## VI. 400 CARD PER MINUTE READER

## GENERAL DESCRIPTION

The 400 card per minute reader (Figure VI-1) can operate simultaneously with the central processor and other peripheral operations. The reader obtains required AC and DC voltages from the central processor's main power supply via the reader cable. A motor in the card reader provides the driving force for the reading mechanism. By means of a belt, it drives the main pulley which in turn is geared to the clutch drive shaft, the feed rollers, and the eject rollers.

Basic components of the card reader are: an input hopper, a card feed mechanism, a reading station, and an output hopper (often called a stacker). During normal operation, the card reader operates under control of its associated logic to physically move cards out of the input hopper, past the reading station, and into the output hopper. Figure VI-2 is a simplified diagram of card reader mechanism, showing the locations of the various components. Not shown are the motor, the timing and synchronization photosensors, the clutch, and the clutch solenoid.


Figure VI-1. 400 Card Per Minute Reader


The card reader reads standard size (7-3/8 by 3-1/4 inch) 80 -column, 12 -row cards at the rate of 400 cards per minute when operating in the continuous read mode. Cards are read column-by-column, twelve rows at a time by the reading station. Outputs from the reading station are fed into the memory of the central processor.

The input hopper holds approximately 600 cards. The microswitch mounted on the bottom of the hopper notifies the input logic (and the operator by means of the CARD READER READY indicator on the control console) whether or not there are cards in the hopper. The feed table is located beneath the input hopper. Under the control of the clutch, the feed knife (Figure

VI-3) in the top of the feed table moves one card at a time from the bottom of the card deck and feeds it broadside into the feed rollers which engage the card and transport it onto the sensing platform (Figure VI-2). The clutch may be energized either manually (for single card feed), or by depressing the LOAD CARD switch on the control console, or automatically (for continuous card feed) under program control. The kinetic and antistatic rollers (Figure VI-4) keep the card aligned as it emerges from the feed rollers, and insure proper positioning of the card on the sensing platform. After a momentary pause, the pusher under the control of the clutch, pushes the card on the sensing platform forward lengthwise until it is partially through the reading station and its leading edge


Figure VI-2. Diagram of Card Reader Mechanism
is between the pressure rollers (sometimes called eject rollers). The pusher controls movement as the first four columns move under the photosensors. The pressure rollers then grip the leading edge of the card as it emerges from the reading station, propel it the rest of the way through the mechanism, and finally eject it into the output hopper which catches and stacks the cards. The hopper has a capacity of approximately 600 cards. When the first card is approximately half way through the pressure rollers, the feed knife picks the next card from the hopper and feeds it onto the sensing platform, overlapping the card already there.


Figure VI-3. Card Reader Feed Throat and Feed Knife

The reading station consists of twelve photo-transistors and their light sources. As the card passes between the lamps and photo-transistors, the information punched in each column is sensed and transmitted to the logic circuits where it is converted to binary digital form (if the card fed was in Hollerith code) and transferred into the memory of the central processor.

Card Formats. The card reader is capable of reading cards punched with either rectangular or circular holes in any of three formats, illustrated in Figure VI-5. A brief description of each of the card formats follows.

Hollerith Alphanumeric Format. Each card column contains one alphanumeric character punched in standard Hollerith code. (See Appendix D) Since there are eighty columns on a card, each card may contain as many as 80 characters. The code includes representation for 26
alphabetic letters, 0 through 9 decimal numbers, and eleven special purpose characters, making a total of 47 including a blank. Information entered in this format is translated by the computer into 6-bit binary coded decimal configuration. When the information is read into memory, each character becomes a part of a 'word' of information and an alphanumeric data word consists of three 6-bit binary coded decimal characters. The first character read from a card is stored in bit positions 2 through 7 of a memory location; the second character is stored in bit positions 8 through 13; and the third is stored in bit positions 14 through 19. Bit positions 0 and 1 are automatically set to 0 . The following illustrates word division and column use:

## Hollerith

012345678910111213141516171819


The 80 columns of a card require 27 memory addresses to contain the information punched in one alphanumeric card; the last six bits of the 27 th word are left blank.

10-Row Binary Format. Each card column contains one half of a data word, so each card may contain as many as 40 words. The first column of any successive odd-even combination of columns contains the most significant half of a word and the second contains the least significant half. Card row 0 is considered the most significant row; card row 9 is considered the least significant. Card rows 11 and 12 are not used. A binary data word consists of 19 binary digits plus a sign.

