

CONTROL DATA
167-2
CARD READER

VOLUME 1
DESCRIPTION, OPERATION,
AND MAINTENANCE

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VOLUME 1
DESCRIPTION, OPERATION,
AND PROGRAMMING

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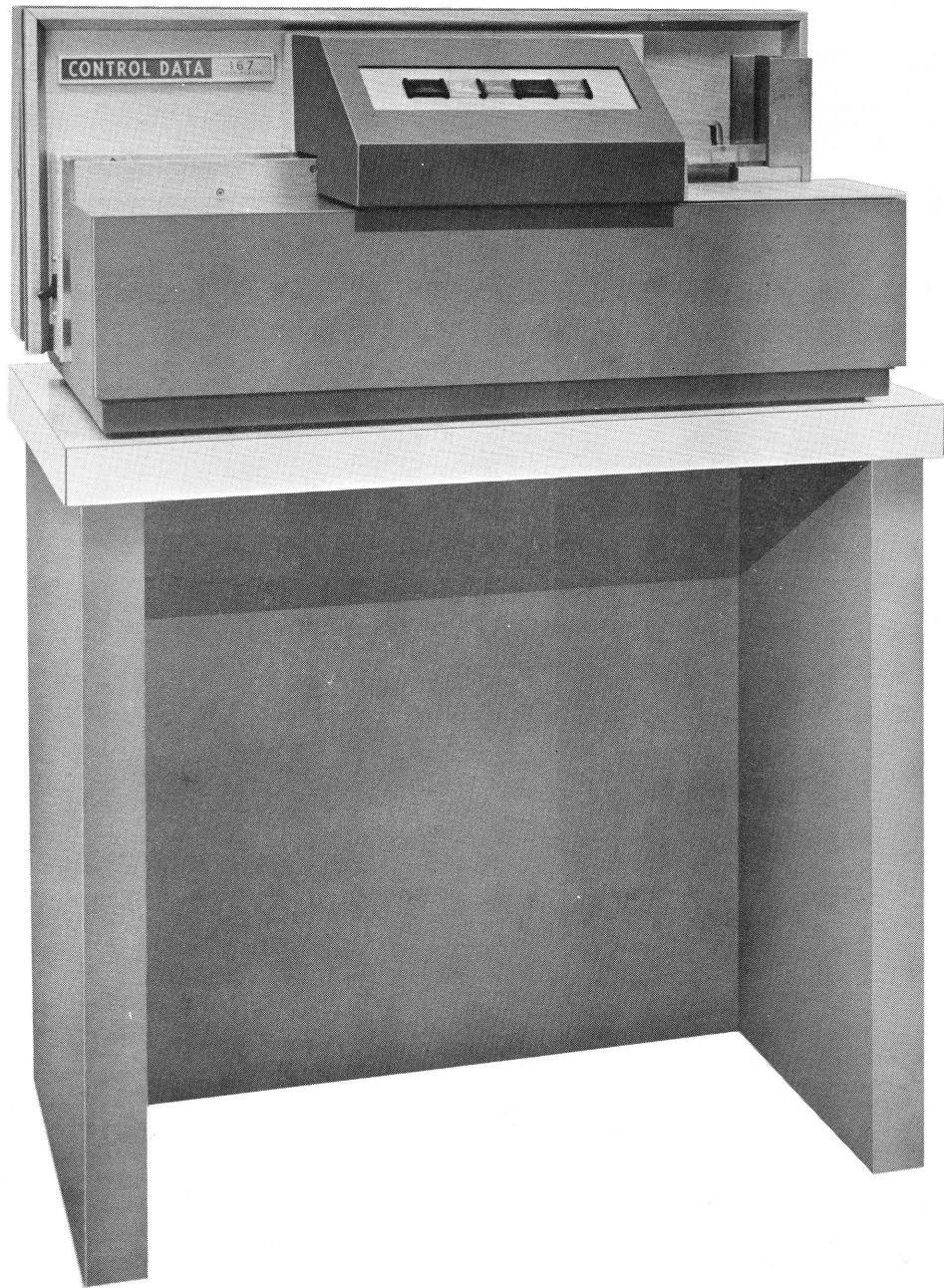
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CHAPTER 1

DESCRIPTION

The CONTROL DATA* 167-2 Card Reader reads data from standard punched cards and transfers it to a computer, magnetic tape unit, or line printer. Data is read column by column and sent to associated equipment in a 12-bit per word parallel mode. The operator has a choice of reading data just as it appears on a card, or first translating it from Hollerith into BCD format for special purpose usage. After translation, two Hollerith columns are automatically packed into one column consisting of two 6-bit BCD words.

TABLE 1-1. SPECIFICATIONS

MECHANICAL		
	Card Reader	Pedestal
Height	13 1/2 inches	27 inches
Width	29 3/4 inches	30 inches
Depth	18 inches	18 1/2 inches
Weight	120 pounds	90 pounds
Cooling Requirements	670 BTU/hour	
Hopper Capacity	500 cards	
Stacker Capacity	500 cards	
Reading Speed	250 cards/minute maximum	
ELECTRICAL		
Power Requirements	115 vac, 1 phase, 60 cps, 1.7 amp	
Reading Method	Photo-electric: 12 card-row cells 2 card-detect cells	
Timing Source	Magnetic Reluctance Pickup	

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TABLE 1-2. EF CODES

Code	Function
4500	EF clear
4501	Free run read
4502	Single cycle read
4505	FRR, H → BCD and Pack
4506	SCR, H → BCD and Pack
4540	Check status

Table 1-3 lists possible responses to a status request. Multiple faults are indicated as the sum of individual faults.

TABLE 1-3. STATUS RESPONSES

Code	Meaning
0000	167-2 ready
0001	Hopper empty
0002	Stacker full
0004	Feed failure
0010	Program error
0020	Amplifier failure
0040	Motor power off

Chapter 2, Operation and Programming, discusses in detail the use of the EF codes and explains the meaning of each status response.

The 167-2 reads data from cards photoelectrically. As each card-column passes the read station, light passes through each hole present in that column and strikes a solar cell. The 167-2 amplifies any signals present at the solar cells to standard logic voltage levels, translates and packs them if requested, and gates them to the computer or other interrogating device. Off-line, the card reader is directed by pseudo select codes.

