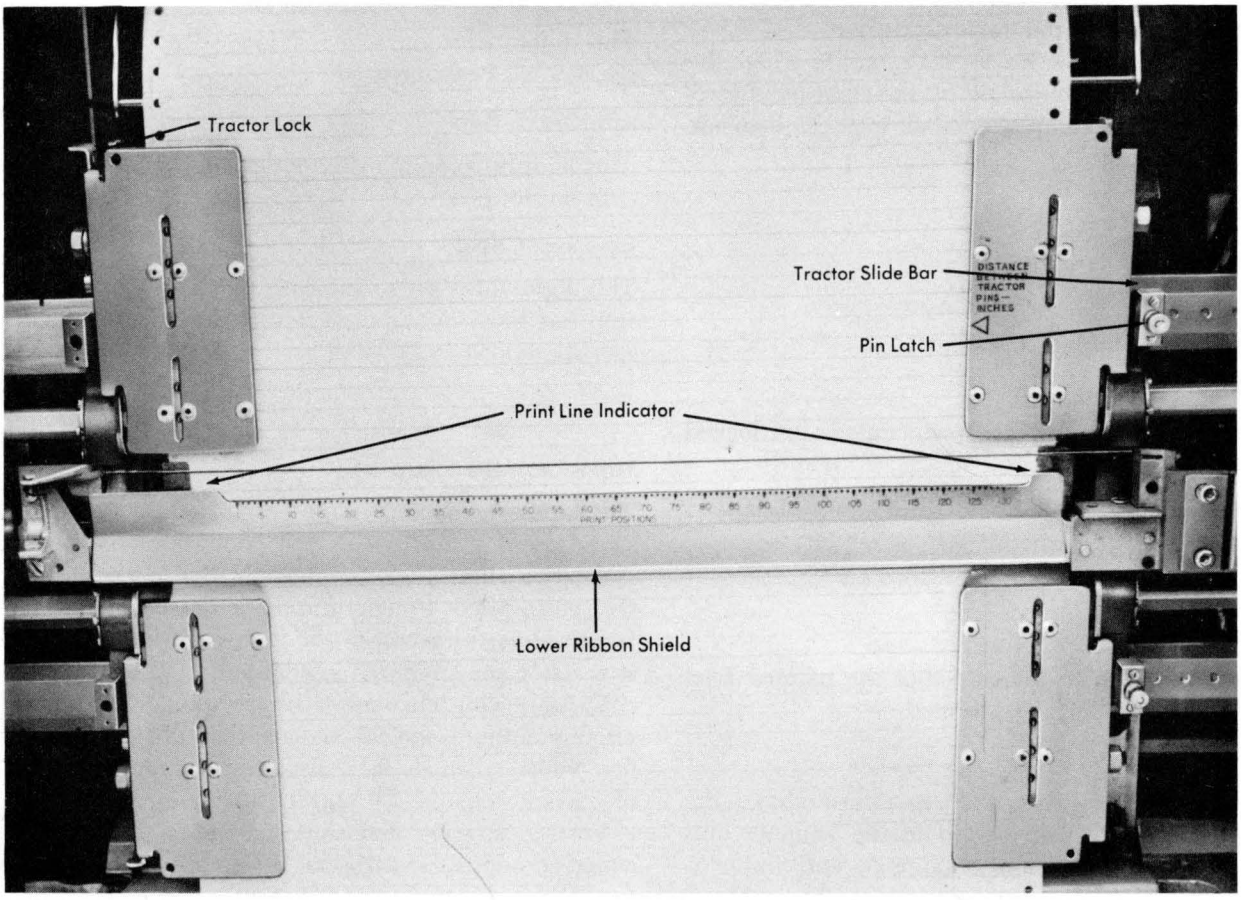


Figure 25. Print Line Indicator and Ribbon Shield

forms tractors are mounted on these bars. The forms tractors are movable, and to facilitate this movement there are notches in the tractor slide bar. The following procedure, for proper adjustment of these notches according to the form being used, applies to the upper tractor slide bar. Procedure for the lower slide bar is similar.

The left tractor is locked in place by a spring-loaded latch in one of the nine notches located one inch apart on the tractor slide bar. The third notch from the left end is the normal location for most applications.

The first notch is used for forms from 5½ to 18¾ inches wide. When this notch is used, the print unit's lateral movement is limited to .4 inch.

The second notch is used for forms from 4½ to 17¾ inches in width. When this notch is used, the print unit's lateral movement is limited to 1.4 inch.

The third notch is used for forms from 3½ to 16¾ inches wide. When this notch or notches 4 through 9 are used, full lateral print unit movement (2.4 inches) is possible.

The ninth (last) notch can be used for forms from 3½ to 10¾ inches wide. When this notch is used, the first usable print position is 38.

The right-hand tractor is locked in place by spring-loaded pins snapped into any one of 27 holes, located one-half inch apart on the tractor slide bar.

The movement of the tractor slide bar, in which the holes are located, is controlled by the right-hand tractor vernier. Movement up to one-half inch can be made by the vernier knob.

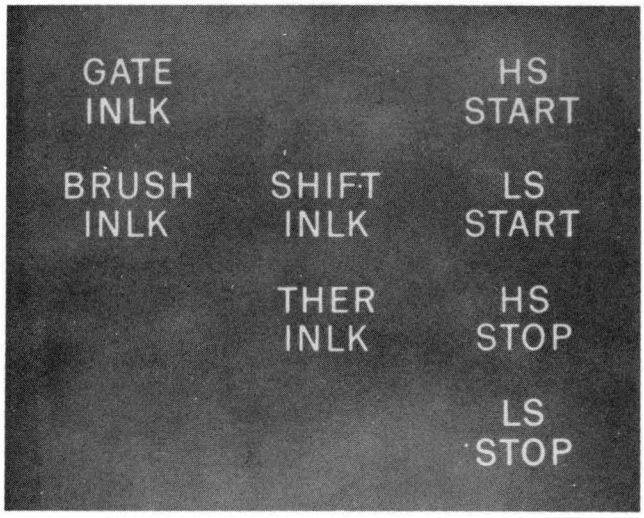


Figure 26. Printer Indicator Panel

Indicator Panel Lights

GATE INTERLOCK

This light turns on when the print unit is not locked in position (Figure 26).

BRUSH INTERLOCK

This light is on if the carriage tape brushes are not latched in position for operation.

SHIFT INTERLOCK

This light turns on to indicate that the manual feed clutch is not properly positioned.

THERMAL INTERLOCK

This light indicates that a temperature above the operating limit has been sensed in the hammer unit or chain drive unit; the light remains on until the temperature drops to an acceptable level. The 1403 is interlocked during this time.

HIGH SPEED START

This light turns on when a high speed skip has been initiated.

LOW SPEED START

This light turns on when a low speed skip or line spacing has been initiated.

HIGH SPEED STOP

This light turns on to indicate that high speed skipping is to be stopped.

LOW SPEED STOP

This light turns on to indicate that a low speed skip stop has been initiated. It is ON when the carriage is not in motion.

Tape-Controlled Carriage

The tape-controlled carriage (Figure 27) controls high speed feeding and spacing of continuous forms. The carriage is controlled by punched holes in a paper tape that corresponds in length to the length of one or more forms. Holes punched in the tape stop the form when it reaches any predetermined position.

Carriage skip channels 1-12 are standard. The tape circuits initiate special signals that are sent to the CPU when channels 9-12 are sensed. Program testing of carriage channels 9 and 12 is standard.

Vertical spacing and skipping are initiated by the stored program. Horizontal spacing is 10 characters to the inch. Vertical spacing of either six or eight lines to the inch is manually selected by the operator.

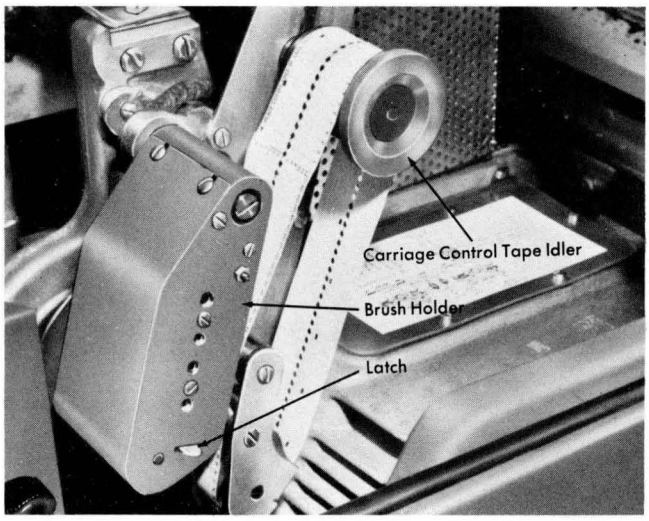


Figure 27. Tape Controlled Carriage

Forms skip at the rate of 35 inches per second if vertical spacing is set for six lines to the inch. With the dual-speed carriage, distances of less than eight lines are skipped at 35 inches per second, and those of more than eight lines at 75 inches per second; the last eight spaces skipped in a high speed skip are skipped at 35 inches per second.

The carriage accommodates continuous forms of a maximum length of 22 inches (at 6 lines per inch) or 16½ inches (at 8 lines per inch). The minimum length is 1 inch. For efficient stacking of forms, the recommended maximum length is 17 inches. The width of the form can vary from a recommended minimum of 3½ inches to a maximum of 18¾ inches, including punched margins.

Forms can be designed to permit printing in practically any desired arrangement. Skipping to different sections of the form can be controlled by the program and by holes punched in the carriage tape.

CONTROL TAPE

The control tape (Figure 27) has 12 columnar positions indicated by vertical lines. These positions are called channels. Holes can be punched in each channel throughout the length of the tape. A maximum of 132 lines can be used to control a form, although for convenience, the tape blanks are slightly longer. Horizontal lines are spaced six to the inch for the entire length of the tape. Round holes in the center of the tape are pre-punched for the pin-feed drive that advances the tape in synchronism with the movement of a printed form through the carriage. The effect is exactly the same as though the control holes were punched along the edge of each form.

Punching the Tape: A small, compact punch (Figure 28) is provided for punching the tape. The tape is first marked in the channels in which the holes are to be punched. This can be done easily by laying the tape beside the left edge of the form it is to control, with the top line (immediately under the *glue* portion) even with the top edge of the form. A mark is then made in the first channel, on the line that corresponds to the first printing line of the form. Additional marks are made in the appropriate channels for each of the other skip stops, and for the overflow signal required for the form.

The marking for one form should be repeated as many times as the usable length of the tape (22 inches) allows. With the tape thus controlling several forms in one revolution through the sensing mechanism, the life of the tape is increased. Finally, the line corresponding to the bottom edge of the last form should be marked for cutting after the tape is punched.

The tape is inserted in the punch by placing the line to be punched over a guide line on the base of the punch and placing the center feed holes of the tape over the pins projecting from the base. The dial is then turned until the arrow points at the number of the channel to be punched. Pressing on the top of the punch, toward the back, cuts a rectangular hole at the intersection of a vertical and horizontal line in the required channel of the tape. The tape should never be punched in more than one channel on the same line. Holes in the same channel should not be

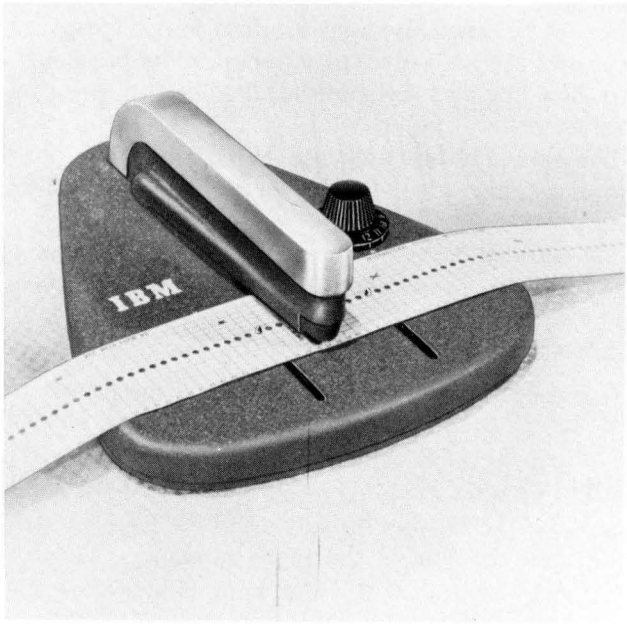


Figure 28. Tape Punch

spaced closer than 8 lines apart. After the tape is punched, it is cut and looped into a belt. The bottom end is glued to the top section, marked *glue,* with the bottom line coinciding with the first line. Before the tape is glued, the glaze on the tape should be removed by an ink eraser; if this is not done, the tape ends may come apart. The center feed holes should coincide when the two ends of the tape are glued together.

The last hole punched in the tape should be at least four lines from the cut edge, because approximately the last half inch of the tape overlaps the *glue* section when the two ends are spliced. If it is necessary to punch a hole lower than four lines from the bottom of the form, the tape should be placed with the top line (immediately under the *glue* portion) four lines lower than the top edge of the form, before marking the channels. To compensate for the loss, the tape should then be cut four lines lower than the bottom edge of the form.

8-LINES-PER-INCH SPACING

The control tape for 8-lines-per-inch spacing is punched as it would be for normal 6-lines-per-inch spacing. Each line on the tape always equals one line on the form, regardless of whether the latter be 6 or 8 lines-per-inch. In measuring a control tape for a document printed 8 lines to the inch, every $\frac{1}{8}$ inch on the form represents one line on the tape.

CARRIAGE TAPE BRUSHES

Two sets of reading brushes (Figure 29), mounted on the same frame, are used to sense holes in the carriage control tape. A small contact roll is used for each set of brushes. One set is called the *slow brushes.* The other set is called the *stop brushes.* Seven spaces, as measured by the control tape, separate the brush sets. The slow brushes are positioned ahead of the stop brushes.

The slow brushes are used to control high speed skipping. They regulate the speed of the last eight spaces of a high speed skip.

All carriage tape brushes can function to stop a carriage skip under control of the stored program.

INSERTING CONTROL TAPE IN CARRIAGE

1. Raise the counterbalanced cover of the printer to gain access to the tape reading mechanism.
2. Turn the feed clutch to a disengaged (neutral) position (Figure 22).
3. Raise the brushes by moving to the left the latch located on the side of the brush holder.
4. Place one end of the tape loop, held so that the printed captions can be read, over the pin-feed drive wheel so that the pins engage the center drive holes.

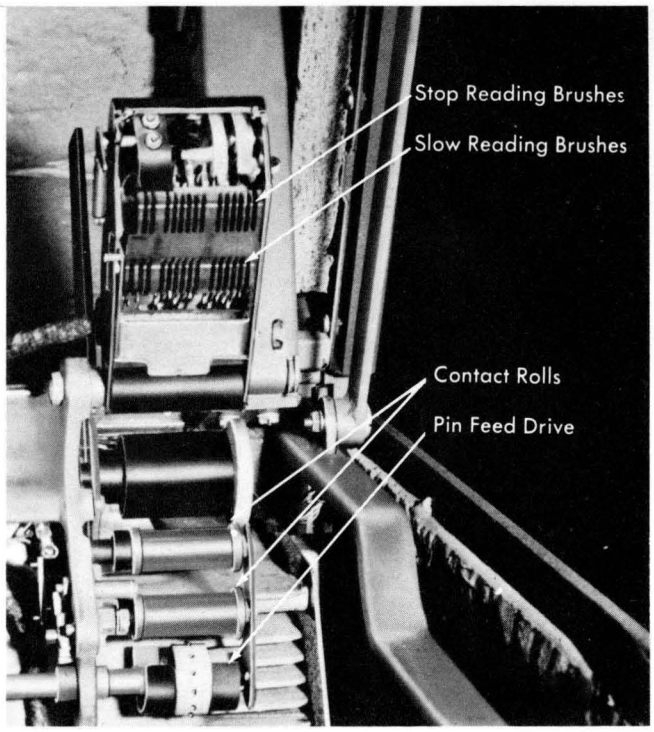


Figure 29. Carriage Tape Brushes

5. Place the opposite end of the loop around the adjustable carriage control tape idler.
6. Remove excess slack from the tape by loosening the locking knob on the idler and moving the idler in its track. Tighten the knob when the desired tension is reached. The tape should be just tight enough so that it gives slightly when the top and bottom portions of the loop are pressed together (see Figure 27). If it fits too tightly, damage occurs to the pin-feed holes.
7. Press the brushes down until they latch, and close the printer cover when the tape is in position.
8. Press the carriage restore key to bring the tape to its home position, and turn the feed clutch knob back to the engaged position. The carriage is ready to operate.

RIBBON CHANGING

To change the ribbon (Figure 30) on the 1403:

1. Turn off power in the printer.
2. Lift up the printer cover.
3. Pull back and unlock the print unit release lever. Swing the print unit out.
4. Open the top ribbon cover.
5. Unlatch the print line indicator ribbon shield and swing it against the form.
6. Push the top ribbon roll to the right (hinged side of print unit), lift out the left end of the ribbon roll, and remove roll from the drive end of mechanism.

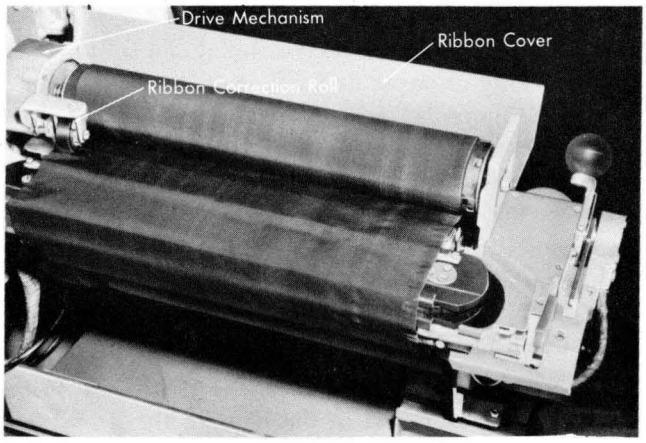


Figure 30. Ribbon Mechanism

7. Slip the ribbon out from under the ribbon correction roll.

8. To remove the bottom roll, press the ribbon roll to the right, and lower the left end of the ribbon roll and remove it from the drive end of the mechanism.

When replacing the ribbon in the machine, hand-tighten the ribbon to remove slack from in front of the printing mechanism. Ribbons are available in widths of 5, 8, and 11 inches in addition to the standard 14 inches. The ribbon width lever (Figure 31) can adjust the ribbon feed mechanism to accommodate the various ribbon widths.

FORMS INSERTION

1. Raise the counterbalanced cover of the printer to gain access to the print and forms area.

2. Turn the feed clutch knob to a neutral position.

3. Unlock and swing back the print unit by using the print unit release lever.

4. Unlock the paper guide bars by pulling out on the raised handles (upper and lower).

5. Open the upper and lower forms tractors (Figure 32).

6. Set the left forms tractors slightly to the left of the first unit position by pulling up or down in the tractor lock (upper and lower tractor). See Figure 25.

7. Insert form on pins and close tractor cover.

8. Pull out on right tractor pin and move tractor to desired location to line up the right side of form. The pin should latch in one of the recesses in the tractor slide bars. See Figure 25.

9. Insert form on pins and close tractor covers.

10. Use the tractor vernier knob to tighten the tension on the form. This knob is used for adjustments up to one-half inch.

11. Check the position and line where printing will occur, by swinging the ribbon shield against the form (it is marked with each print position). If the horizontal alignment is not correct, it can be adjusted by using the horizontal adjustment knob and/or the lateral print vernier knob for slight adjustments. The vertical adjustment can be made by using the paper advance knob and/or vertical print adjustment knob.

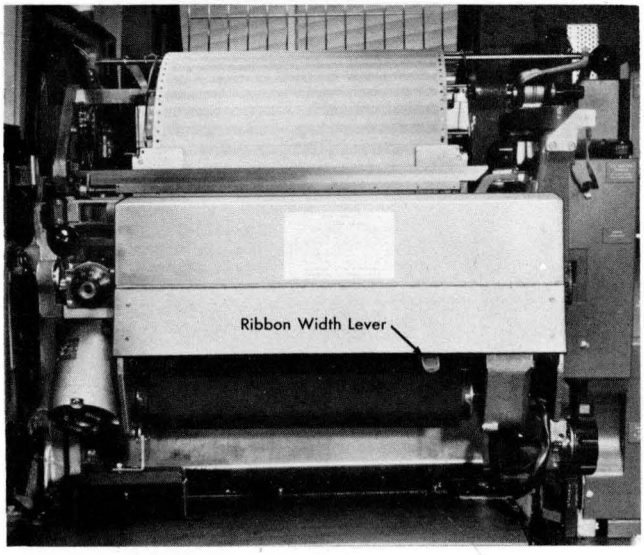


Figure 31. Front Cover, Open

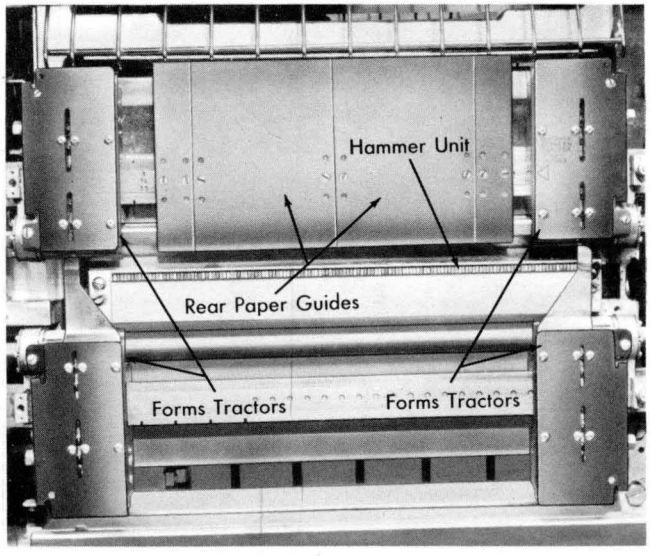


Figure 32. Forms Tractor

12. Return the upper and lower paper guide bars to the closed positions (Figure 33).

Some 1403 printers have the tractor-mounted jam detection device which, together with elimination of front "clip on" paper guides, eliminates the need for the upper and lower paper guide bars. The forms insertion procedure for a 1403 with the tractor mounted jam detection device instead of the upper and lower tape guides is the same except that steps 4 and 12 are skipped.

13. Return the print unit to its normal position and lock it in place.
14. Restore the carriage tape to the first printing position by pressing the carriage restore button.
15. Return the feed clutch knob to a drive position at either six or eight lines-per-inch, depending on the form to be printed.
16. Close the outside cover of the printer.

PAPER STACKER

The paper stacker provides a manual control for optimum stacking of paper at the rear of the printer. Two controls (Figure 34) permit the operator to set up the paper stacker for each individual run.

The upper lever controls the position of the paper guide at the stacker. This lever is indexed (0-6) so that the set position can be recorded for reference in the operator's procedures.

Form Design

Some of the customary rules for designing forms should be reconsidered in the light of the many new features introduced by the IBM 1403 Printer.

1. The print unit contains 100 print positions in a 10.0-inch width or a maximum of 132 print positions (special feature) in a 13.2-inch width. Each print position can print any character.
2. Editing, high speed skipping, and other features are included in the system.