When reading a card punched in 10 -row binary format, no decoding or conversion is necessary since binary information is written in memory bit-by-bit as it appears on the card. Information read from the first column and each successive odd-numbered column is written in bit positions 0 through 9 of a memory location. Information from the second and all successive even-numbered columns is written in bit positions 10 through 19. The following illustrates word division and column use for 10 -row binary code.


10- Row Binary

012345678910111213141516171819


12-Row Binary Format. Each card column contains twelve binary digits, and each card, therefore, may contain as many as eighty 12-bit characters. This format permits the GE 225 input equipment to process the punched card output of competitive data processing systems.

When reading a card punched in 12 -row binary format, the operation is similar to that for 10 -row binary except that information read from each column is stored in a separate memory cell and only bit positions 8 through 19 of a memory word are used. Bit positions 0 through


Figure VI-4. Card Reader Feed Mechanism


Figure VI-5. Card Formats


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7 are automatically set to 0 . The following ilustrates word division and column use for i2-row binary code.

## 12- Row Binary

012345678910111213141516171819


## Card Reader Instructions

All instructions dealing with the card reader have an operation code (bits 0 through 4) of 10101 ( 25 in octal). They also have either 00 or 11 in bit positions 7 and 8 . The binary value of bits 7 and 8 determine whether the instruction is an input/output type of command or a branch command: 00 indicates input/output and 11 indicates a branch.

The six instructions that deal with the card reader are:

Read Cards Binary (RCB) 250YY01
This instruction initiates continuous reading of cards in 10 -row column binary code. YY (bits 9 through 12) indicates the four most significant bits of the address in memory where writing will begin. Bit positions 13 through 19 are initially considered to be zeros. Y must be a multiple of 128 (decimal) and not greater than 1920 (decimal) which is 3600 (octal).

Read Cards Decimal (RCD) 250YY00
This instruction initiates the continuous reading of cards that previously have been punched in standard Hollerith alphanumeric code. However, unlike information read from binary cards, it must be converted to a binary coded decimal form prior to being written in memory. YY (bits 9 through 12) indicates the four most significant bits of the memory address and bit positions 13 through 19 are initially considered to be zeros. Y must be a multiple of 128 (decimal) and not greater than 1920 (decimal) which is 3600 (octal).

Read Cards Full (RCF) 250 YY 10
This instruction causes one card which has been punched in 12 -row binary format to be readinto memory locations Y through Y plus 79. Y must be a multiple of 128 (decimal) and not greater
than 1920 (decimal) which is 3600 (octal).
Halt Card Reader $\quad$ (HCR) 2500004

This instruction halts the card reader during an RCB or RCD operation, but the reader will not halt until after the entire card has been read. If column 4 of a card has already been read when the HCR instruction is issued, the card reader will read that card plus the following one before halting.

Branch on Card Reader Ready (BCR) 2514006
This instruction is used to test the status of the card reader before issuing a read card instruction. If the reader is ready, the central processor will execute the next instruction in sequence. If it is not ready, the central processor will skip the next instruction and proceed from there. The card reader will not be ready if one or both of the following conditions exist:

The input hopper is empty.
A card is currently being read.

## Branch on Card Reader Not Ready (BCN) 2516006

Like the BCR instruction, this tests the status of the card reader prior to issuing a read card instruction. In this case, if the card reader is not ready due to one of the two conditions (See BCR instruction), the central processor will execute the next instruction in sequence, and if the card reader is ready, it will skip the next instruction and proceed from there.

## Card Reader Controls and Indicators

There are only 3 controls on the card reader itself. They are:

Power Switch: This is on the front of the card reader (Figure VI-1). It is a butterfly switch with the 2 positions labeled ON and OFF. It turns AC power on to provide power for the reader's motor and its sensing lamps. The computer power (DC) must also be on for reader operation.

Card Feed Switch. This switch, also on the front of the card reader, allows the operator to manually halt the feeding of cards during the actual running of a program rather than halting the program by throwing the auto-manual switch on the console to manual. It is a butterfly switch with labels STOP and ENABLE. When the card feed switch is turned off, the card reader ready line will go down thus causing the program to hang in a busy loop.