CHAPTER 2
OPERATION AND PROGRAMMING

MANUAL CONTROLS AND INDICATORS

TABLE 2-1. SWITCHES AND INDICATORS

Name		Function
Main Power (2S01)	S*	Connects 167 to power lines
Motor Power (3S04)	S	Applies power to drive motor and excitors
Row 12 "0" Check Disable (3S05)	I**	Motor is running
	S	Disables amplifier "0" check of 12th row when cut-corner cards are used
Load (3S06)	I	Disabled condition
	S	Initiates a Free Run Read (FRR) operation
Stop (3S07)	S	Disables Clutch
	I	Indicates stop
Margin (3S02)	S	Used during routine maintenance reliability tests

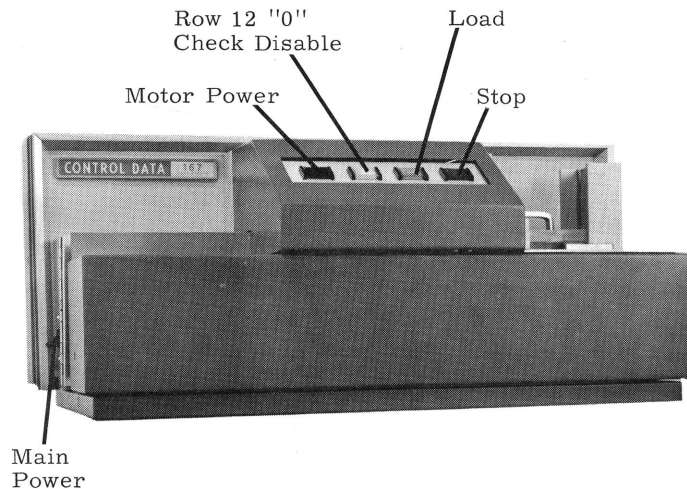


Figure 2-1. Card Reader Controls

* Switch
** Indicator

CARD READER PREPARATION

To prepare the 167-2 for control by interrogating equipment:

- 1) Place cards in hopper, face down, column one in direction of feed
- 2) Turn on Row 12 "0" Check Disable switch if cut-corner cards are used
- 3) Off-line, press H → BCD and Pack switch for translation of Hollerith format into packed BCD format
- 4) Turn on Main Power switch
- 5) Turn on Motor Power switch
- 6) Issue master clear
- 7) Card reader now ready for external control

EXTERNAL FUNCTION CODES

SELECT CODES

Operation of the 167-2 card reader is initiated by coded EF instructions from an interrogating device (table 2-2). 12-bit function codes transmitted by the EXC (7500) or EXF (75XX) instruction from the 160/160-A, or pseudo codes from a line printer direct operations through controls in the card reader. The upper 6 bits (octal 45XX) select the card reader; the lower 6 bits (octal XX00 through XX40) specify the card reader operation. Specially punched cards must be used for untranslated card to printer operation. See Control Data 166-2 Printer manual, volume 1.

TABLE 2-2. EF SELECT CODES

Code	Name	Description
4500	EF Clear	<p>Clears EF Select FFs and Start Counter FF. Issue an EF clear to terminate:</p> <ol style="list-style-type: none"> 1) a FRR (4501) operation. If card reader is to stop immediately after reading a card, the clear must be received within 1.5 ms after reading of the 80th column. 2) A SCR (4502) operation at any time during the cycle.
4501	Free Run Read (on-line only)	<p>Actuates clutch and starts card movement. Cards move continually without need for reselection between cards. Operation terminates when card reader receives an EF clear (4500) or generates an input disconnect. An input disconnect results from:</p> <ol style="list-style-type: none"> 1) a feed failure, 2) a late input request (program error), or 3) an amplifier failure. <p>Check status immediately after receiving the disconnect. The operator must master clear the card reader before reading can resume.</p>
4502	Single Cycle Read	<p>Actuates clutch and starts card movement. Each 4502 select causes one card to move. The operator may terminate a read operation anytime during a cycle by issuing an EF clear (4500). To read the next card, status must be checked (4540), and another 4502 issued. Full speed operation is possible if 4502 is reselected within 4 ms after the 80th column is read.</p>
4505	FRR, H → BCD and Pack	
4506	SCR, H → BCD and Pack	
4540	Check Status (on-line only)	<p>A 4540 status request directed to the card reader and followed by an input to A (76 instruction) provides the computer with information (a coded response) relative to card reader status. This code is issued anytime previous to a 4501, 02, 05, or 06 code, or after the last word desired from a card in the 4502 mode. A status request should follow each input disconnect.</p>

STATUS RESPONSES

Table 2-3 is a list of status responses the card reader may send to the computer. Multiple faults appear in coded form as the sum of individual faults. For example, 0005 (0001 + 0004) means there was a feed failure and the hopper is empty.

TABLE 2-3. STATUS RESPONSES

Code	Name	Description
0000	167-2 Ready	
0001	Hopper Empty	All cards have been read
0002	Stacker Full	To prevent a card jam, remove accumulated cards from stacker
0004	Feed Failure	If accompanied by hopper empty, cards are all read; if not, a feed problem exists
0010	Program Error	Input requested too late by interrogating device
0020	Amplifier Failure	At least one of the 12 row amplifiers is not functioning properly
0040	Motor Power Off	6S04 is off

PROGRAM TIMING

Each card requires 240 ms to pass through the read station. The card reader may send up to 40 translated or 80 untranslated 12-bit words to the interrogating device from each card. Program timing is identical for single cycle and free run read. Figure 2-2 shows the program timing for one card cycle. On-line, this chart enables a programmer to make full use of the computer between card columns and to reselect the card reader at a time that assures full speed operation.