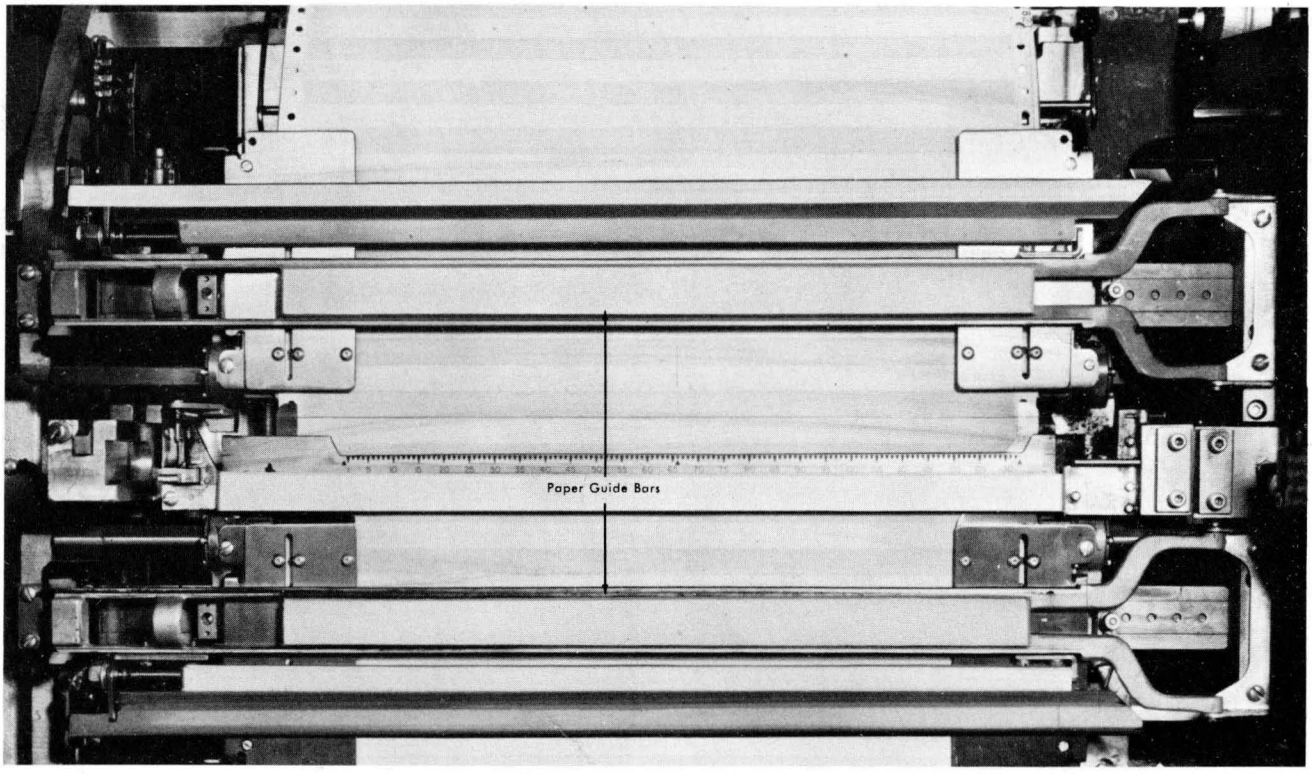


Figure 33. Paper Guide Bars

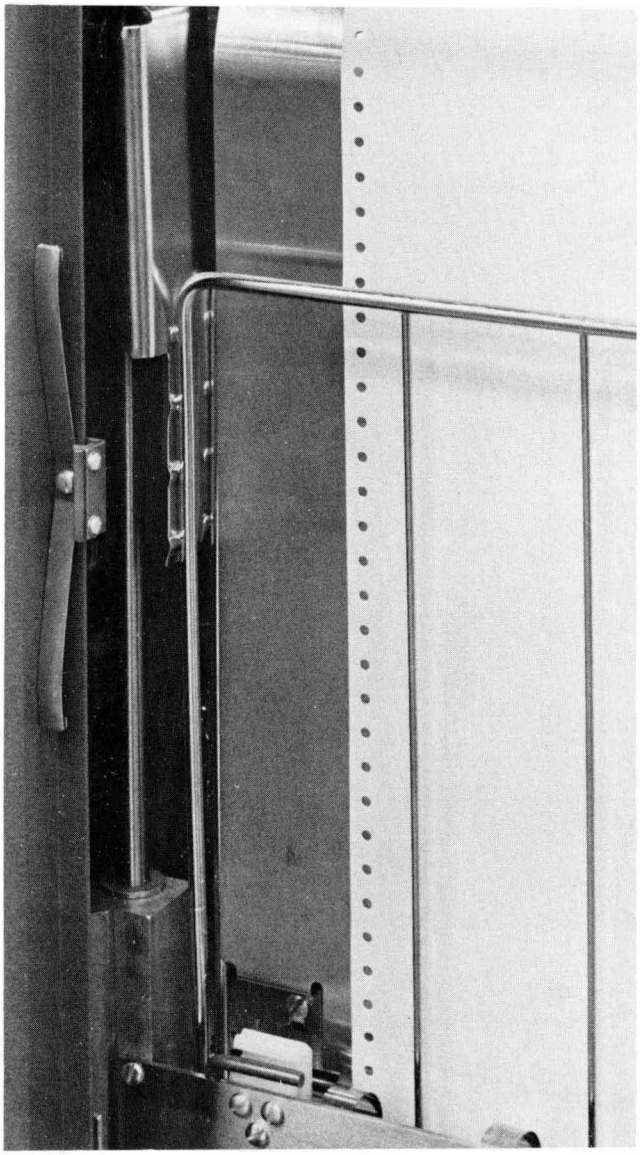


Figure 34. Paper Stacker Controls

One of the basic tools used in designing forms is the spacing chart (Figure 35). The numbers across the top from 0 to 13 represent the tens and hundreds positions of the print-position number, and the numbers directly beneath represent the units position of the print position number. Print position 42 can be located by referring first to the 4 column and then to the digit 2 within the 4 column. Print-position 9 can be located by referring to the 0 column and then to the digit 9 within that column.

A facsimile of the carriage-control tape for marking the control punching for a specific form is shown in Figure 35. Notations have been included relative to standard form width and form depths, lateral movement of the carriage, and instructions to forms manufacturers.

The IBM 1403 Printer carriage is designed to feed marginally punched continuous forms satisfactorily under the conditions and specifications outlined in Figure 36. These specifications, if followed, give maximum operating efficiency when the 1403 carriage is used. They are not intended to be restrictive, rather they are intended to permit customers to purchase their continuous forms from the manufacturer of their choice.

FORM DESIGN AS AFFECTED BY THE PRINT UNIT

In view of the 100 or 132 print positions and the 13.2-inch print unit, these factors should be considered when designing forms to be used on the 1403 printer:

1. The maximum form width is 18¾ inches, and the minimum is 3½ inches (Figure 36).
2. The maximum form length is 22 inches at six-lines-per-inch spacing, or 16½ inches at 8 lines per inch. For efficient stacking of forms, the recommended maximum forms length is 17 inches.
3. Because all print positions can print all characters, form depth can be reduced, and carbon paper eliminated, by the use of side-by-side printing. For example, *sold to* and *ship to* names can be printed on the same line, one on the left side of the form and the other on the right.
4. Forms can be designed for printing six or eight lines to the inch. Single-space, eight-lines-per-inch printing is not recommended when the registration between lines is critical.
5. Forms can be designed for variable line spacing within a form by use of single-, double-, or selective-space control.
6. It is possible to dispense with many vertical lines, because the system can be programmed to print commas, decimals, oblique lines, dashes, and other symbols.
7. A vertical line should not be printed between two adjacent printing positions because there is an overall maximum tolerance of only .013 inch between adjacent characters.
8. The number of legible copies that can be produced depends on the weight of the paper used for each form, and on the carbon coating.

Because the striking force of the print hammers is not adjustable, paper and carbon should be tested in conjunction with the print-density control lever and the print timing dial.

9. The CR (credit symbol) prints from two print positions and the minus sign prints from one. For this reason the minus sign is recommended as a credit symbol instead of the CR symbol.

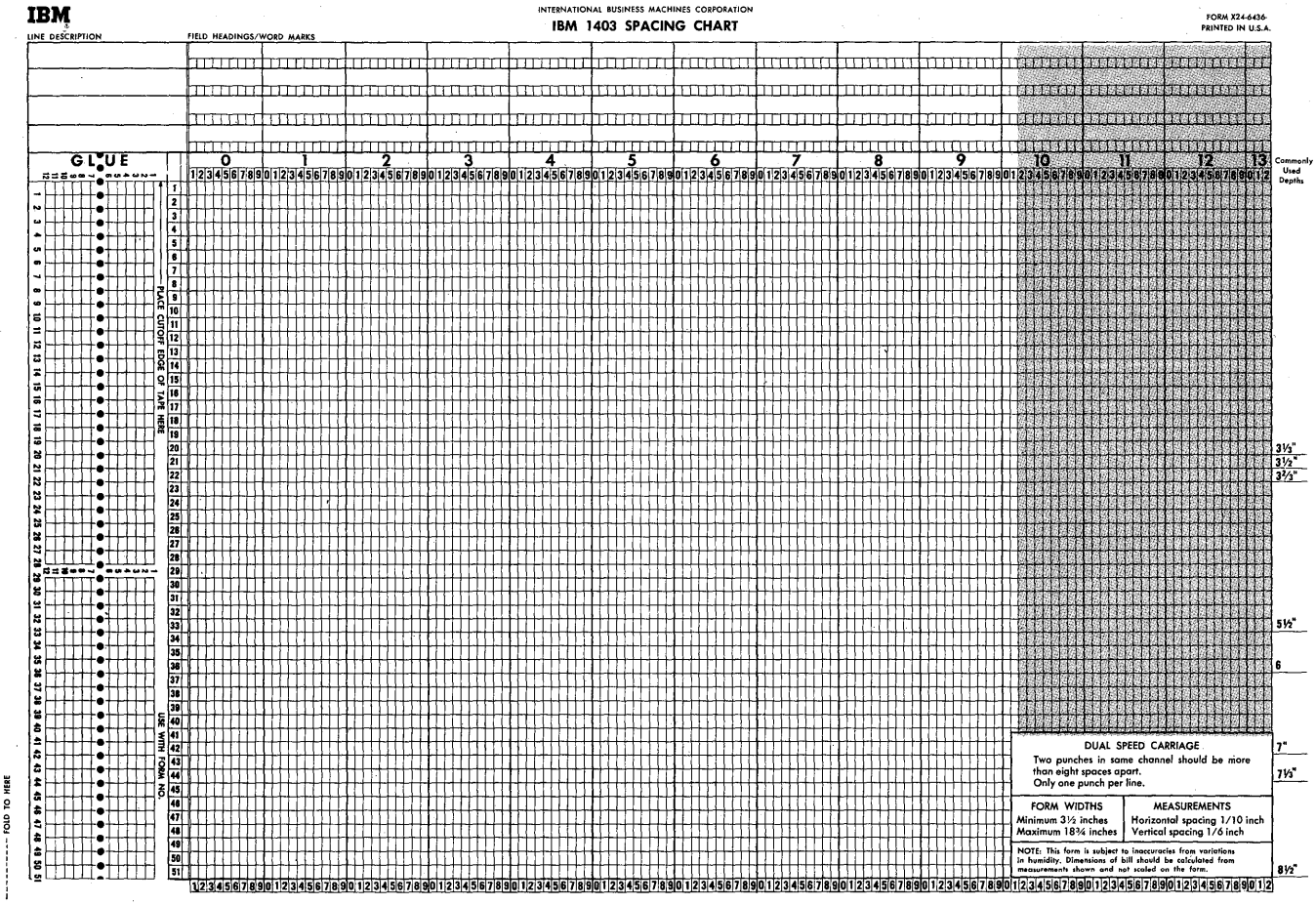


Figure 35. Forms Spacing Chart

10. The dollar symbol does not have to be preprinted on a check form, because this symbol can be programmed to print immediately to the left of significant digits.

FORMS SPECIFICATIONS AND DIMENSIONS

Paper Characteristics: The paper used for continuous forms must be of sufficient weight and strength to prevent the holes from tearing out during feeding or ejecting of the form. This is particularly important when single-part forms are being used.

The paper must not be so stiff as to cause improper feeding or excessive bulging, particularly at the outfold.

Paper must be as free from paper dust or lint as possible.

Weight: The number of legible copies required is a factor in determining the weight of the paper to be used in a multiple-part set.

Best results on multiple-copy forms require a lightweight paper of 13 pounds or less, except for the last copy. Again, the number of copies, as well as the distance of the form away from the hammers (variable by the print density control lever), affects the determination of paper weight.

Feeding and legibility performance can best be determined by making test runs of sample sets of forms.

Friction: During the feeding operation, fricton on marginally punched continuous forms should be eliminated by the following means:

1. Place the pack of forms directly beneath the front of the printer on the forms stand, in a position that eliminates any abnormal *drag* on the forms.

2. Allow sufficient clearance between the hammers and the print chain, to permit the forms to be fed by the pins freely, and without interference. This can be accomplished by properly setting the print density control lever.

Perforated Lines: The perforations between forms should be sufficiently deep to permit easy separation, but not so deep as to tear in ordinary handling or feeding through the machine.

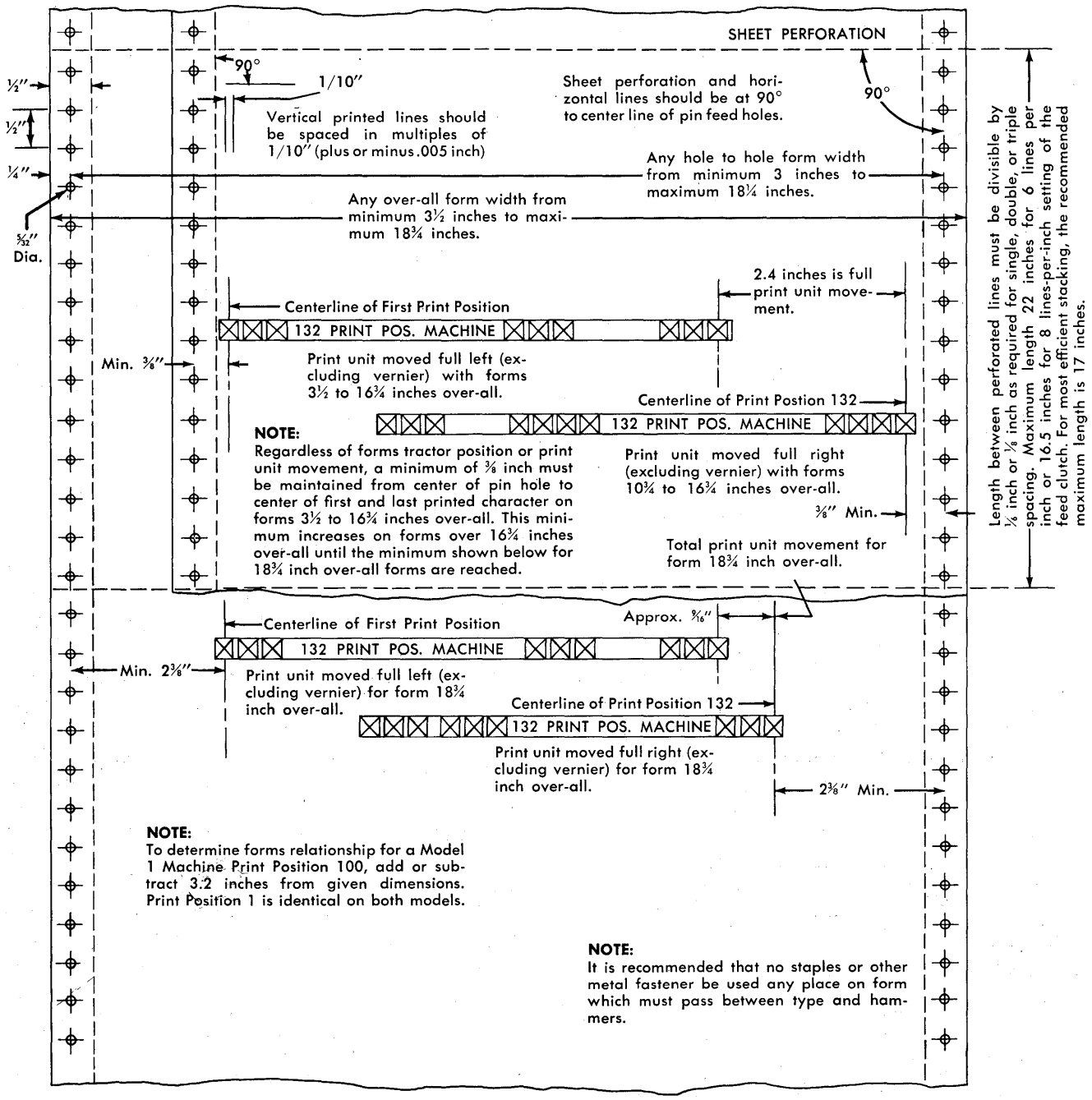


Figure 36. Form Specifications

The perforated lines at the end of the form should always be located at 90 degrees to a vertical center line through the marginal holes.

Cut and uncut portions should be uniformly accurate in length and spacing to insure proper and efficient tearing.

Vertical perforations at the margin for removal of the marginally punched strip can vary depending upon requirements. The distance from the edge of the form to the marginal perforations is usually ½ inch.

Marginal Holes: Continuous forms should have holes in both right and left margins, 5/32 inch in diameter, spaced vertically ½ inch apart from center to center, the full length of the form. The holes should be located this way on all copies of all sets throughout each pack of forms.

It is possible, however, to use holes of any size, shape, and spacing that accomplish the equivalent feeding conditions.

Vertical lines passing through the two vertical rows of pin holes must be parallel. It is recommended that the edges of the form be 1/4 inch from the vertical center lines through the holes.

A horizontal line passing through the center of any two marginal holes on the same line should be at a 90-degree angle to either vertical center line through the marginal holes.

Spacing between holes, center-to-center, must be such that the pins in the forms tractor, 1/8 inch in diameter and spaced 1/2 inch apart, enter and leave the holes in the paper, freely without tearing the paper.

Width of Forms: Although forms of any width within the extremes of those shown in Figure 36 can be used, it is recommended that form widths be confined to the standard sizes shown in Figure 37.

Length of Forms Between Perforated Lines: The 1403 accommodates marginally punched continuous forms up to a maximum length of 22 inches, at 6 lines per inch. It is recommended, however, that form lengths be confined to regular lengths, such as 3, 3 1/3, 3 1/2, 3 2/3, 4, 4 1/4, 5, 5 1/2, 6, 7, 8, 8 1/2, 10, 11, 12, 14, 16, and 17 inches.

Line Spacing: The forms tractor of the 1403 can be set by the operator for single-space printing, 6 or 8 lines per inch. For 6 lines to the inch, the length of the form must be evenly divisible by 1/6 inch for single spacing, by 1/3 inch for double spacing, and by 1/2 inch for triple spacing. Similarly, spacing of 8 lines to the inch requires that the length of the form be evenly divisible by 1/8 inch for single spacing, by 1/4 inch for double spacing, and by 3/8 inch for triple spacing.

Single-space printing at 8 lines to the inch on the 1403 is not recommended when the registration between lines is critical.

Multiple Copies: Multiple-copy forms consisting of more than four parts, and forms with the first part made of paper of more than 13-pound weight, should be tested under operating conditions to determine the suitability of feeding and legibility.

If multiple-copy forms are not fastened together, the carbon paper must be kept in line with the form by an acceptable method. One such method is center carbon without pin holes, glued to the set, or full-width carbon paper punched with substantially larger marginal holes that are approximately centered with the corresponding holes in the form. Marginal holes in the carbon that are substantially larger than the corresponding holes in the forms make allowance for carbon shrinkage and provide the processing tolerance necessary for some of the commonly used form structures.

One-time carbon paper or carbon-backed paper can be used. The carbon paper or coating should produce the required number of legible copies without excessive smudging. This can be determined best by making test runs with sample sets of forms containing different qualities of carbon papers.

Fastening of Multiple-Copy Forms: The width, length, and number of copies of the form determine the fastening requirements for satisfactory feeding through the forms tractor. For most efficient stacking, however, it is recommended that a suitable fastening method always be used with multiple copy forms.

If the construction of the form is such that the parts are of different widths, the necessity for, and the method of, fastening the form should be determined by the width of the parts, the depth of the form (shown in Figure 38), and weight of paper.

Forms of fanfold construction can be used on the 1403 printer.

When card-tag or rag-content paper stock is used, a test of sample sets of forms should be made to determine the exact fastening requirements. The fastening may consist of any satisfactory method, such as stitching or gluing, that prevents the copies from shifting. It is essential, however, that whatever fastening medium is used should not impair the feeding or printing alignment of the form.

OVER-ALL WIDTH (INCHES)	HOLE-TO-HOLE (INCHES)
4 3/4	4 1/4
5 3/4	5 1/4
6 1/2	6
8	7 1/2
8 1/2	8
9 1/2	9
10 5/8	10 1/8
11	10 1/2
11 3/4	11 1/4
12	11 1/2
12 27/32	12 11/32
13 5/8	13 1/8
14 7/8	14 3/8
15 1/2	15
16	15 1/2
16 3/4	16 1/4
17 25/32	17 9/32

Figure 37. Standard Size Forms

FORM DEPTH (Inches)	MAXIMUM DISTANCE BETWEEN FASTENINGS (Inches)
1 to 5	5
5-1/5 to 11	11
11 to 14	7
14 to 17	8½

Figure 38. Fastening Requirements for Multiple-Copy Forms

Registration of Forms: The assembly of multiple-copy forms should insure that the punching and printing of all copies of the form are in absolute registration with the material printed by the 1403. The following tolerances should be maintained.

1. Vertical Lines: Vertical columns of print positions are spaced 1/10 inch apart. There are 50 printing spaces in 5 inches. Vertical rules printed on a form should be spaced in multiples of 1/10 inch.

The center line of any one character, with reference to any other character on the same line, may have a plus or minus tolerance of .0065 inch, or a maximum over-all tolerance of .013 inch. From a forms viewpoint, it is practically impossible to guarantee that the cumulative tolerance of printing plate shrinkage, paper shrinkage, and marginal hole perforations does not exceed .0065 inch. This precludes the possibility of retaining satisfactory registration if vertical rules are spaced to split between print positions.

Where vertical lines are required, such rules should split the respective print position, thereby assigning that particular position for separation of the columnar field (dollars and cents, for example). However, in view of the fact that the 1403 can print special characters such as period and comma in every print position, the use of these symbols as decimal points, etc., avoids the need for vertical lines for such separations.

Vertical printed lines should parallel a vertical center line passing through the marginal holes.

2. Horizontal Lines: Horizontal printed lines on the form should be at a 90-degree angle to the vertical center line passing through the paper-feed pin holes.

The spacing should conform to the setting of the 1403 forms tractor – 6 or 8 lines to the inch.

3. Margins: It is recommended that no staples or other metal fasteners be used with multiple-copy forms. If unavoidable, it is important that either the left or right margin (whichever has the staples) be set outside the print hammer area, so that staples or other metal fasteners do not pass between the chain and hammer unit.

1403 Timing Considerations

The transfer of data from the print area of core storage to the print synchronizer requires 1,100 microseconds for 100 print positions, and 1,452 microseconds for 132 print positions. The printer is not busy at this time; BUSY comes on at the successful completion of the transfer. It remains ON for a minimum of 82,420 microseconds if there is not an automatic space, or a minimum of 103,820 microseconds if there is an automatic space. In case of an unsuccessful transfer, the printer may be readdressed immediately by the CPU; however, the second data transfer will not actually start until 1,463 microseconds after the initiation of the first transfer.

Special Features

NUMERICAL PRINT FEATURE

The numerical print feature for the 1403 printer has been designed for those businesses having certain 1410 applications that require no alphabetic printing. For example, banks, insurance companies, and utilities prepare many reports with only numeric printing. With this feature, the time required to produce these reports can be reduced by as much as 50 per cent. The manufacturing, wholesaling, and retailing levels of other industries also can use this feature for the many applications in which reports are or can be numerically coded.

With this feature, the systems user can switch from the alphameric to the numeric mode, simply by changing the chain cartridge in the 1403. The numeric chain is composed of 15 character sets, with 16 characters (digits 0 through 9 $. , * - □) in each set. In the numeric mode, the 1403 can print 1,285 lines per minute – more than twice as fast as in the alphameric mode.

To change from one mode to another, an operator, with no special tools, removes one chain and replaces it with the other. Before locking the new cartridge in place, it is only necessary to move the chain enough to permit the chain drive to engage. When a chain cartridge is placed in the 1403, the corresponding mode is selected automatically. If the printer is in the numeric mode, characters other than the 16 specified for numeric printing cause a print check error.

INTERCHANGEABLE CHAIN CARTRIDGE ADAPTER

Many scientific and commercial applications require distinctive type styles for particular printing jobs. This special feature for the 1403 allows chain cartridges to be interchanged.

With this feature, an operator can insert an interchangeable chain cartridge with a different type font, type style, or special character arrangement.

The procedure for changing a cartridge is:

1. Turn off system power.
2. Lift up the printer cover.
3. Pull back and unlock the print unit release lever.
4. Unlatch the ribbon shield and swing it against the paper.
5. Open the ribbon cover and remove the lower ribbon spool. Slide ribbon from under the skew roll and store the lower ribbon spool on the ribbon cover.
6. Grasp the cartridge handles and raise them to a vertical position. (This unlocks the cartridge from the T-casting.)
7. Lift straight up on the handles and raise the cartridge until it clears its locating pins. At this point it is free from the machine. Place the cartridge on a surface that will tolerate oil and ink. (A container is provided for storing the cartridge that is not in use.)
8. Grasp the handles of the second interchangeable cartridge and, raising them to a vertical position, lift the cartridge into position over the locating pin. (Check for foreign matter clinging to underside of cartridge.)
9. Lower the cartridge gently into position over its guide pins and release the handles. *Do not force either handle down at this point.* The 132-hammer end of the cartridge should settle fully down to the base. The 1-hammer end will not be down in position at this time.
10. Rotate the chain in the normal printing direction (counterclockwise, as viewed from the top). The chain can be rotated by pressing your finger against a character on the chain. At the same time, apply pressure to the button (located between the print timing dial and the cartridge) on the top cover. Rotate the chain slowly until the drive key drops into the drive slot. The chain will stop and the cartridge will settle correctly into position on the 1-hammer end.
11. Lower the cartridge handles to their horizontal position. *Do not force.* If force is required, the cartridge is not fully seated; repeat steps 8 to 10.
12. Replace the ribbons; latch the ribbon shield into place; close the T-casting and the top cover; apply power to the system and resume printing.