Hopper Empty Switch. This switch is at the
bottom (right end) of the input hopper and is not labeled. Its location can be seen in Figure VI-2. When energized by no cards being in the input hopper, it places the reader in a 'not ready' condition. To manually read a card, the operator can hold this switch down with his finger to place the reader in a 'ready' status.

External control switches associated with the card reader are on the control console. (Figure VI-6). They are:

LOAD CARD Switch. When this switch is depressed and the AUTOMATIC/ MANUAL switch is in MANUAL, the reading of one binary card takes place. The LOAD CARD switch thus simulates an RCB instruction and reads the information into memory, starting at location
00000. The switch is normally used for initial program startup.

CARD READER READY Indicator. This indicator will be turned on whenever the card reader is in the 'ready' status. The card reader will always be considered ready when: 1) there are cards in the input hopper, and 2) the reader is not currently performing a reading operation.

CARD READER ALARM Indicator. This indicator will be turned on whenever a read-card instruction is given and the reader is busy. This indicator will also be turned on by an attempt to execute a read card instruction (or initiate card reading by depression of the LOAD CARD switch) when the hopper is empty, or no card has been positioned on the sensing platform


Figure VI-6. Control and Indicators of the Control Console
of the reader. This latter set of conditions normally indicates misfeed in the reader. When this alarm condition occurs, processor operation will halt. This alarm may be turned off by depression of the RESET ALARM button on the control console.

RESET ALARM switch
LOAD CARD switch
AUTO/MANUAL
switch
START
switch

These switches on the control console which apply to card reader operations are described in Table V and also under the general description of the control console. For that reason they are not described here.


1. Joggle the cards against the left edge of the stacking table to make sure they are in line lengthwise.

2. Slap the end and top edges of the card deck until edges look smooth.

## SETUP PROCEDURES

Prepare the card reader for input to the central processor as follows. (See Table IV for a summary of controls and indicators.)

1. Place the reader's power switch in the ON position to turn power on to the card reader.
2. Place the reader's card feed switch in the ENABLE position.
3. Ready cards and load into input hopper as follows: (See Figure VI-7)

4. Lower the card deck face down into the card input hopper without letting cards slip.

5. Quickly withdraw the hand, allowing the card deck to fall to the bottom of the card input hopper.

Figure VI-7. Loading Cards
a. Remove the card weight from the card input hopper.
b. Joggle the edges of the card deck on the stacking table to make sure all of the cards are aligned.
c. Hold the card deck tightly with one hand and riffle cards with the other - both forward and backward. This removes static electricity which could cause the cards to stick and result in a card jam.
d. Joggle the cards again to align them perfectly.
e. Lower the card deck into the card input hopper with the cards face down and the 9 -edge first.
f. Withdraw the hand quickly, allowing the cards to fall to the bottom of the hopper.
g. Place the card weight gently on top of the cards in the input hopper.

It is sometimes necessary to add cards to a hopper partly full, as when a large number of cards must be fed for a single program. This is done as follows:

1. Leave the weight off when loading the initial deck into the input hopper. (Use of this weight is mandatory only when a few cards are left in the hopper.)
2. When the input hopper is partially empty, add cards to those already there.
3. Remove cards from the output hopper when cards fill to a level slightly above the movable gate, joggle and restack them in a
seperate location.
4. Repeat steps 2 and 3 until all cards have been placed in the input hopper.
5. Add two blank cards to the last batch loaded, and replace the card weight.

Feeding of cards is initiated at the control console. The procedures at the control console are covered in the section IV of this manual, and should be referred to for card operations.

Cards are removed from the card output hopper by opening the swing-out card tray and lifting the card deck. (See Figure VI-8). For a large card deck, it may be necessary to remove cards while they are still being fed. The output hopper should be permitted to fill only slightly above the movable gate.


Figure VI-8. Removing Cards

TABLE IV.
SUMMARY OF CONTROLS AND INDICATORS
FOR THE 400 CARD PER MINUTE READER


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## SPECIAL PROCEDURES

## Clearing Card Jams

Card jams can result from either malfunctioning equipment or from cards in poor condition. The operator can often correct jams by pulling out the wrinkled or mutilated cards by hand. More serious jams, especially those in the reading station, will require calling on the service engineer. The operator should not try to remove jammed cards with sharp tools, as the smooth surfaces of the feed mechanism can easily be damaged. Card jams can occur at the feed throat, on the sensing platform, or in the read station.