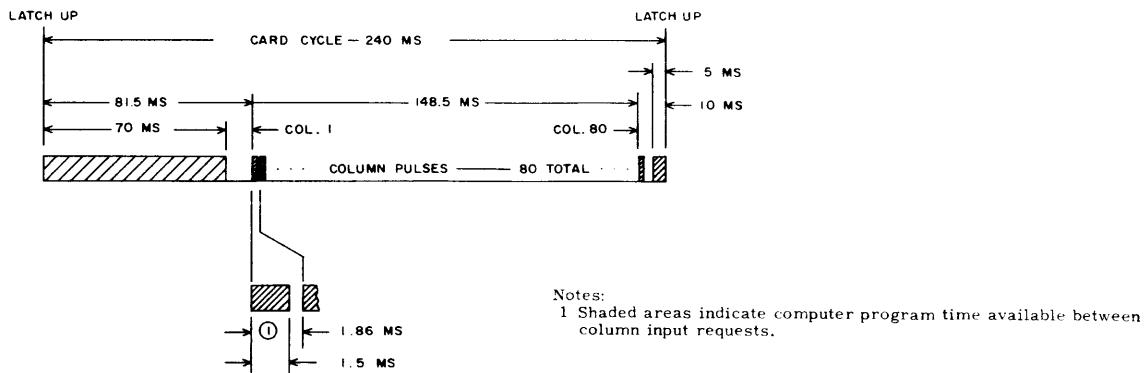
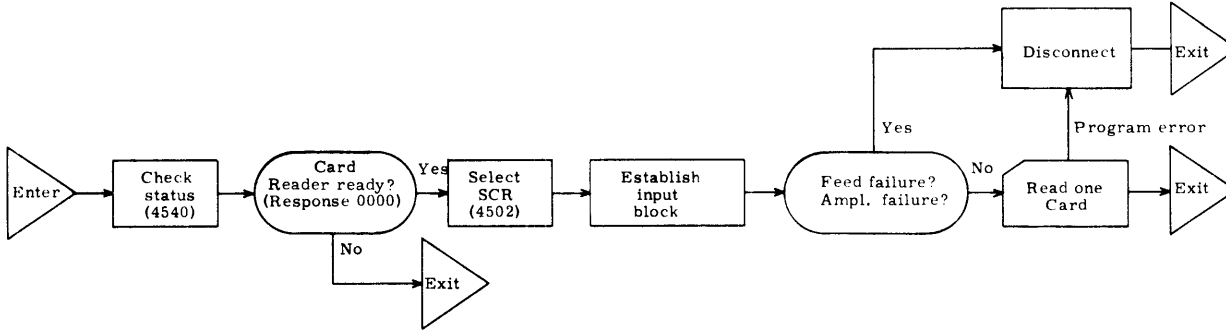
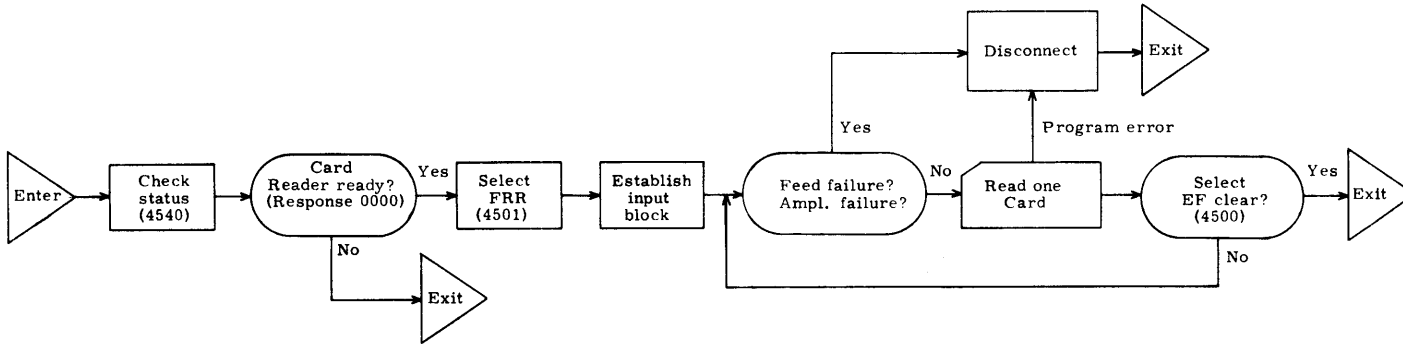


Figure 2-2. Program Timing

Figure 2-3. Flow Charts of Sample Programs



SINGLE CYCLE READ



FREE RUN READ

TRANSLATOR CODES

Table 2-4 lists the Hollerith (and Hollerith-type) codes required to produce BCD codes 00-77₈ for use by the 166 series of line printers. The table includes a list of the characters that will be printed by these codes.

TABLE 2-4. BCD VS HOLLERITH CODES

BCD Code	Character	Hollerith Code	BCD Code	Character	Hollerith Code
00	:	illegal	40	-	11
01	1	1	41	J	11 1
02	2	2	42	K	11 2
03	3	3	43	L	11 3
04	4	4	44	M	11 4
05	5	5	45	N	11 5
06	6	6	46	O	11 6
07	7	7	47	P	11 7
10	8	8	50	Q	11 8
11	9	9	51	R	11 9
12	0	0	52	%	11 0
13	=	3 8	53	\$	11 3 8
14	≠	4 8	54	*	11 4 8
15	≤	5 8	55	↑	11 5 8
16	'	6 8	56	↓	11 6 8
17	[7 8	57	>	11 7 8
20	blank	unpunched	60	+	12
21	/	0 1	61	A	12 1
22	S	0 2	62	B	12 2
23	T	0 3	63	C	12 3
24	U	0 4	64	D	12 4
25	V	0 5	65	E	12 5
26	W	0 6	66	F	12 6
27	X	0 7	67	G	12 7
30	Y	0 8	70	H	12 8
31	Z	0 9	71	I	12 9
32]	0 2 8	72	<	12 0
33	,	0 3 8	73	.	12 3 8
34	(0 4 8	74)	12 4 8
35	→	0 5 8	75	≥	12 5 8
36	≡	0 6 8	76	?	12 6 8
37	~	0 7 8	77	;	12 7 8

CHAPTER 3
PRINCIPLES OF OPERATION

This chapter discusses the principles of operation for each section of the card reader logic. The accompanying diagrams are simplified. For more details, refer to the unabridged logic diagrams in volume II, appendix F.