IBM 1009 Data Transmission Unit

Indicator lights and functional keys and switches are located on the console panel (Figure 39) on the top portion of the 1009 Data Transmission Unit. They are used by the terminal attendant in operating the 1009 during either a transmitting or receiving operation.

Indicator Lights

POWER

This light indicates that the power was turned on by pressing the power ON key. It goes off when the power is turned off.

READY

This light is on when there is a line for data transmission established between two IBM 1009 Data Transmission Units, and the two units are in synchronism. The test-normal switch on both 1009's must be set at NORMAL. Also, the data key on both telephones must be operated, and both connected data processing systems must have power ON.

RUN

When the 1009 is in an operative status (after the 1009 start key is pressed, and before the attached system starts data transmission), the run light is on. It stays on while the 1009 is in operation. The run light goes out under any of these conditions:

1. The stop key is pressed.
2. The power OFF key is pressed.
3. The end-of-file light comes on.
4. The telephone light comes on.
5. An error condition causes the alarm to sound (see "Audible Alarm").

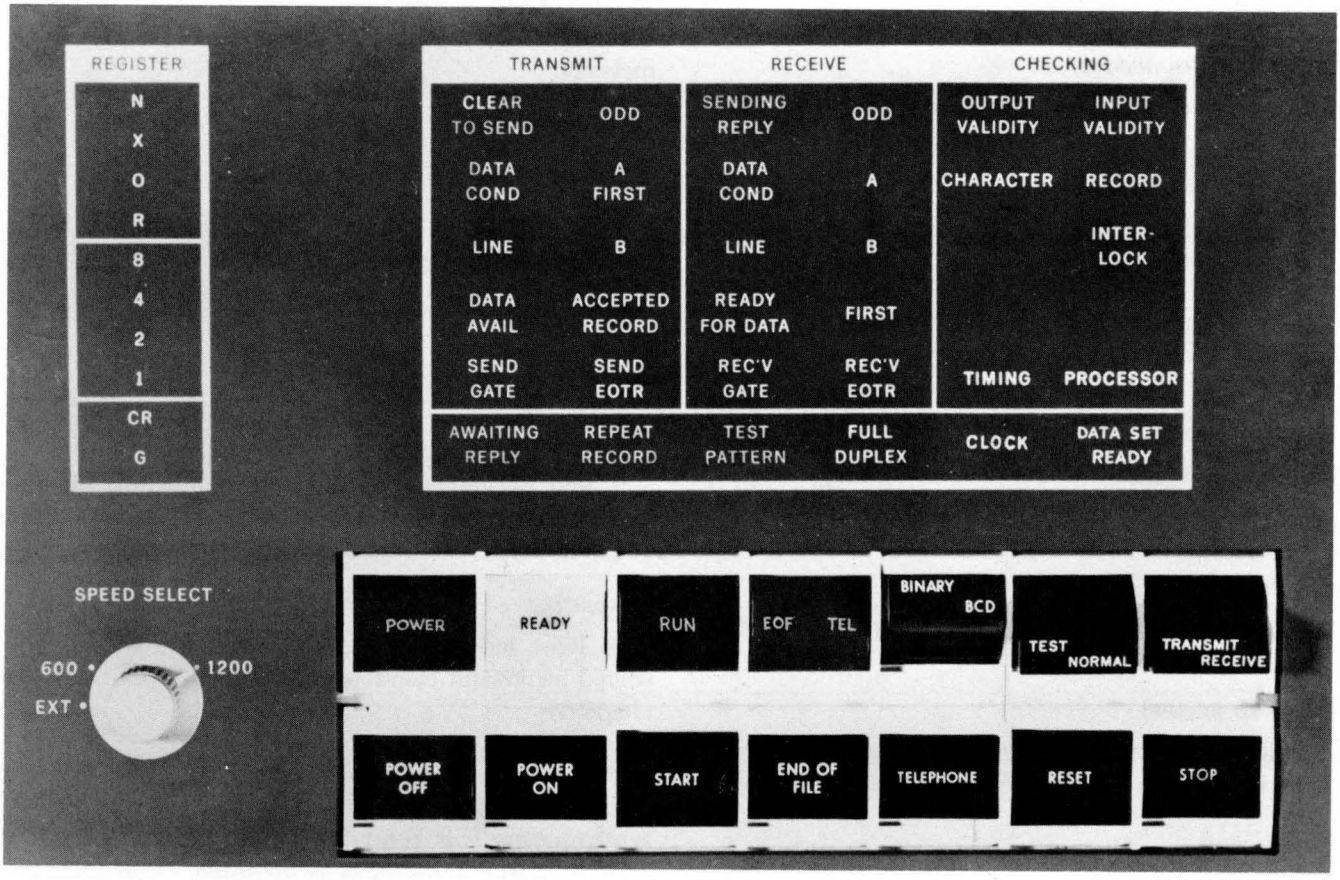


Figure 39. 1009 Operating Keys and Lights

END-OF-FILE

When either attendant presses the 1009 end-of-file key, the end-of-file light on the other 1009 is turned on, and the alarm sounds. The signal is returned immediately to the originating 1009, causing the EOF light to come on, and the alarm to sound. Pressing the stop key on each 1009 turns these signals off.

TELEPHONE

If a line for data transmission is established, and either terminal attendant presses the telephone key of the 1009, the TEL light turns on, and an alarm sounds on the other 1009 console. The signal is returned immediately to the originating 1009, causing the TEL light to come on, and the alarm to sound. Pressing the stop key on each 1009 turns these signals off.

Other Console Lights

These are the lights in the upper section of the 1009 console. They are used primarily by the IBM Customer Engineer for diagnostic purposes.

CLEAR TO SEND

This light is under control of the communications-company data set. It indicates that transmission can take place.

DATA COND (TRANSMIT)

This light indicates that the message is being transmitted.

LINE (TRANSMIT)

This light indicates that the data set is receiving information from the 1009.

DATA AVAIL

This light indicates that a message is ready for transmission.

AWAITING REPLY

This light indicates that the transmitting 1009 is waiting for an accepted record, or a repeat-record indication from the receiving 1009.

ODD (TRANSMIT)

This light is on during the transmission of every other message.

ACCEPTED RECORD

This light indicates that a correct message transmission acknowledgment was transmitted from the receiving 1009.

SEND EOTR

This light indicates the end of each message.

REPEAT RECORD

This light indicates that an incorrect message transmission acknowledgement was transmitted from the receiving 1009.

SENDING REPLY

This light indicates that the end of the message was detected and the receiving 1009 is ready to send a message transmission acknowledgement to the transmitting 1009.

DATA COND (RECEIVE)

This light indicates that the message is being received.

LINE (RECEIVE)

This light indicates that the 1009 is receiving information from the data set.

READY FOR DATA

This light indicates that the receiving 1009 is ready to receive data.

TEST PATTERN

This light indicates that the test-normal switch on the *other* 1009 is set to TEST and is sending test signals.

ODD (RECEIVE)

This light is on during the reception of every other message.

REC'V EOTR

This light indicates the end of each message.

FULL DUPLEX

This light indicates that the 1009 is conditioned for full duplex (four-wire) communications facilities.

OUTPUT VALIDITY

This light indicates

1. that the data processing system has received an invalid character (even parity), or
2. that the data processing system has failed to receive a character from the 1009, or
3. the loss of a message between 1009's.

CHARACTER

This light indicates that the receiving 1009 has received an invalid character or an invalid parity check character.

TIMING

This light indicates that the two 1009's are out of synchronism. This condition is also indicated by the audible alarm if the 1009 is operative or in the RUN status.

INPUT VALIDITY

This light indicates that two or three consecutive error messages have been detected. If the third message is correct, the light is turned off; if the following message is also incorrect, the light is turned off by pressing the 1009 start key, and transmission continues.

RECORD

This light indicates that a message was lost in the transmission between 1009's.

INTERLOCK

This light indicates

1. that the 1009 is in a receive-run condition, and the attached system is operating under transmit program control, or
2. that the 1009 is in a transmit-run condition and the attached system is operating under receive program control, or
3. that the stored program has addressed the 1009 for some reason, but the 1009 is not in RUN condition, and is unable to respond.

PROCESSOR

This light indicates

1. that the transmitting 1009 has not received the next character from the attached system within the three-second interval that follows the transmission of the preceding character, or
2. that the system has not started the transmission of the next message within the three-second interval that follows the previous message acknowledgement, or
3. that the system was not ready to accept the character available from the 1009, or
4. that the system did not generate a message transmission acknowledgement within the three-second interval that follows the end-of-message indication.

DATA SET READY

This light indicates that the data key on the telephone has been operated.

Keys

POWER-ON

Pressing this key turns on the power in the 1009. Because the power goes on immediately, it is not necessary to hold the key down.

POWER-OFF

Pressing this key turns off the power in the 1009.

START

If the IBM data processing system and the 1009 Data Transmission Unit have been conditioned to transmit or receive, the terminal attendant presses the start key on the 1009. This causes the run light to come on.

END-OF-FILE

When all messages of a group have been transmitted, the attendant at the sending station presses the stop key and then the end-of-file key. This signals the attendant at the receiving station by turning on the end-of-file light and the audible alarm on the receiving 1009. Pressing the stop key on the receiving unit turns off both signals.

The transmitting station end-of-file light also turns on and the audible alarm sounds. Pressing the stop key at each terminal turns off both signals.

TELEPHONE

If a line for data transmission has been established and either terminal attendant wants to talk to the other, he presses the telephone key. This allows the message being transmitted to be completed. The telephone key signals the other station by turning or the telephone light and causing the alarm to sound. Pressing the stop key on the 1009 being signaled, turns off both signals.

RESET

If both the reset key and the stop key are pressed simultaneously, or if the reset key is pressed following the operation of the stop key, an immediate stop in transmission is effected.

STOP

This key is pressed to stop either the transmit or the receive function. If it is pressed while a message is being transmitted or received, the function will stop when the message is complete. If both the stop key and the reset key are pressed simultaneously, an *immediate* stop is effected. If both keys are pressed simultaneously during the transmission of a message, that message will be sent again. Also, a stop key operation turns off

1. the end-of-file light and the associated audible alarm,
2. the telephone light and the associated audible alarm,
3. the audible alarm caused by the three successive errors in the transmission of the same record, and
4. the audible alarm caused by one 1009 getting out of synchronism with the other.

Switches

BCD/BINARY

This switch specifies the coding of blank characters for data transmission. Both 1009 switch settings must be the same. When set to BCD the character set is 55

characters. When set to BINARY, the character set is 64 characters.

TEST-NORMAL

When this switch is set at TEST, test signals are sent to the remote terminal. The 1009 that receives the test signals acknowledges it by turning on the test pattern light located in the upper portion of the console panel.

When the test-normal switch is set at NORMAL, the 1009 can execute its normal transmit and receive functions.

TRANSMIT-RECEIVE

This switch sets the mode of operation. If the 1009 is to work in conjunction with an IBM data processing system as a transmitting station, this switch is set at TRANSMIT. If the 1009 is to work with an IBM data processing system as a receiving station, the switch is set at RECEIVE.

SPEED-SELECTOR

The setting of this switch, and the type of data set determine the transmission speed of the terminal. This switch must be at one of three settings to be compatible with the data set:

600 — 600 bits (75 characters) per second.

1200 — 1200 bits (150 characters) per second.

Ext — up to 2400 bits (300 characters) per second. At this setting, transmission speed is determined strictly by the frequency of the data set.

NOTE: The setting of the speed-selector switches on both the transmitting and the receiving 1009's must be the same.

Audible Alarm

The audible alarm is a loudspeaker designed to signal the terminal attendant under these conditions:

1. When the transmitting-station attendant presses the end-of-file key, the audible alarm and the end-of-file light of the receiving 1009 turn on. Pressing the stop key on the receiving 1009 turns both signals off.
2. When one terminal attendant presses the telephone key, the audible alarm and the telephone light turn on in the 1009 being called. Pressing the stop key of the 1009 being called turns both signals off.
3. Errors in three successive transmissions of the same message cause the alarm to sound in the transmitting and/or receiving 1009. Pressing the 1009 stop key turns the associated alarm off.
4. If one 1009 gets out of synchronization with the other, the alarm sounds at both terminals. Pressing the stop key on each 1009 turns the alarm off.
5. If the 1009 is in a RECEIVE-RUN condition and the attached system is operating under a transmit program, the alarm sounds. The alarm turns off when the transmit-receive switch is set to the correct setting and the 1009 start key is operated.
6. If the 1009 is in a TRANSMIT-RUN condition and the attached system is operating under a receive program, the alarm sounds. The alarm turns off when the transmit-receive switch is set to the correct setting, and the 1009 start key is operated.
7. If the program addresses the 1009 for any reason and the 1009 is not in a RUN condition, the alarm sounds. The alarm turns off when the RUN condition is established in the 1009.
8. If the receiving data processing system, operating under the control of a receive program, fails to take a character from the receiving 1009; the alarm sounds. Pressing the stop key on the 1009 turns the alarm off.
9. If the transmitting 1009 has not received the next character within the three-second interval that follows the transmission of the preceding character, the alarm sounds.
10. If the transmitting system has not started the transmission of the next message within the three-second interval that follows the previous message acknowledgement, the alarm sounds.
11. If the receiving system did not generate a message transmission acknowledgement within the three-second interval that follows the end-of-message indication, the alarm sounds.

Operating Principles

A person trained to operate the data processing system should be able to operate the IBM 1009 Data Transmission Unit with a minimum of formal training. Instructions, including error and other conditional procedures, should be made available to all operators for ready reference.

Before data is sent, the terminal attendants should complete certain housekeeping operations, such as loading the transmit and receive programs, loading the data to be sent, and readying the data processing system and the 1009. The completion of operations such as these before the scheduled time of transmission or reception of data minimizes any delays after making the connection for data transmission.

MAKING THE CONNECTION

Any terminal attendant can establish a line for data transmission by dialing the telephone number of another terminal. If the call is routed through operators, advise them that the call is to be a data transmission call, and that the transmission should not be monitored. Monitoring will degrade the transmission. The transmitting equipment is ready to transmit if:

1. The transmit program has been loaded in the data processing unit.

2. The input (card or magnetic tape) equipment is ready.

3. The 1009 is in a ready condition (power on, BINARY/BCD switch set to desired mode, test-normal switch set to NORMAL, transmit-receive switch set to TRANSMIT).

When the telephone rings at the terminal being called, the attendant answers the telephone and tells the caller whether or not the equipment is ready to accept data. The receiving equipment is ready to receive if:

1. The receive program has been loaded in the data processing system.

2. The output (card or magnetic tape) facilities are ready.

3. The 1009 is in a ready condition (power on, BINARY/BCD switch set to the desired mode, test-normal switch set to NORMAL, transmit-receive switch set to RECEIVE).

If the equipment is ready, each terminal attendant presses the data key on his telephone and cradles the telephone handset. When the ready light on the 1009 glows, each terminal attendant presses the start button on the 1009 console. When the run light glows, he presses the start button on the 1401 to begin the transmission of data.

ENDING THE OPERATION

When the last record has been sent and received correctly,

1. The attendant at the transmitting terminal:

a. presses the end-of-file key on the 1009 to turn on the EOF light and the audible alarm on the receiving 1009.

b. presses the stop key to turn off the EOF light and the audible alarm on the transmitting 1009.

c. presses the TALK key on the telephone to disconnect the line for data transmission.

2. The attendant at the receiving terminal:

a. presses the stop key on the 1009 to turn off the EOF light and audible alarm.

b. presses the TALK key on the telephone to disconnect the line for data transmission.

3. After pressing the TALK key, both terminal attendants should listen for a dial tone to be sure the line is disconnected.

OPERATOR CALLS

If the attendant at either terminal wants to talk to the attendant at the other terminal, he presses the telephone key on the 1009. The TEL light and audible alarm signal the attendant at the remote terminal. If a message is being transmitted when the telephone key is pressed, that message will be completed before the 1009 stops.

When the 1009 stops,

1. The attendant being called

a. presses the stop key on the 1009 to turn off the TEL light and the audible alarm,

b. presses the TALK key on the telephone, and

c. picks up the telephone receiver, and answers the call.

2. The calling attendant

a. presses the TALK key on the telephone, and

b. picks up the telephone receiver, and begins the conversation.

When the conversation is ended,

1. The attendant called

a. presses the data key on the telephone, and

b. cradles the telephone receiver so that the transmission of data can continue.

2. The calling attendant

a. presses the data key on the telephone,

b. cradles the telephone receiver so that the transmission of data can continue, and

c. presses the start key on the 1009 to resume data transmission.

IBM 1011 Paper Tape Reader

The signal lights and control switches for the IBM 1011 Paper Tape Reader are shown in Figure 40. The indicator lights, located above the operating switches, keys, and lights are primarily for IBM Customer Engineers' use in diagnostic testing and preventive maintenance routines. The reel power switch is located on the tape reader below the reading head (Figure 42).

SWITCHES

Start: Pressing this switch turns ON the ready light, puts the 1011 in a read condition (if the interlocks are properly conditioned), and signals the using system that paper-tape reading can begin.

Stop: Pressing this switch stops paper-tape reading and turns OFF the ready light. Pressing the start switch resumes the paper-tape reading operation.

Reset: Pressing this switch resets the necessary circuits to the beginning of an operation. This switch is not effective when the ready light is ON.

The 1011 is reset to a letters-shift mode, and remains in the letters-shift mode until a figures-shift tape character is read from the tape.

Reel/Strip Selector: This switch has two positions. For reel and center-roll feeding, the switch must be in the right position; for strip feeding, in the left position.

Power: This switch has two positions. In the upper (ON) position, this switch supplies power to the 1011

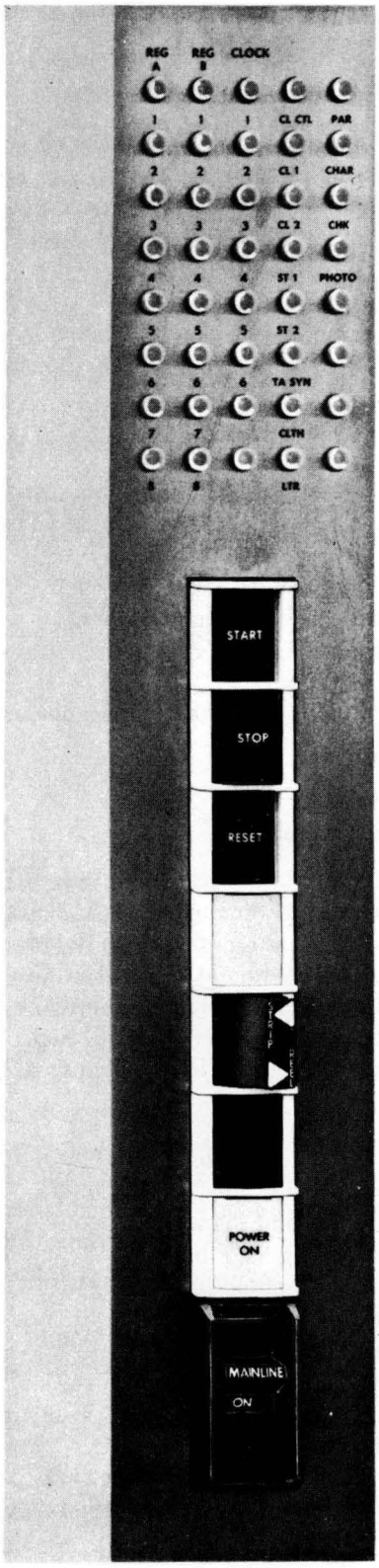


Figure 40. 1011 Operating Keys and Lights

and turns on the power-on light. In the lower (OFF) position this switch removes power from the 1011 and turns off the power light.

Reel Power: Pressing this switch supplies power to the take-up (left-hand) and supply (right-hand) reels when the buffer arms are in normal operating position.

LIGHTS

Ready: When ON, this light indicates that the 1011 is either waiting for a signal from the using system to read paper tape, or is reading paper tape. This light turns on at the beginning of an operation after the start switch is pressed, and turns off when the stop switch or power switch is presssed, or when one of the following conditions causes the reader to stop:

1. paper-tape break
2. paper-tape tightness
3. run-out of paper tape
4. 1011 not ready
5. power failure
6. photocell failure
7. parity error detected (control panel not wired to continue reading)
8. unwired character read (control panel not wired to continue reading)

Power-On: When ON, this light indicates that ac power is being supplied to the 1011. The light turns on when the power switch is ON and turns off when the power switch is turned off.

Paper Tape

CHAD AND CHADLESS PAPER TAPE

The small paper particles either completely punched out of paper tape, or partially punched out (90 per cent of circumference punched) are called *chads*. Paper tape with completely punched-out holes, is called chad tape. Paper tape with partially-punched holes is called chadless tape because it does not produce loose chads.

STRIP OF PAPER TAPE

A free length of punched paper tape, measuring not less than 20 inches nor more than 20 feet, is called a *strip*. Included in these dimensions, the strip must have leader and trailer portions that are each at least ten inches long. Feed holes must be punched in the leader and trailer. Codes may also be punched in the leader and trailer; however, since codes may be read, usually no codes other than letter shift or tape feed are punched in the leader and trailer.

ROLL OF PAPER TAPE

Punched paper tape that is wound clockwise (viewed from top with three-hole side up) around itself, be-

ginning with the leading end, is called a *roll.* A roll of chadless tape is wound so that the chads protrude toward the outside of the roll. A roll feeds from the leading end at the center toward the trailing end on the outside. Both the leader and trailer portions must be at least ten inches long. A leader of 48 inches is necessary, however, for complete loading; that is, for attaching the leading end to the take-up reel before starting to read. A roll with an inside diameter of 4½ inches, maximum, should have an outside diameter of not more than 10½ inches. A roll with an inside diameter of 2¾ inches, minimum (IBM 961 or 962 Tape Punch rewind), should not exceed 300 feet in length or six inches outside diameter.

REEL OF PAPER TAPE

Punched paper tape that is wound clockwise (viewed from top with three-hole side up) around itself, beginning with the trailing end, is called a *reel.* A reel of chadless tape is wound so that the chads protrude toward the center of the reel. When mounted on the paper tape reader, a reel feeds from the leading end on the outside, toward the trailing end on the inside. Both the leader and trailer portions must be at least ten inches long. A leader of 48 inches is necessary, however, for complete loading; that is, for attaching the leading end to the take-up reel before starting to read. The length of a reel of tape should not exceed the capacity of the take-up reel.

PAPER-TAPE SPECIFICATIONS

The IBM 1011 Paper Tape Reader is designed to operate with either IBM 190216 ($^{11}/_{16}$-inch width, 5-track) or IBM 304469 (1-inch width, 8-track) paper tape. Other paper tape of equivalent paper stock may be used. Specifications for acceptable tape:

1. Widths of tape:
   $^{11}/_{16} \pm .003$
   $^{7}/_{8} \pm .003$
   $1 \pm .003$
2. Distance from 3-hole edge of tape to center line of feed holes: .392 + .003 – .009 inch.
3. Vertical distance (across width of tape) between centers of holes: .100 ± .002 inch.
4. Horizontal distance (parallel with edges of tape) between centers of holes:
   .100 ± .001 inch for feed holes
   .100 ± .003 inch for code holes
5. Vertical distances (across width of tape) across holes:
   .072 + .001 — .002 inch for code holes
   .046 + .002 — .001 inch for feed holes
6. Thickness of tape: .004 ± .003 inch.
7. Chadless tape: All chads in chadless tape must be on the same side of the paper (as normally punched). No chad may be folded back more than 90 degrees from the paper. Fanfolded or creased chadless tape is not acceptable for use with the paper tape reader.
8. Feed holes must be in line with the code holes. Chad paper tape must have punched-out feed holes.
9. Splicing: A splice should be made only in non-data portions of paper tape because correct reading of tape cannot be assured at the point of splice. Splices must not block, or in any way restrict, the feed holes because the reader feeds and guides the tape by means of the feed holes. Specifications for a splice are:
   a. Total thickness of the splice must not exceed .010 inch.
   b. Tape overlap at the splice should be no more than one tape code in length (.1 inch).
   c. The leading edge of the splice should be on the topside of the tape as it passes over the reading head.
   d. The splice must be at least as strong as the tape itself.
   e. The splice must be no wider than the tape itself.
   f. The splice must be flexible.
   g. The splice must be free of staples and gummy substances which could build up on the reading mechanism.

PREPARING PAPER TAPE READER FOR STRIP FEEDING

1. Turn the reel/strip toggle switch to the STRIP position.
2. Open the reading-head tape guides and place a loop of the tape leader over the reading head so that the sprocket drive engages the feed holes. The tape at the bottom of the loop must pass between the two reading-head rollers (Figure 41).

