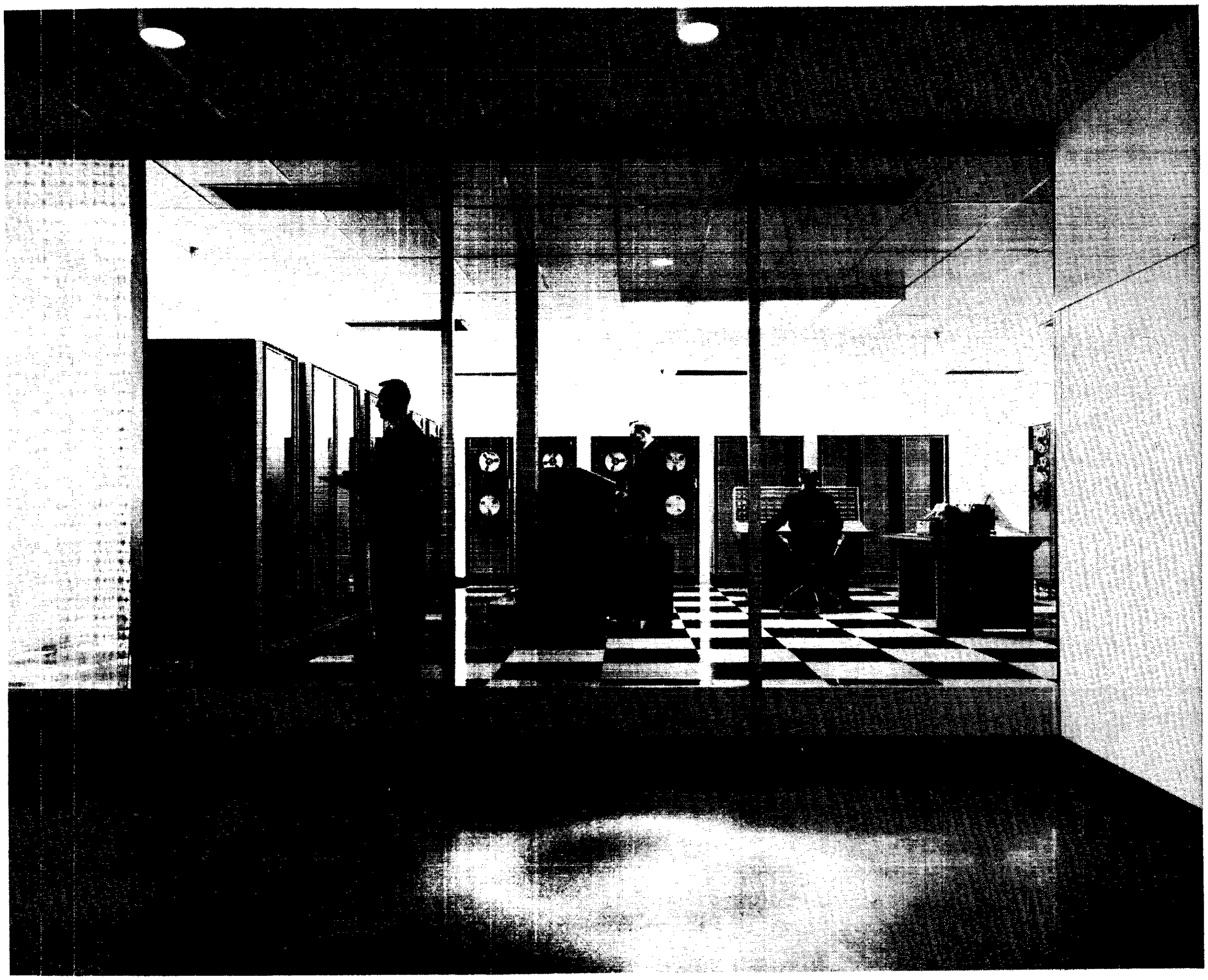
OPERATOR'S MANUAL

FOR TRAINING AND REFERENCE

June, 1961

The Sylvania 9400 Data Processing System

An Important New Concept in Data Processing



(FRONTISPIECE) 9400 INSTALLATION SYLVANIA DSO, NEEDHAM

SYLVANIA 9400
DATA PROCESSING SYSTEM

OPERATOR'S MANUAL

for Training and Reference

SYLVANIA ELECTRONIC SYSTEMS

A Division of Sylvania Electric Products Inc.

DATA SYSTEMS OPERATIONS

189 B Street, Needham 94, Massachusetts

SYLVANIA ELECTRONIC SYSTEMS
Government Systems Management
for GENERAL TELEPHONE & ELECTRONICS

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I. THE 9400 COMPUTER

A. GENERAL DESCRIPTION

1. The 9400 is a general purpose, large scale, automatic electronic computer system.

As an automatic electronic machine the 9400 is part of the rapidly growing family of computers which have been developed largely since 1950. These machines are automatic because processing of data is effected under control of a series of instructions (the program) which is internally stored. They are electronic, having departed from the electro-mechanical principles of earlier punched card equipment (E.A.M.), taking advantage of the much greater speed of purely electronic switching circuitry.

The 9400 is large scale in that its large and flexible arithmetic potential, its repertoire of instructions, its memory size, and number of input-output device options place it in a class with the twelve largest and most powerful general purpose machines currently being marketed.

2. The 9400 is a solid state, asynchronous computer with a 32K random access memory.

Solid state refers to the advanced miniaturized circuitry which employs tiny semiconductor devices such as transistors rather than vacuum tubes. A transistorized machine requires less floor space, uses less power, generates much less heat, and achieves much faster speeds (125,000 instructions a second in the 9400) than machines using vacuum tubes.

Asynchronous describes the input-output principle of the machine. Because the rate at which information can be entered into the machine is less than 1/10th as fast as it can be processed internally the speed of the machine can be utilized best only if several units can be reading into or out of the machine simultaneously with the internal processing of data. Large scale machines for this reason make use of "In-Out Processors", actually small computers themselves, which control reading and writing independently (or "asynchronously") of the main computer which may be executing the main program at the same time.

Random access memory size is an important factor in the capacity of a computer. The Sylvania 9400 has a full memory of 32,768 "Words" (octal 77777).

3. The 9400 is a binary machine using a fixed word length in parallel and single address instructions.

Because data is represented in the machine by electronic switching circuits which are confined to two state devices (on-off flip-flops; magnetized clockwise - magnetized counter-clockwise ferrite cores, etc.) the best numbering system to be used is one with only two symbols, "1" and "0": the binary system. Use of binary arithmetic allows the machine to achieve its amazing processing speeds. The machine can be programmed to convert binary to decimal numbers automatically for printed output. Octal numbers are used as a convenient shorthand for binary (see Table G).

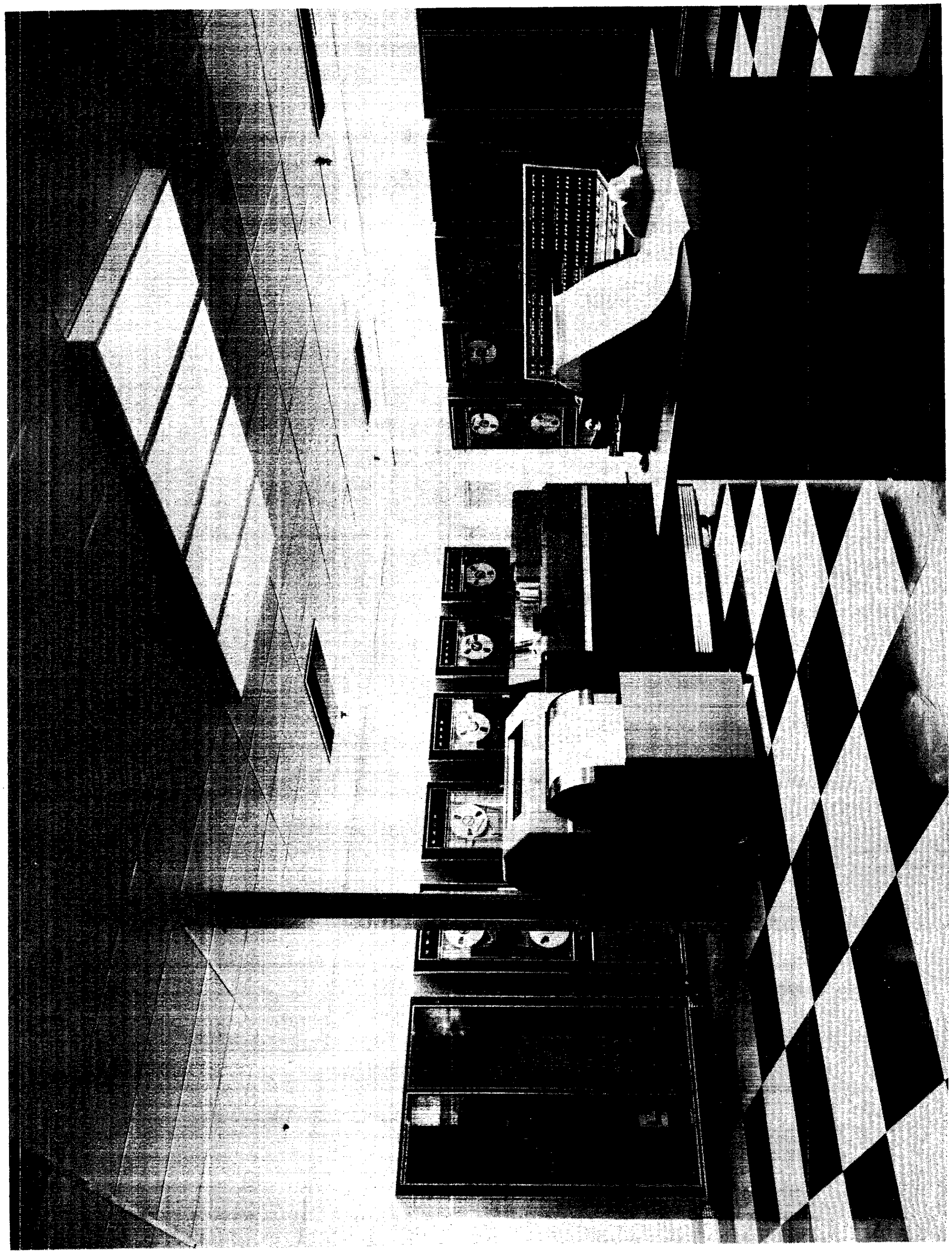


FIGURE 1. GENERAL VIEW, SYLVANIA NEEDHAM 9400 INSTALLATION

The computer word is the basic information unit. The 9400 word has a fixed length of 36 bits plus sign which may be processed as six six-bit alphanumeric fieldata characters. Data is stored as words in memory locations holding one word each and moved as words during processing in parallel, each bit being sent into a register simultaneously.

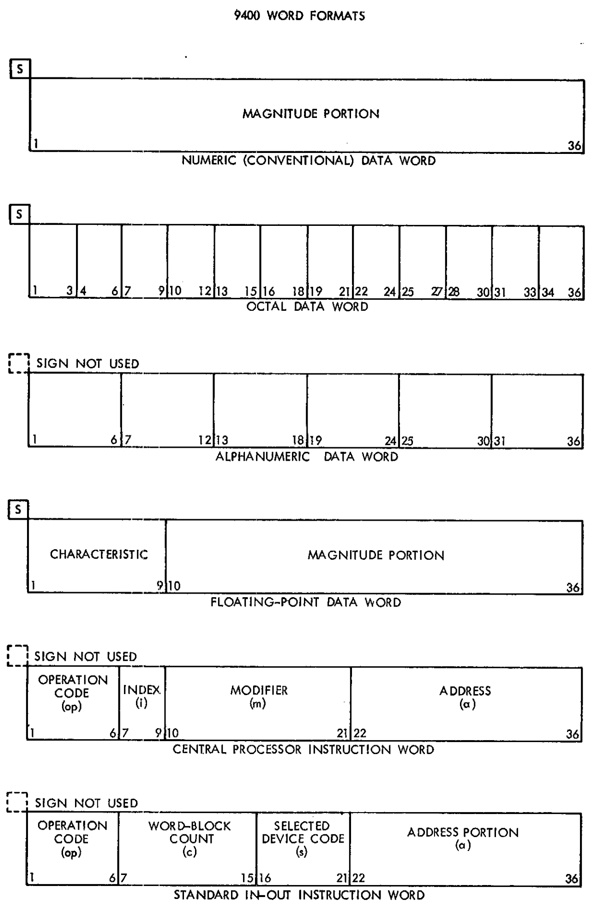


FIGURE 2. WORD FORMATS

Instructions are single address orders in that they act upon one word stored in one particular register or memory location. One instruction, however, can be used over and over again modified to address a different word each time by means of indexing.

B. DATA FLOW

The diagram below shows the components of the 9400; the arrows indicate the flow of data between these units. Notice that each I/O Processor is directly connected to each peripheral device by its own transfer bus, and to the main computer by the main transfer bus.

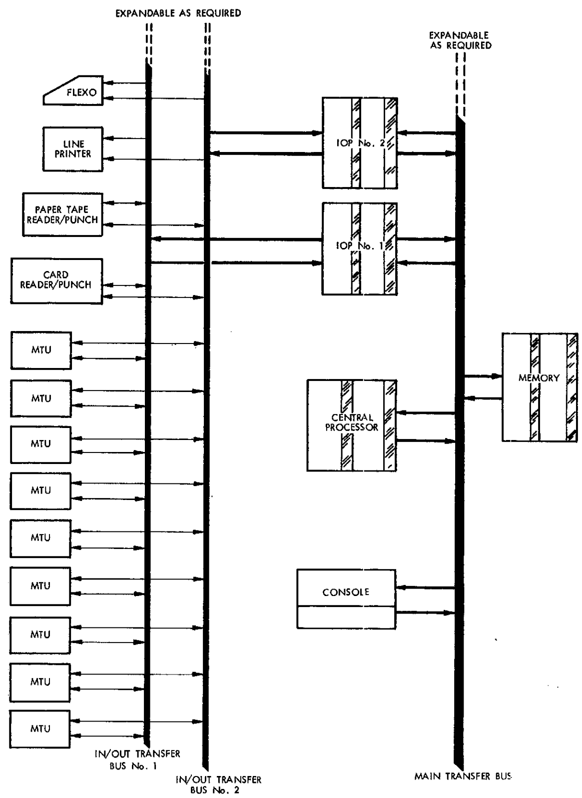


FIGURE 3. DATA FLOW

C. COMPONENTS

The actual floor layout of a typical 9400 installation showing all units and their physical relationship to one another is shown by the following diagram.