EF CODE TRANSLATOR

Many peripheral equipments may be connected to the computer. The EF code translator (figure 3-1) recognizes selection of the 167-2 and determines the function it is to perform. EF select codes from the computer, or pseudo codes from other interrogating equipment, are received on the output lines. The accompanying function ready signal enables the 167-2 to translate the codes and set the function select FF's. EF bits 6-11 (octal 45XX) select the card reader; bits 00, 01, 02, or 05 select the function. Previous to an EF selection, a $0.8\mu\text{sec}$ pulse from A209 clears the function select FF's. An output resume, which is directed back to the interrogator after $5\mu\text{sec}$, turns off the function ready and clears the output lines. The interrogating equipment may request status (4540), free run read (4501), or single cycle read (4502). On-line, H \rightarrow BCD and Pack is selected along with FRR or SCR if the card data must be translated.

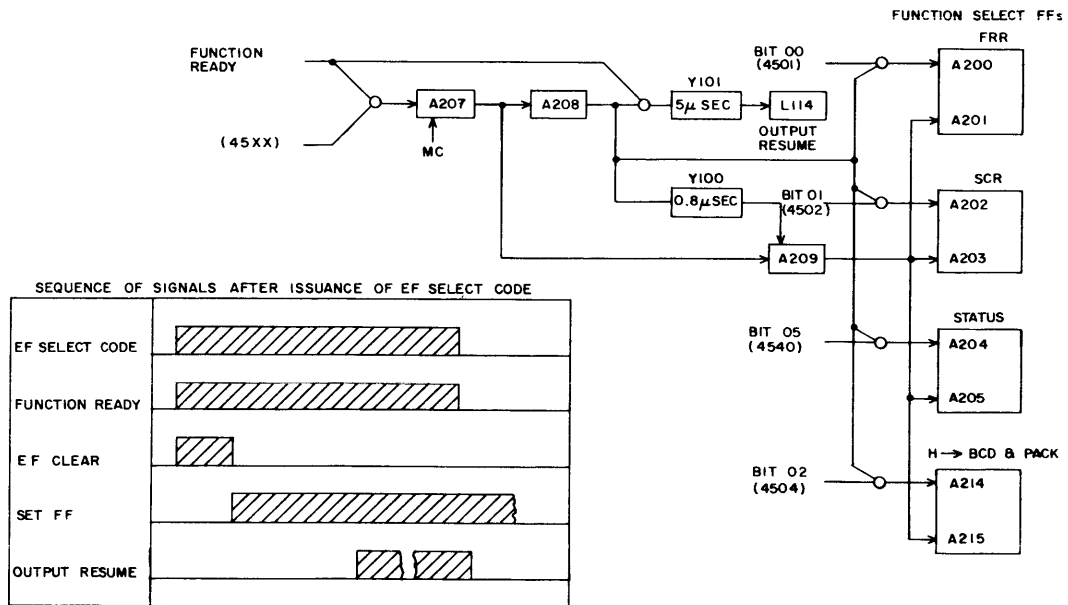


Figure 3-1. EF Code Translator

CHECK STATUS

Before selecting or reselecting a 167-2 read operation, the computer must sense card reader conditions by executing a status request (4540) followed by an input to A (76) instruction. Coded status information* is transferred to the computer on its input lines. Execution of a status request (4540), accompanied by a function ready signal, sets the Status FF. An input request, which may appear any time thereafter, generates an input ready signal and simultaneously gates status information to the computer. The input ready causes the input request to drop; a 0.8 μ sec pulse clears the Status FF. Figure 3-2 shows the circuits and timing associated with a status operation.