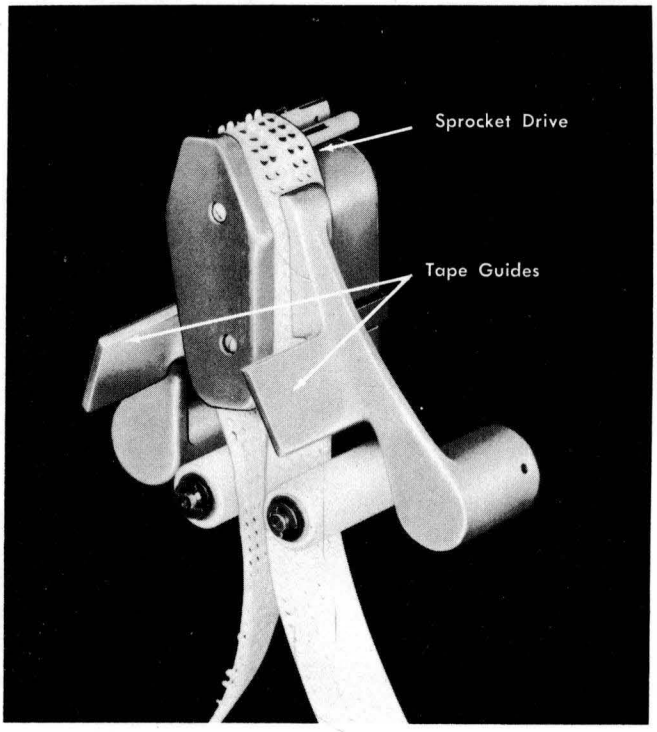


Figure 41. Strip Feeding

3. Remove the slack from the loop and close the reading-head tape guides.

4. Check to be sure that the strip is not rolled, curled, or wound in a figure eight.

5. For maximum tape-reading efficiency, the tape guides and reading head should be cleaned with a soft brush, once each 8-hour shift.

PREPARING PAPER TAPE READER FOR REEL FEEDING

1. Turn the reel/strip toggle switch to the REEL position (Figure 42).

2. Move the two buffer arms upward until they latch in position.

3. Move the center-roll idler clockwise until it latches in the vertical position.

4. Mount the take-up reel on the left capstan.

5. Mount the supply reel on the right capstan, making sure that the three-hole side of the tape is away from the machine.

6. Grasp the leading end of the tape at the right side of the supply reel, pull downward, and draw the end from right to left so that the tape passes below the buffer-arm rollers and reading-head rollers but above the stationary rollers.

7. Secure the leading end of tape to the take-up reel so that by turning the take-up reel counterclockwise, tape will be pulled from the supply reel.

8. Move the two buffer arms downward to their operating positions.

9. Press the reel-power push-button switch.

10. Open the reading-head tape guides and place a loop of tape over the reading head so that the sprocket drive engages the feed holes. The tape at the bottom of the loop must pass between the two reading-head rollers.

11. For maximum tape-reading efficiency, the tape guides and reading head should be cleaned with a soft brush, once each 8-hour shift.

PREPARING PAPER TAPE READER FOR CENTER-ROLL FEEDING

1. Turn the reel/strip toggle switch to the REEL position.

2. Move the two buffer arms upward until they latch in position (Figure 43).

3. Move the center-roll idler clockwise until it latches in the vertical position.

4. Mount the take-up reel on the left capstan.

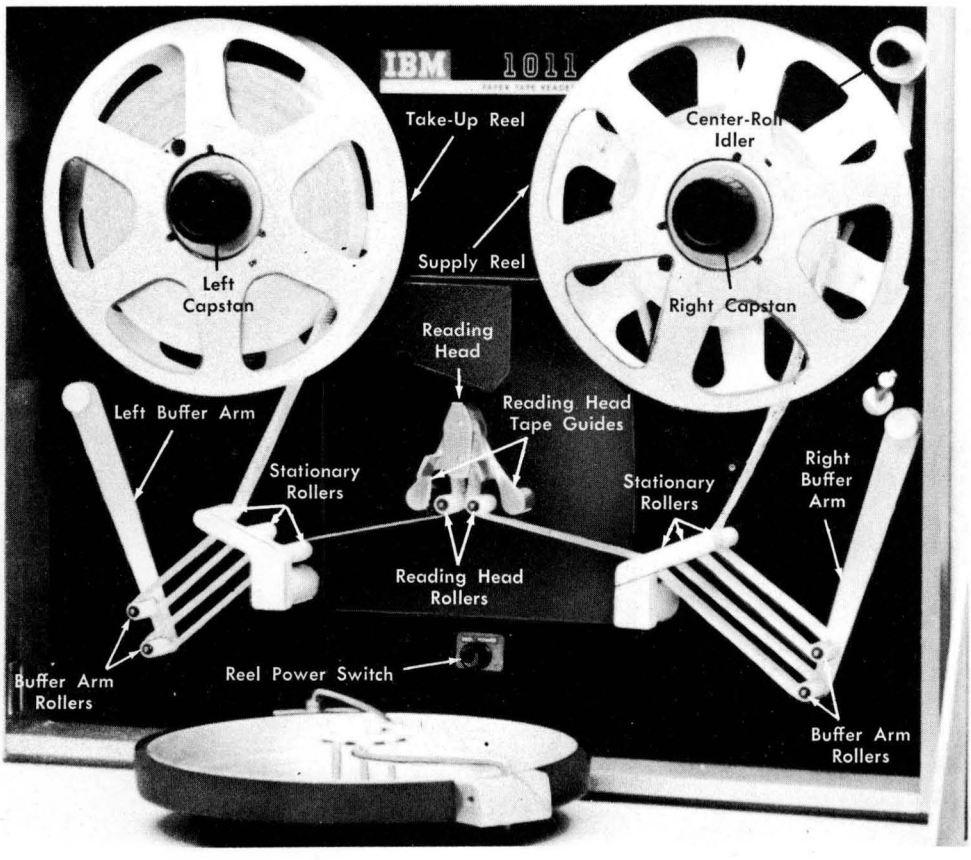


Figure 42. Reel Feeding

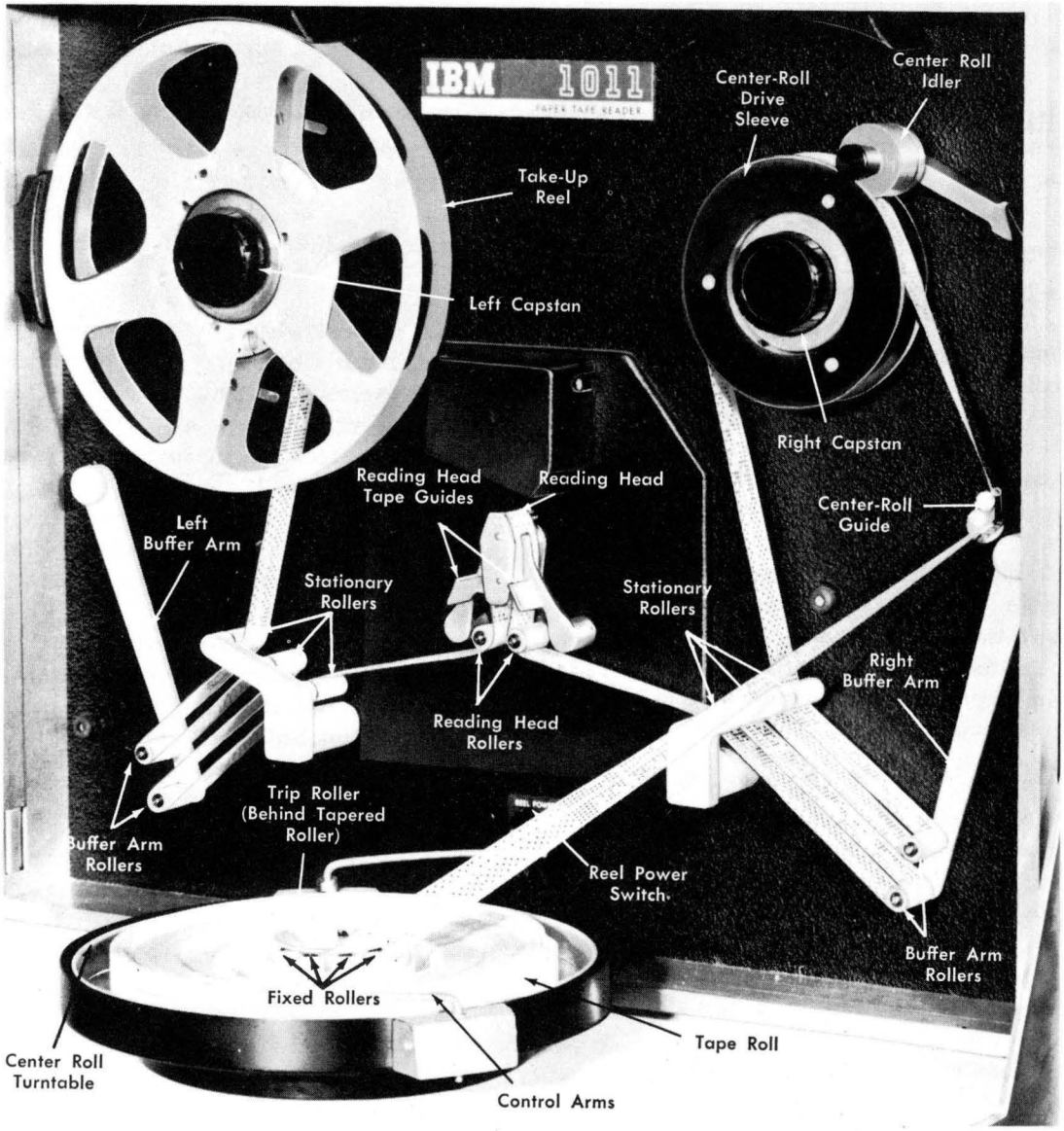


Figure 43. Center-Roll Feeding

5. Mount the center-roll drive sleeve on the right capstan.

6. Mount the center-roll turntable on the shelf and move aside the control arms.

7. Place the roll of tape on the turntable concentric with the rollers.

8. Grasp the leading end of tape and draw it inside the ring of fixed rollers, by passing it to the left of the trip roller.

9. From the trip roller, draw the end around the tapered roller, and then to the right and upward so that the end passes above the roll of tape on the turntable.

10. Pass the end of tape through the center-roll guide and over the drive sleeve.

11. Move the center-roll idler counterclockwise until it rests upon the tape and drive sleeve.

12. Pull the leading end at the left of the drive sleeve downward, and then draw the end from right to left so that the tape passes below the buffer-arm rollers but above the stationary rollers.

13. Secure the leading end of tape to the take-up reel so that by turning the take-up reel counterclockwise, tape will be pulled from the roll of tape on the turntable.

14. Move the two buffer arms downward to their operating positions.

15. Press the reel-power push-button switch.

16. Open the reading-head tape guides and place a loop of tape over the reading head so that the spocket

drive engages the feed holes. The tape at the bottom of the loop must pass between the two reading-head rollers.

17. For maximum tape-reading efficiency, the tape guides and reading head should be cleaned with a soft brush, once each 8-hour shift.

Control-Panel Summary

A door, located in the top section of the IBM 1011 rear panel, provides access to the panel.

The hubs of the control panels (Figures 44 and 45) are arranged in 22 columns numbered from 1 to 22, and 34 rows lettered A to AK. The location of a hub can be identified by use of these co-ordinates. For example, the parity-error hub is located at A, 12. The co-ordinates for each set of hubs are listed below, after the names of the hubs.

Two types of removable, single, self-contacting control panels are available, the 5-track and the 8-track type. All hubs on the 5-track control panel are identical with those on the 8-track panel except the decode exit, tape-level exit, and tape-level decode entry hubs.

The control and special-purpose hubs are as follows:

TAPE LEVEL EXIT—A, 5-8, AND DECODE ENTRY—B, 5-8

Wiring the tape-level exit hubs to the decode-entry input hubs sets the reader for the type of tape being used. These hubs provide for redirecting the upper (away from the 3-hole edge) four of the eight tracks of data received from the reading unit.

Wiring: In the 8-track mode, the wiring of tape-level exits 5, 6, 7, and 8 to decode entries CK, 5, 6, and EOL, respectively, provides for decoding the IBM 8-track code. In the 5-track mode, the wiring of tape-level exit 5 to decode entry 5, and tape-level exit 6 to decode entry 6 hubs, provides for decoding telegraphic 5-track code.

SP LTRS (SPACE LETTERS)—A-B, 9

The two hubs labeled SP LTRS are a switch. When 5-track telegraphic tape is used and the switch is wired ON, the *space* tape character causes a change to letter shift. The letter shift remains in effect until a *figure*-shift tape character is read from the tape.

Wiring: These hubs are a normally-off switch. Connecting these two hubs turns the switch ON.

PT PAR (PAPER TAPE PARITY)—A-B, 10

The two hubs labeled PT PAR are a switch. When 8-track IBM tape is read and the switch is ON, punchings are checked for odd parity. The switch is wired OFF when 5-track tape is used; otherwise, erroneous indications of parity errors occur.

Wiring: These hubs are a normally-on switch. Connecting these two hubs turns the switch OFF.

5 TR (FIVE TRACK)—A-B, 11

These two hubs labeled 5 TR are a switch. The wiring of these hubs determines the 1011 operation mode (5-track or 8-track). This switch must be wired OFF when 8-track IBM tape is being used. If not wired OFF, erroneous indications of errors occur.

Wiring: Switch ON — no wiring. Switch OFF — wire from upper to lower hub.

PE (PARITY ERROR)—A, 12

This hub emits an impulse when a parity error occurs (even number of holes is sensed in a paper-tape character). When a parity error occurs and the hub is wired to any encode entry or data-omit entry, the parity error is signaled to the central processing unit, and paper-tape reading continues. If the parity-error hub is wired to an encode-entry hub, the corresponding character is transmitted to core storage in place of the error character. If PARITY ERROR is wired to a data-omit entry hub, the error character is deleted.

When a parity error occurs and the parity-error hub is not wired to either an encode entry or a data-omit entry hub, reading stops and the ready light is turned off. The central processing unit is also made aware of the error condition.

Wiring: Wire PE hub to any encode entry or data-omit entry hub.

UC (UNWIRED CHARACTER)—A, 13

Unwired characters (punched in tape but not wired from their decode-exit hubs) cause UC (unwired character) hub to emit an impulse.

Wiring: UC wired to an encode-entry hub provides an identifying character for entry into core storage. When UC is wired to a data-omit entry hub, the character is deleted and does not use up a position in core storage. If the UC hub is not wired to either an encode entry, data-omit entry, or end-of-record hub, the 1011 stops reading and the ready light is turned off. Wiring UC to both data-omit and encode-entry hubs is not valid control-panel wiring.

EOR IN AND OUT (END OF RECORD IN AND OUT)—C-D, 22

Any paper-tape code can be assigned as an EOR character by control-panel wiring. Sensing an EOR character terminates the paper-tape read operation.

Wiring: The wiring of the EOR hubs varies with the type of data processing system connected to the 1011. Wiring of these hubs is explained in both the 1401 and 1410 sections of this manual.

REDUCERS—E-J, 5-10

Two sets of reducers are standard equipment. Each set consists of four IN hubs and one OUT hub. Any impulses directed to the IN hubs are available at the OUT hub. For example, any combination of tape character

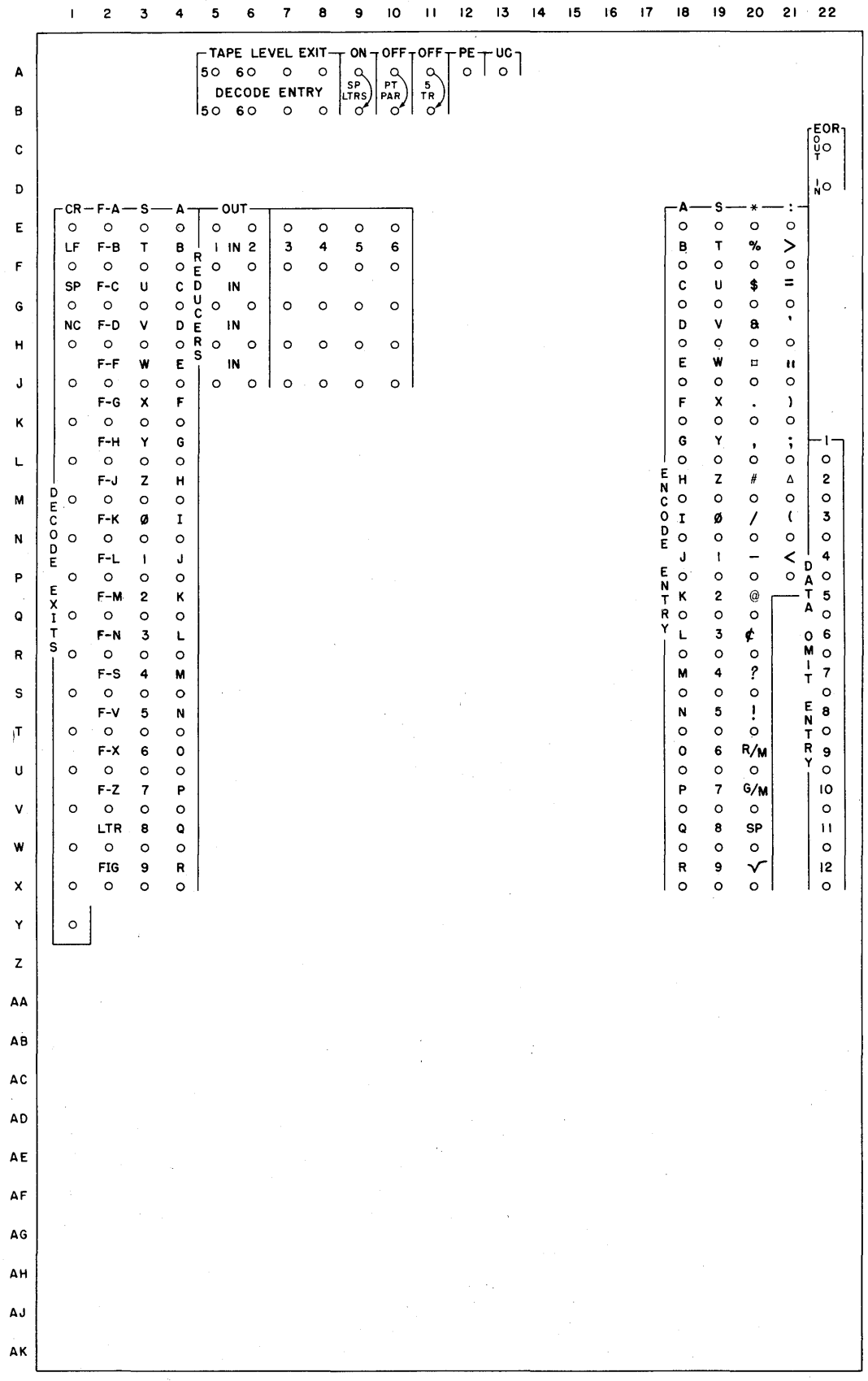


Figure 44. Five-Track Control Panel

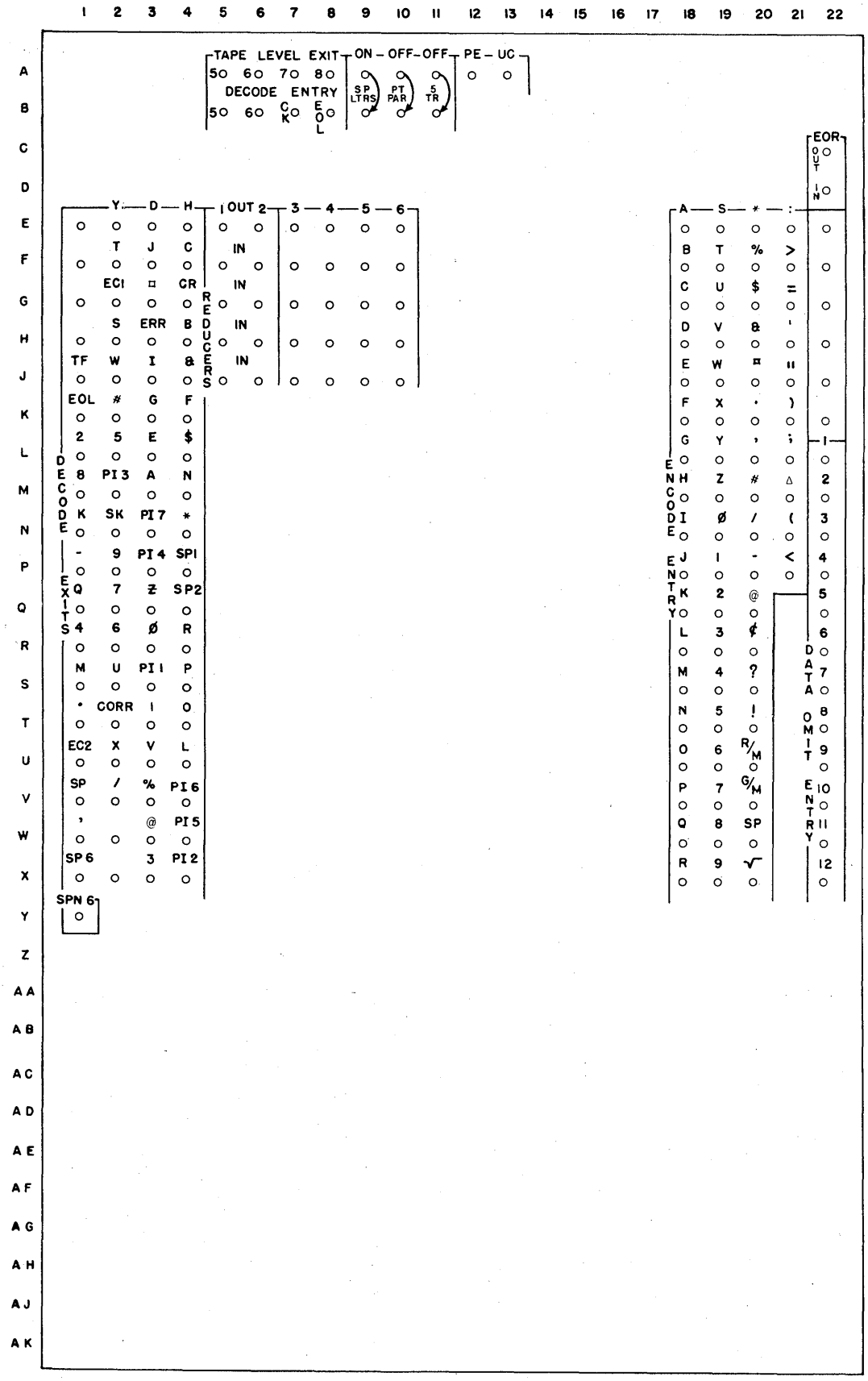


Figure 45. Eight-Track Control Panel

decode-exit hubs wired to IN hubs 1, 2, 3, and 4 emits an impulse from the OUT hub. Reducers must be used instead of split wiring.

Wiring: Wire any one, two, three, or four decode-exit hubs to any one, two, three, or four IN hubs. Wire the OUT hub to any encode-entry hub, any data-omit entry hub, or the end-of-record hub.

DATA OMIT ENTRIES—L-X, 22

The twelve data-omit entry hubs are used to prevent unwanted tape characters from entering core storage and to by-pass unwired tape characters.

Wiring: Unwanted character — wire from the decode-exit hub that represents the unwanted tape character to any one of the data-omit entry hubs. Unwired character — wire from the UC hub to any data-omit entry hub.

DECODE EXITS—E-Y, 1; E-X, 2-4

As each tape character is read, its impulse is available at the corresponding decode-exit hub. The 5-track control panel has exit hubs for all 58 telegraphic 5-track codes (including blank). The 8-track control panel has exit hubs for all 65 IBM 8-track codes (including EOL). The decode exit, tape-level exit, and decode-entry hubs are the only hubs on the 5-track control panel that differ from those on the 8-track control panel. All other hubs are identical.

Wiring: Wire decode-exit hubs to any one of these hubs, depending on the operation involved:

1. Encode-entry hubs
2. Data-omit entry hubs
3. End-of-record IN hub
4. Reducer IN hubs

ENCODE ENTRIES—E-X, 18-20; E-P, 21

Impulsing an encode-entry hub develops the 1401-1410 binary-coded decimal character that has been designated for that particular hub. The binary-coded decimal character is then read into core storage.

Wiring: Wiring to the encode-entry hubs is:

1. From decode-exit hubs for most data characters, or
2. from reducer OUT hubs, from unwired character (UC) and parity-error (PE) hubs.

IBM 1014 Remote Inquiry Unit

The inquiry unit is comprised of an input-output (I-O) printer, a control section located on the I-O printer keyboard, and an indicator light panel. The I-O printer is equipped with a 44-character keyboard (26 alphabetic, 10 numeric, and 8 special characters: & . - $ * , # / [Figure 46]). All other special characters are printed as a number sign (#).

The control section contains the switch and keys needed to operate the unit:

ON-OFF switch furnishes power to the inquiry unit.

Inquiry Request key signals the inquiry unit adapter that an inquiry unit wants to have an inquiry request message processed. This inquiry request is examined by the adapter.

Inquiry Release key:

1. Signals the inquiry unit adapter that the sending of the inquiry request message is completed. The adapter acknowledges the message completion by turning OFF the inquiry unit proceed light and initiating an I-O printer carriage-return operation.

2. Generates a group mark that is placed in the input synchronizer position adjacent to the last character of the inquiry request message.