Jams in the Feed Throat, The feed throat gap is adjusted such that one, and only one, card can be passed through the gap into the feed rollers. If the adjustment is not made properly or the leading edge of the card has been warped by humidity or frayed through improper handling, the card will not pass through the gap and this condition will result in a misfeed. Since a card was not fed onto the reading station, the next read-card command will result in a card feed error. The damaged card must be removed from the input hopper and reconditioned.

Jams at the Sensing Platform, If the feed rollers get out of adjustment, a card may be driven up into the support bracket. The result is an accordion-folded card. Often two cards are jammed into the first one before the reader halts. At most, three cards jam before the reader is stopped and the CARD READER alarm indicator on the console is turned on. After the cards reach the sensing platform they are usually in good enough condition to continue through the read station.

Jams in the Read Station. An obstruction blocking the path of the cards can cause jams between the read station and the stacker. Operator's fingers are a common obstacle at this point; don't reach into the stacker while the reader is in operation. Jams at this point often result in serious trouble because it is necessary to forcibly remove the cards from the eject rollers. Caution must be exercised when removing cards from this area because leaving particles of card in the eject rollers or under the diodes can mis-align the read mechanism. Partial disassembly by the service engineer may be required to clear this area.

## Reconditioning Cards

Mutilated cards should be reconditioned only in an emergency. Damaged cards should be discarded as soon as possible. Attempting to read any card that is in the least damaged may result in a serious jam.

However, there may be times when it is advantageous to attempt a reread.

When the edges of a card are slightly damaged they may be improved by rubbing them with the back of a fingernail or by drawing the card over the edge of the stacking table. When a card has been folded in a jam, it is difficult to straighten. However, this procedure may straighten the card sufficiently to be read.

## Reproducing Cards

When a card is damaged it is necessary to replace it. In this case it may be desirable to reproduce the card on the spot, even though this is not efficlent use of computer time. Procedures for this are:

1. Place the card to be reproduced on the sensing platform as follows:
a. Place the card in the input hopper and push it into the feed rollers. This must be done cautiously. The card must be fed into the rollers straight.
b. Manually register the card against the pusher arm.
2. With the computer in manual, place in the A register the instruction RCD ( 2500000 octal) for a decimal card or RCB (2500001 octal) for a binary card. Transfer the contents of the A register to the I register by pressing the $A$ to $I$ switch.
3. While holding down the hopper-empty switch on the card reader; press the START button on the console. The card reader will read that card into memory starting at location 0000.
4. Place in the A register the instruction WCD (2500002 octal) for punching a decimal card or WCB ( 2500003 octal) to punch a binary card. Transfer the contents of the A register to the I register and press START. The card punch will punch a card from memory starting with location 0000.
5. Remove the reproduced card from the card punch and visually compare it to the original card by placing the two cards together and looking through the punched holes. If the new card is not correct, repeat the reproduction procedure. If a correct card is not produced after the third try, the original card probably cannot be read and must be reproduced by other means.

## Caring for Cards

General Tips on Care of a Working Deck. Cards are sources of precision data, and as such must not be bent, folded, or otherwise damaged by improper handling, storage, or use. They should not be held together by rubber bands, paper clips, or staples. The 'hip pocket' method of transporting them to the job is never recommended. Every effort should be made to avoid getting dirt or moisture on the cards, and all rough handling is taboo.

Card Joggling. One of the most important phases in the preparation of cards for card reader operation is that of 'joggling' the input deck. Many misreads and damaged cards can be avoided if the cards are put in the proper working condition before they are placed in the card feed hopper. Cards should be riffled to eliminate static electricity prior to joggling. Card readers, punches, etc., are equipped with a card joggling plate for use in card preparation. The quantity of cards which can be easily held in one hand should be placed against this plate, face toward the operator, and nine edge down. While holding the cards lightly with one hand, butt the leading edge of the deck against this plate, and with the other hand gently slap the cards toward the joggling plate using an up and down motion. Continue this process until all of the cards are joggled into a uniform deck.

Yisual Inspection. After the cards are joggled into a uniform deck, inspect the deck for nicked, frayed, split, and badly warped cards. Nicked, frayed and split conditions are extremely critical when they are on that edge of the card which loads the card into the reader mechanism. All cards of the type just described should be removed and replaced with a remade card before processing is attempted.