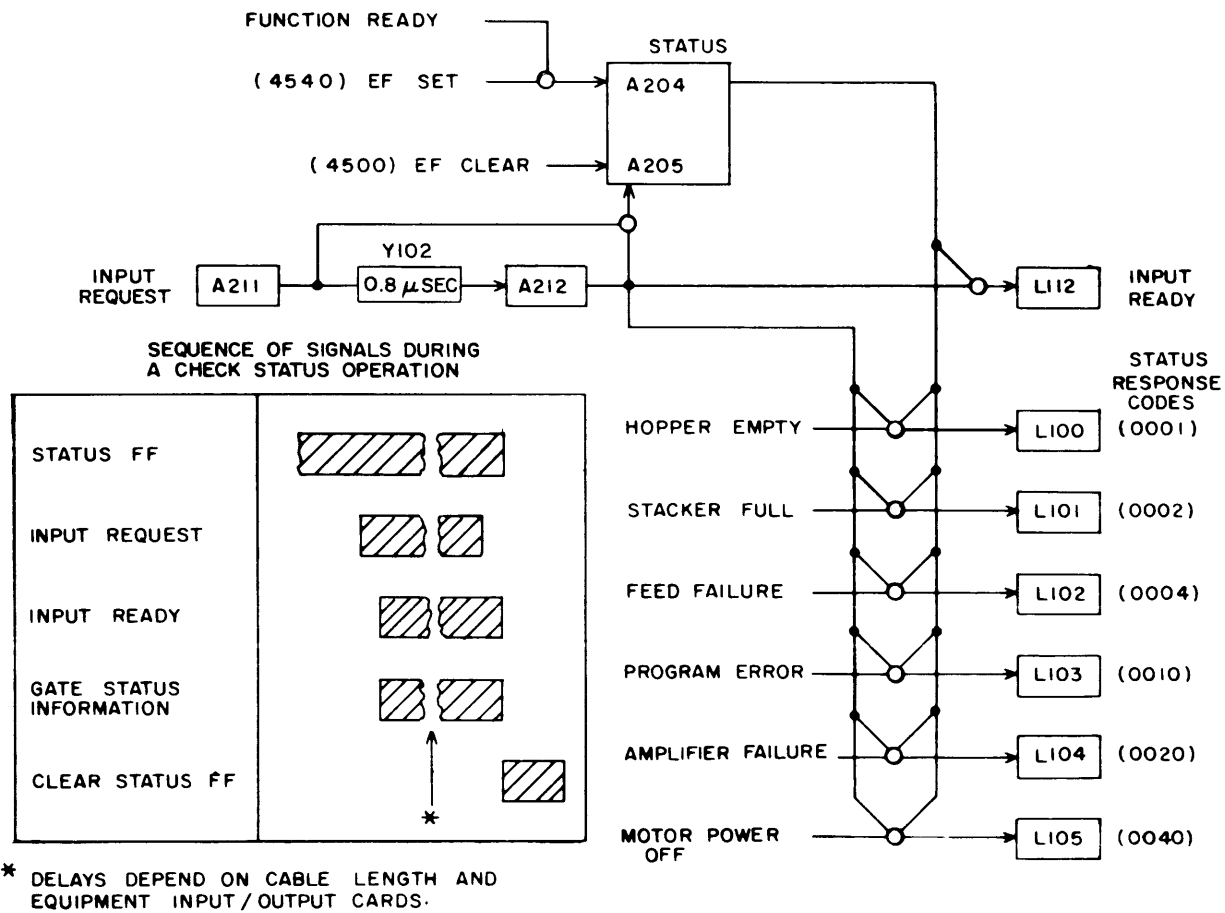
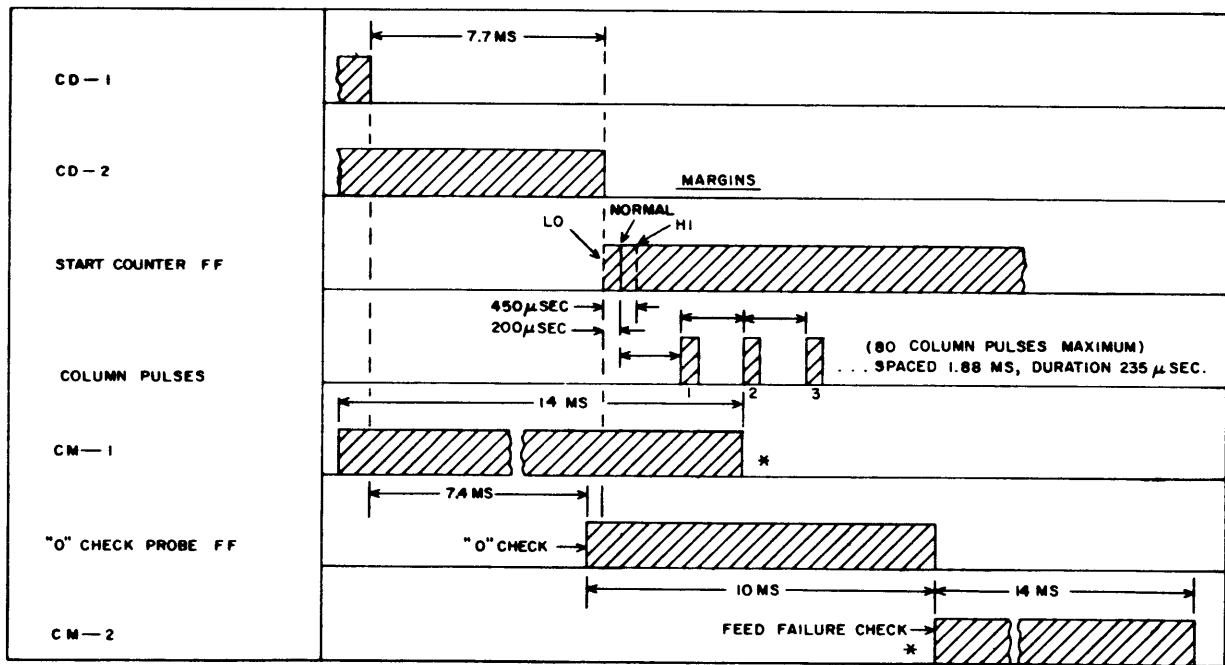


Figure 3-2. Status

* See Operation and Programming, chapter 2.

READING CARDS

The 167-2 reads a card one column at a time and sends data to the interrogator in a 12-bit per word parallel mode. The card reader includes a Hollerith to BCD translator and packer for special applications. Fourteen exciter lamp/solar cell pairs are located in the read station. Twelve of these are for reading data from the 12 card rows; one (CD-2) starts the counter and one (CD-1) stops the counter. A magnetic reluctance pickup emits pulses continuously at the rate of eight per card column. Two cams generate signals during each card cycle. The timing relationship between signals is shown in figure 3-3.



* SET CAM AT THIS EDGE.

Figure 3-3. Timing Chart - 167-2

FREE RUN READ

The Free Run Read FF (figure 3-4) is set by either an EF code 4501 from the computer or by a signal from Load switch S06 on the card reader control panel. On-line it can be cleared only by an EF clear. The FRR FF output gates the input to clutch puller P120. The Load switch permits local starting of the card reader. Stop switch S07, used for local stopping of a FRR operation, must be returned to the normal (light off) position before operation may resume. An input to L120 from the Start Counter FF locks out the clutch puller during the time that the counter is running.

SINGLE CYCLE READ

The Single Cycle Read FF (figure 3-4) is set by EF code 4502 and is cleared by the first column pulse during a read cycle or by an EF clear (4500). Its main functions are to gate the input to R114 and to pull the clutch for one read cycle.