3. Turns on the inquiry status latch in the 1410.

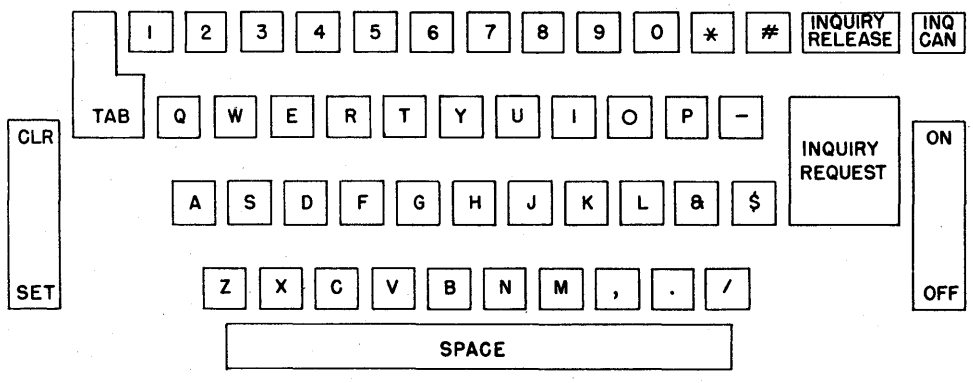


Figure 46. 1014 Keyboard

Inquiry Cancel (Inq Can) key (during an inquiry request operation) releases the inquiry unit, turns off the request light, and ends the inquiry request routine in the inquiry unit adapter. The adapter acknowledges the inquiry routine cancellation by turning off the inquiry unit proceed light and initiating an 1-0 printer carriage return operation. The key is used also during inquiry operations to turn off the inquiry unit check light or the exceed speed light or both.

The indicator light panel (located to the right of the 1-0 printer) contains additional lights needed by the operator:

Request: Operating the inquiry request key turns on the white request light. Pressing the inquiry release key turns it off. Operating the inquiry cancel key can also turn off the request light.

Proceed: This green light turns on when the input synchronizer is free and can accept the inquiry request message. The light turns off when either the release or the cancel key is operated.

Check: This red light indicates the detection of a parity error in the inquiry unit, during an inquiry request or inquiry reply operation. Operating the cancel key on the inquiry unit turns off this light.

Exceed Speed: This red light turns on when the maximum inquiry request keying rate (about 12½ characters per second) is exceeded. Operating the cancel key on the inquiry unit turns off this light.

Forms: This red light, when lit, indicates that the inquiry unit is out of forms; however, several more lines can be printed before the forms clear the platen. Inserting more forms turns the light off.

This section is concerned with the actual physical steps necessary to perform individual operations such as reading data from a card reader, punching cards, reading tape, and so forth. In figures, depressed entry keys are shown shaded. For all descriptions, power is assumed to be at an operating level, and all registers, counters, indicators, etc., to be in an initial or starting condition. Depression of a key in a column resets any other key previously depressed in that column.

Loading Card Data — 1402

Cards to be read into the system are placed in the card read hopper 9-edge first, face down, and the card hopper weight is placed on top of the cards. The sequence of operations then is:

1. Depress the *end-of-file* key on the reader. This key insures that the last card in the hopper will be read after preceding cards have been processed. If this key is not depressed, the *start* key will have to be depressed when the hopper becomes empty in order to read the last cards. Another way to accomplish reading of the last card is to place three blank cards at the end of the card deck being read.

2. The card reader *start* key is depressed. When depressed, the data recorded in the first card is read into the 1414 buffer.

3. A *read select* instruction, addressing the proper data channel and card reader, is set up in the *entry keys* (Figure 47) and the console *load* key is depressed.

The select instruction (assume 1402 on Channel A and reading column binary cards) for the PRD is −176203001230; the RDS format is +076203001230. The octal representation of the information is used.

4. With the console *automatic* key on, depression of the console *load* key automatically generates an IORD

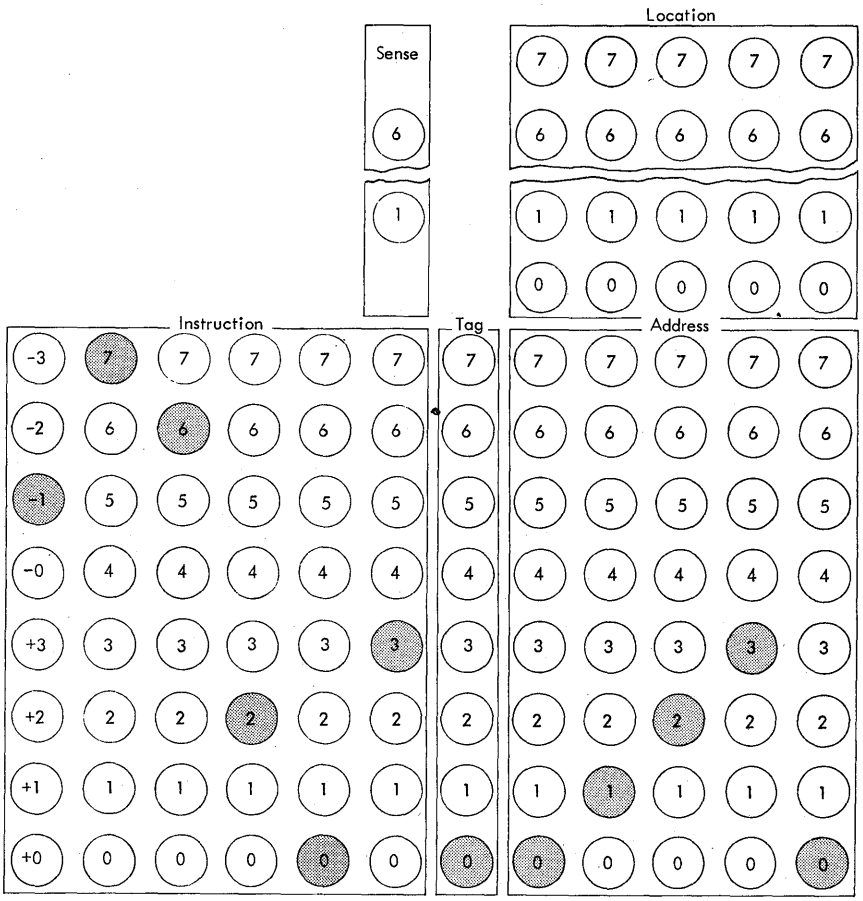


Figure 47. Read Select Card Reader Format

command with a maximum word count and a starting address of 00100. This command is loaded into the channel control registers.

5. The first data word from the first card is therefore placed in core location 00100, the second word into location 00101, and so on until all data from that card have been placed in core storage. Since each card is treated as a record, the channel-in-use indicator (turned on when the read select instruction was executed) is now turned off. Computer program control is automatically transferred to the instruction in core location 00101 (read from the first card) and this instruction is executed.

To provide for continued reading of cards, the data of the first card must be appropriate instructions to re-select the card reader, reset and load a channel command with proper word count and starting address, and all other necessary instructions needed to put all data of the cards into core storage and check the cards.

The same general procedure is used to load card data from the 1622 reader; however, the 1622 card reader *start* key is depressed because no end-of-file key is available on the 1622.

Loading Magnetic Tape Data

If data are to be loaded from magnetic tape instead of cards, the procedure is basically the same. The tape unit is first put in a ready state, with tape reel mounted, tape unit load and ready keys depressed, and the tape unit ready light on. The read select instruction octal format (assume tape unit 1 attached to data channel A, and data in BCD format) is +076200001201 (Figure 48). Operations are:

1. The read select instruction is set up in the *entry* keys and the console *load* key is pressed.

2. As before, an IORD command with a maximum word count and a starting address of 00100 is auto-

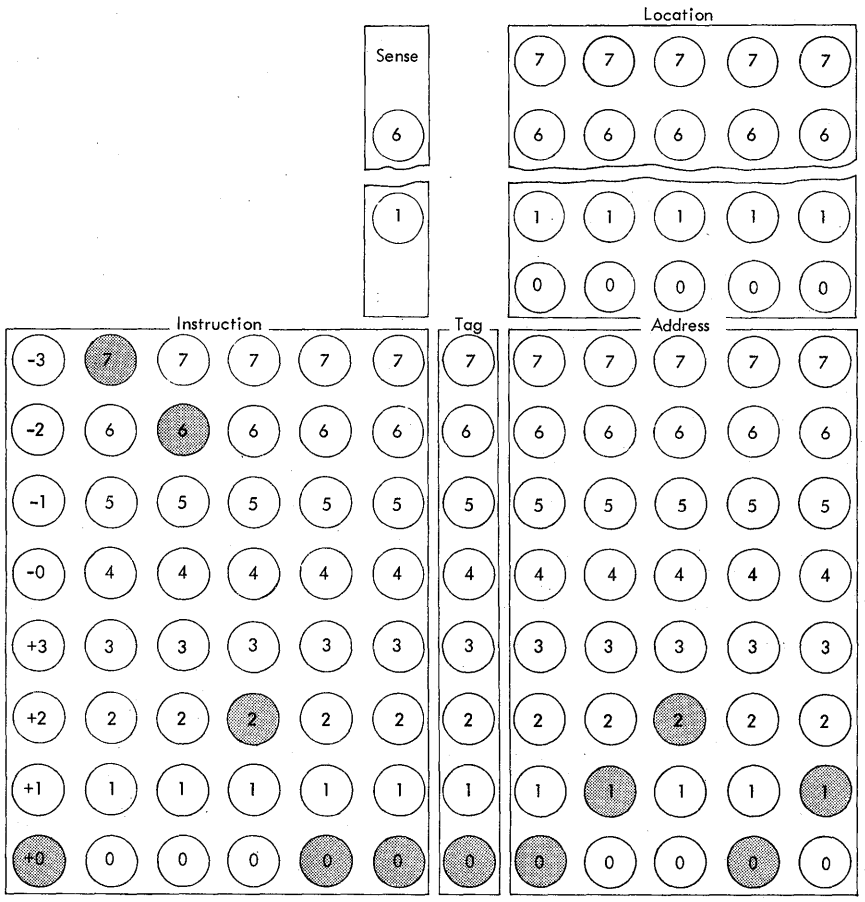


Figure 48. Read Select Tape Unit 1 Format

matically generated and loaded into the channel control registers.

3. The first data word from tape is read into core location 00100, the second word into location 00101, and so on until the end-of-record gap is sensed on the tape unit. The end-of-record signal turns the channel-in-use indicator off and transfers program control to the instruction in location 00101, which is then executed.

Loading Entry Key Data

The *enter storage* key may be used to put 36 bits of information into a particular storage location. Assume the bit configuration +010101010101 is to be inserted into core location 01753. Entry keys would be depressed as shown in Figure 49. With the CPU in manual status (*automatic* switch in *manual* position), depression of the *enter storage* key places the contents of the *entry key word bank* into the location specified by the *location bank entry keys.*

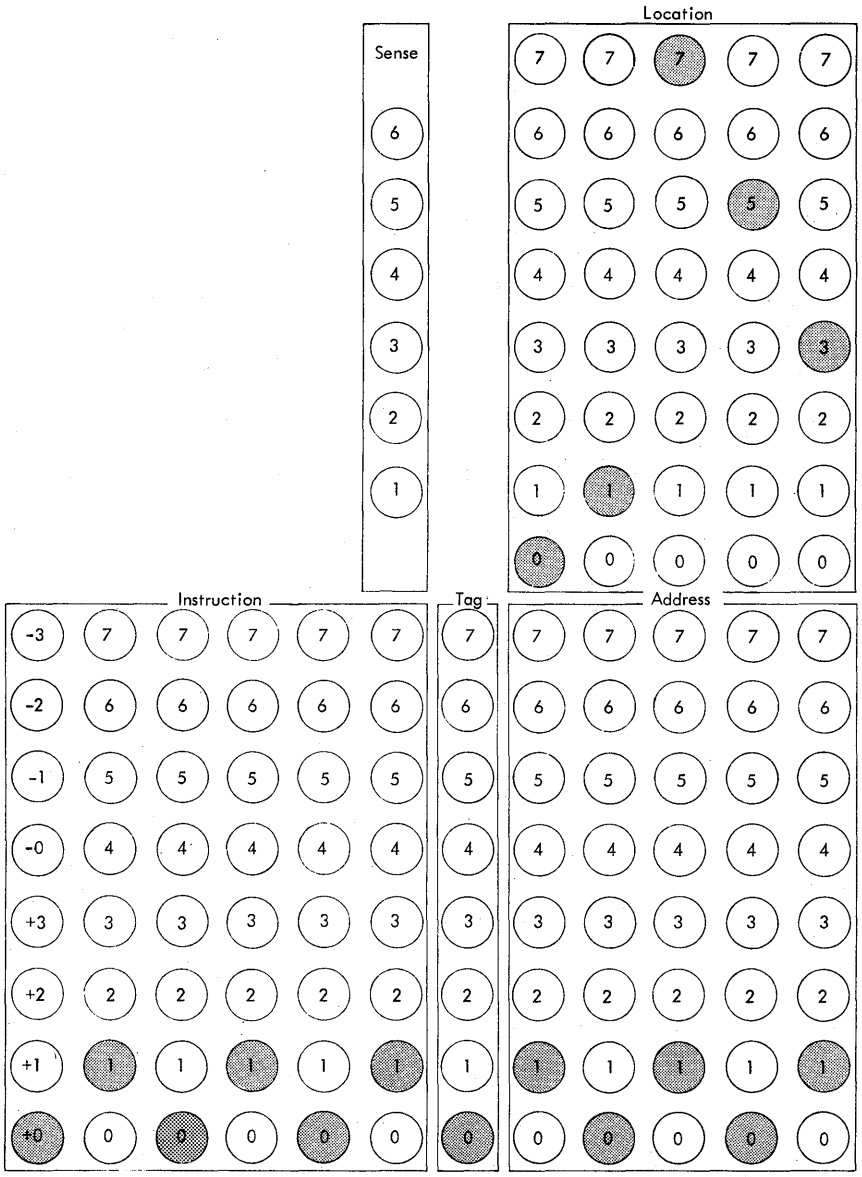


Figure 49. Enter Storage Format

The *enter instruction* key may be used to execute an instruction set up in the *entry keys* when the CPU is in manual status. For example, assume that a halt instruction has been executed, and a transfer to a subroutine located at 05000 is to be executed. The transfer instruction octal format is +002000005000 (Figure 50). This configuration is set up in the *entry keys* and, upon depression of the *enter instruction* key, the transfer instruction is executed. To execute the subroutine, the *automatic switch* must be returned to *automatic* and the console *start key* must be depressed.

Off-Line Operation

Both the IBM 1402 Card Read Punch and the IBM 1403 Printer may be used off-line when not being used by the computer. Thus, it is possible to perform a card-to-card or a card-to-printer operation without removing either unit from the system. With a card-to-card operation in off-line mode, the 1403 printer may be used by the computer in an on-line operation. The panel (Figure 51) of the 1414 I/O Synchronizer, to which the 1402 and 1403 are attached, contains the necessary switches and keys to perform the operations.

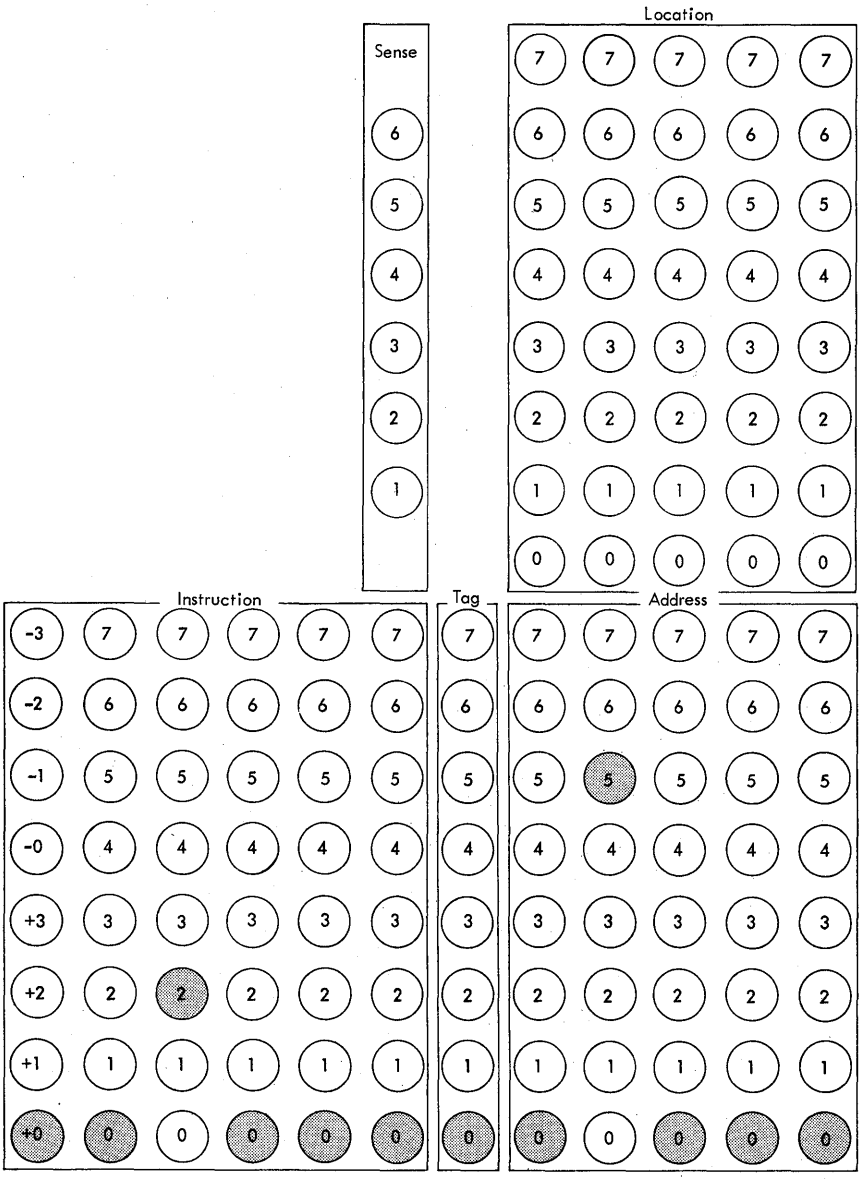


Figure 50. Instruction Entry Format

Synchronizer Keys and Switches

Off-Line Mode: This switch selects the type of off-line operation to be performed. It allows one or two units to be logically removed from the computer line without tying up the entire synchronizer. The switch is set to the normal position when all units are operating on-line. To perform a card-to-card operation the switch is set to the RD-PCH position. For a card-to-printer operation, the switch is set to the RD-PRT position.

Off-Line: This key removes the area selected by the off-line mode switch from computer control. Pressing this key also activates the 1414 power control on and off keys. When in the off-line mode, the key is lighted. When lighted, depression of this key returns the selected area to on-line operation (the off-line mode switch should also be returned to the normal position).

Check Stop: With on-line operation this switch is normally in the off position. When in the on position, the synchronizer is stopped after an operation during which an error was detected.

Space: This switch causes either single or double carriage spacing in the printer when it operates off-line.

Card-to-Card Off-Line

The card deck to be reproduced is placed in the read feed, and blank cards are placed in the punch feed of the 1402. The data from the first card fed through the read feed goes to the read buffer. From there, the record (data) is sent to the punch buffer, finally to be recorded in the first card through the punch feed.

Cards must be run-in to both read and punch feeds. This run-in causes the first card (read feed) to load into the read buffer. After run-in (both read and punch units ready), the 1414 switches and keys are set as follows:

SWITCH	SETTING	NOTES
Off-Line	On	
Off-Line Mode	Rd-Pch	Removes the reader and punch from computer control.
Check Stop	On	Stops the operation after the card in which an error occurs.
	Off	Allows errors to be ignored.

Card-To-Printer Off-Line

The card deck to be printed is placed in the read feed of the 1402. The data from the first card read goes to the read buffer. The contents of the read buffer are transferred to the print buffer and the line prints.

Cards are run-in to the 1402 read feed to load the first card into the read buffer. After the run-in is complete (and the printer is ready), the operation is set up as follows:

SWITCH	SETTING	NOTES
Off-Line	On	
Off Line Mode	Rd-Prt	Removes both the reader and the printer from computer control.
Check Stop	On	Stops the operation after the card in which an error occurs.
	Off	Ignores errors.
Space	Single	Causes a single space before each print line.
	Double	Causes a double space before each print line.

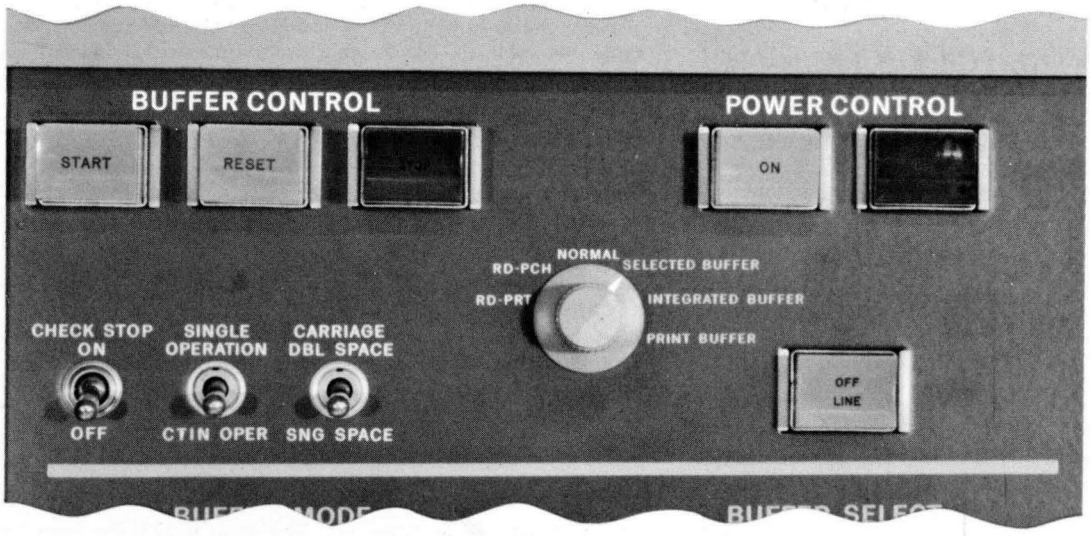


Figure 51. 1414 Panel

Appendix A. Instructions

Instructions for the 7040 and 7044 systems are offered in several options to satisfy different performance requirements. The basic set has been carefully selected to satisfactorily operate a low-compute requirement system application. The extended performance option enhances the computing and compiling ability by providing automatic indexing and logic, and character-handling operations. The single-precision floating-point option significantly improves performance on large number calculations and the double-precision floating-point option provides higher accuracy.

Indirect addressing ability is provided for all appropriate instructions, using the same method as with IBM 7090 and 7094 systems.

When the execution time of an instruction is variable, an instruction type number is included in the following instruction lists. To obtain the execution times in microseconds, multiply the number of cycles by the appropriate cycle time (2.0 or 8.0 microseconds). Both an alphabetic instruction list by option and a complete alphabetic list are included. The complete alphabetic list also indicates which central processing unit, data channel, and device indicators are set by execution of the instruction. For a detailed description of how the indicators are set, refer to the individual instruction description.

Instruction Types

7040	7044
Type 1 — ALS, ARS, LGL, LGR, LLS, LRS, and RQL	
These instructions are executed in 1 cycle if the extent of the shift is six places or less. Each additional six-place shift or portion thereof requires ⅓ cycle.	These instructions are executed in 2 cycles if the extent of the shift is six places or less. Each additional six-place shift or portion thereof requires 1 cycle.
Type 2 — DVP	
This instruction is executed in 7⅔ cycles unless a divide check occurs, in which case it requires 2 cycles.	This instruction is executed in 20 cycles unless a divide check occurs, in which case it requires 3 cycles.
Type 3 — MPY	
This instruction is executed in 4 cycles if the MQ contains two or fewer ones. Each additional 6 ones or portion thereof in the MQ requires ⅓ cycle. If the content of Y is zero, the instruction is completed in 2 cycles.	This instruction is executed in 9 cycles if the MQ contains two or fewer ones. Each additional 6 ones or portion thereof in the MQ requires 1 cycle. If the content of Y is zero, the instruction is completed in 3 cycles.
Type 4 — VDP	
This instruction is executed in 2 cycles if the count is zero or one. Each additional two quotient positions or portion thereof requires ⅓ cycle.	This instruction is executed in 2 cycles if the count is zero. It requires 3 cycles if the count is one. Each additional two quotient positions or portion thereof requires 1 cycle.
Type 5 — VLM	
This instruction is executed in 2 cycles if the count is zero or one or if the content of Y is zero. Each additional six steps or portion thereof requires ⅓ cycle. To determine the number of additional steps: add the number of zeros to twice the number of ones in the low-order C bits of the MQ; then subtract one.	This instruction is executed in 2 cycles if the count is zero. It requires 3 cycles if the count is one or if the content of Y is zero. Each additional six steps or portion thereof requires 1 cycle. To determine the number of additional steps: add the number of zeros to twice the number of ones in the low-order C bits of the MQ; then subtract one.
Type 6 — FAD and FSB	
These instructions are executed in a minimum of 2⅓ cycles and a maximum of 8⅔ cycles. In determining average speed, a number of representative programs were traced. The times shown are based on an analysis of several million operands. Execution times greater than 2⅓ cycles are a result of shifting to equalize exponents before adding and to normalize the result after adding. Shifting requires ⅓ cycle for each six places or portion thereof.	These instructions are executed in a minimum of 4 cycles and a maximum of 23 cycles. In determining average speed, a number of representative programs were traced. The times shown are based on an analysis of several million operands. Execution times greater than 4 cycles are a result of shifting to equalize exponents before adding and to normalize the result after adding. Shifting requires one cycle for each six places or portion thereof.
Type 7 — FDP	
This instruction is executed in 7 cycles unless a divide check occurs, in which case it requires 2 cycles.	This instruction is executed in 18 cycles unless a divide check occurs, in which case it requires only 3 cycles.
Type 8 — FMP and UFM	
These instructions are executed in a minimum of 3⅔ cycles and a maximum of 5 cycles. If C(MQ) fraction is zero, it requires only 2 cycles.	These instructions are executed in a minimum of 8 cycles and a maximum of 12 cycles. If C(MQ) fraction is zero, it requires only 2 cycles.
Type 9 — UFA and UFS	
Execution time is the same as for type 6, except maximum is 6⅓ cycles due to un-normalized operation.	Execution time is the same as for type 6, except maximum is 16 cycles due to un-normalized operation.