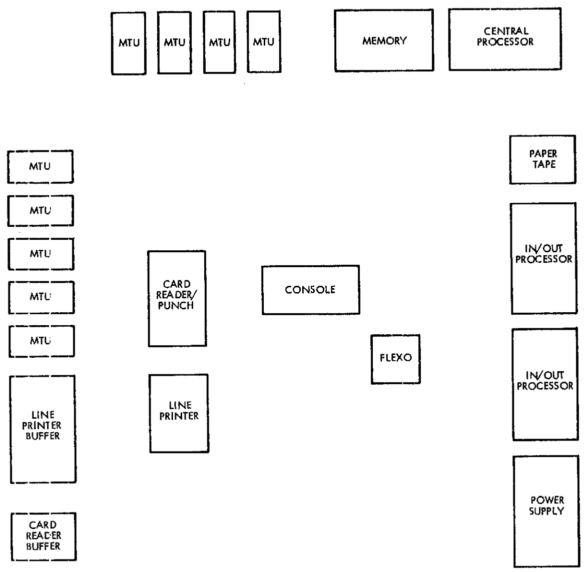


FIGURE 4. FLOOR PLAN

II. CONSOLE OPERATION

A. THEORY OF CONSOLE USE

By definition the functioning of an automatic computer should be automatic. In theory console use is limited to initiating a series of program sequences and as a maintenance aid. Indicators and switches for manual monitoring and intervention, however, are required for the following general reasons:

1. To increase program flexibility by permitting manual switch settings to alter the course of a program.

2. To indicate the presence and nature of any machine malfunction.

3. To indicate program malfunction.

4. To assist in "debugging" programs by displaying registers and memory locations and permitting instructions in core to be manually displayed.

5. To select any one of various in-out devices to initiate each program, or to restart a program which has been interrupted at any given location.

B. CONSOLE DESCRIPTION

The console may be divided into four functional areas for convenience: 1) Display indicator, status and alarm lights, located primarily across the upper portion; 2) Sense, Word, and Special Switches, located across the bottom portion; 3) Operation Switches (buttons) located across the top of the lower portion and lower right hand side of the lower portion; 4) Engineering maintenance panel, normally retracted, (not to be used by computer operators).

1. DISPLAY INDICATORS, STATUS AND ALARM LIGHTS

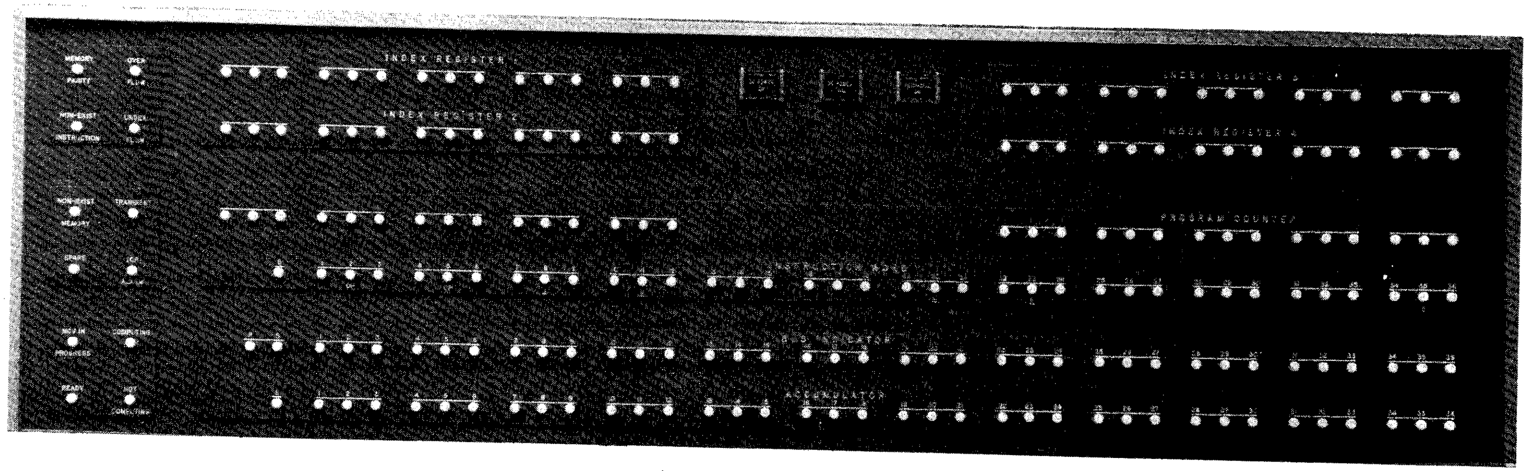
DISPLAY INDICATORS:

a. Index Registers - Contents of the four index registers are displayed continually by the four rows of 15 light indicators at the top of the console.

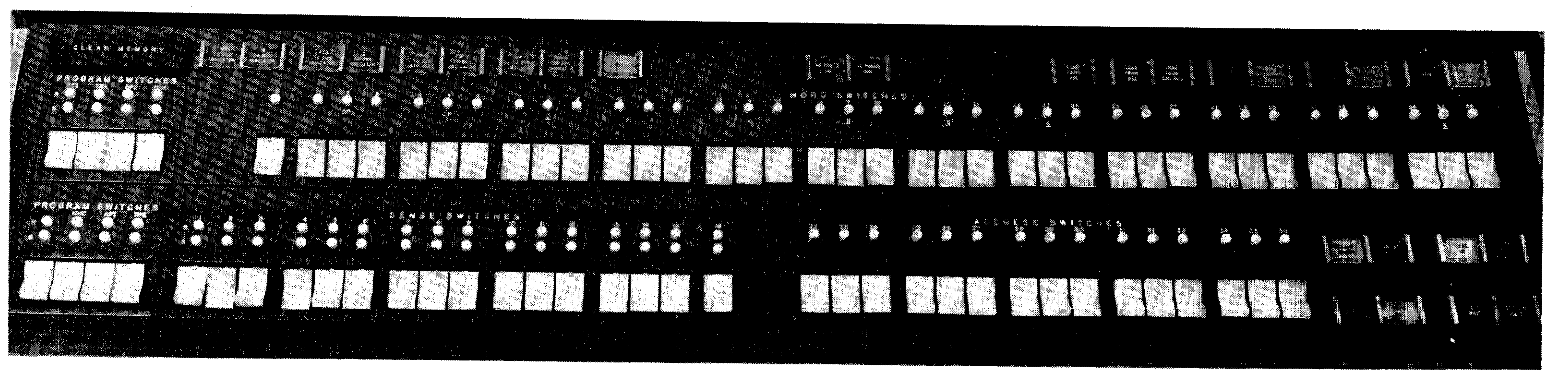
b. Program Counter - The memory address of the next instruction to be executed by the computer is displayed by the PC indicator lights located beneath IR4 Indicators.

The matching set of fifteen lights beneath IR3 are spares provided for expansion of the basic machine.

c. Instruction Word - Displays the instruction word last executed as contained in the following registers:



(UPPER PANEL)



(LOWER PANEL)

FIGURE 5. CONTROL CONSOLE

Register	Bits / Light No.	Contains
Instruction Register	S, 1-6	Operation Code
"X" Register	7-9	Index
"G" Register	10-21	Modifier
Address Register	22-36	1st Operand Address

d. Bus Indicator - Displays the present contents of any of six registers as selected by the appropriate Register Selector Switch. "P" represents the memory parity check bit.

e. Accumulator - Displays present contents of the accumulator.

ALARM INDICATORS (upper left corner):

Any of these indicators may be reset by the Clear Error Switch. Setting No Halt on Error Switch will inhibit error halts by the central processor but not the indicators.

f. Memory Parity Error - Each transfer of a word in or out of memory is checked by a parity bit for an odd number of "one" bits. Should a bit be dropped during the transfer or while stored, "even" parity will result causing the Memory Parity Error switch to be set, halt the machine, and light the appropriate indicator.

g. Non - existent Instruction - Lights when an illegal op code is sensed in the Instructor Register.

h. Non-existent Memory - Lights when a non-existent location is sensed in the address register.

i. Overflow - Lights when a "one" bit is pushed out of the accumulator and lost due to the entry of a number too large for the arithmetic unit. This alarm will not necessarily cause the machine to halt, as the instruction causing the overflow can be coded to cause the central processor to 1) ignore overflow, 2) to set the alarm but not halt, 3) to set the alarm and halt.

j. Underflow - Operates as the overflow alarm when underflow is caused in floating point operations.

k. Transient - Indicates occurrence of an intolerable power transient which would cause a computer error. The machine will halt only if Halt on Transient Switch is "On".

l. In - Out Processor Alarm - Lights when any error is sensed in the I/O Processor.

m. Spare - The eighth light in this group is not used at present.

n. DC Power Failure - A square red alarm light, lit in the event of an interruption in DC power.

2. SENSE, WORD, AND PROGRAM SWITCHES

a. Sense Switches - Sixteen three position sense switches are located in the lower left hand portion of the console. They increase the flexibility of programs and operate as follows:

In the neutral position the switches may be sensed, set or reset automatically by the program. The condition is reflected by the Indicator lights above each switch.

Program instructions may specify that sense switches be set or reset manually. In this condition the switches cannot be changed automatically by the program.

Sense switches may be altered manually at any time including when the computer is operating.

b. Address Switch Register (ASR) Fifteen address switches correspond to the fifteen bits in the address portion of the instruction word. The specified octal address must be entered in the ASR for the following console operations: Read-In, Read-Out, and Start at ASR. Use of the ASR is illustrated in the following problem: Read out of memory location 7134. This is executed as follows:

1. Depress "One Instruction Mode" switch.
2. Set ASR to 7134 (octal).
3. Depress "MO to Bus" indicator switch.
4. Depress "Read Out" Switch.
5. Memory cell 7134 is displayed in the Bus Indicator Register.

c. Word Switch Register (WSR) - These thirty-seven switches correspond to the bits of the 9400 Instruction Word. An instruction keyed into the WSR may be used as follows:

1. It may be placed in the storage location indicated by the ASR to correct an instruction of a program that was automatically read in, or build a program manually.

2. It may be executed by a Manual Instruct operation.

3. It may be addressed by the program as a word of input; it is a one way transmission only.

d. Program Switches - Seven program switches and one spare are located in the lower left hand corner of the console. They function as the sense switches except that they may be changed only when the machine is halted. They may be set internally by the program when in neutral position. SPI is a "spring loaded" switch. It will flip back to neutral position immediately after being manually set, leaving future control with the program.

1. FCI (Functional Control Character Interrupt) - During an input operation when a special control character is read in and the FCI switch is set, the program will be interrupted and transferred to locations 00016 through 00019.

2. TRA (Trapping Mode) - If set, program is interrupted when a transfer order is sensed and control transferred to storage location 00002.

3. SPI (Stop Program Interrupt) - Spring loaded; prevents program interrupt from occurring when set manually. This switch is set automatically when program interrupt occurs and will not be reset unless so programmed.

4. ISN (Interpret Sign) - During input-output operations ISN SET enables the sign bit of each word to be regarded as part of the word.

5. NHC (No Halt on Processor Error) - Set, NHC causes In/Out Processor alarms to be ignored, although indicator lights will function.

6. API (Alarm Program Interrupt) - Set, API causes control to transfer to location 00028 when an overflow or underflow condition occurs. Programmed over or underflow control is ignored.

7. TPE (Tape Erase) - When set the operator, by manually executing a "Write" instruction, may erase data from magnetic tape where a bad spot has been detected. The switch is automatically reset by the "Write" instruction.

3. OPERATION SWITCHES (BUTTONS)

a. Clear Memory - Protected from accidental switching by a red cover which must be lifted. Sets all memory locations to zero.

b. Register Selector - Series of six switches to select register to be displayed on bus indicator. Switches for PIR 3, PIR 4, and blank switch are not active. Switches are as follows:

MO	- Memory Output Register to Bus Indicator
B	- "B" Register to Bus Indicator
PCS	- Program Counter Store to Bus Indicator
Q	- "Q" Register to Bus Indicator
PIR(1-4)	- Processor Instruction Register specified to Bus Indicator

c. AC Power On and Off - These switches, green and red respectively, located in the center of the console, turn power on or off for the entire machine.

d. Program Read In Switches - Used to load programs into memory from Card Reader (CRD RDR), Paper Tape Reader (PTU), or Magnetic Tape Unit (MTU).

e. Halt on Transient - Causes computer to halt on abnormal power transient which would cause errors. The transient Indicator will light whether the switch is "on" or "off".

f. No Halt on Error - Depressing this switch will prevent error alarms from halting the machine.

g. Clear C.P. - Resets to zero all Central Processor switches and registers.

h. One Instruction - Causes just one instruction to be executed when Start at ASR or Start at P.C. is depressed.

i. Run - Causes the computer to operate under program control upon initiating the program with the appropriate switch. Depressing "Run" will release the computer from either "One Instruction" or "single step" control.

j. Single Step - Used primarily for engineering checkout; causes the machine to go through each timing function of an instruction under manual control.

k. Clear Error - Resets all error alarms.

l. Start at PC - Starts operation of a program beginning with the location in the Program Counter. This is the normal manner to resume operation after a halt.

m. Read In - Enters contents of WSR into location specified in the ASR.

n. Read Out - Causes location in ASR to be transferred to Memory In-Out Register (MO) from which it may be displayed by depressing the MO to Bus Indicator Switch.

o. Manual Instruct - Causes instruction in the WSR to be executed.

p. Start at ASR - Starts operation of a program beginning with the instruction at the address in the ASR.

q. Read Out - Will move contents of address in ASR to the Memory Output Register which may then be displayed by depressing MO to Bus Indicator.

r. CP Halt - Causes central processor to halt but allows I/O Processor(s) to complete instruction(s) currently being executed. System may be restarted by depressing Start at PC.

s. System Halt - Causes Central Processor and I/O Processors to halt. System cannot normally be restarted because I/O Processor control registers are cleared.

C. CONSOLE OPERATIONS

1. INITIATING AUTOMATIC OPERATION under program control:

a. Load program into appropriate input device (MTU, Card Reader, or Paper Tape Reader) and put device in "ready" status.

b. Depress Run Switch.

c. Depress appropriate Load Switch.

d. Reading errors are indicated on the console (IOP alarm) and I/O Processor, and normally by a machine halt. Action to be taken is dependent on the type of error as indicated by the I/O Processor and will be described in Section III, below.

2. RESTARTING PROGRAMS after program halt or alarm halt - Depress Start at P.C.

3. ONE INSTRUCTION - For purposes of debugging, programmers may desire to observe operation one instruction at a time.

a. If program is running, depress CP Halt.

b. Depress One Instruction.

c. Enter address of first instruction desired in ASR.

d. Depress Start at ASR.

4. DISPLAY MEMORY LOCATION or register

a. If program is running, depress CP Halt.

b. Depress MO to Indicator.

c. Place address of desired location or register in ASR.

d. Depress Read Out.

5. ENTER INSTRUCTION (manually)

a. Place octal representation of instruction in WSR.

b. Place address in ASR.

c. Depress Read In.

III. IN-OUT PROCESSORS

A. GENERAL DESCRIPTION

The In-Out Processor is essentially a small computer designed to act as a link between numerous diverse input-output devices and the central processor. As many as four I-O Processors may be incorporated in the 9400 System, each being directly connected with all In-Out devices. The In-Out Processors perform the following functions:

1. Synchronize the timing of in-out devices with the central processor memory access timing.

2. Convert data formats and codes so that they are acceptable to the output device.

3. Schedule in-out operations when more than one instruction is waiting to be excuted.

4. Provide built-in checks for reading or writing errors.

Each processor consists of two sections, the Control Section and the Data Handling Section.

1. Control Section – Occupying the right hand side of the Processor, the Control Section consists of two groups of registers.

a) PIR (Processor Instruction Register). This register is similar in function to the Instruction Word Registers of the Central Processing Unit. It is addressable as a unit, and contains the in-out order currently being executed. It actually consists of four sub-registers:

ISR – Instruction Register (op-code)

WBC – Word Block Counter (number of words to be transmitted)

DAR – Device Address Register (Address of selected device)

ADC – Address Counter (address of first location to be read into or out of; incremented by one each transmission except when it refers to an addressable register or the instruction is "Read Reverse").

b) Order Sequence Registers

OSR (Order Sequence Register) stores address of next in-out order to be executed when program is operating in the Order Sequence Mode ("stacking" of in-out orders so that Processors may operate as efficiently as possible semi-independently of the main computer).