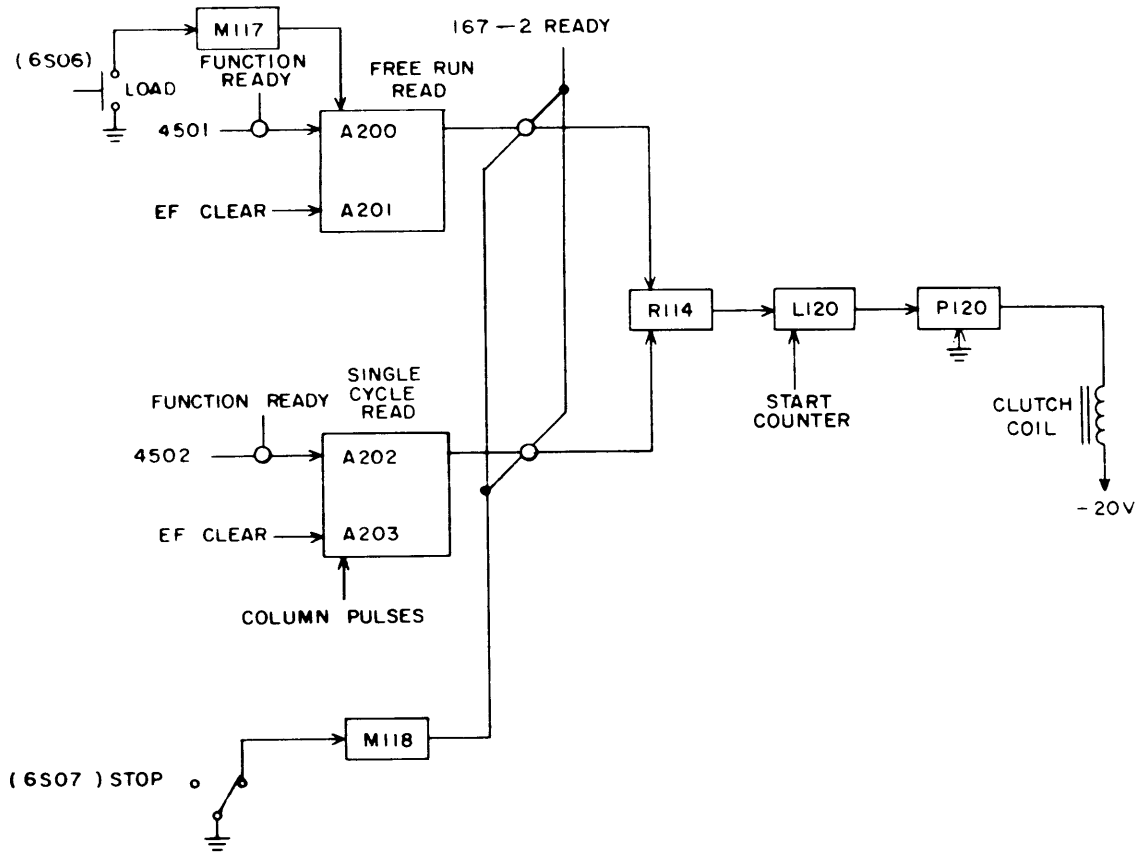


Figure 3-4. Free Run and Single Cycle Read

CUMULATIVE-8 COUNTER

Selecting the free run or single cycle read mode pulls the clutch and advances a card through the read station (figure 3-4). When no card is in the read station, a "1" from CD-1 holds a forced clear on the Start Counter FF (figure 3-5). As a card enters, the clear drops. Selection of the read operation removes a lockout "1" from B112 so that CD-2 can set the Start Counter FF. The setting of this FF reapplies a lockout to B112 via R119 and removes a forced clear from the cumulative-8 counter. This allows pulses from the magnetic reluctance pickup to advance the counter.

The counter emits one signal for every eight it receives from the pickup. A pulse generator (K115 and Y106) shapes these output signals into $0.8\mu\text{sec}$ pulses. Delays Y103 and Y104 prevent short extraneous pulses from advancing the counter. During maintenance tests, an adjustable delay (Y105 + Y111 + no delay) allows the operator to vary the position of the column pulses with respect to the card columns. Signal CM-1 drops to "0" after the first column of a card has been read. This prevents the Start Counter FF from being reset until the next card enters the read station. Delay Y112 ensures that B112 remains locked out until CM-1 drops in case an EF clear (4500) immediately follows the reading of the first column.

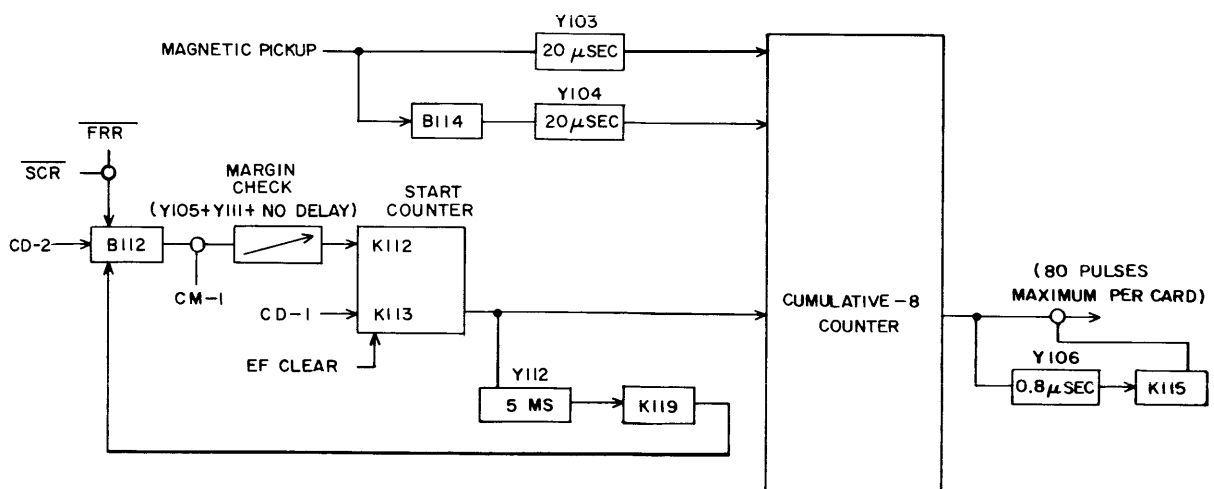


Figure 3-5. Cumulative - 8 Counter

PERMIT INPUT

Direct Input (figure 3-6)

The column pulses emitted by the counter coincide with the data from each card column. If an input request is present, the pulses set the Permit Input FF and gate data to the interrogator. If the input request is not present, an input disconnect occurs. An input ready is sent to the interrogator $5\mu\text{sec}$ after an input request is received. This turns off the input request and clears the input lines.