7040	7044
Type 10 — DFAD, DFSB	
These instructions are executed in a minimum of 4 cycles and a maximum of 11 cycles. The longer times are a result of shifting, as explained in Type 6.	These instructions are executed in a minimum of 7 cycles and a maximum of 28 cycles. The longer times are a result of shifting, as explained in Type 6.
Type 11 — DFMP	
This instruction is executed in a maximum of 13⅔ cycles. If C(AC) and C(MQ) are zero, the instruction requires 3 cycles.	This instruction is executed in a maximum of 36 cycles. If C(AC) and C(MQ) are zero, the instruction requires 3 cycles.
Type 12 — DFDP	
This instruction is executed in a maximum of 18⅓ cycles, and a minimum of 17 cycles. If a divide check occurs, this instruction may require as few as 3 cycles.	This instruction is executed in a maximum of 50 cycles, and a minimum of 46 cycles. If a divide check occurs, this instruction may require as few as 4 cycles.
Type 13 — BSR, ETT, PRD, PWR, RDS, REW, RUN, SEN, WBT, WEF, and WRS	
These instructions are executed in the times given if the channel is not busy and the device selected is ready and not busy. Otherwise, execution is delayed until these conditions do exist. If the channel is not busy and the on-line 1401 is selected, a programmed response is required from the 1401 before these instructions can complete execution.	These instructions are executed in the times given if the channel is not busy and the device selected is ready and not busy. Otherwise, execution is delayed until these conditions do exist. If the channel is not busy and the on-line 1401 is selected, a programmed response is required from the 1401 before these instructions can complete execution.
Type 14 — BSR, REW, RUN, and WEF	
These instructions complete execution in the times given, but the channel remains busy for the duration of the backspace or write end of file. The channel is busy on rewind instructions only long enough to pick relays in the tape unit.	These instructions complete execution in the times given, but the channel remains busy for the duration of the backspace or write end of file. The channel is busy on rewind instructions only long enough to pick relays in the tape unit.
Type 15 — VMA	
This instruction is executed in 2 cycles if the count is zero or one. Each additional 6 steps or portion thereof requires 1/3 cycle. To determine the number of additional steps add the number of "zeros" to twice the number of "ones" in the low order C bits of the MQ, then subtract one.	This instruction is executed in 2 cycles if the count is zero. Three cycles are required if the count is one. Each additional 6 steps or portion thereof requires 1 cycle. To determine the number of additional steps add the number of "zeros" to twice the number of "ones" in the low order C bits of the MQ, then subtract one.

Alphabetic Instruction List — By Option

INST	OP CODE	AVERAGE CYCLES 7040	AVERAGE CYCLES 7044	TYPE
Basic Instruction Set				
ACL	+0361	2	2	
ADD	+0400	2	2	
ALS	+0767	2	4	1
ANA	−0320	2	2	
ARS	+0771	2	4	1
CAL	−0500	2	2	
CAS	+0340	2	3	
CHS	+0760..002	1	2	
CLA	+0500	2	2	
CLS	+0502	2	2	
COM	+0760..006	1	2	
DCT	+0760..012	1	2	
DVP	+0221	7⅔	20	2
ENK	+0760..004	1	2	
HPR	+0420	1	2	
LAS	−0340	2	3	
LBT	+0760..001	1	2	
LDQ	+0560	2	2	
LGL	−0763	2	4	1
LGR	−0765	2	4	1
LLS	+0763	2	4	1
LRS	+0765	2	4	1
MPY	+0200	5	12	3
ORA	−0501	2	2	
PBT	−0760..001	1	2	
RQI	−0773	2	4	1
SLW	+0602	2	2	
SSP	+0760..003	1	2	
STA	+0621	3	3	
STD	+0622	3	3	
STL	−0625	3	3	
STO	+0601	2	2	
STQ	−0600	2	2	
STR	−1000	2	2	
STZ	+0600	2	2	
SUB	+0402	2	2	
SWT	+0760..16x	1	2	
TMI	−0120	1	1	
TNZ	−0100	1	1	
TOV	+0140	1	1	
TPL	+0120	1	1	
TRA	+0020	1	1	
TRP	−1165	1	1	
TRT	−1164	1	1	
TSL	−1627	3	3	
TZE	+0100	1	1	
VDP	+0225	5	10	4
VLM	+0204	4	9	5
VMA	−1204	—	—	15
XEC	+0522	1	1	
Extended Performance Set				
AXT	+0774	1	1	
CCS	−1341	2	3	
LAC	+0535	2	2	
LDC	−0535	2	2	
LXA	+0534	2	2	
LXD	−0534	2	2	
MIT	−1341	2	3	
MSM	−1623	3	3	
MSP	−1623	3	3	
PAC	+0737	1	2	
PAX	+0734	1	2	
PCS	−1505	2	2	
PDC	−0737	1	2	
PDX	−0734	1	2	

INST	OP CODE	AVERAGE CYCLES 7040	7044	TYPE
PLT	−1341	2	3	
PXA	+0754	1	2	
PXD	−0754	1	2	
SAC	−1623	3	3	
SXA	+0634	3	3	
SXD	−0634	3	3	
TIX	+2000	1	2	
TMT	−1704	1+2N	2+2N	
TNX	−2000	1	2	
TSX	+0074	1	2	
TXH	+3000	1	2	
TXI	+1000	1	2	
TXL	−3000	1	2	
Single-Precision Floating-Point Set				
FAD	+0300	3	5½	6
FDP	+0241	7	18	7
FMP	+0260	4½	10	8
FSB	+0302	3	5½	6
UFA	−0300	2⅔	5	9
UFM	−0260	4⅓	10	8
UFS	−0302	2⅔	5	9
Double-Precision Floating-Point Set				
DFAD	+0301	4½	8½	10
DFDP	−0241	17⅔	48	12
DFMP	+0261	12	31	11
DFSB	+0303	4½	8½	10
Memory Protect Set				
RPM	−1004	2	2	
SPM	−1160	1	1	
Direct Data Set				
PSLB	−0664	2	3	
PSLC	+0665	2	3	
PSLD	−0665	2	3	
PSLE	+0666	2	3	

INST	OP CODE	AVERAGE CYCLES 7040	7044	TYPE
SSLB	−0660	2	2	
SSLC	+0661	2	2	
SSLD	−0661	2	2	
SSLE	+0662	2	2	
Input/Output Instructions				
BSR	+0764	2	4	13, 14
CTR	−1766	1	2	
ENB	+0564	2	2	
ETT	−0760.x2xx	1	2	13
ICT	−1760 014	1	2	
IOT	+0760 005	1	2	
PRD	−1762	2	4	13
PWR	−1766	2	4	13
RCHA	+0540	2	2	
RCT	+0760 014	1	2	
RDC	+0760 x352	1	2	
RDS	+0762	2	4	13
REW	+0772	2	4	13, 14
RUN	−0772	2	4	13, 14
SCHA	+0640	2	2	
SEN	−1762	1	2	13
TCOA	+0060	1	2	
TDOA	−1060	1	2	
TEF	+0030	1	2	
TRC	+0022	1	2	
WBT	+0766	2	4	13
WEF	+0770	2	4	13, 14
WRS	+0766	2	4	13
1401 Option Instructions				
SLFA	−1760	1	2	
SLNA	−1760	1	2	

Appendix B. Instruction List — Alphabetic Order with Formats

Symbols used with the instruction formats are:

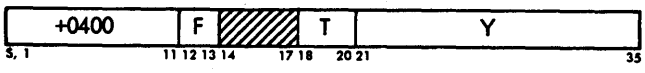
F	Indirect Addressing Flag Field
C	Count Field
I	Channel A I/O Device Adapter Field
S	Card Punch Stacker Select Character
B	I/O Device Busy Status Character
M	I/O Device Input/Output Buffer Select Character
T	Index Register Tag Field
Y	Operand Designation Field

Instructions are listed in alphabetic order without regard to optional features. An asterisk (*) following the instruction name designates an optional instruction. Operation codes are shown in octal notation.

MNEMONIC AND NAME

ACL—Add and Carry Logical Word

ADD—Add

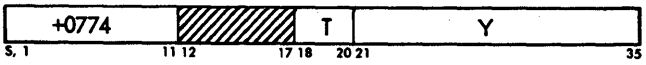


ALS—Accumulator Left Shift

ANA—And to Accumulator

ARS—Accumulator Right Shift

AXT—Address to Index True*

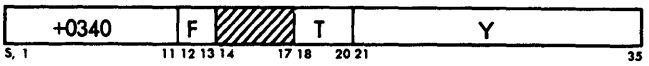


BSR—Backspace Record

CAL—Clear and Add Logical Word

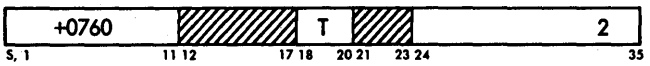
MNEMONIC AND NAME

CAS—Compare Accumulator with Storage



CCS—Compare Character with Storage*

CHS—Change Sign



CLA—Clear and Add

CLS—Clear and Subtract

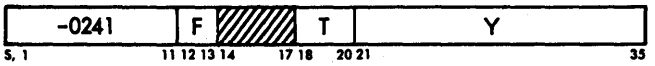
COM—Complement Magnitude

CTR—Control Select

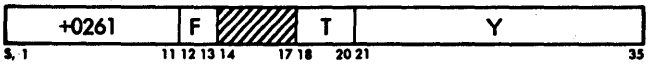
DCT—Divide Check Test

DFAD—Double Precision Floating Add*

DFDP—Double Precision Divide or Proceed*



DFMP—Double Precision Floating Multiply*



DFSB—Double Precision Floating Subtract*

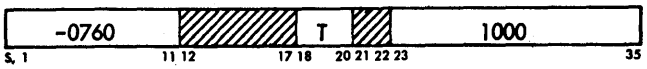
DVP—Divide or Proceed

MNEMONIC AND NAME

ENB—Enable from Y

ENK—Enter Keys

ETTA—End of Tape Test, Channel A



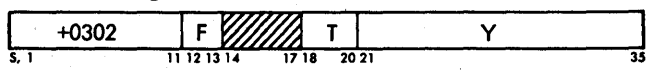
ETTB	− 0760	2000
ETTC	− 0760	3000
ETTD	− 0760	4000
ETTE	− 0760	5000

FAD—Floating Point Add*

FDP—Floating Divide or Proceed*

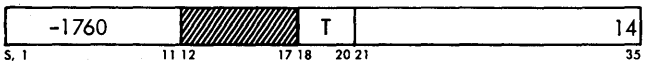
FMP—Floating Point Multiply*

FSB—Floating Point Subtract*



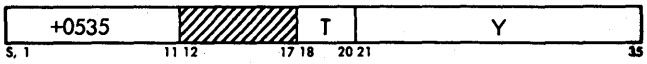
HPR—Halt and Proceed

ICT—Inhibit Channel Traps



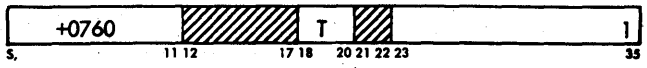
IOT—Input/Output Check Test

LAC—Load Complement of Address in Index*



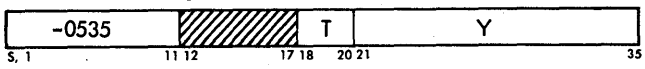
LAS—Logical Compare Accumulator with Storage

LBT—Low Bit Test

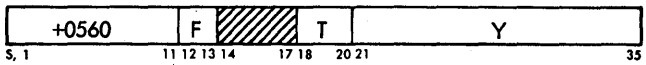


MNEMONIC AND NAME

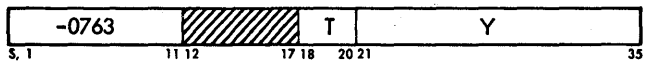
LDC—Load Complement of Decrement in Index*



LDQ—Load Multiplier-Quotient

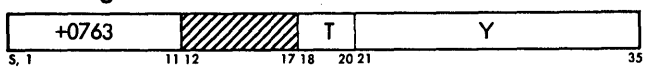


LGL—Logical Left Shift

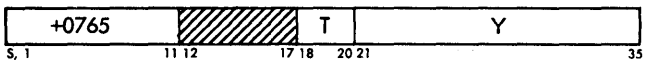


LGR—Logical Right Shift

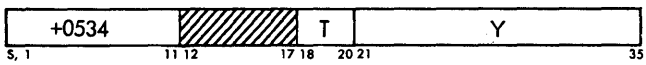
LLS—Long Left Shift



LRS—Long Right Shift

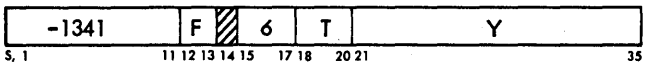


LXA—Load Index from Address*

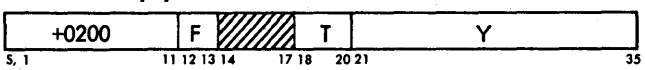


LXD—Load Index from Decrement*

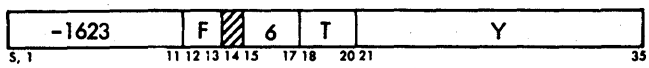
MIT—Storage Minus Test*



MPY—Multiply

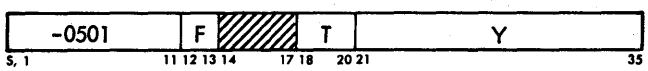


MSM—Make Storage Sign Minus*



MSP—Make Storage Sign Plus*

ORA—Or to Accumulator

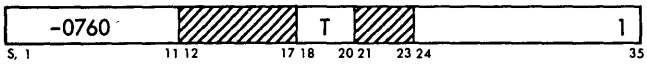


PAC—Place Complement of Index in Address*

MNEMONIC AND NAME

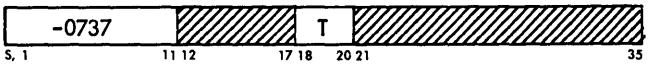
PAX—Place Address in Index*

PBT—P Bit Test

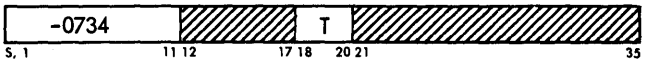


PCS—Place Character from Storage*

PDC—Place Complement of Decrement in Index*

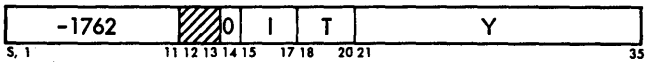


PDX—Place Decrement in Index*



PLT—Storage Plus Test*

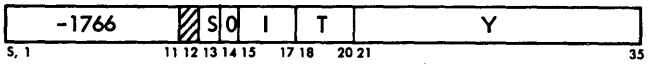
PRD—Prepare to Read



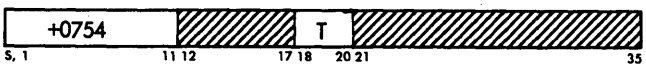
PSLB—Present Sense Lines, Channel B*

PSLC + 0665
PSLD − 0665
PSLE + 0666

PWR—Prepare to Write

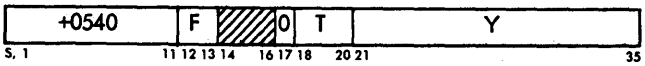


PXA—Place Index in Address*



PXD—Place Index in Decrement*

RCHA—Reset and Load Channel A



RCHB − 0540
RCHC + 0541
RCHD − 0541
RCHE + 0542

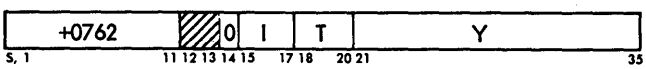
MNEMONIC AND NAME

RCT—Restore Channel Traps

RDCA—Reset Data Channel A

RDCB + 0760 2352
RDCC + 0760 3352
RDCD + 0760 4352
RDCE + 0760 5352

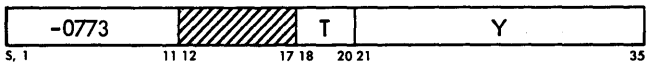
RDS—Read Select



REW—Rewind

RPM—Release Protect Mode*

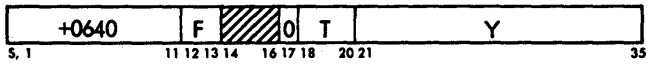
RQL—Rotate Quotient Left



RUN—Rewind and Unload

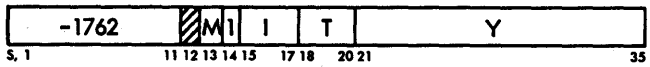
SAC—Store Accumulator Character*

SCHA—Store Channel A

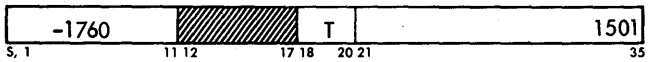


SCHB − 0640
SCHC + 0641
SCHD − 0641
SCHE + 0642

SEN—Sense Select



SLFA—Status Line Off, Channel A* **115**



MNEMONIC AND NAME

SLNA—Status Line On, Channel A* **115**

SLW—Store Logical Word

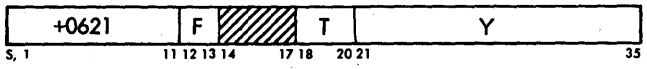
SPM—Set Protect Mode*

SSLB—Store Sense Lines, Channel B* **113**

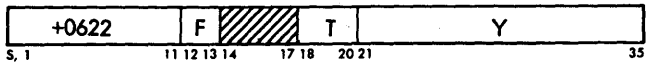
SSLC + 0661
SSLD − 0661
SSLE + 0662

SSP—Set Sign Plus

STA—Store Address



STD—Store Decrement



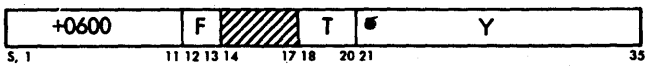
STL—Store Instruction Counter

STO—Store Accumulator

STQ—Store Multiplier-Quotient

STR—Store Location and Trap

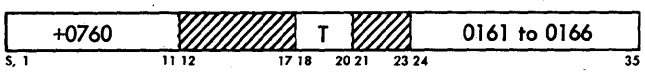
STZ—Store Zero



SUB—Subtract

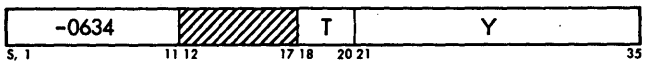
MNEMONIC AND NAME

SWT—Sense Switch Test

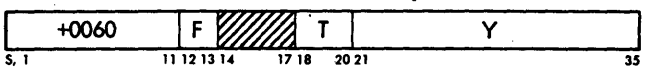


SXA—Store Index in Address*

SXD—Store Index in Decrement*



TCOA—Transfer on Channel A in Operation



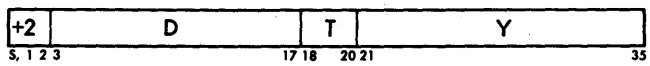
TCOB + 0061
TCOC + 0062
TCOD + 0063
TCOE + 0064

TDOA—Transfer on Device in Operation, Channel A

TEFA—Transfer on End of File, Channel A

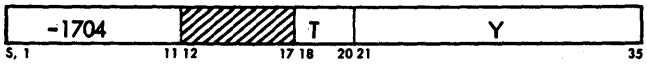
TEFB − 0030
TEFC + 0031
TEFD − 0031
TEFE + 0032

TIX—Transfer on Index*

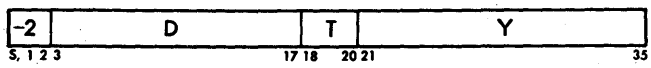


TMI—Transfer on Minus

TMT—Transmit*



TNX—Transfer on No Index*

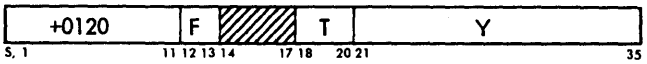


TNZ—Transfer on No Zero

TOV—Transfer on Overflow

MNEMONIC AND NAME

TPL—Transfer on Plus



TRA—Transfer

TRCA—Transfer on Redundancy Check, Channel A

TRCB — 0022
TRCC + 0024
TRCD — 0024
TRCE + 0026

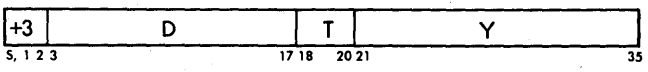
TRP—Transfer and Restore Parity and Traps

TRT—Transfer and Restore Traps

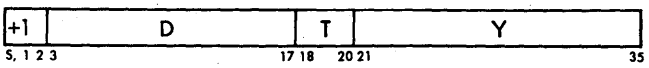
TSL—Transfer and Store Instruction Counter

TSX—Transfer and Set Index*

TXH—Transfer on Index High*



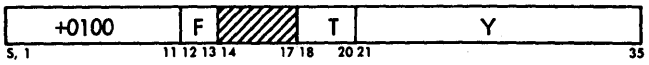
TXI—Transfer with Index Incremented*



TXL—Transfer on Index Low*

MNEMONIC AND NAME

TZE—Transfer on Zero



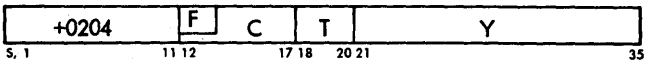
UFA—Unnormalized Floating Add*

UFM—Unnormalized Floating Multiply*

UFS—Unnormalized Floating Subtract*

VDP—Variable Divide or Proceed

VLM—Variable Length Multiply



VMA—Variable Length Multiply/Accumulate

WBT—Write Blank Tape

WEF—Write End of File

WRS—Write Select

XEC—Execute

Appendix C. Powers of Two Table

2^n	n	2^{-n}
1	0	1.0
2	1	0.5
4	2	0.25
8	3	0.125
16	4	0.062 5
32	5	0.031 25
64	6	0.015 625
128	7	0.007 812 5
256	8	0.003 906 25
512	9	0.001 953 125
1 024	10	0.000 976 562 5
2 048	11	0.000 488 281 25
4 096	12	0.000 244 140 625
8 192	13	0.000 122 070 312 5
16 384	14	0.000 061 035 156 25
32 768	15	0.000 030 517 578 125
65 536	16	0.000 015 258 789 062 5
131 072	17	0.000 007 629 394 531 25
262 144	18	0.000 003 814 697 265 625
524 288	19	0.000 001 907 348 632 812 5
1 048 576	20	0.000 000 953 674 316 406 25
2 097 152	21	0.000 000 476 837 158 203 125
4 194 304	22	0.000 000 238 418 579 101 562 5
8 388 608	23	0.000 000 119 209 289 550 781 25
16 777 216	24	0.000 000 059 604 644 775 390 625
33 554 432	25	0.000 000 029 802 322 387 695 312 5
67 108 864	26	0.000 000 014 901 161 193 847 656 25
134 217 728	27	0.000 000 007 450 580 596 923 828 125
268 435 456	28	0.000 000 003 725 290 298 461 914 062 5
536 870 912	29	0.000 000 001 862 645 149 230 957 031 25
1 073 741 824	30	0.000 000 000 931 322 574 615 478 515 625
2 147 483 648	31	0.000 000 000 465 661 287 307 739 257 812 5
4 294 967 296	32	0.000 000 000 232 830 643 653 869 628 906 25
8 589 934 592	33	0.000 000 000 116 415 321 826 934 814 453 125
17 179 869 184	34	0.000 000 000 058 207 660 913 467 407 226 562 5
34 359 738 368	35	0.000 000 000 029 103 830 456 733 703 613 281 25
68 719 476 736	36	0.000 000 000 014 551 915 228 366 851 806 640 625
137 438 953 472	37	0.000 000 000 007 275 957 614 183 425 903 320 312 5
274 877 906 944	38	0.000 000 000 003 637 978 807 091 712 951 660 156 25
549 755 813 888	39	0.000 000 000 001 818 989 403 545 856 475 830 078 125