DAS (Device Address Storage Register) holds the control bits (16-21) which enable the programmer to control the setting of various in-out alarms and activity flip-flops.

2. Data Handling Section is concerned primarily with word to character conversion and parity checking of data being read or written. It consists of the following:

a) BFR – Buffer Register
b) Character Buffer Registers (5)
c) DSU – Device Switching Unit

The contents of all the above registers are indicated by the green neons at the end of each logic card in the I-O Processors. By reading these neons when the machine is halted it is possible to determine the exact condition of the processor which caused the halt.

B. SWITCHES AND INDICATORS

Two switches and five indicators are located at the upper right hand corner of the In-Out Processor (see Figure 6).

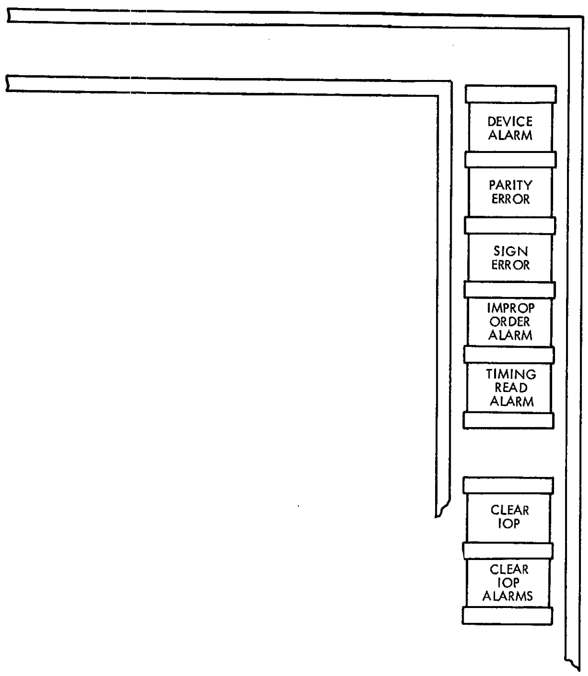


FIGURE 6. IN-OUT PROCESSOR INDICATORS

1. Device Alarm (Red) indicates hardware malfunction in the device currently addressed. If a tape unit causes the halt, the program should be rerun on another unit. If no alternate device is available maintenance should be notified immediately unless the malfunction can be rectified by the operator (e.g., a card feed jam).

2. Parity Error indicates loss of a bit when transferring data to or from cards, magnetic tape, or paper tape. It is normally caused by a hardware malfunction or magnetic tape deterioration. Engineers should be called in immediately.

3. Sign Error – In read/write operations the machine must be told whether to operate in the Interpret Sign Mode (ISN) or Non-Interpret Sign Mode (NISN). The type of mode may be selected automatically under program control or manually by setting the ISN console switch. ISN words encountered when the machine is in NISN status (and visa versa) will cause a machine halt and light the Sign Error light on the processor.

To restart the machine the operator should change the status of the ISN switch manually, depress "Clear IOP Alarms" on the IOP (or "Clear Error" on the console), and depress "Start at PC". If the alarm persists the program should be returned to the programmer with the faulty card marked and appropriate comments.

4. Improper Order Alarm indicates a programmer error. The input-output order being docoded may be missing a word count or device address. Operators should display the instruction on the console to determine the error if possible and return the program to the programmer with the appropriate comments.

5. Timing Read Alarm indicates information has been recorded erroneously on tape due to possible tape deterioration or machine malfunction.

Switches:

1. Clear IOP. Depressing this switch

resets all registers and buffers in the In-Out Processor.

2. Clear IOP Alarms enables re-starting the machine by resetting the alarm causing the halt. The same operation may be effected by depressing "Clear Error" on the console.

IV. PERIPHERAL EQUIPMENT

A. MAGNETIC TAPE UNITS

1. Description

a. Function

Magnetic Tape offers the fastest means of computer input and output, and the most economical medium for storing large volumes of data either temporarily or over the long term. As the basic in/out device, the 9400 utilizes 8-10 Magnetic Tape Units.

b. Tape

Storage medium consists of one inch mylar base magnetic tape on reels, 3600 feet of tape on each reel. The dull side of the tape is covered with a magnetic coating of metallic oxide. Information is recorded on this material in sixteen parallel channels, considered as two bands of eight channels each. Characters are represented in each group of channels by a bit configuration similar to that used by eight channel paper tape. They are read alternately from one side to the other.

Information is recorded at a density of 756 characters/inch (378 on each side). Tape read or write speed is 120 inches a second, effecting a character transfer rate of about 90,000 characters a second.

Certain parts of the tape are insensitive. Other areas should not be written on. Each end of the tape consists of a metallic leader strip about twenty feet in length. Any instruction causing a tape to attempt to read or rewind the metallic leader will cause a device alarm.

Several feet after the beginning of the sensitized portion of the tape an adhesive reflective strip is placed on the back (shiny side) of the tape to the outside of an imaginary center line. A similar mark is placed several feet from the end of the sensitized portion of the tape, this one inside the imaginary center line of the tape.

Beginning of tape and end of tape strips are sensed by a special photo sensing device when they enter the head assembly. During rewinding or reading in reverse when the beginning of tape strip is sensed the BTA flip-flop (internal) is set automatically. No information can be written while this flip-flop is set.

While BTA is set, a write command will be delayed until the reflective strip has moved across the sensing device. When the End of Tape strip is sensed during a read forward or write instruction the ETA flip-flop is set. The current instruction will be completed. In the single order mode one more block may be written. Any additional read or write orders will not be executed.

If the programmer has set the ETI (end tape interrupt) decision switch when

ETA is set program interrupt will occur immediately. Control will be transferred to memory location 10_8 for I/O Processor 1, or location 11_8 for I/O Processor 2.

c. Magnetic Tape Unit

The 9400 tape units are made up of two functionally separate assemblies:

1) Tape handling assembly - moves the tape through the head assembly at the required speeds.

2) Read/Write Equipment - consisting mainly of the head assembly, this purely electronic device transfers information between the tape and the In/Out Processor.

The read/write assembly normally presents no difficulties for operators, except that they must ensure cleanliness of the read/write head. The read/write head continually reads automatically what it writes, a feature which provides an important check on output accuracy. Any discrepancy sensed will cause a parity alarm in the processor.

The tape transport system is much more complex, requiring careful maintenance and fine adjustment. This system requires careful handling on the part of operators. Operators should not attempt to alter any mechanical controls on these units.

The 9400 tape units achieve a start-stop speed of .003 seconds. The principal technique employed to achieve these high speeds is to bypass the drag of the relatively heavy tape reels by placing storage arms and vacuum buffers between the tape drive mechanism and the tape reels. By means of vacuum sensing holes in the vacuum buffers and "error signals" generated by the storage arms when they are moved by the tape from their neutral position the motors controlling the tape reel movement are actuated in accordance with tape drive requirements.

2. Changing Tapes

Tape changing is facilitated by the use of a leader strip permanently attached to the lower reel which remains threaded through the read/write unit at all times. In normal standby or automatic condition the supply reel is connected to the machine reel leader; it is positioned so that the lower reel has taken up the permanent leader and the metallic leader from the upper reel, and the sensitive "working" area of tape is over the read/write head. Instructions for changing tape assume that these conditions exist.

Removing Reel

a) Switch Settings (See Figure 7):

Power Switch – On

Mode Selector – Manual

Function Control – Stop

b) Turn function control switch to Reverse. Tape will rewind until connection between the supply reel and the permanent leader is reached.

c) Return the function control to Stop, the mode selector to Standby.

d) Open the cover door and engage the leader clamp (failure to do this can result

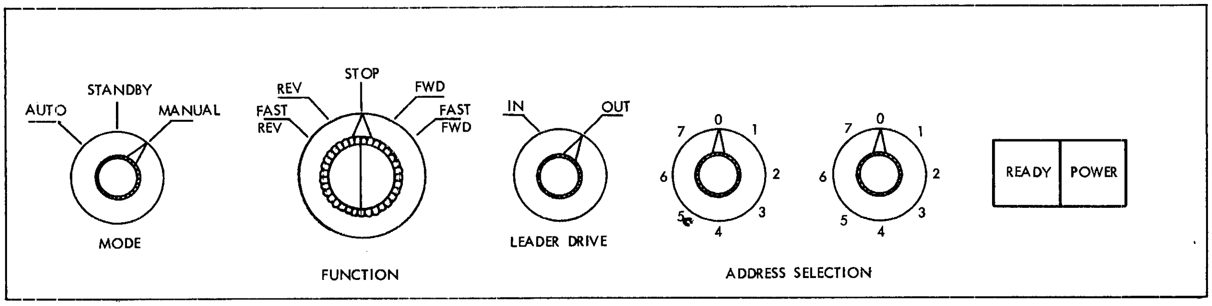


FIGURE 7. TAPE UNIT MANUAL CONTROLS

in losing the permanent leader through the read/write assembly and necessitate rethreading).

e) Turn upper reel clockwise until the leader connection is easily accessible.

f) Disconnect leader.

g) Release upper reel by pulling locking lever outward.

Loading New Upper Reel

a) Keep switch settings as follows:
Power Switch – On
Mode Selector – Standby
Manual Control – Stop

b) Place new reel over the hold-down assembly so that tape will unwind in a clockwise direction.

c) Lock reel firmly by pressing locking lever inward.

d) Turn upper reel clockwise to unwind enough tape to meet the permanent leader. Connect the supply reel leader with the permanent leader.

e) Rotate the upper reel until slack is taken up.

f) Release the leader clamp and close the door.

g) Move function control to Forward. Move mode selector to Manual. Turn leader drive switch to Drive.

h) The leader drive switch is spring loaded and will return to Off as soon as it is released. The tape will continue to advance until manual control is returned to Stop. Tape motion may be stopped as soon as the entire leader has been taken up by the lower reel and the reflective strip has passed the photo-sensing device.

i) To ready unit for automatic operation, place mode switch at Auto.

3. Threading Permanent Leader (See Figure 8)

The permanent leader should remain threaded at all times and permanently locked above the head assembly. Occasionally due to wear it must be replaced. The procedure is as follows:

a) Switch settings:
Power Switch – On
Mode Selector – Standby
Function Control – Stop

b) Remove old leader from lower reel.

c) Starting with plain end, wind about 10 feet of new leader clockwise on the take-up reel.

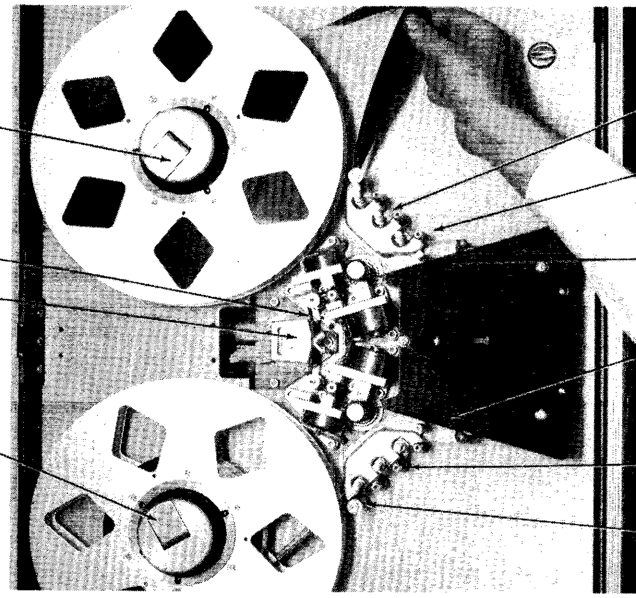


FIGURE 8. TAPE LEADER THREADING

d) Push tape storage arms inward and into the finger assemblies until they latch into position.

e) Thread leader through the rows of rollers of the lower storage arm and finger assembly, around the vacuum buffer roller, back past the lower vacuum buffer and around the capstans and brake posts of the head assembly.

f) Pull leader back across the upper vacuum buffer, around the roller, and through the rollers of the upper storage arm and finger assembly.

g) Secure the leader with the leader clamp and release the sensing arms from their latched positions by pressing them gently inward.

h) Check that the tape is properly seated between the flanges of all guide rollers. A new feed reel may now be loaded as described above.

4. Operation

a) Indicators

1. Rewind is lit while tape is being rewound.

2. Beginning of Tape – when the tape has been completely rewound, the Rewind light goes out and the Beginning of Tape indicator is lit. At this point the beginning of tape is positioned over the read/write head.

3. Write Lockout - To prevent information on tape from being accidentally destroyed by being written over, a programmer may request that the Write Lockout Ring be removed from the tape reel. When a tape has been mounted with the ring removed, Write Lockout Indicator will be lit.

4. Select - Lights when that tape unit is logically connected with the computer (during reading or writing).

5. Ready - Indicates that the unit is ready for operation.

b) Addressing Tapes

The octal logical address of the tape unit is indicated by the Address Indicator to the right of the indicator lights. This address is relative, i.e., it changes as determined by the program being run. Required logical address is set manually by the operators by means of the Address Selection Switches located to the right of the manual controls.

c) Alarms

Operator's error, programmer errors, or tape unit malfunctions will cause the Device Alarm Indicator on the In/Out Processor and the console IOP Alarm Light to light, and normally, a machine halt. Some of the conditions which may cause a device alarm are:

1. Leader clamp not released.

2. Mode Switch not in Auto.

3. Tape leader not advanced past the read/write head.

4. Power interruption.

5. Improper loop length in vacuum chamber.

6. Improper vacuum pressure.

7. Attempting to write on a file protected tape.

8. Attempting to write at End of Tape, attempting to rewind at Beginning of Tape.

9. Two tapes set at the same logical address.

5. Tape Care and Handling

Operators must exercise care in handling magnetic tapes for the following reasons:

a) The tape itself represents a substantial investment to Sylvania, costing in the neighborhood of $100 a reel.

b) Information recorded on the tape may represent a much greater investment. Poor handling can cause it to be lost.

c) Tapes are manufactured to very high tolerances and can easily be damaged by improper handling.

d) Operators may often be handling tapes belonging to a Sylvania customer. In the interest of customer relations these tapes must be kept in good condition.

To prevent damage or loss of information due to dirt:

a) Keep tape in its dust-proof container at all times except when it is actually mounted on a tape unit.

b) Keep container closed when it is empty.

c) Do not place a tape on the top of a tape unit.

d) Never attempt to alter the label on a tape reel by erasing or scraping. If it does not pull off easily, place another label over it.

To prevent damage due to pressure or shock:

a) Do not press or squeeze reels at the outer edge; pressure can cause the outermost turns of tape to be crimped. Information is written to within .02 inch of the edge and any disfiguration can cause reading errors.

b) Handle tape carefully during loading to prevent creases or nicks on the edges.

c) Never throw or mishandle tape reels, whether in protective containers or not.

When any question of tape damage exists:

a) Inspect reel carefully for bending.

b) Inspect outermost turns for evidence of crimping, nicks, creases, or dirt.

c) Check tape as outlined in Section VI.

d) If information is missing and/or if the tape must be trimmed, notify the dispatcher. Conditions which require trimming tape and method of trimming are described in Section VI D, below.