Storage. If a card deck is to be retained for rerun, it must be properly stored. This necessitates some method of keeping the card deck under pressure while in storage to prevent curling, buckling or bending. When cards are in a tray or open carton, keep them pressure blocked. Compressors are standard on card trays for this purpose. In open cartons, a piece of metal, wood, or folded cardboard may be used. For extremely small decks, the use of cardboard, cut slightly larger than the cards, placed in front and in back of the deck, will provide adequate protection. A rubber band may then be used to hold the deck together. Cards and card cartons must be placed so the cards remain standing on edge while stored.

The supply of blank cards must also be stored in areas of approximately the same relative humidity as the machine room. If this is not possible, at least a week's supply of cards should be kept in the machine area. This procedure usually provides ample time for cards to become acclimatized, eliminating a major cause of warping. Cold storage places as well as extremely hot storage places should be avoided. Cold
cards tend to pick up moisture when brought into the machine room; excessively warm cards lose thir moisture content and are inclined to split.

Temperature and Humidity Effects on Cards. Temperature and humidity conditions have a decisive effect and should be constantly considered, especially when cards have been exposed to improper conditions during shipment or storage. High temperature may cause cards to become brittle and to tear or wear excessively while being read. Low humidity may cause cards to take on a static charge of electricity which causes them to cling to one another. Frequently this results in multiple feed or failure to feed and often causes card jams. The dryness can also cause cards to flake or wear excessively. High humidity may also cause cards to curl or warp.

Optimum temperature and humidity conditions are: (Under these conditions cards cause no reader trouble)

Temperature 72 degrees to 78 degrees $F$ Humidity $40 \%$ to $60 \%$

Operable temperature and humidity conditions are: ( $80 \%$ satisfactory card feed)

Temperature 65 degrees to 85 degrees $F$ Humidity $20 \%$ to $60 \%$

The range of temperature and humidity may be wider during storage than that for card use. The limits are:

Temperature 0 degrees to 120 degrees $F$ Humidity $10 \%$ to $90 \%$

However, if the cards are stored in an area where the temperature and humidity differ greatly from that of the computer room, the cards must be conditioned at the proper computer-room conditions prior to use. The actual conditioning time required depends upon the temperature and humidity conditions where cards were stored or transported, and the length of time the cards were exposed to the out-of-limits conditions. If cards were away from computer-room conditions for more than 12 hours, they normally require 24 hours of conditioning. If less than 12 hours, the conditioning time should be twice the time of exposure.

Each time a card is read by the card reader it is warped slightly by the card reader mechanism. This warpage is not serious provided the card is not sent through the card reader several times in a row in which case the warpage will become permanent, thereby causing card jams. If, after one or two readings the cards are allowed to stand tightly packed in a suitable container for a period of 24 hours, the warpage will iron out and eliminate possible jams due to warpage.

Since it is often not possible for a mixture of cards manufactured by different vendors to be run through the reader, care must be taken to insure that cards used are from a single source. When there is a wide discrepancy between thicknesses and surface finishes, the cards cannot be mixed.

## ERRORS AND OPERATOR

## CORRECTIVE ACTION

## Operator Checklist

If the operator neglects to do any one of the following, the card reader will fail to operate or read correctly and may cause halts during runs.

1. Turn on power to the card reader (both switches).
2. Set up the deck correctly: remove superfluous remarks cards, use correct load and transfer cards, put two blank cards on top of the deck in the input hopper.
3. Riffle cards to remove static electricity.
4. Put weight on cards when there are only a few cards in the hopper.
5. Clear CARD READER alarm on console (press RESET ALARM).
6. Unload output hopper before it gets too full.

TABLE V.
400 CARD PER MINUTE READER ERROR CONDITIONS

| Error Condition | Possible Cause | Corrective Action |
| :--- | :--- | :--- |
| Reader feeds one card and halts |  |  |
| Reader feeds one card and <br> halts | Necessary load card not on deck, <br> or cards out of order | Put deck in order, reload cards <br> and restart read operation. |
| CARD READER alarm light <br> comes on; reader is inopera- <br> tive; computer halts (aborts <br> program) | Input hopper empty | Load input hopper, press <br> RESET ALARM switch; restart <br> program. |