Appendix D. Octal-Decimal Integer Conversion Table

0000 to 0777 (Octal)	0000 to 0511 (Decimal)

Octal	Decimal
10000 -	4096
20000 -	8192
30000 -	12288
40000 -	16384
50000 -	20480
60000 -	24576
70000 -	28672

	0	1	2	3	4	5	6	7
0000	0000	0001	0002	0003	0004	0005	0006	0007
0010	0008	0009	0010	0011	0012	0013	0014	0015
0020	0016	0017	0018	0019	0020	0021	0022	0023
0030	0024	0025	0026	0027	0028	0029	0030	0031
0040	0032	0033	0034	0035	0036	0037	0038	0039
0050	0040	0041	0042	0043	0044	0045	0046	0047
0060	0048	0049	0050	0051	0052	0053	0054	0055
0070	0056	0057	0058	0059	0060	0061	0062	0063
0100	0064	0065	0066	0067	0068	0069	0070	0071
0110	0072	0073	0074	0075	0076	0077	0078	0079
0120	0080	0081	0082	0083	0084	0085	0086	0087
0130	0088	0089	0090	0091	0092	0093	0094	0095
0140	0096	0097	0098	0099	0100	0101	0102	0103
0150	0104	0105	0106	0107	0108	0109	0110	0111
0160	0112	0113	0114	0115	0116	0117	0118	0119
0170	0120	0121	0122	0123	0124	0125	0126	0127
0200	0128	0129	0130	0131	0132	0133	0134	0135
0210	0136	0137	0138	0139	0140	0141	0142	0143
0220	0144	0145	0146	0147	0148	0149	0150	0151
0230	0152	0153	0154	0155	0156	0157	0158	0159
0240	0160	0161	0162	0163	0164	0165	0166	0167
0250	0168	0169	0170	0171	0172	0173	0174	0175
0260	0176	0177	0178	0179	0180	0181	0182	0183
0270	0184	0185	0186	0187	0188	0189	0190	0191
0300	0192	0193	0194	0195	0196	0197	0198	0199
0310	0200	0201	0202	0203	0204	0205	0206	0207
0320	0208	0209	0210	0211	0212	0213	0214	0215
0330	0216	0217	0218	0219	0220	0221	0222	0223
0340	0224	0225	0226	0227	0228	0229	0230	0231
0350	0232	0233	0234	0235	0236	0237	0238	0239
0360	0240	0241	0242	0243	0244	0245	0246	0247
0370	0248	0249	0250	0251	0252	0253	0254	0255

	0	1	2	3	4	5	6	7
0400	0256	0257	0258	0259	0260	0261	0262	0263
0410	0264	0265	0266	0267	0268	0269	0270	0271
0420	0272	0273	0274	0275	0276	0277	0278	0279
0430	0280	0281	0282	0283	0284	0285	0286	0287
0440	0288	0289	0290	0291	0292	0293	0294	0295
0450	0296	0297	0298	0299	0300	0301	0302	0303
0460	0304	0305	0306	0307	0308	0309	0310	0311
0470	0312	0313	0314	0315	0316	0317	0318	0319
0500	0320	0321	0322	0323	0324	0325	0326	0327
0510	0328	0329	0330	0331	0332	0333	0334	0335
0520	0336	0337	0338	0339	0340	0341	0342	0343
0530	0344	0345	0346	0347	0348	0349	0350	0351
0540	0352	0353	0354	0355	0356	0357	0358	0359
0550	0360	0361	0362	0363	0364	0365	0366	0367
0560	0368	0369	0370	0371	0372	0373	0374	0375
0570	0376	0377	0378	0379	0380	0381	0382	0383
0600	0384	0385	0386	0387	0388	0389	0390	0391
0610	0392	0393	0394	0395	0396	0397	0398	0399
0620	0400	0401	0402	0403	0404	0405	0406	0407
0630	0408	0409	0410	0411	0412	0413	0414	0415
0640	0416	0417	0418	0419	0420	0421	0422	0423
0650	0424	0425	0426	0427	0428	0429	0430	0431
0660	0432	0433	0434	0435	0436	0437	0438	0439
0670	0440	0441	0442	0443	0444	0445	0446	0447
0700	0448	0449	0450	0451	0452	0453	0454	0455
0710	0456	0457	0458	0459	0460	0461	0462	0463
0720	0464	0465	0466	0467	0468	0469	0470	0471
0730	0472	0473	0474	0475	0476	0477	0478	0479
0740	0480	0481	0482	0483	0484	0485	0486	0487
0750	0488	0489	0490	0491	0492	0493	0494	0495
0760	0496	0497	0498	0499	0500	0501	0502	0503
0770	0504	0505	0506	0507	0508	0509	0510	0511

1000 to 1777 (Octal)	0512 to 1023 (Decimal)

	0	1	2	3	4	5	6	7
1000	0512	0513	0514	0515	0516	0517	0518	0519
1010	0520	0521	0522	0523	0524	0525	0526	0527
1020	0528	0529	0530	0531	0532	0533	0534	0535
1030	0536	0537	0538	0539	0540	0541	0542	0543
1040	0544	0545	0546	0547	0548	0549	0550	0551
1050	0552	0553	0554	0555	0556	0557	0558	0559
1060	0560	0561	0562	0563	0564	0565	0566	0567
1070	0568	0569	0570	0571	0572	0573	0574	0575
1100	0576	0577	0578	0579	0580	0581	0582	0583
1110	0584	0585	0586	0587	0588	0589	0590	0591
1120	0592	0593	0594	0595	0596	0597	0598	0599
1130	0600	0601	0602	0603	0604	0605	0606	0607
1140	0608	0609	0610	0611	0612	0613	0614	0615
1150	0616	0617	0618	0619	0620	0621	0622	0623
1160	0624	0625	0626	0627	0628	0629	0630	0631
1170	0632	0633	0634	0635	0636	0637	0638	0639
1200	0640	0641	0642	0643	0644	0645	0646	0647
1210	0648	0649	0650	0651	0652	0653	0654	0655
1220	0656	0657	0658	0659	0660	0661	0662	0663
1230	0664	0665	0666	0667	0668	0669	0670	0671
1240	0672	0673	0674	0675	0676	0677	0678	0679
1250	0680	0681	0682	0683	0684	0685	0686	0687
1260	0688	0689	0690	0691	0692	0693	0694	0695
1270	0696	0697	0698	0699	0700	0701	0702	0703
1300	0704	0705	0706	0707	0708	0709	0710	0711
1310	0712	0713	0714	0715	0716	0717	0718	0719
1320	0720	0721	0722	0723	0724	0725	0726	0727
1330	0728	0729	0730	0731	0732	0733	0734	0735
1340	0736	0737	0738	0739	0740	0741	0742	0743
1350	0744	0745	0746	0747	0748	0749	0750	0751
1360	0752	0753	0754	0755	0756	0757	0758	0759
1370	0760	0761	0762	0763	0764	0765	0766	0767

	0	1	2	3	4	5	6	7
1400	0768	0769	0770	0771	0772	0773	0774	0775
1410	0776	0777	0778	0779	0780	0781	0782	0783
1420	0784	0785	0786	0787	0788	0789	0790	0791
1430	0792	0793	0794	0795	0796	0797	0798	0799
1440	0800	0801	0802	0803	0804	0805	0806	0807
1450	0808	0809	0810	0811	0812	0813	0814	0815
1460	0816	0817	0818	0819	0820	0821	0822	0823
1470	0824	0825	0826	0827	0828	0829	0830	0831
1500	0832	0833	0834	0835	0836	0837	0838	0839
1510	0840	0841	0842	0843	0844	0845	0846	0847
1520	0848	0849	0850	0851	0852	0853	0854	0855
1530	0856	0857	0858	0859	0860	0861	0862	0863
1540	0864	0865	0866	0867	0868	0869	0870	0871
1550	0872	0873	0874	0875	0876	0877	0878	0879
1560	0880	0881	0882	0883	0884	0885	0886	0887
1570	0888	0889	0890	0891	0892	0893	0894	0895
1600	0896	0897	0898	0899	0900	0901	0902	0903
1610	0904	0905	0906	0907	0908	0909	0910	0911
1620	0912	0913	0914	0915	0916	0917	0918	0919
1630	0920	0921	0922	0923	0924	0925	0926	0927
1640	0928	0929	0930	0931	0932	0933	0934	0935
1650	0936	0937	0938	0939	0940	0941	0942	0943
1660	0944	0945	0946	0947	0948	0949	0950	0951
1670	0952	0953	0954	0955	0956	0957	0958	0959
1700	0960	0961	0962	0963	0964	0965	0966	0967
1710	0968	0969	0970	0971	0972	0973	0974	0975
1720	0976	0977	0978	0979	0980	0981	0982	0983
1730	0984	0985	0986	0987	0988	0989	0990	0991
1740	0992	0993	0994	0995	0996	0997	0998	0999
1750	1000	1001	1002	1003	1004	1005	1006	1007
1760	1008	1009	1010	1011	1012	1013	1014	1015
1770	1016	1017	1018	1019	1020	1021	1022	1023

Octal-Decimal Integer Conversion Table

	0	1	2	3	4	5	6	7
2000	1024	1025	1026	1027	1028	1029	1030	1031
2010	1032	1033	1034	1035	1036	1037	1038	1039
2020	1040	1041	1042	1043	1044	1045	1046	1047
2030	1048	1049	1050	1051	1052	1053	1054	1055
2040	1056	1057	1058	1059	1060	1061	1062	1063
2050	1064	1065	1066	1067	1068	1069	1070	1071
2060	1072	1073	1074	1075	1076	1077	1078	1079
2070	1080	1081	1082	1083	1084	1085	1086	1087
2100	1088	1089	1090	1091	1092	1093	1094	1095
2110	1096	1097	1098	1099	1100	1101	1102	1103
2120	1104	1105	1106	1107	1108	1109	1110	1111
2130	1112	1113	1114	1115	1116	1117	1118	1119
2140	1120	1121	1122	1123	1124	1125	1126	1127
2150	1128	1129	1130	1131	1132	1133	1134	1135
2160	1136	1137	1138	1139	1140	1141	1142	1143
2170	1144	1145	1146	1147	1148	1149	1150	1151
2200	1152	1153	1154	1155	1156	1157	1158	1159
2210	1160	1161	1162	1163	1164	1165	1166	1167
2220	1168	1169	1170	1171	1172	1173	1174	1175
2230	1176	1177	1178	1179	1180	1181	1182	1183
2240	1184	1185	1186	1187	1188	1189	1190	1191
2250	1192	1193	1194	1195	1196	1197	1198	1199
2260	1200	1201	1202	1203	1204	1205	1206	1207
2270	1208	1209	1210	1211	1212	1213	1214	1215
2300	1216	1217	1218	1219	1220	1221	1222	1223
2310	1224	1225	1226	1227	1228	1229	1230	1231
2320	1232	1233	1234	1235	1236	1237	1238	1239
2330	1240	1241	1242	1243	1244	1245	1246	1247
2340	1248	1249	1250	1251	1252	1253	1254	1255
2350	1256	1257	1258	1259	1260	1261	1262	1263
2360	1264	1265	1266	1267	1268	1269	1270	1271
2370	1272	1273	1274	1275	1276	1277	1278	1279

	0	1	2	3	4	5	6	7
2400	1280	1281	1282	1283	1284	1285	1286	1287
2410	1288	1289	1290	1291	1292	1293	1294	1295
2420	1296	1297	1298	1299	1300	1301	1302	1303
2430	1304	1305	1306	1307	1308	1309	1310	1311
2440	1312	1313	1314	1315	1316	1317	1318	1319
2450	1320	1321	1322	1323	1324	1325	1326	1327
2460	1328	1329	1330	1331	1332	1333	1334	1335
2470	1336	1337	1338	1339	1340	1341	1342	1343
2500	1344	1345	1346	1347	1348	1349	1350	1351
2510	1352	1353	1354	1355	1356	1357	1358	1359
2520	1360	1361	1362	1363	1364	1365	1366	1367
2530	1368	1369	1370	1371	1372	1373	1374	1375
2540	1376	1377	1378	1379	1380	1381	1382	1383
2550	1384	1385	1386	1387	1388	1389	1390	1391
2560	1392	1393	1394	1395	1396	1397	1398	1399
2570	1400	1401	1402	1403	1404	1405	1406	1407
2600	1408	1409	1410	1411	1412	1413	1414	1415
2610	1416	1417	1418	1419	1420	1421	1422	1423
2620	1424	1425	1426	1427	1428	1429	1430	1431
2630	1432	1433	1434	1435	1436	1437	1438	1439
2640	1440	1441	1442	1443	1444	1445	1446	1447
2650	1448	1449	1450	1451	1452	1453	1454	1455
2660	1456	1457	1458	1459	1460	1461	1462	1463
2670	1464	1465	1466	1467	1468	1469	1470	1471
2700	1472	1473	1474	1475	1476	1477	1478	1479
2710	1480	1481	1482	1483	1484	1485	1486	1487
2720	1488	1489	1490	1491	1492	1493	1494	1495
2730	1496	1497	1498	1499	1500	1501	1502	1503
2740	1504	1505	1506	1507	1508	1509	1510	1511
2750	1512	1513	1514	1515	1516	1517	1518	1519
2760	1520	1521	1522	1523	1524	1525	1526	1527
2770	1528	1529	1530	1531	1532	1533	1534	1535

2000 to 2777 (Octal)	1024 to 1535 (Decimal)

Octal	Decimal
10000 -	4096
20000 -	8192
30000 -	12288
40000 -	16384
50000 -	20480
60000 -	24576
70000 -	28672

	0	1	2	3	4	5	6	7
3000	1536	1537	1538	1539	1540	1541	1542	1543
3010	1544	1545	1546	1547	1548	1549	1550	1551
3020	1552	1553	1554	1555	1556	1557	1558	1559
3030	1560	1561	1562	1563	1564	1565	1566	1567
3040	1568	1569	1570	1571	1572	1573	1574	1575
3050	1576	1577	1578	1579	1580	1581	1582	1583
3060	1584	1585	1586	1587	1588	1589	1590	1591
3070	1592	1593	1594	1595	1596	1597	1598	1599
3100	1600	1601	1602	1603	1604	1605	1606	1607
3110	1608	1609	1610	1611	1612	1613	1614	1615
3120	1616	1617	1618	1619	1620	1621	1622	1623
3130	1624	1625	1626	1627	1628	1629	1630	1631
3140	1632	1633	1634	1635	1636	1637	1638	1639
3150	1640	1641	1642	1643	1644	1645	1646	1647
3160	1648	1649	1650	1651	1652	1653	1654	1655
3170	1656	1657	1658	1659	1660	1661	1662	1663
3200	1664	1665	1666	1667	1668	1669	1670	1671
3210	1672	1673	1674	1675	1676	1677	1678	1679
3220	1680	1681	1682	1683	1684	1685	1686	1687
3230	1688	1689	1690	1691	1692	1693	1694	1695
3240	1696	1697	1698	1699	1700	1701	1702	1703
3250	1704	1705	1706	1707	1708	1709	1710	1711
3260	1712	1713	1714	1715	1716	1717	1718	1719
3270	1720	1721	1722	1723	1724	1725	1726	1727
3300	1728	1729	1730	1731	1732	1733	1734	1735
3310	1736	1737	1738	1739	1740	1741	1742	1743
3320	1744	1745	1746	1747	1748	1749	1750	1751
3330	1752	1753	1754	1755	1756	1757	1758	1759
3340	1760	1761	1762	1763	1764	1765	1766	1767
3350	1768	1769	1770	1771	1772	1773	1774	1775
3360	1776	1777	1778	1779	1780	1781	1782	1783
3370	1784	1785	1786	1787	1788	1789	1790	1791

	0	1	2	3	4	5	6	7
3400	1792	1793	1794	1795	1796	1797	1798	1799
3410	1800	1801	1802	1803	1804	1805	1806	1807
3420	1808	1809	1810	1811	1812	1813	1814	1815
3430	1816	1817	1818	1819	1820	1821	1822	1823
3440	1824	1825	1826	1827	1828	1829	1830	1831
3450	1832	1833	1834	1835	1836	1837	1838	1839
3460	1840	1841	1842	1843	1844	1845	1846	1847
3470	1848	1849	1850	1851	1852	1853	1854	1855
3500	1856	1857	1858	1859	1860	1861	1862	1863
3510	1864	1865	1866	1867	1868	1869	1870	1871
3520	1872	1873	1874	1875	1876	1877	1878	1879
3530	1880	1881	1882	1883	1884	1885	1886	1887
3540	1888	1889	1890	1891	1892	1893	1894	1895
3550	1896	1897	1898	1899	1900	1901	1902	1903
3560	1904	1905	1906	1907	1908	1909	1910	1911
3570	1912	1913	1914	1915	1916	1917	1918	1919
3600	1920	1921	1922	1923	1924	1925	1926	1927
3610	1928	1929	1930	1931	1932	1933	1934	1935
3620	1936	1937	1938	1939	1940	1941	1942	1943
3630	1944	1945	1946	1947	1948	1949	1950	1951
3640	1952	1953	1954	1955	1956	1957	1958	1959
3650	1960	1961	1962	1963	1964	1965	1966	1967
3660	1968	1969	1970	1971	1972	1973	1974	1975
3670	1976	1977	1978	1979	1980	1981	1982	1983
3700	1984	1985	1986	1987	1988	1989	1990	1991
3710	1992	1993	1994	1995	1996	1997	1998	1999
3720	2000	2001	2002	2003	2004	2005	2006	2007
3730	2008	2009	2010	2011	2012	2013	2014	2015
3740	2016	2017	2018	2019	2020	2021	2022	2023
3750	2024	2025	2026	2027	2028	2029	2030	2031
3760	2032	2033	2034	2035	2036	2037	2038	2039
3770	2040	2041	2042	2043	2044	2045	2046	2047

3000 to 3777 (Octal)	1536 to 2047 (Decimal)

4000	2048
to	to
4777	2559
(Octal)	(Decimal)

Octal	Decimal
10000 -	4096
20000 -	8192
30000 -	12288
40000 -	16384
50000 -	20480
60000 -	24576
70000 -	28672

	0	1	2	3	4	5	6	7
4000	2048	2049	2050	2051	2052	2053	2054	2055
4010	2056	2057	2058	2059	2060	2061	2062	2063
4020	2064	2065	2066	2067	2068	2069	2070	2071
4030	2072	2073	2074	2075	2076	2077	2078	2079
4040	2080	2081	2082	2083	2084	2085	2086	2087
4050	2088	2089	2090	2091	2092	2093	2094	2095
4060	2096	2097	2098	2099	2100	2101	2102	2103
4070	2104	2105	2106	2107	2108	2109	2110	2111
4100	2112	2113	2114	2115	2116	2117	2118	2119
4110	2120	2121	2122	2123	2124	2125	2126	2127
4120	2128	2129	2130	2131	2132	2133	2134	2135
4130	2136	2137	2138	2139	2140	2141	2142	2143
4140	2144	2145	2146	2147	2148	2149	2150	2151
4150	2152	2153	2154	2155	2156	2157	2158	2159
4160	2160	2161	2162	2163	2164	2165	2166	2167
4170	2168	2169	2170	2171	2172	2173	2174	2175
4200	2176	2177	2178	2179	2180	2181	2182	2183
4210	2184	2185	2186	2187	2188	2189	2190	2191
4220	2192	2193	2194	2195	2196	2197	2198	2199
4230	2200	2201	2202	2203	2204	2205	2206	2207
4240	2208	2209	2210	2211	2212	2213	2214	2215
4250	2216	2217	2218	2219	2220	2221	2222	2223
4260	2224	2225	2226	2227	2228	2229	2230	2231
4270	2232	2233	2234	2235	2236	2237	2238	2239
4300	2240	2241	2242	2243	2244	2245	2246	2247
4310	2248	2249	2250	2251	2252	2253	2254	2255
4320	2256	2257	2258	2259	2260	2261	2262	2263
4330	2264	2265	2266	2267	2268	2269	2270	2271
4340	2272	2273	2274	2275	2276	2277	2278	2279
4350	2280	2281	2282	2283	2284	2285	2286	2287
4360	2288	2289	2290	2291	2292	2293	2294	2295
4370	2296	2297	2298	2299	2300	2301	2302	2303

	0	1	2	3	4	5	6	7
4400	2304	2305	2306	2307	2308	2309	2310	2311
4410	2312	2313	2314	2315	2316	2317	2318	2319
4420	2320	2321	2322	2323	2324	2325	2326	2327
4430	2328	2329	2330	2331	2332	2333	2334	2335
4440	2336	2337	2338	2339	2340	2341	2342	2343
4450	2344	2345	2346	2347	2348	2349	2350	2351
4460	2352	2353	2354	2355	2356	2357	2358	2359
4470	2360	2361	2362	2363	2364	2365	2366	2367
4500	2368	2369	2370	2371	2372	2373	2374	2375
4510	2376	2377	2378	2379	2380	2381	2382	2383
4520	2384	2385	2386	2387	2388	2389	2390	2391
4530	2392	2393	2394	2395	2396	2397	2398	2399
4540	2400	2401	2402	2403	2404	2405	2406	2407
4550	2408	2409	2410	2411	2412	2413	2414	2415
4560	2416	2417	2418	2419	2420	2421	2422	2423
4570	2424	2425	2426	2427	2428	2429	2430	2431
4600	2432	2433	2434	2435	2436	2437	2438	2439
4610	2440	2441	2442	2443	2444	2445	2446	2447
4620	2448	2449	2450	2451	2452	2453	2454	2455
4630	2456	2457	2458	2459	2460	2461	2462	2463
4640	2464	2465	2466	2467	2468	2469	2470	2471
4650	2472	2473	2474	2475	2476	2477	2478	2479
4660	2480	2481	2482	2483	2484	2485	2486	2487
4670	2488	2489	2490	2491	2492	2493	2494	2495
4700	2496	2497	2498	2499	2500	2501	2502	2503
4710	2504	2505	2506	2507	2508	2509	2510	2511
4720	2512	2513	2514	2515	2516	2517	2518	2519
4730	2520	2521	2522	2523	2524	2525	2526	2527
4740	2528	2529	2530	2531	2532	2533	2534	2535
4750	2536	2537	2538	2539	2540	2541	2542	2543
4760	2544	2545	2546	2547	2548	2549	2550	2551
4770	2552	2553	2554	2555	2556	2557	2558	2559

5000	2560
to	to
5777	3071
(Octal)	(Decimal)

	0	1	2	3	4	5	6	7
5000	2560	2561	2562	2563	2564	2565	2566	2567
5010	2568	2569	2570	2571	2572	2573	2574	2575
5020	2576	2577	2578	2579	2580	2581	2582	2583
5030	2584	2585	2586	2587	2588	2589	2590	2591
5040	2592	2593	2594	2595	2596	2597	2598	2599
5050	2600	2601	2602	2603	2604	2605	2606	2607
5060	2608	2609	2610	2611	2612	2613	2614	2615
5070	2616	2617	2618	2619	2620	2621	2622	2623
5100	2624	2625	2626	2627	2628	2629	2630	2631
5110	2632	2633	2634	2635	2636	2637	2638	2639
5120	2640	2641	2642	2643	2644	2645	2646	2647
5130	2648	2649	2650	2651	2652	2653	2654	2655
5140	2656	2657	2658	2659	2660	2661	2662	2663
5150	2664	2665	2666	2667	2668	2669	2670	2671
5160	2672	2673	2674	2675	2676	2677	2678	2679
5170	2680	2681	2682	2683	2684	2685	2686	2687
5200	2688	2689	2690	2691	2692	2693	2694	2695
5210	2696	2697	2698	2699	2700	2701	2702	2703
5220	2704	2705	2706	2707	2708	2709	2710	2711
5230	2712	2713	2714	2715	2716	2717	2718	2719
5240	2720	2721	2722	2723	2724	2725	2726	2727
5250	2728	2729	2730	2731	2732	2733	2734	2735
5260	2736	2737	2738	2739	2740	2741	2742	2743
5270	2744	2745	2746	2747	2748	2749	2750	2751
5300	2752	2753	2754	2755	2756	2757	2758	2759
5310	2760	2761	2762	2763	2764	2765	2766	2767
5320	2768	2769	2770	2771	2772	2773	2774	2775
5330	2776	2777	2778	2779	2780	2781	2782	2783
5340	2784	2785	2786	2787	2788	2789	2790	2791
5350	2792	2793	2794	2795	2796	2797	2798	2799
5360	2800	2801	2802	2803	2804	2805	2806	2807
5370	2808	2809	2810	2811	2812	2813	2814	2815