B. LINE PRINTER AND BUFFER

1. DESCRIPTION

On-line printed output at up to 900 lines/minute is provided by the 9400 Line Printer. To achieve its high print speed the printer employs a drum type printing device.

The printing drum lengthwise offers 120 print positions. At each print position, encircling the drum, are the sixty-four available characters, all the "A's" for instance placed at the same position on the perimeter of the drum. The drum rotates continuously at 900 r.p.m. The paper feeder advances the paper one line at a time, pausing long enough for all sixty-four characters to pass by the line to be printed (1/900th of a minute). Between the paper and the drum passes the inking ribbon, continuously moving, parallel to the paper movement so that an entirely new area of ribbon is presented to each printing position before each line is printed.

The relationship between the print drum, the ribbon, the paper, and the hammers is shown in the diagram below. The view is from the end of the drum. Arrows indicate the motion of the paper and ribbon.

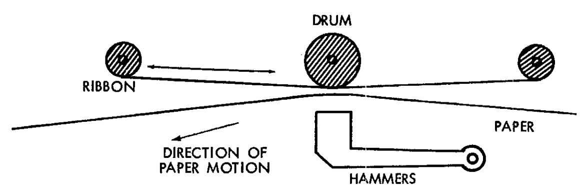


FIGURE 9. LINE PRINTER

Control of the characters which are to be printed each revolution of the drum (each line of printing) is effected by timing functions, one for each character. An impulse at one timing function will cause its corresponding character to be printed. If all print hammers were impulsed at "3" time, for instance, 120 "c's" would be printed on that line.

Printing format (spacing, carriage return, tabbing, etc.) is controlled in three ways. The programmer can control format by means of functional control characters written into his coding. The operator may control format by switch settings on the printer. The programmer or the operator can control the arrangement of printed output by two plugboards on the line printer buffer.

The function of the line printer buffer is to set up the impulses from the computer to activate the printing hammers at the proper timing function and control the paper advance solenoids. The buffer holds twenty words (120 characters). No information will be printed until:

a) the buffer is filled,

b) tab plug number 121 is encountered,

c) a carriage return character is sensed.

2. MANUAL CONTROLS AND SWITCHES

Printer Controls

a) Main Shaft Switch – applies power.

b) Automatic paper advance switch – this two position switch functions identically to the manual spacing controls located on the front of the printer (see below).

c) Manual Paper Free Run – causes paper to advance freely as long as it is depressed.

d) Manual Paper Single Step – will advance the paper one line each time it is pressed.

Buffer Controls

a) Power Switch – Applies DC Power.

b) Manual Reset – Clears buffer memory. Should be pressed before any printing operation to prevent the printing of leftover information from a previous run.

c) Manual Printout – When the computer is halted, pressing Manual Printout will cause the last line of information sent to the buffer from the central processor (being held in the buffer storage) to be printed out. Manual Printout must always be used at the end of printing in the Verbatim mode to cause the last line to be printed.

d) Mode Selector

Single – Causes single spacing in automatic mode. Line feed characters are ignored.

Double – Causes double spacing in automatic mode. Line feed characters are ignored.

Program – Allows printing under program control. The first character of each line is interpreted as a line-feed control character.

Verbatim – Prints information found in memory exactly as it is received – control characters printed as numeric information, etc. Printing is double spaced, 120 characters per line. Manual Printout must be pressed to print the last line in this mode.

e) Lines Per Page Switches – Lines printed before overflow to a new page is controlled by this set of six switches. These switches may be thought of as the six places of a six digit binary number. A switch up represents a one. Down, zero. The six switches, therefore, can be used to indicate any number of lines from 0-63.

f) Page Separation – The number of lines to be spaced at the top and bottom of each page is indicated by these two switches. The spacing effected by each switch setting is indicated by arrows above the switches themselves.

3. PLUGBOARDS

Two plugboards, located on the control panel of the buffer, control printing format. The tab plugboard controls column spacing in conjunction with programmed tab characters. The juxtaposition board may be used to alter the order in which columns are printed independently of programming.

a) Tab Plugboard

Fifteen sockets are provided on the buffer control panel for receiving up to fifteen tab plugs. Each of these sockets correspond to one of fifteen buffer locations. Each tab plug is wired to specify the buffer location (or print position) which is printed on the plug. Plugs must be inserted in adjacent sockets in ascending numeric order. A tab code in a program looking for a tab stop which has been omitted or passed will cause a device alarm.

A standard set of tab stops are normally used in the printer buffer. Operators seldom need change them. Should a programmer specify his own tab settings, when the program has been completed the standard plugs should be replaced.

b) Juxtaposition Plugboard

Normally the wires in the juxtaposition board are arranged so that information between the buffer and the printer is transmitted unaltered. Operators will probably not be called upon to change this board. By means of the juxtaposition board, however, the option is offered to transpose the relationship of the printing impulses between the buffer and the printing positions of the print drum by physically rearranging the wires.

4. OPERATION

a) Turning on power

1. Open the access panel at the front of the printer cabinet and set the line power circuit breaker in the on (up) position.

2. Set the d-c power supply circuit breaker on the front panel of the buffer cabinet in the on (up) position.

3. Check the d-c meter for a correct (27-28 volt) d-c output.

b) Loading the printer

1. Place a full bin of paper to rear of printer so that when it is fed into the machine the lined side will face up.

2. Place output bin in front of the unit.

3. Raise rear printer cover.

4. Lift the no-back bar at the front of the printer so that it will be held clear of the printing table while loading paper.

5. Remove the pressure pad assembly near the character wheel.

6. Pass the paper through the printer to the front of the cabinet passing beneath the character wheel. Raise the front cover and pull enough extra sheets through to provide slack for threading onto the tractor pins.

7. Raise the paper hold-down clamps over the tractor pins.

8. Lower the paper hold-down clamps and check that the paper is properly aligned across the printing table between the two tractors.

9. Replace the pressure pad and lower the no-back bar.

10. Advance paper manually so that pages are coordinated with the page separation control.

11. Lower the front and rear covers.

c) Automatic Operation

1. Check tab plugboard for standard stops.

2. Set lines per page and separation switches if special settings are requested.

3. Set Mode Switch as specified in the programmer instructions.

4. Press Manual Reset to eliminate any residual data in the buffer.

5. After any printing interruption press manual reset before restarting the computer.

d) Alarms

1. Stop Alarm – set whenever a stop code is read into the printer. No further printing can occur until the stop alarm is reset by the operator's pressing the Manual Reset Switch.

2. PTF (paper and ribbon feed alarm) – set when paper supply is exhausted or when there is no ribbon on the line printer.

3. PPE (Buffer Parity Alarm) – set whenever a parity error is sensed in the line printer buffer memory.

4. PBA (Buffer Timing Alarm) – set when the timing for the line printer buffer becomes out of phase with respect to the computer memory timing.

The setting of any of these alarms will cause the printer to halt and the device alarm indicator on the In-Out Processor to be lit. Each alarm may be reset by pressing Manual Reset on the Buffer Rack.

C. CARD READER/PUNCH AND BUFFER

1. DESCRIPTION

The 9400 Card Reader/Punch contains two independent devices mounted on the same base, which cannot be used simultaneously. The card punch operates at a speed of 100 cards / minute; the reader reads 200 cards/minute. This applies to Serial No. 1 machine only.

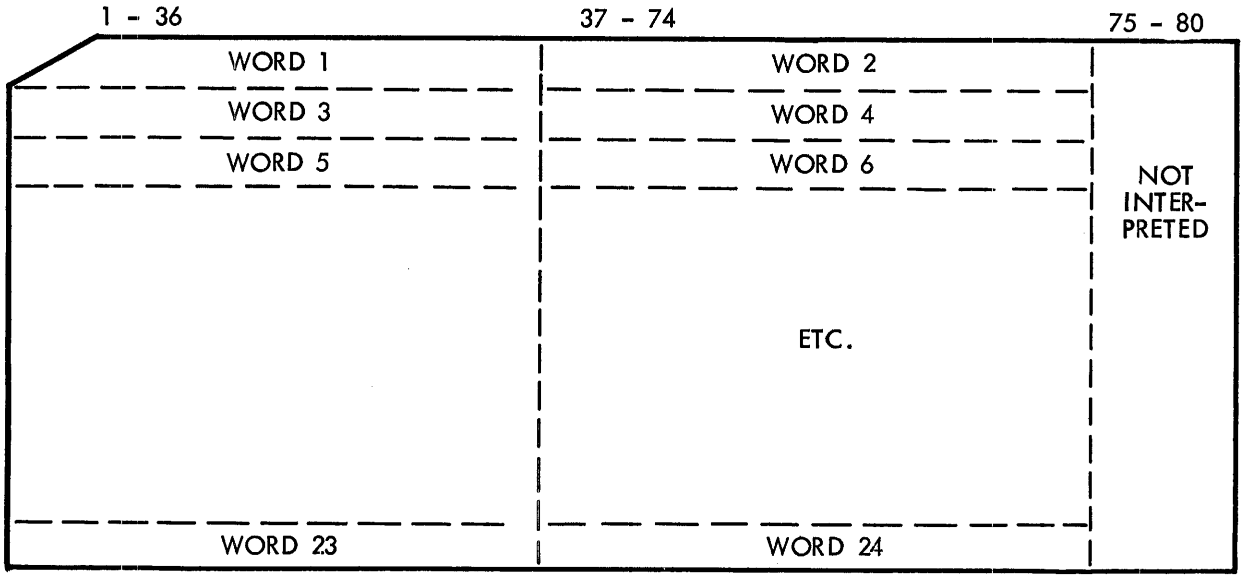
Linking the Card Reader/Punch with the I/O Processor is the Card Reader/Punch Buffer. The buffer receives and stores each word of information to be punched and transmits it to the devices in synchronization with the punch timing.

2. CARD FORMATS

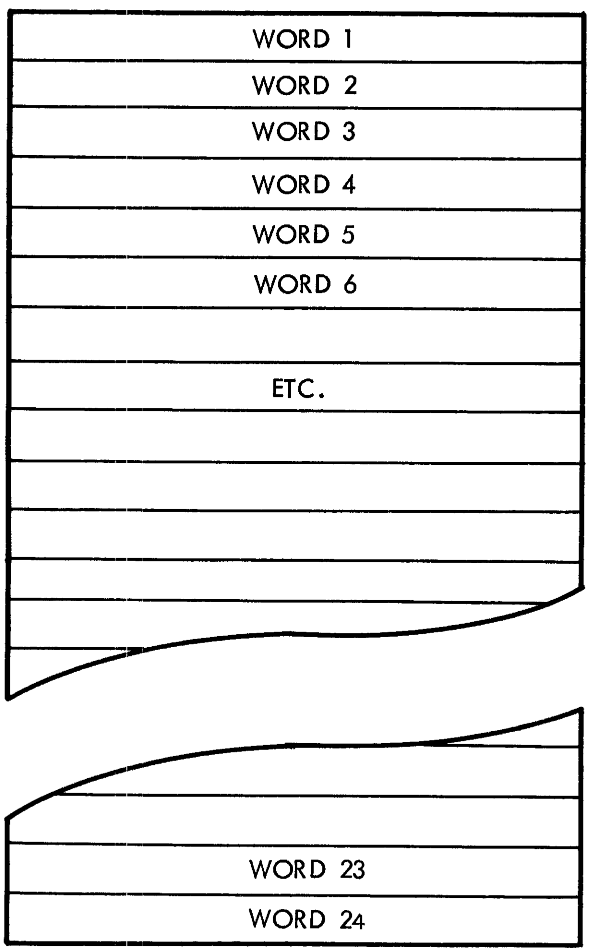
In accordance with two sizes of computer words and the manner in which they are handled in the machine two kinds of card formats must be considered. The two types of words are:

a) 37 bit words–instruction words and signed numeric data words which consist of 36 bits plus a sign bit. The sign position is interpreted as a part of the word (ISN word).

b) 36 bit words – These words are treated as 36 bits without a sign (NISN word).



WORDS AS APPEARING IN MEMORY



Reading in the ISN mode column 75-80 are ignored. Words are read into core from 12 row left, 12 row right, 11 row left, etc. Twenty four words are thereby formed in storage.

By the same token twenty-four words from storage are punched unaltered into cards in the same format.

FIGURE 10. CARD INTERPRETATION, ISN MODE

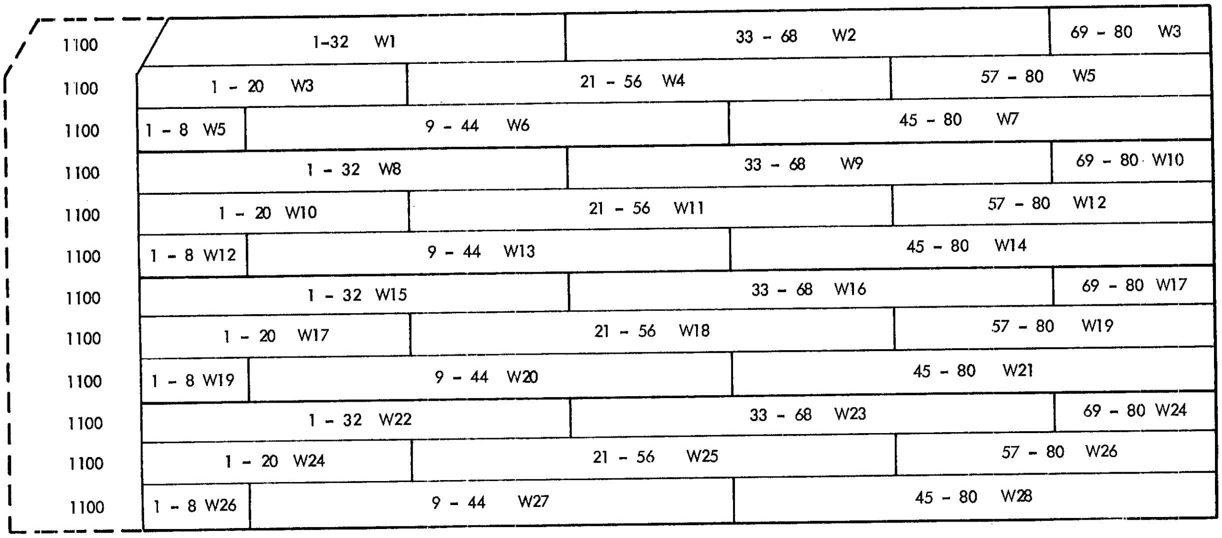


FIGURE 11. CARD INTERPRETATION,
NISN MODE

KEY: [1-32] CARD COLUMNS
[W 1] WORD NUMBER
[1100] BITS INSERTED

The above diagram illustrates the method by which data is read from cards into memory in the non-interpret sign mode. Since the card reader treats each card as if it had 84 columns, the data in the first 36 columns does not make up the first word in memory. Four bits are generated and inserted by the card reader buffer everytime the reader begins reading the contents of a particular row on the card. This results in a word configuration in memory with four extra bits per card row, 28 words per card.

To determine the position in a particular word that these bits occupy one need only to refer to the above diagram. As an example, the fifth set of inserted bits occupies the 12th through 15th bit positions of the tenth word read into memory.

When punching cards from memory the data in these bit positions are dropped by the card reader buffer and will not be punched. Therefore, a programmer, in order that no information is lost, must insert these bits in his output before attempting to punch information from memory in the non-interpret sign mode.

It is a function of the Hollerith to Fieldata conversion routines to compensate for the presence of these bits during reading and punching operations.