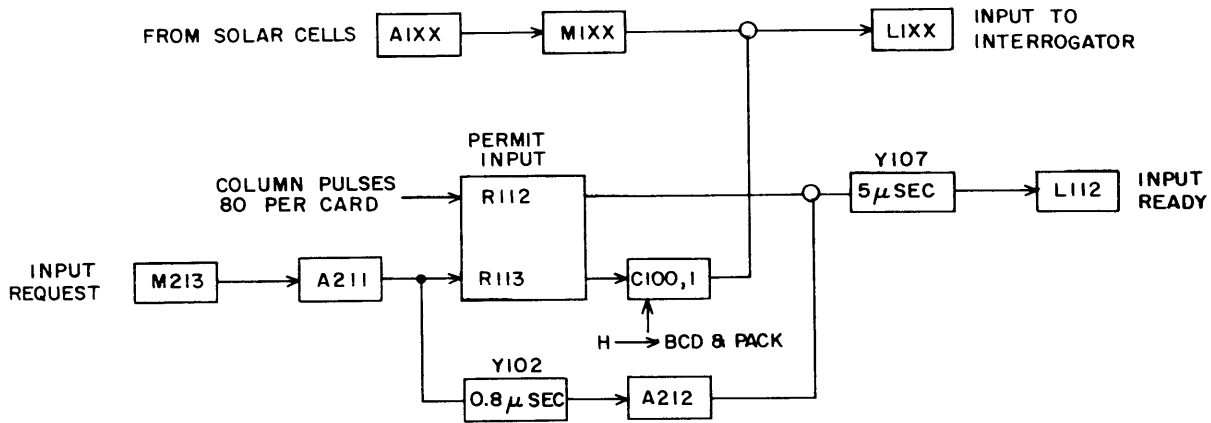


Figure 3-6. Direct Input

Translated and Packed Input (figure 3-7)

In this mode, data from cards punched in Hollerith code format is translated by a series of inverters into 6-bit BCD format. After translation, the card reader packs two 6-bit words into one column, then sends the resulting 12-bit word to the interrogator. The 80 column pulses emitted by the counter coincide with the data from each card column. Figure 3-8 shows the timing during an input from one card. Initially, the Packer and Permit Input FFs are in the cleared state. The first input request must arrive between the EF select and the generation of the first column pulse. Column pulse No. 1 sets the Packer FF and gates the translated word from card column No. 1 into the H register; after $450\mu\text{sec}$, column pulse No. 2 is enabled to set the Permit Input FF. This gates one 12-bit word to the interrogator and generates an input ready. Data (column

No. 1) from the H register goes into the upper six bits; column No. 2 into the lower six bits. As soon as the input request drops, the H register, and the Packer and Permit Input FFs are cleared. Reading continues, with the remaining odd numbered column pulses (3-79) loading the H register, and even numbered pulses (4-80) causing an input. When no more cards are available, CD-1 reappears and locks out the Packer FF via inverters R118 and R119. On-line, the H → BCD and Pack FF is set by including bit 02 with the regular FRR and SCR codes. Off-line, the FF is set by a switch on the console.

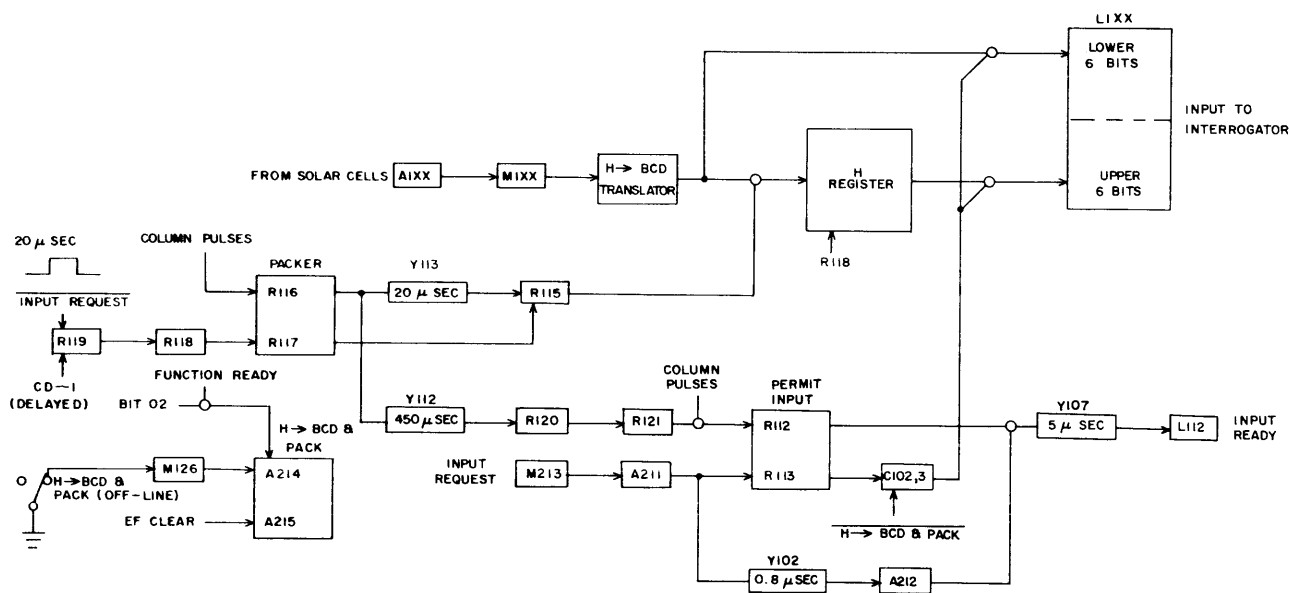


Figure 3-7. Translated and Packed Input

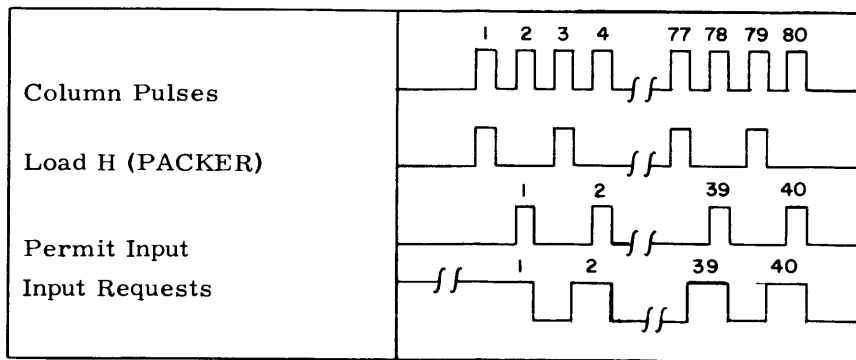


Figure 3-8. Translate and Pack Timing

INPUT DISCONNECT

On-line, the input instruction may establish a storage field block of greater capacity than the anticipated input block. The input disconnect indicates to the computer that the card reader has no more data to deliver, so the computer may return to its main program with no further delay. Three sets of conditions will cause a disconnect: feed failure, program error, or amplifier failure (figure 3-9).