	0	1	2	3	4	5	6	7
5400	2816	2817	2818	2819	2820	2821	2822	2823
5410	2824	2825	2826	2827	2828	2829	2830	2831
5420	2832	2833	2834	2835	2836	2837	2838	2839
5430	2840	2841	2842	2843	2844	2845	2846	2847
5440	2848	2849	2850	2851	2852	2853	2854	2855
5450	2856	2857	2858	2859	2860	2861	2862	2863
5460	2864	2865	2866	2867	2868	2869	2870	2871
5470	2872	2873	2874	2875	2876	2877	2878	2879
5500	2880	2881	2882	2883	2884	2885	2886	2887
5510	2888	2889	2890	2891	2892	2893	2894	2895
5520	2896	2897	2898	2899	2900	2901	2902	2903
5530	2904	2905	2906	2907	2908	2909	2910	2911
5540	2912	2913	2914	2915	2916	2917	2918	2919
5550	2920	2921	2922	2923	2924	2925	2926	2927
5560	2928	2929	2930	2931	2932	2933	2934	2935
5570	2936	2937	2938	2939	2940	2941	2942	2943
5600	2944	2945	2946	2947	2948	2949	2950	2951
5610	2952	2953	2954	2955	2956	2957	2958	2959
5620	2960	2961	2962	2963	2964	2965	2966	2967
5630	2968	2969	2970	2971	2972	2973	2974	2975
5640	2976	2977	2978	2979	2980	2981	2982	2983
5650	2984	2985	2986	2987	2988	2989	2990	2991
5660	2992	2993	2994	2995	2996	2997	2998	2999
5670	3000	3001	3002	3003	3004	3005	3006	3007
5700	3008	3009	3010	3011	3012	3013	3014	3015
5710	3016	3017	3018	3019	3020	3021	3022	3023
5720	3024	3025	3026	3027	3028	3029	3030	3031
5730	3032	3033	3034	3035	3036	3037	3038	3039
5740	3040	3041	3042	3043	3044	3045	3046	3047
5750	3048	3049	3050	3051	3052	3053	3054	3055
5760	3056	3057	3058	3059	3060	3061	3062	3063
5770	3064	3065	3066	3067	3068	3069	3070	3071

Octal-Decimal Integer Conversion Table

	0	1	2	3	4	5	6	7
6000	3072	3073	3074	3075	3076	3077	3078	3079
6010	3080	3081	3082	3083	3084	3085	3086	3087
6020	3088	3089	3090	3091	3092	3093	3094	3095
6030	3096	3097	3098	3099	3100	3101	3102	3103
6040	3104	3105	3106	3107	3108	3109	3110	3111
6050	3112	3113	3114	3115	3116	3117	3118	3119
6060	3120	3121	3122	3123	3124	3125	3126	3127
6070	3128	3129	3130	3131	3132	3133	3134	3135
6100	3136	3137	3138	3139	3140	3141	3142	3143
6110	3144	3145	3146	3147	3148	3149	3150	3151
6120	3152	3153	3154	3155	3156	3157	3158	3159
6130	3160	3161	3162	3163	3164	3165	3166	3167
6140	3168	3169	3170	3171	3172	3173	3174	3175
6150	3176	3177	3178	3179	3180	3181	3182	3183
6160	3184	3185	3186	3187	3188	3189	3190	3191
6170	3192	3193	3194	3195	3196	3197	3198	3199
6200	3200	3201	3202	3203	3204	3205	3206	3207
6210	3208	3209	3210	3211	3212	3213	3214	3215
6220	3216	3217	3218	3219	3220	3221	3222	3223
6230	3224	3225	3226	3227	3228	3229	3230	3231
6240	3232	3233	3234	3235	3236	3237	3238	3239
6250	3240	3241	3242	3243	3244	3245	3246	3247
6260	3248	3249	3250	3251	3252	3253	3254	3255
6270	3256	3257	3258	3259	3260	3261	3262	3263
6300	3264	3265	3266	3267	3268	3269	3270	3271
6310	3272	3273	3274	3275	3276	3277	3278	3279
6320	3280	3281	3282	3283	3284	3285	3286	3287
6330	3288	3289	3290	3291	3292	3293	3294	3295
6340	3296	3297	3298	3299	3300	3301	3302	3303
6350	3304	3305	3306	3307	3308	3309	3310	3311
6360	3312	3313	3314	3315	3316	3317	3318	3319
6370	3320	3321	3322	3323	3324	3325	3326	3327

	0	1	2	3	4	5	6	7
6400	3328	3329	3330	3331	3332	3333	3334	3335
6410	3336	3337	3338	3339	3340	3341	3342	3343
6420	3344	3345	3346	3347	3348	3349	3350	3351
6430	3352	3353	3354	3355	3356	3357	3358	3359
6440	3360	3361	3362	3363	3364	3365	3366	3367
6450	3368	3369	3370	3371	3372	3373	3374	3375
6460	3376	3377	3378	3379	3380	3381	3382	3383
6470	3384	3385	3386	3387	3388	3389	3390	3391
6500	3392	3393	3394	3395	3396	3397	3398	3399
6510	3400	3401	3402	3403	3404	3405	3406	3407
6520	3408	3409	3410	3411	3412	3413	3414	3415
6530	3416	3417	3418	3419	3420	3421	3422	3423
6540	3424	3425	3426	3427	3428	3429	3430	3431
6550	3432	3433	3434	3435	3436	3437	3438	3439
6560	3440	3441	3442	3443	3444	3445	3446	3447
6570	3448	3449	3450	3451	3452	3453	3454	3455
6600	3456	3457	3458	3459	3460	3461	3462	3463
6610	3464	3465	3466	3467	3468	3469	3470	3471
6620	3472	3473	3474	3475	3476	3477	3478	3479
6630	3480	3481	3482	3483	3484	3485	3486	3487
6640	3488	3489	3490	3491	3492	3493	3494	3495
6650	3496	3497	3498	3499	3500	3501	3502	3503
6660	3504	3505	3506	3507	3508	3509	3510	3511
6670	3512	3513	3514	3515	3516	3517	3518	3519
6700	3520	3521	3522	3523	3524	3525	3526	3527
6710	3528	3529	3530	3531	3532	3533	3534	3535
6720	3536	3537	3538	3539	3540	3541	3542	3543
6730	3544	3545	3546	3547	3548	3549	3550	3551
6740	3552	3553	3554	3555	3556	3557	3558	3559
6750	3560	3561	3562	3563	3564	3565	3566	3567
6760	3568	3569	3570	3571	3572	3573	3574	3575
6770	3576	3577	3578	3579	3580	3581	3582	3583

6000 to 6777 (Octal)	3072 to 3583 (Decimal)

Octal	Decimal
10000 -	4096
20000 -	8192
30000 -	12288
40000 -	16384
50000 -	20480
60000 -	24576
70000 -	28672

	0	1	2	3	4	5	6	7
7000	3584	3585	3586	3587	3588	3589	3590	3591
7010	3592	3593	3594	3595	3596	3597	3598	3599
7020	3600	3601	3602	3603	3604	3605	3606	3607
7030	3608	3609	3610	3611	3612	3613	3614	3615
7040	3616	3617	3618	3619	3620	3621	3622	3623
7050	3624	3625	3626	3627	3628	3629	3630	3631
7060	3632	3633	3634	3635	3636	3637	3638	3639
7070	3640	3641	3642	3643	3644	3645	3646	3647
7100	3648	3649	3650	3651	3652	3653	3654	3655
7110	3656	3657	3658	3659	3660	3661	3662	3663
7120	3664	3665	3666	3667	3668	3669	3670	3671
7130	3672	3673	3674	3675	3676	3677	3678	3679
7140	3680	3681	3682	3683	3684	3685	3686	3687
7150	3688	3689	3690	3691	3692	3693	3694	3695
7160	3696	3697	3698	3699	3700	3701	3702	3703
7170	3704	3705	3706	3707	3708	3709	3710	3711
7200	3712	3713	3714	3715	3716	3717	3718	3719
7210	3720	3721	3722	3723	3724	3725	3726	3727
7220	3728	3729	3730	3731	3732	3733	3734	3735
7230	3736	3737	3738	3739	3740	3741	3742	3743
7240	3744	3745	3746	3747	3748	3749	3750	3751
7250	3752	3753	3754	3755	3756	3757	3758	3759
7260	3760	3761	3762	3763	3764	3765	3766	3767
7270	3768	3769	3770	3771	3772	3773	3774	3775
7300	3776	3777	3778	3779	3780	3781	3782	3783
7310	3784	3785	3786	3787	3788	3789	3790	3791
7320	3792	3793	3794	3795	3796	3797	3798	3799
7330	3800	3801	3802	3803	3804	3805	3806	3807
7340	3808	3809	3810	3811	3812	3813	3814	3815
7350	3816	3817	3818	3819	3820	3821	3822	3823
7360	3824	3825	3826	3827	3828	3829	3830	3831
7370	3832	3833	3834	3835	3836	3837	3838	3839

	0	1	2	3	4	5	6	7
7400	3840	3841	3842	3843	3844	3845	3846	3847
7410	3848	3849	3850	3851	3852	3853	3854	3855
7420	3856	3857	3858	3859	3860	3861	3862	3863
7430	3864	3865	3866	3867	3868	3869	3870	3871
7440	3872	3873	3874	3875	3876	3877	3878	3879
7450	3880	3881	3882	3883	3884	3885	3886	3887
7460	3888	3889	3890	3891	3892	3893	3894	3895
7470	3896	3897	3898	3899	3900	3901	3902	3903
7500	3904	3905	3906	3907	3908	3909	3910	3911
7510	3912	3913	3914	3915	3916	3917	3918	3919
7520	3920	3921	3922	3923	3924	3925	3926	3927
7530	3928	3929	3930	3931	3932	3933	3934	3935
7540	3936	3937	3938	3939	3940	3941	3942	3943
7550	3944	3945	3946	3947	3948	3949	3950	3951
7560	3952	3953	3954	3955	3956	3957	3958	3959
7570	3960	3961	3962	3963	3964	3965	3966	3967
7600	3968	3969	3970	3971	3972	3973	3974	3975
7610	3976	3977	3978	3979	3980	3981	3982	3983
7620	3984	3985	3986	3987	3988	3989	3990	3991
7630	3992	3993	3994	3995	3996	3997	3998	3999
7640	4000	4001	4002	4003	4004	4005	4006	4007
7650	4008	4009	4010	4011	4012	4013	4014	4015
7660	4016	4017	4018	4019	4020	4021	4022	4023
7670	4024	4025	4026	4027	4028	4029	4030	4031
7700	4032	4033	4034	4035	4036	4037	4038	4039
7710	4040	4041	4042	4043	4044	4045	4046	4047
7720	4048	4049	4050	4051	4052	4053	4054	4055
7730	4056	4057	4058	4059	4060	4061	4062	4063
7740	4064	4065	4066	4067	4068	4069	4070	4071
7750	4072	4073	4074	4075	4076	4077	4078	4079
7760	4080	4081	4082	4083	4084	4085	4086	4087
7770	4088	4089	4090	4091	4092	4093	4094	4095

7000 to 7777 (Octal)	3584 to 4095 (Decimal)

Appendix E. Octal-Decimal Fraction Conversion Table

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000	.000000	.100	.125000	.200	.250000	.300	.375000
.001	.001953	.101	.126953	.201	.251953	.301	.376953
.002	.003906	.102	.128906	.202	.253906	.302	.378906
.003	.005859	.103	.130859	.203	.255859	.303	.380859
.004	.007812	.104	.132812	.204	.257812	.304	.382812
.005	.009765	.105	.134765	.205	.259765	.305	.384765
.006	.011718	.106	.136718	.206	.261718	.306	.386718
.007	.013671	.107	.138671	.207	.263671	.307	.388671
.010	.015625	.110	.140625	.210	.265625	.310	.390625
.011	.017578	.111	.142578	.211	.267578	.311	.392578
.012	.019531	.112	.144531	.212	.269531	.312	.394531
.013	.021484	.113	.146484	.213	.271484	.313	.396484
.014	.023437	.114	.148437	.214	.273437	.314	.398437
.015	.025390	.115	.150390	.215	.275390	.315	.400390
.016	.027343	.116	.152343	.216	.277343	.316	.402343
.017	.029296	.117	.154296	.217	.279296	.317	.404296
.020	.031250	.120	.156250	.220	.281250	.320	.406250
.021	.033203	.121	.158203	.221	.283203	.321	.408203
.022	.035156	.122	.160156	.222	.285156	.322	.410156
.023	.037109	.123	.162109	.223	.287109	.323	.412109
.024	.039062	.124	.164062	.224	.289062	.324	.414062
.025	.041015	.125	.166015	.225	.291015	.325	.416015
.026	.042968	.126	.167968	.226	.292968	.326	.417968
.027	.044921	.127	.169921	.227	.294921	.327	.419921
.030	.046875	.130	.171875	.230	.296875	.330	.421875
.031	.048828	.131	.173828	.231	.298828	.331	.423828
.032	.050781	.132	.175781	.232	.300781	.332	.425781
.033	.052734	.133	.177734	.233	.302734	.333	.427734
.034	.054687	.134	.179687	.234	.304687	.334	.429687
.035	.056640	.135	.181640	.235	.306640	.335	.431640
.036	.058593	.136	.183593	.236	.308593	.336	.433593
.037	.060546	.137	.185546	.237	.310546	.337	.435546
.040	.062500	.140	.187500	.240	.312500	.340	.437500
.041	.064453	.141	.189453	.241	.314453	.341	.439453
.042	.066406	.142	.191406	.242	.316406	.342	.441406
.043	.068359	.143	.193359	.243	.318359	.343	.443359
.044	.070312	.144	.195312	.244	.320312	.344	.445312
.045	.072265	.145	.197265	.245	.322265	.345	.447265
.046	.074218	.146	.199218	.246	.324218	.346	.449218
.047	.076171	.147	.201171	.247	.326171	.347	.451171
.050	.078125	.150	.203125	.250	.328125	.350	.453125
.051	.080078	.151	.205078	.251	.330078	.351	.455078
.052	.082031	.152	.207031	.252	.332031	.352	.457031
.053	.083984	.153	.208984	.253	.333984	.353	.458984
.054	.085937	.154	.210937	.254	.335937	.354	.460937
.055	.087890	.155	.212890	.255	.337890	.355	.462890
.056	.089843	.156	.214843	.256	.339843	.356	.464843
.057	.091796	.157	.216796	.257	.341796	.357	.466796
.060	.093750	.160	.218750	.260	.343750	.360	.468750
.061	.095703	.161	.220703	.261	.345703	.361	.470703
.062	.097656	.162	.222656	.262	.347656	.362	.472656
.063	.099609	.163	.224609	.263	.349609	.363	.474609
.064	.101562	.164	.226562	.264	.351562	.364	.476562
.065	.103515	.165	.228515	.265	.353515	.365	.478515
.066	.105468	.166	.230468	.266	.355468	.366	.480468
.067	.107421	.167	.232421	.267	.357421	.367	.482421
.070	.109375	.170	.234375	.270	.359375	.370	.484375
.071	.111328	.171	.236328	.271	.361328	.371	.486328
.072	.113281	.172	.238281	.272	.363281	.372	.488281
.073	.115234	.173	.240234	.273	.365234	.373	.490234
.074	.117187	.174	.242187	.274	.367187	.374	.492187
.075	.119140	.175	.244140	.275	.369140	.375	.494140
.076	.121093	.176	.246093	.276	.371093	.376	.496093
.077	.123046	.177	.248046	.277	.373046	.377	.498046

Octal-Decimal Fraction Conversion Table

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000000	.000000	.000100	.000244	.000200	.000488	.000300	.000732
.000001	.000003	.000101	.000247	.000201	.000492	.000301	.000736
.000002	.000007	.000102	.000251	.000202	.000495	.000302	.000740
.000003	.000011	.000103	.000255	.000203	.000499	.000303	.000743
.000004	.000015	.000104	.000259	.000204	.000503	.000304	.000747
.000005	.000019	.000105	.000263	.000205	.000507	.000305	.000751
.000006	.000022	.000106	.000267	.000206	.000511	.000306	.000755
.000007	.000026	.000107	.000270	.000207	.000514	.000307	.000759
.000010	.000030	.000110	.000274	.000210	.000518	.000310	.000762
.000011	.000034	.000111	.000278	.000211	.000522	.000311	.000766
.000012	.000038	.000112	.000282	.000212	.000526	.000312	.000770
.000013	.000041	.000113	.000286	.000213	.000530	.000313	.000774
.000014	.000045	.000114	.000289	.000214	.000534	.000314	.000778
.000015	.000049	.000115	.000293	.000215	.000537	.000315	.000782
.000016	.000053	.000116	.000297	.000216	.000541	.000316	.000785
.000017	.000057	.000117	.000301	.000217	.000545	.000317	.000789
.000020	.000061	.000120	.000305	.000220	.000549	.000320	.000793
.000021	.000064	.000121	.000308	.000221	.000553	.000321	.000797
.000022	.000068	.000122	.000312	.000222	.000556	.000322	.000801
.000023	.000072	.000123	.000316	.000223	.000560	.000323	.000805
.000024	.000076	.000124	.000320	.000224	.000564	.000324	.000808
.000025	.000080	.000125	.000324	.000225	.000568	.000325	.000812
.000026	.000083	.000126	.000328	.000226	.000572	.000326	.000816
.000027	.000087	.000127	.000331	.000227	.000576	.000327	.000820
.000030	.000091	.000130	.000335	.000230	.000579	.000330	.000823
.000031	.000095	.000131	.000339	.000231	.000583	.000331	.000827
.000032	.000099	.000132	.000343	.000232	.000587	.000332	.000831
.000033	.000102	.000133	.000347	.000233	.000591	.000333	.000835
.000034	.000106	.000134	.000350	.000234	.000595	.000334	.000839
.000035	.000110	.000135	.000354	.000235	.000598	.000335	.000843
.000036	.000114	.000136	.000358	.000236	.000602	.000336	.000846
.000037	.000118	.000137	.000362	.000237	.000606	.000337	.000850
.000040	.000122	.000140	.000366	.000240	.000610	.000340	.000854
.000041	.000125	.000141	.000370	.000241	.000614	.000341	.000858
.000042	.000129	.000142	.000373	.000242	.000617	.000342	.000862
.000043	.000133	.000143	.000377	.000243	.000621	.000343	.000865
.000044	.000137	.000144	.000381	.000244	.000625	.000344	.000869
.000045	.000141	.000145	.000385	.000245	.000629	.000345	.000873
.000046	.000144	.000146	.000389	.000246	.000633	.000346	.000877
.000047	.000148	.000147	.000392	.000247	.000637	.000347	.000881
.000050	.000152	.000150	.000396	.000250	.000640	.000350	.000885
.000051	.000156	.000151	.000400	.000251	.000644	.000351	.000888
.000052	.000160	.000152	.000404	.000252	.000648	.000352	.000892
.000053	.000164	.000153	.000408	.000253	.000652	.000353	.000896
.000054	.000167	.000154	.000411	.000254	.000656	.000354	.000900
.000055	.000171	.000155	.000415	.000255	.000659	.000355	.000904
.000056	.000175	.000156	.000419	.000256	.000663	.000356	.000907
.000057	.000179	.000157	.000423	.000257	.000667	.000357	.000911
.000060	.000183	.000160	.000427	.000260	.000671	.000360	.000915
.000061	.000186	.000161	.000431	.000261	.000675	.000361	.000919
.000062	.000190	.000162	.000434	.000262	.000679	.000362	.000923
.000063	.000194	.000163	.000438	.000263	.000682	.000363	.000926
.000064	.000198	.000164	.000442	.000264	.000686	.000364	.000930
.000065	.000202	.000165	.000446	.000265	.000690	.000365	.000934
.000066	.000205	.000166	.000450	.000266	.000694	.000366	.000938
.000067	.000209	.000167	.000453	.000267	.000698	.000367	.000942
.000070	.000213	.000170	.000457	.000270	.000701	.000370	.000946
.000071	.000217	.000171	.000461	.000271	.000705	.000371	.000949
.000072	.000221	.000172	.000465	.000272	.000709	.000372	.000953
.000073	.000225	.000173	.000469	.000273	.000713	.000373	.000957
.000074	.000228	.000174	.000473	.000274	.000717	.000374	.000961
.000075	.000232	.000175	.000476	.000275	.000720	.000375	.000965
.000076	.000236	.000176	.000480	.000276	.000724	.000376	.000968
.000077	.000240	.000177	.000484	.000277	.000728	.000377	.000972

Octal-Decimal Fraction Conversion Table

OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.	OCTAL	DEC.
.000400	.000976	.000500	.001220	.000600	.001464	.000700	.001708
.000401	.000980	.000501	.001224	.000601	.001468	.000701	.001712
.000402	.000984	.000502	.001228	.000602	.001472	.000702	.001716
.000403	.000988	.000503	.001232	.000603	.001476	.000703	.001720
.000404	.000991	.000504	.001235	.000604	.001480	.000704	.001724
.000405	.000995	.000505	.001239	.000605	.001483	.000705	.001728
.000406	.000999	.000506	.001243	.000606	.001487	.000706	.001731
.000407	.001003	.000507	.001247	.000607	.001491	.000707	.001735
.000410	.001007	.000510	.001251	.000610	.001495	.000710	.001739
.000411	.001010	.000511	.001255	.000611	.001499	.000711	.001743
.000412	.001014	.000512	.001258	.000612	.001502	.000712	.001747
.000413	.001018	.000513	.001262	.000613	.001506	.000713	.001750
.000414	.001022	.000514	.001266	.000614	.001510	.000714	.001754
.000415	.001026	.000515	.001270	.000615	.001514	.000715	.001758
.000416	.001029	.000516	.001274	.000616	.001518	.000716	.001762
.000417	.001033	.000517	.001277	.000617	.001522	.000717	.001766
.000420	.001037	.000520	.001281	.000620	.001525	.000720	.001770
.000421	.001041	.000521	.001285	.000621	.001529	.000721	.001773
.000422	.001045	.000522	.001289	.000622	.001533	.000722	.001777
.000423	.001049	.000523	.001293	.000623	.001537	.000723	.001781
.000424	.001052	.000524	.001296	.000624	.001541	.000724	.001785
.000425	.001056	.000525	.001300	.000625	.001544	.000725	.001789
.000426	.001060	.000526	.001304	.000626	.001548	.000726	.001792
.000427	.001064	.000527	.001308	.000627	.001552	.000727	.001796
.000430	.001068	.000530	.001312	.000630	.001556	.000730	.001800
.000431	.001071	.000531	.001316	.000631	.001560	.000731	.001804
.000432	.001075	.000532	.001319	.000632	.001564	.000732	.001808
.000433	.001079	.000533	.001323	.000633	.001567	.000733	.001811
.000434	.001083	.000534	.001327	.000634	.001571	.000734	.001815
.000435	.001087	.000535	.001331	.000635	.001575	.000735	.001819
.000436	.001091	.000536	.001335	.000636	.001579	.000736	.001823
.000437	.001094	.000537	.001338	.000637	.001583	.000737	.001827
.000440	.001098	.000540	.001342	.000640	.001586	.000740	.001831
.000441	.001102	.000541	.001346	.000641	.001590	.000741	.001834
.000442	.001106	.000542	.001350	.000642	.001594	.000742	.001838
.000443	.001110	.000543	.001354	.000643	.001598	.000743	.001842
.000444	.001113	.000544	.001358	.000644	.001602	.000744	.001846
.000445	.001117	.000545	.001361	.000645	.001605	.000745	.001850
.000446	.001121	.000546	.001365	.000646	.001609	.000746	.001853
.000447	.001125	.000547	.001369	.000647	.001613	.000747	.001857
.000450	.001129	.000550	.001373	.000650	.001617	.000750	.001861
.000451	.001132	.000551	.001377	.000651	.001621	.000751	.001865
.000452	.001136	.000552	.001380	.000652	.001625	.000752	.001869
.000453	.001140	.000553	.001384	.000653	.001628	.000753	.001873
.000454	.001144	.000554	.001388	.000654	.001632	.000754	.001876
.000455	.001148	.000555	.001392	.000655	.001636	.000755	.001880
.000456	.001152	.000556	.001396	.000656	.001640	.000756	.001884
.000457	.001155	.000557	.001399	.000657	.001644	.000757	.001888
.000460	.001159	.000560	.001403	.000660	.001647	.000760	.001892
.000461	.001163	.000561	.001407	.000661	.001651	.000761	.001895
.000462	.001167	.000562	.001411	.000662	.001655	.000762	.001899
.000463	.001171	.000563	.001415	.000663	.001659	.000763	.001903
.000464	.001174	.000564	.001419	.000664	.001663	.000764	.001907
.000465	.001178	.000565	.001422	.000665	.001667	.000765	.001911
.000466	.001182	.000566	.001426	.000666	.001670	.000766	.001914
.000467	.001186	.000567	.001430	.000667	.001674	.000767	.001918
.000470	.001190	.000570	.001434	.000670	.001678	.000770	.001922
.000471	.001194	.000571	.001438	.000671	.001682	.000771	.001926
.000472	.001197	.000572	.001441	.000672	.001686	.000772	.001930
.000473	.001201	.000573	.001445	.000673	.001689	.000773	.001934
.000474	.001205	.000574	.001449	.000674	.001693	.000774	.001937
.000475	.001209	.000575	.001453	.000675	.001697	.000775	.001941
.000476	.001213	.000576	.001457	.000676	.001701	.000776	.001945
.000477	.001216	.000577	.001461	.000677	.001705	.000777	.001949

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