The computer must be told when reading or writing information whether to operate in the Interpret Sign (ISN) Mode or Non-Interpret Sign (NISN) Mode. This function is performed by the sensable ISN flip-flop. Manual ISN control is described above, Section II. Information written in one mode cannot be read in another, or visa versa. Such an operation in most cases will cause a Sign Error Halt by the I/O Processor, and in all cases, garbled information to be written from or read into core.

Except when loading a program operators should leave the manual ISN switch in neutral condition so that the flip-flop may be controlled by the programmer. If the program is correctly written, no sign errors should occur. Operators should leave ISN manually set only if specifically told to do so by the programmer.

Cards may be read or punched in one of two formats depending on the type of data being represented:

a) Binary Cards - Cards punched as output from an assembly (the object program) are in binary form. Information is represented in the card exactly as it was, or will be represented and processed internally. No conversion is necessary. Starting at the upper left hand row, the card contains the equivalent of 24 computer words, each containing 36 bits plus sign bit. <u>These cards must be read in the ISN mode</u>.

In the ISN mode columns 75 - 80 are not interpreted. Twelve row represents the word count and hashsum, which are selfchecking features, and the starting location, which tells the loader the location in core which the next 22 words will be read into. The way in which ISN cards are read into core is illustrated in Figure 10.

b) <u>Symbolic or Hollerith Coded Cards</u> - programs being assembled, and usually data cards are symbolic and are keypunched in Hollerith Codes (Appendix F). <u>These cards are normally read in the NISN mode.</u> All eighty columns are interpreted. Information read into the computer in Hollerith codes cannot be used until it is converted to fieldata codes or to binary with a conversion program. The order in which data is read from cards in the NISN mode and packed into words in core is illustrated in Figure 11.

3. CONTROL PANEL

Card formats are determined by control panel wiring. A removeable plugboard located under the card punch motor controls formats in both reading and writing. Normally the "standard" board will be kept in the Card Reader Punch. It should be removed only when the "MOBIDIC" board is requested by a programmer. Use of this board will cause cards punched to be compatible with the MOBIDIC Card Reader.

4. CARD READ OPERATION

a) <u>Checking Feature</u>

Cards fed into the card reader pass over two reading stations. The actual reading is done at the second station. The first station is used for checking: the data read as the card passes under the first station is held for one cycle until that same card is read at the second station. The data is matched and any disparity indicates a reading error and will cause an alarm.

b) Controls

1. Read Start

The card reader is "Readied" by depressing Read Start. A two cycle feed is initiated which will move the first card under the second read brushes and the second card under the first read brushes. When Load from Card Reader is pressed at the console the first card is read and the first instruction is executed. Normally this first instruction orders the machine to read in more cards, thereby initiating automatic operation.

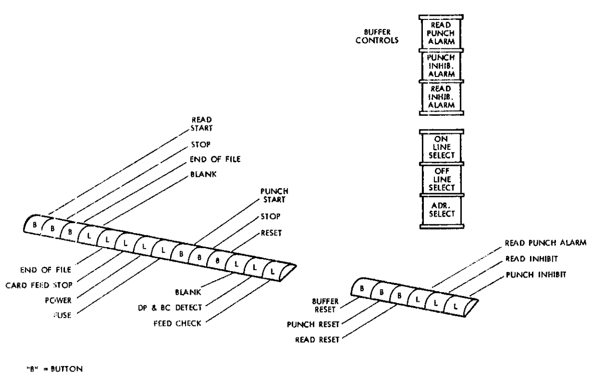


FIGURE 12.
CARD READER/PUNCH CONTROLS

2. Read Stop

The read stop pushbutton is used to stop automatic card reading. This control, used with the read reset pushbutton, permits single card reading under manual control.

3. Read Reset

The read reset pushbutton of the buffer controls is used to permit computer control of the read operation. When the button is pressed, the read inhibit indicator goes out and the equipment is ready for computer operation. This control is inoperative until the read mechanism has been loaded and is readied for operation by the read start control.

4. Read Inhibit

The read inhibit indicator of the buffer controls is lighted when power is applied to the reader-punch when the card hopper is empty, or when the card stacker is full. The light goes out when the read reset pushbutton is pressed, and the card hopper is loaded or the card stacker is emptied.

5. Read Punch Alarm

The read punch alarm indicator is used for either read or punch operations to indicate the card feed has been interrupted or d-c or a-c power has failed. After the card feed or power failure condition has been corrected, this indicator light goes out.

6. Card Feed Stop

The card feed stop indicator is lighted when cards fail to leave the card hopper. This indicator goes out once the feed failure condition has been corrected.

The end-of-file pushbutton and the end-of-file indicator light are not used. The unlabelled light between the end-of-file pushbutton and the end-of-file indicator is lit when the unit is not in "ready" status.

c) Card Reader Operations

Turning On Power

1. Set the main power switch in the on (up) position.

2. Check the power indicator at the front panel to see that power is on at its proper level.

Readying Reader for Automatic Operation

1. Load punched card deck into card reader feed hopper. Cards should be face down, twelve edge toward the machine.

2. Press Read Start pushbutton.

3. Press Read Reset and Buffer Reset.

4. The card reader can now be operated under program control.

Clearing the Read Mechanism

The read mechanism may be cleared at any time during operation by pressing the read stop pushbutton and removing the cards from the hopper. Then, the read start pushbutton is pressed to feed the remaining cards past the read stations to the card stacker without reading.

Refilling the Card Hopper

When the card hopper is emptied during operation, the read mechanism will stop with two cards unread and the read inhibit indicator will light. The read reset pushbutton is pressed to read the two remaining cards. If more cards are to be read, the hopper is reloaded and the read reset pushbutton is pressed.

Emptying the Card Stacker

When the card stacker is filled, the mechanism stops and the read inhibit indicator lights. The cards may be removed from the card stacker and operation restarted by pressing the read reset pushbutton.

Correcting Feed Failure

When feed failure occurs between the hopper and the first read station or between the first read station and the second read station, the read punch alarm lights. Feed failure is corrected by removing the cards from the card hopper and pressing the read start pushbutton until all cards are emptied from the card reader. Then the card hopper is reloaded and the reader is restarted.

If the first card fails to leave the card hopper, the reader is cleared, reloaded, and restarted. If feed errors reoccur, equipment failure or worn cards may be indicated.

5. CARD PUNCH OPERATION

a) Punch Controls

Punch Start

The punch start pushbutton is used to initiate the two-cycle card feed. When the button is pressed, the first card moves from the punch station to the read punch station. The second card is then moved from the hopper to the punch station. No punching is performed during the two-cycle card feed. The start control is inoperative after starting until the card hopper is empty.

Punch Stop

The punch stop pushbutton is used to stop automatic punching under control of the computer. This control, used with the punch reset pushbutton, permits single card punching under manual control.

Punch Reset

The punch reset pushbutton of the buffer controls is used to permit computer control of punching. When the button is pressed, the punch inhibit indicator goes out and the equipment is ready for computer operation. This control is inoperative until the punch mechanism has been loaded and readied for operation by the punch start control.

Punch Inhibit

The punch inhibit indicator is lighted when power is applied to the punch unit or during a punching operation when the card feed hopper is empty or stacker is filled. Operation is resumed when cards are inserted in the feed hopper, the stacker emptied, and Punch Reset is depressed.

Feed Check

When cards fail to feed during a machine cycle Feed Check is lighted.

DP and BC Check (Double Punch and Blank Column)

Blank column checking is a device commonly used to sense errors in punching. This check is not operative on the 9400.

b) Card Punch Operations

Preparing for Automatic Operation

1. Load blank (unpunched) cards into the punch card hopper, face down twelve row toward the punch unit.

2. Press the punch start pushbutton.

3. Press the Punch Reset pushbutton and Buffer Reset.

4. The card punch is ready to begin punching automatically under computer control.

Other Operations

Operations such as clearing the punch mechanism, emptying the stacker, and correcting a feed failure are carried out in a manner identical to those operations for the Card Reader (see 3d, above).

D. PAPER TAPE READER/PUNCH

1. General Description

The 9400 Paper Tape unit allows paper tape input or output on line. The unit consists of two independent units, a punch unit and a read unit, both built to Sylvania specifications and housed in a single cabinet designed for the 9400.

The punch unit prepares eight channel alphanumeric tape, punching at a rate of 100 characters per second in Fieldata codes. Tape read units available offer read speeds of either 1000 or 270 characters per second in the Free Running Mode or at 200 characters per second or any specified slower rate in the Stop-on-each-character mode. The tape may be fed from a short continuous loop, or from reels holding up to 1000 feet of tape. Reading is accomplished by photo-electric sensing device. The character image is picked up by a silicon photo-sensing head from a special light directed at the tape passing between it and the head.

2. Eight Channel Paper Tape

Eight channel paper tape is compatible with the 6 bit Fieldata alphanumeric codes which the 9400 is designed to handle. Each character is punched across the tape, bits 1-6 in channels 1 through 6. The tape is read by the machine so that channel one is considered the "inside" bit position, or the position closest to the machine. The tape is divided crosswise as follows:

a) Channel 1, 2, 3 – 1st three bits of Fieldata Code

b) Feed holes

c) Channel 4, 5, 6 – remaining three bits of Fieldata Code

d) Channel 7 – Control Character

e) Channel 8 – Parity bit ("even" parity, or total number of punches must equal an even number.)

3. Paper Tape Punch Operation

a) Loading Tape

Tape must be fed through the punch unit as illustrated in Figure 13. It is loaded as follows:

1) To gain access turn locking knobs at the top of the unit and slide it forward from the cabinet.

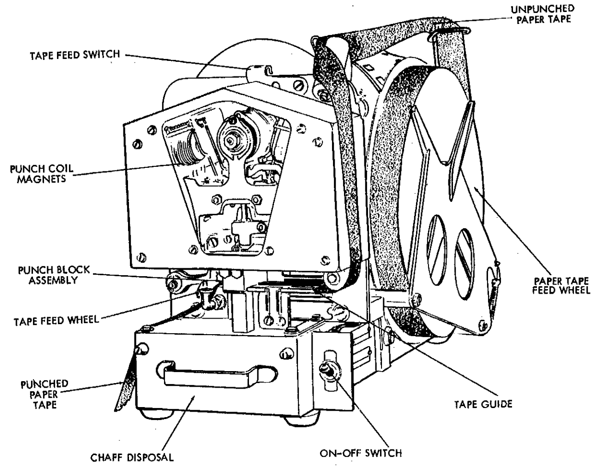


FIGURE 13. PAPER TAPE PUNCH

2) Place roll of unpunched tape on the paper feed reel so that it unrolls in a counter-clockwise direction from the bottom.

3) Feed tape through wire tape guide at rear of the unit and around the wood guide roller at the front.

4) Raise the spring loaded clamp on the tape feed wheel and insert the tape into the metal guide, across the punch block, and over the toothed feed wheel. (If the leading edge of the tape is not stiff it should be trimmed with scissors before attempting to load it through the punch block.)

5) To start automatic feeding of the tape depress the Tape Feed Switch at the top of the unit while gently pulling the leading edge of the tape.

6) Insert tape into take-up reel if necessary.

b) Power: Two toggle switches must be in "on" position -

1) Punch Power switch (at top of unit)

2) Take-up reel motor switch (at lower right hand corner)

The unit is now ready for automatic operation under program control.

c) Alarms

The following conditions will cause a device alarm: (machine halt and console alarm light)

1) When paper tape punch is physically disconnected when called in by a program.

2) When the power supply is interrupted.

3) When the tape is broken.

4) When there is not sufficient tape left on the feed reel.

During automatic operation operators should monitor the punch to prevent the occurrence of these conditions.

4. Paper Tape Reader Operation

a) Loading Reader

1) Tape is normally read from the upper reel. Place reel on the reader so it unwinds in a clockwise direction and the "narrow" side (with three channels between the feed holes and the edge) is closest to the machine.

2) Feed tape around tension control arms (see Figure 14).

3) Feed the tape between the clamp and reader photodiodes, turning the pressure roller control knob counter-clock-wise to allow free passage of the tape. To clamp the tape turn the pressure roller control knob clockwise until it clicks.

4) Check for free movement of the tape by manually moving it up and down past the reader.

5) Start tape on takeup reel if leader is long enough.

b) Switches

1) Place Start - Auto - Stop Switch on Auto.

2) Place Tape Reverse - Normal Switch on Normal.

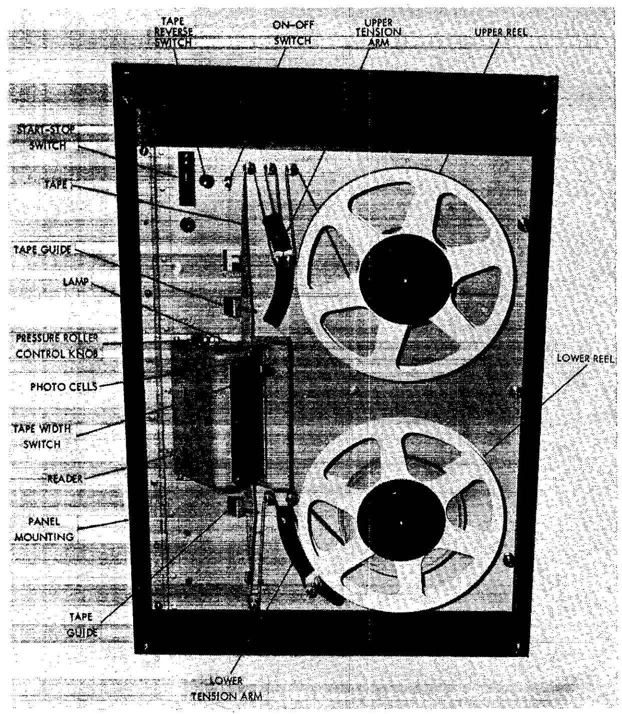


FIGURE 14. PAPER TAPE READER THREADING

3) Put On-Off Switch on On. The unit is now ready for automatic operation.

c) Rewinding

After a reading operation is complete tape that was read from the outside of the reel must be rewound.

1) Set Tape Reverse-Normal switch on Reverse.

2) Initiate rewind by switching the Start-Auto-Stop Switch to Start.

Tapes read from the inside of the reel need not be rewound.

d) Operation

1) Device Alarm: the computer will be halted and Device Alarm light turned on when the reader is physically disconnected or the power supply is interrupted.

2) Program Interrupt will occur in the program when a stop code (octal 57) is encountered and the EFI Switch has been set by the program.

3) Reading of tape can be stopped at any point and resumed without losing any information as breaking action occurs within .01 inch.

E. AUTOMATIC TYPEWRITER

1. Description

Low-speed output for the 9400 is offered by the automatic typewriter. It will write information from core storage in octal or alphanumeric modes at a rate of 575 characters a minute, entirely under program control.

Automatic transmission is one way only — as output. However, punched paper tape may be generated as a by-product of typing hard copy manually and in turn may be read into the machine by the paper tape reader. The flexowriter may therefore be considered as three parts: the electric typewriter, the paper tape punch, and the paper tape reader. The reader and punch are both external to the computer.

2. Switches:

a) On-Off Switch — main power switch

b) Local-Off-Receive Switch — for automatic operation use Receive position. In this status the Receive Indicator Light will be lit. Local position electrically disconnects the typewriter and allows manual operation.

3. Operations

Automatic (from computer)

a) Local-Off Receive Switch in "Receive" position.

b) All switches controlling the paper tape reader and punch are off.

c) The typewriter is under computer control.

Reading Tape

The typewriter will read and print-out tape as an independent unit. It is operated as follows:

a) Power Switch "On"; Local-Receive Off Switch to "Local".

b) Open the Tape Hold Down Arm by pressing downward and slide the leading end of the tape into the reader. The "narrow" side of the tape (that side with three channels between the pinion holes and the edge) must be closest to the keys.

c) Be sure feed holes have engaged the feed pins.

d) Close tape hold down arm.

e) Press Start Read.

Punching Tape

The unit will punch tape only when it is in "local" status, either reading a tape or being operated manually.

a) Power Switch "On"; Local-Receive-Off Switch in "Local" position.

b) Depress Punch On Switch.

c) Feed tape to be punched through the punch unit by pressing the Tape Feed switch.

d) Proceed to type, or if reading, press Start Read.

e) Errors: Correct an improper code by positioning it at the punch station and pressing Code Delete key.

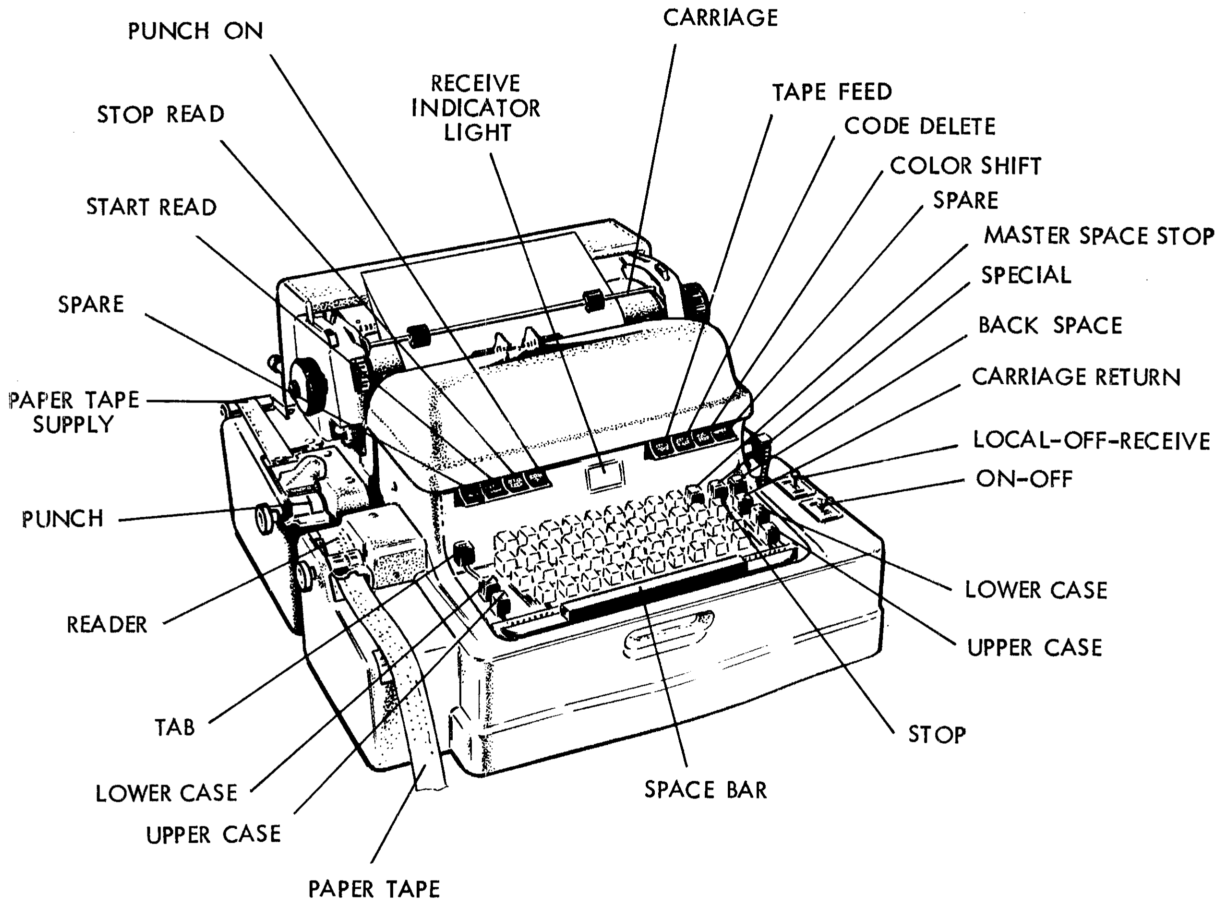


FIGURE 15. AUTOMATIC TYPEWRITER CONTROLS

V. 9400 UTILITY SYSTEM

A. SYSTEMS TAPE

1. PURPOSE OF THE SYSTEMS TAPE

Certain programs designated utilities or library routines must be used frequently in any computer installation. Such programs cannot be re-written by programmers each time they are needed. For reasons of convenience the programs should not have to be submitted and read into the machine as a part of each program to be processed. To provide an easily controlled and rapidly accessible store of frequently used programs is the function of the systems tape.

2. USE OF THE SYSTEMS TAPE

The systems tape will at all times be mounted on a unit with a logical address of 40. This tape should always be rewound (should be no problem since each routine on it is programmed to rewind the tape automatically) and the tape unit in "ready" status.

The tape contains library routines and utility programs. Library routines will be of little concern to operators as they are called in automatically by the Assembly Program.

Utility programs are requested by programmers on the instruction card submitted with each program. The operator must select the utility by means of a call card. Call cards contain the name of the utility to be called in punched in Hollerith code in columns 75 to 80, and a Search Key program. These cards are maintained in a special file at the console.

To call in a program from the Systems Tape, proceed as follows:

a) Set console switches as specified for the program being used. (See below, Section V B.)

b) Select the appropriate call card and place it in the card reader in front of any cards being read in as a part of the program.

c) Ready Card Reader (press read reset and read start).

d) Depress Load from Tape at the console. This operation automatically reads tape from MTU 40.

This procedure initiates the following sequence of automatic operations:

a) A program "read in" function on the systems tape causes the program punched into the call card in the card reader to initiate a Search Key operation on the Systems Tape.

b) The utility programs on the systems tape are searched until a key is found which matches the program specified by the call card. If no match is found a machine halt will ensue.

c) When the key is sensed the computer executes the instructions which follow, comprising a loader which causes the actual program which follows to be loaded into core.

B. UTILITY PROGRAMS

1. ASSEMBLY PROGRAM – 94AP

a) Purpose

To convert symbolic program decks into machine coded binary instructions as follows:

Pass 1

1) Reads in symbolic input from tape or cards.

2) Assigns absolute locations to each instruction beginning with the location specified by the origin card(s).

3) Generates a copy of the input to be used as a symbol table.

Pass 2

1) Rereads input and forms actual computer words by matching words with the symbol table according to interpretation of op or pseudo-op codes.

2) Brings in library routines from systems tape.

3) Generates output in the form of binary punched cards.

4) Produces assembly listing on line printer or on tape to be printed off-line.

b) Input

Tapes

1) Logical 40 - Systems tape

2) Logical 41 - Machine reel (scratch)

3) Logical 43 - Output (optional)

4) Logical 44 - Input (optional)

Symbolic Cards

1) Format

Col 1 -6	sequence
Col 7 -12	symbolic location
Col 14-19	operation code
Col 21-76	variable field
Col 77-80	identification

2) Deck Sequence:

Remarks Card - 1 must precede instruction cards

TCD - Causes preceding instructions to be punched followed by transfer card to the address specified.

END - Causes binary output to be punched or signals end of MACRO definition.

FIN - Marks end of a group of stacked assemblies.

c) Console Switch Settings:

SFF1	Set Reset	card input tape input (44)
SFF3	Set Reset	output on LPR no LPR output
SFF4	Set Reset	output on MT 43 output on paper tape

d) Operating Procedures

1) Select "Assembly" call card and place in front of the deck.

2) Place one blank card in front of the deck if no remarks cards are present.

3) Place call card and symbolic input in card reader and ready card reader.

4) Ready card punch

5) Set console switches

6) Check tapes for proper logical addresses and "ready" status.

7) Press load from MTU

e) Stops

1) HLT-1 (pass 1) - Symbol table is too large.

2) HLT-2 (pass 2) - Hashsum error. Possible machine failure. Press start to ignore.

3) HLT at 7771 - Error in symbol table.

4) HLT-1 (pass 1) - Final stop.

2. Transfer Trace (94TTR1)

a) Purpose

Provides the programmer with a "snapshot" of the console each time a transfer order is trapped. The orders that are trapped are: TRU, TRP, TRN, SEN, TRZ, TRL, SNS, SNR, TRX and TRS.

b) Input

Tapes

Systems Tape - 40

Scratch Tape - 41

Machine Reel (output) - 43

Cards

94TTR1 Call Card

Binary Program Input

c) Switch Settings - None; as required by object program only.

d) Operating Procedures

1) Place cards in card reader, TTR1 Call Card first, then binary cards.

2) Proceed with normal operation as required by the object program.

3) Output for the trace will be printed on the line printer.

3. Core and Tape Dump (94DMP)

a) Purpose

Causes contents of specified core locations and all registers to be printed on the line printer or written onto tape. The tape dump causes a specified number of words on tape to be printed or written in Fieldata on output tape. Core may be restored upon request after a core dump is completed.

b) Input

Tapes

1) Systems tape - 40
2) Scratch tape - 41
3) Output tape - 43 (optional)
4) Input (if a tape dump) - per WSR

Cards

94DMP call card

c) Switches

The Word Switch Register is used to specify core or tape dump, format of output, and number of words to be dumped. Tape output ("off-line") is not applicable at present.

Core Dump Request

WSR	Octal Value	Interpretation
Sign	0 (up)	Specifies Core Dump
1-3	0	Must be zero on dump request
4-6	0	Error — will cause stop
	1	No Op-codes; No on-line; off-line
	2	No Op-codes; on-line; no off-line
	3	No Op-codes; on-line; off-line
	4	Error — will cause stop
	5	Op-codes; no on-line; off-line
	6	Op-codes; on-line; no off-line
	7	Op-codes; on-line; off-line
7-21	XXXXX	First location to dump
22-36	XXXXX	Last location to dump

Restore Core Request

WSR	Octal Value	Interpretation
Sign	0 (up)	This is a core request
1-3	4	Restore Core and halt
	5	Restore core and resume automatic operation at location shown in 22-36
	6	Restore core and resume from original PCS
4-21	0	Not interpreted
22-36	XXXXX	Transfer location to resume operation

Tape Dump Request (2 Words)

First Word in WSR:

WSR	Octal Value	Interpretation
Sign	1 (down)	Specifies Tape dump
1-6	XX	Address tape unit
9	Up	Do not rewind input tape
	Down	Rewind input tape
12	Up	Do not skip on input tape
	Down	Skip on input tape
15	Up	Skip forward
	Down	Skip backward

18	Up	Do not count files to skip
	Down	Count files to skip
19-24	XX	Number of files to skip
27	Up	Do not count blocks to skip
	Down	Count blocks to skip
28-36	XXX	Number of blocks to skip

Second Word in WSR:

WSR	Octal Value	Interpretation
Sign	1 (down)	Tape dump
1-3	0	Error (No anything)
	1	No Fieldata; no on-line; off-line
	2	No Fieldata; on-line; no off-line
	3	No Fieldata; on-line; off-line
	4	Error (no anything)
	5	Fieldata; no on-line; off-line
	6	Fieldata; on-line; no off-line
	7	Fieldata; on-line; off-line
4-9	XX	Number of files to dump (if zero, dump one file).
12	Up	Do not count blocks
	Down	Count Blocks
13-21	XXX	Number of blocks to count
24	Up	Do not count words to dump
	Down	Count words to dump
25-36	XXXX	Number of words to dump (if zero, dump entire block)

d) Operating Procedures

Core Dump:

1) Do not clear the machine

2) Load 94 DMP call card followed by a blank card into card reader and ready the reader.

3) Set WSR as requested

4) Press "load from MTU"

Tape Dump:

1) Load 94DMP call card followed by a blank card into card reader and ready the reader.

2) Enter first word in WSR

3) Press "Load from MTU"

4) After first machine halt enter second word in WSR

5) Press "Load from MTU"

e) Stops

1) HLT 1 – Error halt; no output media specified

2) HLT 2 – WSR is not set

f) Programmers may submit card requests for certain dumps. In this case the WSR is not required. The programmers' request card is placed behind the 94DMP call card, loaded into the Card Reader, and Load from Tape pressed.

4. In-Out Scheduler (94SKED)

a) Purpose

Handles all input and output automatically scheduling units so maximum efficiency is achieved

b) Input

Tapes

1) Systems tape – 40

2) Scratch tape – 41

3) Those tapes required by the program

Cards

94SKED call card

Cards involved in the program

c) Switches – only those specified by the programmer

d) Procedure

1) Ready systems tape, scratch tape, and those tapes required for the program.

2) Place 94SKED call card followed by program input in the card reader and ready the reader.

3) Set console as specified by the programmer and initiate automatic operation by pressing "Load from MTU".

C. OTHER SYSTEMS TAPE ROUTINES

Also on the systems tape are library routines which are called in by the assembly program, and additional utilities. For the utilities, call cards are simply placed in front of the programmers' deck. No special switch settings are required.

VI. MACHINE ROOM PROCEDURE

A. COMPUTER OPERATIONS ORGANIZATION AND RESPONSIBILITIES

The organizational structure of 9400 Computer Operations is illustrated by the block diagram below (Figure 16).

The general task of the 9400 Computer Operations Group is to manage as efficiently as possible the 9400 Computer, responsibility including broad areas which influence expeditious machine operation directly or indirectly. These areas include maintenance of the Utility Package, providing documentation of all utility routines and programs in the program library, control of machine maintenance standards, and ensuing liaison with programming groups, the 9400 Computation Office, Contracts Office, and the Product Support Group.

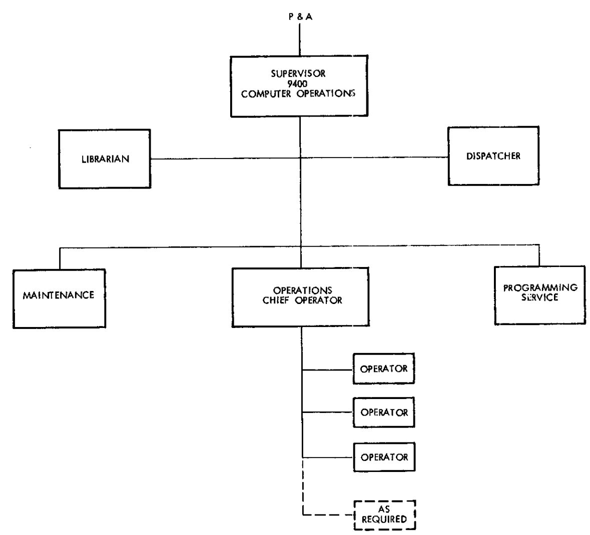


FIGURE 16. 9400 COMPUTER OPERATIONS ORGANIZATION

The Dispatcher is responsible for preparing and enforcing the computer schedule, expediting the machine room workflow, monitoring the assignment of magnetic tapes, and compiling and distributing accurate machine usage and analysis reports.

Operators are responsible for the following:

1. Maintaining all equipment and the computer area itself within the limits specified as Operator Maintenance.

2. Run all programs efficiently and accurately, and in the sequence specified by the dispatcher.

3. Accurately record time to be charged programmers, and, during time not chargeable to programmers, assign time to the proper usage code.

4. Record all information concerning stops and running characteristics which might be of value to the programmer. If the programmer is present, offer all possible assistance in helping him determine the source of unprogrammed stops or results.

5. Devote all free time to learning as much as possible about the machine itself and about programming.

B. OPERATOR MAINTENANCE

Once each eight hours of operation regular operator maintenance must be carried out on all machine units. Normally the operator maintenance period will be at the beginning of each shift, immediately following engineering preventative maintenance (PMT). Whenever possible certain Operator Maintenance tasks should be carried on during PMT when they in no way interfere with the activities of the engineers.

The following maintenance operations will be carried out:

1. CONSOLE AREA AND FLEXO TABLE

a) Dispose of all miscellaneous papers and cards. All items which may be of value give to the dispatcher.

b) Check call cards to be sure all cards are available and in their proper place.

c) Test clock to be sure it is accurately set, the ribbon is making a clear image, and the proper data is being stamped.

d) Wipe console and table with a damp cloth to remove all fingerprints, stains, and dust.

e) Lower engineer's control console if it is in its raised position.

2. MAGNETIC TAPE UNITS

These procedures consist of frequent cleanings of the critical surfaces which contact the tape during transport operation. These surfaces (described below) should be inspected for dirt and dust and in particular for tape-oxide buildup every eight hours of tape-moving operation, and always just prior to critical write or read operation.

It is suggested that a brush with medium-stiff bristles be used to brush loose oxide and dust away from the heads, capstans, pinch-rollers, brakes, and rollers before other cleaning methods, described below, are begun. <u>All these cleaning procedures should be performed with no tape threaded on the transport.</u>

a) Heads

In order to clean the heads a lint-free cloth should be used. A portion of such a wiper should be moistened with magnetic head cleaning solvent and used to dissolve and wipe away any oxide or other foreign substances from the surfaces of the heads. The surfaces should then be wiped finally clean with a dry portion of the cloth. Be careful not to touch the cleaned head surface after this is completed.

b) Capstans and pinch rollers

The capstans and pinch rollers should be treated in a manner similar to that described above for the heads. They should be rotated and all portions carefully cleaned and wiped dry. Never clean these components while they are motor-driven, as the cloth used may be drawn between them and possibly cause serious damage. For cleaning purposes they may be turned by hand. Since they are driven by the same belt, the capstan not being cleaned may be turned by hand and will cause the other one to rotate.

c) Brakes and brake posts

Since these are fixed elements and cannot be rotated, they must be cleaned by inserting the cleaning wiper into the relatively narrow gap between them. Care should be exercised not to leave any shreds of wiping cloth between them where they could interfere with operation or could be carried by the tape to other assemblies.

d) Rollers

All the rollers should be cleaned by the above method, using head-cleaning solvent and drying them afterwards with a clean wiper. All the rollers may be rotated by hand during cleaning. This includes the rollers at the openings of the vacuum buffer chambers, which are accessible at the top and bottom of the buffer assembly.

e) Leaders

Inspect leaders and female connecting tabs for signs of wear and the need for replacement.

3. CARD READER/PUNCH

a) Turn power off.

b) Empty the storage box under the punch unit of all bits and remove any grease or oil smears with a clean, lint-free cloth.

c) Clean the card paths of both the reader and the punch.

4. LINE PRINTER

a) Clean the observation windows and dust catching areas inside the protective hood with a soft, lint-free cloth. A non-scratching, plastic cleaner should be used to remove fingerprints and smudges from the Plexiglass observation windows. Do not use glass cleaner or abrasives.

b) Clean the rubber platen used for ribbon feed with a lint-free cloth and alcohol to remove grease and lint.

c) Clean paper feed trays.

d) Check a sample of printing for line spacing, clarity and linearity.

e) Inspect ribbon for wear.

5. FLEXOWRITER

a) Clean the reader and punch units of any chaff, dust, oil or grease with a lint-free cloth.

b) Check type bars for dirty type face. If necessary clean the type with a stiff brush and type cleaning fluid.

c) Check the ribbon; if it is worn, change it.

6. PAPER TAPE READER/PUNCH

Punch

a) Empty bit storage device and wipe off all signs of lubricating oil or grease with a lint-free cloth.

b) Clean dust-catching areas of the motor and base unit with a clean, lint-free cloth.

c) Check paper tape supply.

Reader

Keep unit clean by wiping carefully with a clean lint-free cloth.

7. GENERAL

Operators are charged with responsibility for the general neatness of the computer area. All printouts should be sent to the dispatcher's area. Tapes not being used must be kept in the tape cart. As soon as programs have been processed they should be returned to the tape cart and not allowed to remain on the top of the card reader or the console.

C. LOGGING MACHINE TIME AND PERFORMANCE

During the shifts scheduled for machine use, every minute of computer time must be accounted for. It is the responsibility of the computer operators and the dispatcher to ensure that this is done.

1. CARDS AND CODE DEFINITIONS

Two cards are provided to record machine usage. Programmer usage time is accounted for on the 9400 Job Card which must be submitted for each program run. Operators under no condition shall accept a program without a Job Card that has been approved by the dispatcher (indicated by a date stamp), even when the machine is idle.

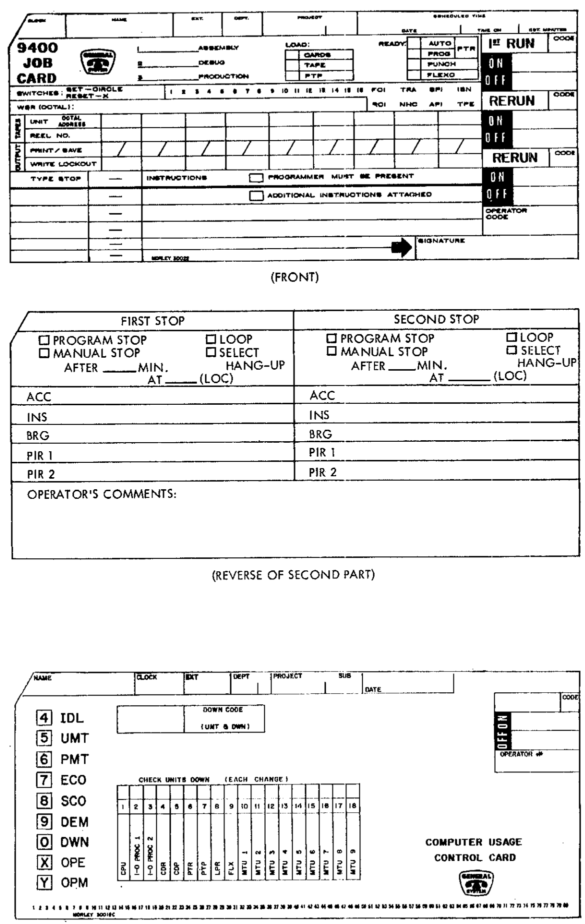


FIGURE 17. 9400 JOB AND CONTROL CARDS

All non-productive machine time must be accounted for on the 9400 Control Card. All time can be classified under one of twelve headings. 1-3 are productive: Assembly, debug, and production runs. These appear in the Job Card.

Codes 4 through 12 are in general considered non-productive. These are shown on the Control Card. The definitions of each category are given below.

4. IDL (Idle) - Time when the machine is in operating condition, but not being used in any way. Normally occurs when no work is available.

5. UMT (Unscheduled Maintenance) - Time lost due to machine unit malfunction which is chargeable to engineering maintenance. Includes time lost running the program on which the malfunction manifested itself, time spent by operators in diagnosing the trouble, and correction of the malfunction as long as it prevents the use of the machine.

6. PMT (Preventive Maintenance) - Daily scheduled maintenance by engineers, usually at the beginning of each shift. If this session lasts longer than the time scheduled, overrun becomes UMT.

7. ECO (Engineering Checkout) - Scheduled engineer time for system modification, analysis, or checkout (normally an entire shift).

8. Not used at present.

9. DEM (Demonstration) - Time used running demonstrative programs which prevent the use of the machine for productive purposes. Should be charged to a project number.

10. DWN (Down) - Machine is inoperative due to machine failure when no action is being taken and a charge to engineers is not authorized. An example is when machine is down due to power failure or air conditioning malfunction.

11. OPE (Operation Error)

12. OPM (Operator Maintenance) - Time used on the machine by operators which uses or prevents the use of the machine.

a) Preventive - Activities such as cleaning tape units, checking tapes, or generating systems tapes.

b) Unscheduled - Time lost when tape causes tape checks to occur during running of a program and for extra cleaning of tape units. Changing the tape and re-running the program is chargeable to the programmer.

2. Clocking Job Cards and Control Cards

An electric clock and time stamp is located on the flexowriter table. Cards must be clocked in as soon as the main frame may be released from the program being completed. Whenever possible, tapes for the next program to be run should be set up while the machine is still working on the prior run. Cards should be clocked in rapid succession so that the clock cannot advance between the two programs. Such a situation causes one minute of machine time to be lost.

Should a machine malfunction or operator error cause time to be lost, procede as follows:

a) Clock out the programmer's Job Card.

b) Place an "X" in the "code" box next to the appropriate run – this indicates that the time is not to be charged to the programmer.

c) Select a Control Card, and write in manually the same "Time On" which was clocked on the programmer's Job Card. This card must account for all time lost including the time the program was running.

d) Encircle the proper code on the Control Card and write in appropriate remarks.

e) When malfunction has been corrected clock out the Control Card and Clock in the Job Card in the space for "Rerun".

f) Process the program and clock it out in the normal manner.

3. Logging Configuration

For purposes of gathering statistics on machine performance and unit reliability several items must be logged on the Job Card and Control Card.

a) During programmer usage the Configuration Code must be entered on the Job Card for each run. The codes will be posted near the console for operator reference.

b) Unit Performance must be indicated on the Control Cards once at the beginning of the 1st shift daily, once at the end, and each time a change in the availability of units occurs. Entries are made in the matrix appearing on the Computer Control Card simply by checking the area provided for each unit for those units which are down.

c) Example:

All units are working and a program is being run. Repeated device alarms on I-O Processor 1 indicates that it may be malfunctioning. The following is done:

1) Job Card is clocked out.

2) The maintenance engineers are called immediately.

3) The time the program had started is manually entered on the Control Card.

4) When the engineers confirm the processor is down "UMT" is circled on the Control Card and I-O Processor 1 in the matrix checked. The proper "Down Code" is also entered.

5) When the unit is properly functioning and the program is to be re-run the Control Card is clocked out, and the Job Card clocked in at "Rerun".

6) A second control card must be initiated to show that the Processor is now "up". Since all units are once more functioning do not indicate any codes or check any units. Simply clock in "time on".

7) If it had been decided to run the computer without I-O Processor 1, the second control card would not be required.

In general, "Down Code" indicates the type of malfunction on the type unit. A table of these codes will be available to operators.

Unit performance code indicates what unit is down for how long.

4. Other Job Card Entries

The Job Card is also used to relay information on stops and running characteristics back to the programmer. This information must be written on the back of the second part of the Job Card. Operators must not obliterate the information on the front of the second part of the job card when writing on the back. To prevent this the operator may 1) fold over the carbon, 2) open up the card, or 3) place a scrap card between the carbon and the second part.

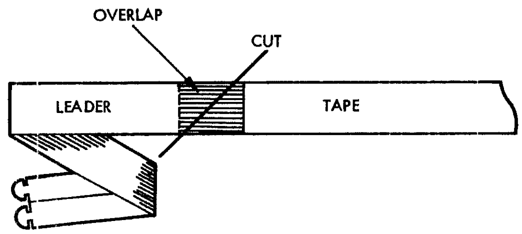
When the program is clocked out the Job Card may be separated. The second part should be placed on top of the deck to be returned to the programmer. The first will be retained at the console for current reference. These cards are picked up by the dispatcher each day, checked, and sent to EAM for keypunching. The punched cards serve as input for all computer usage and performance reports.

D. TAPE CHECKING AND TRIMMING

All machine reels will be periodically checked by the operators as a preventive measure. This operation will be carried out off line when the off-line control unit is available. Bad spots usually develop near the beginning of tape since this area receives by far the most use. To remove these defective areas the tape must be trimmed beyond this spot and the leader and reflective strip moved to the new beginning of tape. (See Figure 18)

After trimming a tape all information before the reflective strip must be erased. This is accomplished with a "manual write" as follows:

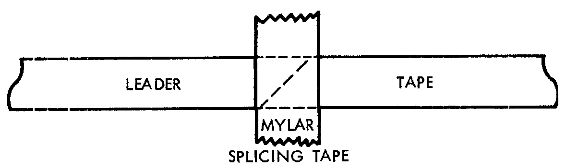
1. Mount tape
2. Place mode control at "manual".
3. Place selector switch at "FWD".
4. Turn manual control to "Manual Write". Advance the tape until the reflective strip has passed over the read/write head. When tape is halted, it is ready to be written in the automatic mode.



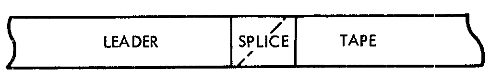
1. Cut leader where it joins tape with scissors.

2. Cut tape about one foot beyond the bad spot.

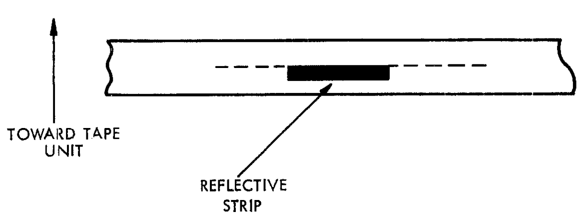
3. Overlap the end of the leader which will be spliced to the tape and the tape end. Cut through both. The leader will now mate perfectly with the tape.



4. Place the tape on a smooth working surface shiny side up. Match leader and tape so that no space shows between the two. Place strip of mylar base splicing tape across the juncture and press firmly.



5. With scissors trim the ends of the splicing tape so that they are just flush with the edge of the tape.



6. Unwind about six more feet of tape and affix reflective strip on the back (shiny) side of the tape. Inside edge of the tape should be on the imaginary center line of the tape. Care must be taken not to touch tape beyond point where strip is placed.

7. Mount tape and manually tape erase from the leader to a point well beyond the reflective strip.

FIGURE 18. TAPE TRIMMING

SYLVANIA 9400 SYSTEM - INSTRUCTION REPERTOIRE

INSTRUCTIONS

o = can be trapped   † = can cause overflow
* = not indexable   pw = per word

Octal Code	Symbol	Fields Used	Timing μsec	Function
24*	ADB	a, i, m	13	Add Modifier
12+	ADD	a, i, m	8	Add
13+	ADM	a, i, m	8	Add Magnitude
11	CAM	a, i,	8	Clear and Add Magnitude
10	CLA	a, i,	8	Clear and Add
14	CLS	a, i,	8	Clear and Subtract
15	CSM	a, i,	8	Clear and Subtract Magnitude
35	CYL	a, i,	8-37	Cycle Long
34	CYS	a, i,	8-37	Cycle Short
22+	DVD	a, i, m	44	Divide
23+	DVL	a, i, m	44	Divide Long
57+	FAM	a, i, m	12-46	Floating Add Magnitude
56+	FLA	a, i, m	12-46	Floating Add
27+	FLD	a, i, m	40	Floating Divide
26	FLM	a, i, m	37	Floating Multiply
60+	FLS	a, i, m	12-46	Floating Subtract
61+	FSM	a, i, m	12-46	Floating Subtract Magnitude
00*	HLT		8	Halt
53*	LXS	a, i, m	8	Load Index
03	LGA	a, i	8	Logical Add
02	LGM	a, i	8	Logical Multiply
04	LGN	a, i	8	Logical Negate
51	LOD	a, i, m	9	Load
21	MLR	a, i	43	Multiply and Round
20	MLY	a, i	43	Multiply
52*	MOV	a, i, m	13	Move
55	MSK	a, i	11	Mask
37	NRM	a, i	9-27	Normalize
54	RPA	a, i	11	Replace Address
01	RPT	a, i, m	8	Repeat
25*	SBB	a, i, m	13	Subtract Modifier
17+	SBM	a, i, m	8	Subtract Magnitude
05°	SEN	a, i, m	8	Sense
30+	SHL	a, i, m	8-22	Shift Left

Octal Code	Symbol	Fields Used	Timing μsec	Function
32	SHR	a, i	8-19	Shift Right
31+	SLL	a, i, m	8-40	Shift Left Long
07°	SNR	a, i, m	8	Sense and Reset
06°	SNS	a, i, m	8	Sense and Set
33	SRL	a, i	8-37	Shift Right Long
50	STR	a, i	8	Store
16+	SUB	a, i, m	8	Subtract
47	TRC	a, i	11	Compare
41*°	TRL	a, i, m	8	Transfer and Load Program Counter Store
46°	TRN	a, i	8	Transfer on Negative
44°	TRP	a, i	8	Transfer on Positive
42°	TRS		8	Transfer to Program Counter Store
40°	TRU	a, i, m	8	Unconditional Transfer
43*°	TRX	a, i, m	11	Transfer on Index
45°	TRZ	a, i	8	Transfer on Zero
67*	BSP-	s, c	8	Backspace Mag. Tape
	B			Backspace c blocks
	F			Backspace c files
70*	RAN-	a, s, c	8+4	Read Alphanumeric
	W		pw	Read c words
	B			Read c blocks
72*	ROK	a, s, c	8+4 pw	Read Octal
71*	RRV-	a, s, c	8+4	Read Reverse
	W		pw	Read c words
	B			Read c blocks
77*	RWD	s	8	Rewind
66*	SKP-	s, c	8	Skip
	B			Skip c blocks
	F			Skip c files
74*	WAN	a, s, c	8+4 pw	Write Alphanumeric
76*	WOK	a, s, c	8+4 pw	Write Octal
75*	WWA	a, s, c	8+4 pw	Rewrite Alphanumeric

ORDER SEQUENCE ORDERS

Octal Code	Symbol	Fields Used	Function
62	SS****	a, s	Initiates Order Sequence for I/O Processor
	S		Interpret Sign
	N		No halt on I/O Processor error
	E		Erase during all writes
	1 through 4		Use I/O Processor No. 1 through No. 4
05	DS	a	Special I/O Device Sense Order for sensing I/O device status prior to executing sequence
63	ST-		
	D		End Sequence, and disconnect I/O Processor
	I		End Sequence, and interrupt Central Processor and disconnect I/O Processor
63	PT-	a	
	U		Transfer sequence to a.
	I		Transfer sequence to a and cause an end-of-order interrupt in the central processor
63	PS-**	a	
	O		If IMO transfer to a
	T		If TRE transfer to a
	S		If ISE transfer to a
	P		If IPE transfer to a
	A		If any of above transfer to a
63	PR-***	a	Same as PS except RESET error alarm (s) before transferring
66	SP-	c	
	B		Space c blocks
	F		Space c files
67	BS-	c	
	B		Back space c blocks
	F		Back space c files
65	WK	a	Write key .
64	SK-	a	Search for key and:
	B		NKY Interrupt on BLE
	F		NKY Interrupt on EOF

Octal Code	Symbol	Fields Used	Function
77	RW		Rewind Magnetic tape
74	GW--	a, c	Gather Write c words starting from location a
	W-		Write c words without termination marks
	B-		Terminate with block end marks
	F-		Terminate with end of file marks
	-P		Procede in sequence
	-I		Interrupt Central Processor and Proceed
	-D		Interrupt Central Processor and disconnect
75	WW--	a, c	Rewrite c words starting from location a. Same controls as GW
70	SC - - -*	a, c	Scatter Read starting at location a
	W--*		Read c words and terminate
	B--*		Read c blocks and terminate
	S--*		Read c words or to BLE marks and terminate
	K--*		Read forward and terminate after next key
	-A-*		Store all words
	-K-*		Store key words
	-D-*		Store data words
	-N-*		Store no words
	--I*		Interrupt Central Processor and proceed
	--D*		Interrupt Central Processor and disconnect
	--P*		Proceed in sequence
	--X		Scatter Read starting at location a
	---F		Enable EOF interrupt

\- mandatory suffix(s)
* optional suffix(s)

LIST OF ADDRESSABLE REGISTERS

Code	Address*	Name
	00000-77737	Memory Storage locations
ir1	77741	Index Register 1
ir2	77742	Index Register 2
ir3	77743	Index Register 3
ir4	77744	Index Register 4
acc	77750	Accumulator
qrg	77751	Q-Register
brg	77752	B-Register
pct	77753	Program Counter
pcs	77754	Program Counter Store
cio	77755**	Instruction register of In-Out Processor receiving the input order
afr	77756	Alarm Switch Register (composite of all alarm switches)
war	77760	Word Switch Register
rar	77761	Real-Time Address Register
ror	77762	Real-Time Output Register
ci1	77770	Instruction register of first In-Out Processor
ci2	77771	Instruction register of second In-Out Processor
ci3	77772	Instruction register of third In-Out Processor
ci4	77773	Instruction register of fourth In-Out Processor
	——***	Nonexistent register

*In octal.

**When used as the address of an input instruction, it tells the In-Out Processor to store the contents of its buffer register in its instruction word register.

***If a nonexistent register is addressed, it will be interpreted as a location which contains all 0's.

I/O Address Assignments

Address*	Name
14 or 15	Card Reader
16	Line Printer
20	Paper Tape Reader
22	Paper Tape Punch
26	Automatic Typewriter
40 - 57	Magnetic Tapes

*In octal.

LIST OF SENSABLE SWITCHES

m (Octal)	Code	Description	Can be SET by Program	Can be RESET by Program	Console-Switchable Momentary	Console-Switchable Lock
0001 - 0077	IOD	In/Out Device Busy Signals	-	-	-	-
0100	OA	Overflow Alarm	X	X	-	-
0102	ISN	Interpret Sign	X	X	X	-
0103	NHC	No Halt Control on I/O Processor Error	X	X	X	-
0104	RPE	Real Time Parity Error	-	X	-	-
0105	ROBB	Real Time Output Busy Bit Signal To Kineplex	X	-	-	-
0110-0117	SFF_{1-8}	Sense Control 1-8	X	X	-	X
0120-0127	SFF_{9-16}	Sense Control 9-16	X	X	-	X
0130-0133	IOA^{1-4}	In/Out Alarm FF in I/O Processor 1-4	-	X	-	-
0134	UA	Underflow Alarm	X	X	-	-
0135	TPE	Tape Erase	X	X	-	-
0136	API	Alarm Program Interrupt	X	X	X	-
0150	FCI	Functional Control Character Interrupt	X	X	X	-
0151-0154	FCC^{1-4}	Read Functional Control Character IOP^{1-4}	X	X	-	-
0155	ROSN	Real Time Output Interpret Sign	X	X	-	-
0156	RISN	Real Time Input Interpret Sign	X	X	-	-
0157	TOT	Transfer Order Trapped	X	X	-	-
0160	SPI	Stop Program Interrupt	X	X	X	-
0161	ETI	End Tape Interrupt (Allow End Tape Signal To Interrupt)	X	X	-	-
0162	EFI	End of File Interrupt (Allow End of Tape Signal to Interrupt)	X	X	-	-
0163	RCI	Real Time Control Character Interrupt	X	X	-	-
0164	RINC	Real Time Control Character Input	-	X	-	-
0165	ROTC	Real Time Control Character Output	X	X	-	-
0166	WEF	Write End of File	X	X	-	-
0167	WCC	Write Control Character	X	X	-	-
0170-0173	ETA^{1-4}	End of Tape Alarm IOP^{1-4}	X	X	-	-
0174-0177	EOF^{1-4}	End of File Alarm IOP^{1-4}	X	X	-	-

LIST OF PROGRAM INTERRUPT ACTIVITY SWITCHES AND LOCATIONS

Function	Signal	Octal	Function	Signal	Octal
In-Out Processor Busy	PRB	0	End of Order Interrupt	EOI^1	14
				EOI^2	15
Device Busy	DVB	1		EOI^3	16
				EOI^4	17
Transfer Order Trapped	TOT	2			
			Functional Control Characters	FCC^1	20
Real Time Input Control Character	RINC	3		FCC^2	21
				FCC^3	22
				FCC^4	23
End of File	EOF^1	4	No Key	NKY^1	24
	EOF^2	5		NKY^2	25
	EOF^3	6		NKY^3	26
	EOF^4	7		NKY^4	27
			Device Trouble	DVT^1	30
End of Tape	ETA^1	10		DVT^2	31
	ETA^2	11		DVT^3	32
	ETA^3	12		DVT^4	33
	ETA^4	13	Overflow or Underflow	API	34

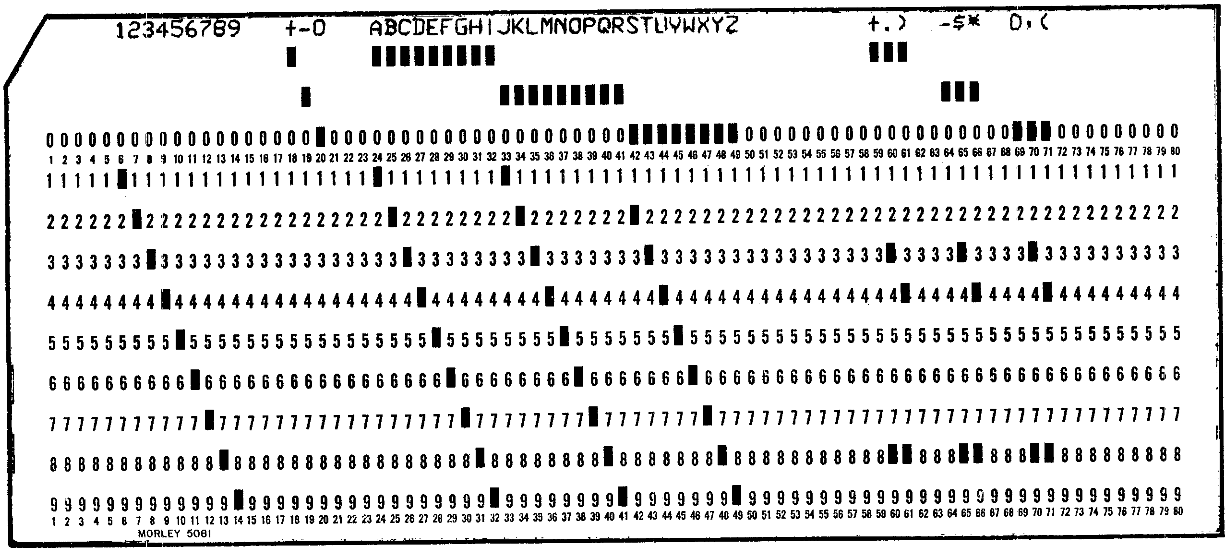
LIST OF ALPHANUMERIC CODES

CODE 543 210	OCTAL Interpretation	CHARACTER	CODE 543 210	OCTAL Interpretation	CHARACTER	CODE 543 210	OCTAL Interpretation	CHARACTER
000 000	00	*Master space ≋	010 101	25	P	101 010	52	"
000 001	01	*Upper Case ~	010 110	26	Q	101 011	53	:
000 010	02	*Lower Case %	010 111	27	R	101 100	54	?
000 011	03	*Line Feed ◊	011 000	30	S	101 101	55	!
000 100	04	*Car. Ret. λ	011 001	31	T	101 110	56	,
000 101	05	*Space Δ	011 010	32	U	101 111	57	+
000 110	06	A	011 011	33	V	110 000	60	0
000 111	07	B	011 100	34	W	110 001	61	1
001 000	10	C	011 101	35	X	110 010	62	2
001 001	11	D	011 110	36	Y	110 011	63	3
001 010	12	E	011 111	37	Z	110 100	64	4
001 011	13	F	100 000	40	)	110 101	65	5
001 100	14	G	100 001	41	-	110 110	66	6
001 101	15	H	100 010	42	+	110 111	67	7
001 110	16	I	100 011	43	<	111 000	70	8
001 111	17	J	100 100	44	=	111 001	71	9
010 000	20	K	100 101	45	>	111 010	72	'
010 001	21	L	100 110	46	_	111 011	73	;
010 010	22	M	100 111	47	$	111 100	74	/
010 011	23	N	101 000	50	*	111 101	75	.
010 100	24	O	101 001	51	(	111 110	76	*Special ▭
						111 111	77	*Idle ←

*Special control characters for typewriter and line printer.
Printed only by line printer on verbatim print-out mode.

NOTE: The 6-bit alphanumeric codes number from 000 000 to 111 111 and correspond in sequence starting with typewriter control characters, alphabetic characters (A through Z), mathematical symbols, arabic numerals (0 through 9) punctuation marks, and special characters. All bit combinations are included and can be represented as printable characters.

HOLLERITH CODES



NUMBERING SYSTEMS

Place Values

Modern number systems are based upon the assignment of different values to numbers depending upon their "place position" in that number. Zeros indicate simply places which are not occupied. The system being used is indicated by the subscript written after the number.

Decimal: (Base 10)

3501_{10} means actually:

1 unit
0 tens
5 hundreds
3 thousands

This same quantity can also be expressed with exponents:

$$(3 \times 10^3) + (5 \times 10^2) + (0 \times 10^1) + (1 \times 10^0)$$

In any number system, going from right (low order) to left (high order) each digit represents an increasing power of the base number.

Octal:

$$3501_8 = (3 \times 8^3) + (5 \times 8^2) + (0 \times 8^1) + (1 \times 8^0) \text{ or}$$

$$1536 + 320 + (0) + (1) = 1857_{10}$$

Binary:

$$101110_2 = (1 \times 2^5) + (0 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0)$$

$$\text{or } 32 + 0 + 8 + 4 + 2 + 0 = 46_{10}$$

Since four and eight are powers of two conversions between octal, quartile, and binary are very easily performed by breaking the binary number into groups of three or two digits respectively. Converting each group provides one digit in the quartile or octal system.

Binary	Quartile	Octal	Decimal
1011	10 11- - 23_4	1 011- - 13_8	11_{10}
10100	1 01 00- - 110_4	10 100- - 24_8	20_{10}
1101110	1 10 11 10- - 1232_4	1 101 110- - 156_8	110_{10}

Octal is the most compact notation which is easily convertible from binary. The octal numbering system for this reason is the one most commonly used with a binary computer. The console indicators are broken up into groups of three for convenient conversions; assembly listings show octal representation, etc. Operators for this reason should be familiar with the relationship between the binary, octal and decimal numbering systems and how each is used.

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