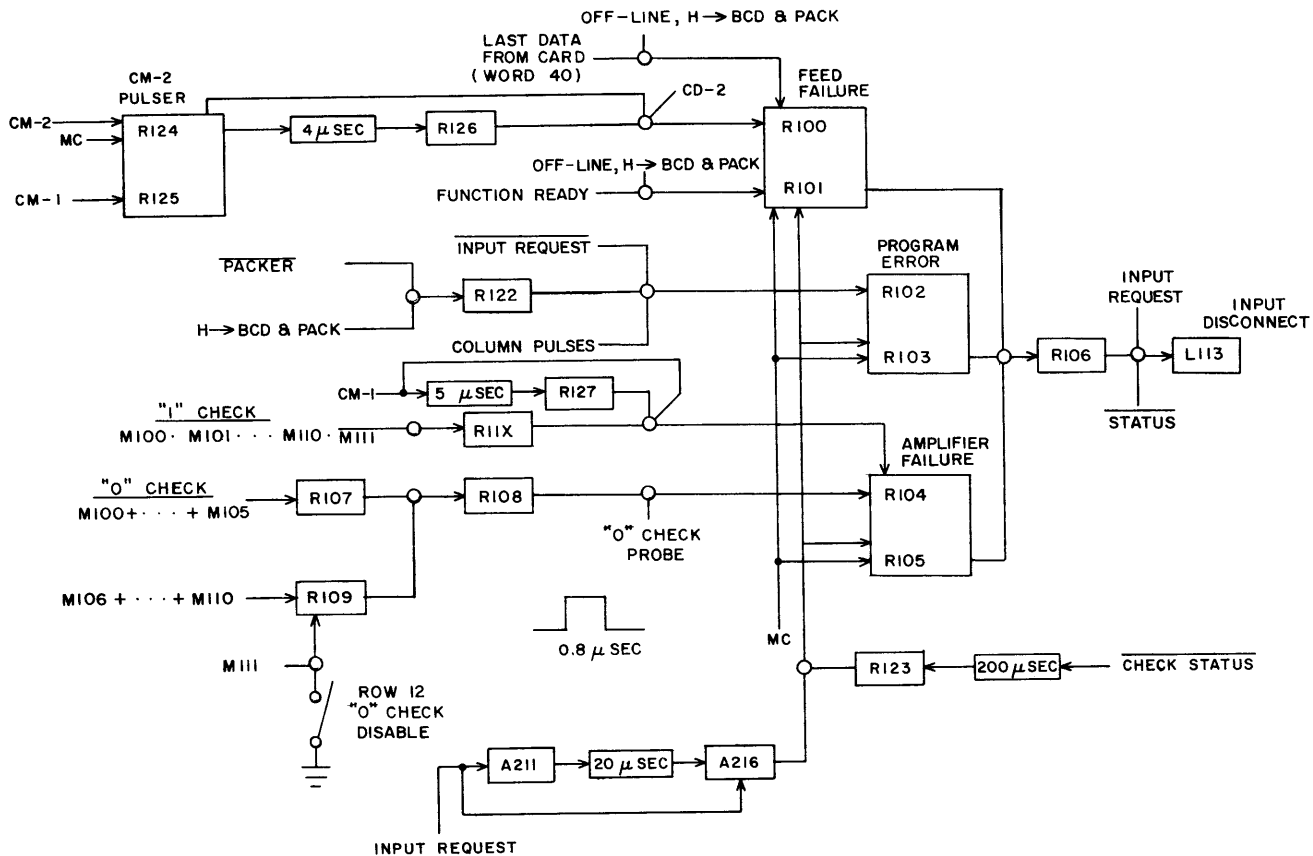


Figure 3-9. Input Disconnect

FEED FAILURE

On-Line

The Feed Failure FF sets if the Start Counter FF has not been set by a card before the signal from CM-2 appears.

Off-Line

When translated data is sent to the line printer, the input disconnect follows the 40th word to the printer. In the printer, this starts a free run operation during which

blanks (2020_g) are loaded into the last 40 memory locations. Either a master clear, a status request, or a function ready clears the Feed Failure FF.

PROGRAM ERROR

Direct Input

The Program Error FF sets if an input request is not present as each column pulse rises. Either a master clear or a status request clears the Program Error FF.

Translated and Packed Input

The Program Error FF sets if an input request is not present as each even numbered column pulse rises. Cleared as noted above.

AMPLIFIER FAILURE

The light amplifiers are checked automatically as each card enters the read station.

"1" Check

As soon as a card covers CD-1, but before it covers the row-lamps, the light amplifiers are checked for output. If any amplifier is not supplying a "1", the Amplifier Failure FF is set. Failure of an amplifier to supply a "1" may be caused by insufficient exciter lamp brilliancy, dirt in the solar cell aperture, or a defective amplifier.

"0" Check

After the "1" check, a "0" check is made to ensure that none of the amplifiers emit a "1" when the solar cell apertures are all covered by the leading edge of a card. The presence of a "1" usually indicates that the brilliance of an exciter lamp is set too high, causing light to penetrate the card and switch the light amplifier. An input disconnect may occur any time that corner-cut cards are used unless the Row 12 "0" Check Disable switch (S05) is on.

Either a master clear or a status request clears the Amplifier Failure FF.

•

After a Status Response has been sent to the computer (normally, status is requested at the end of each card) the input request will drop, thereby clearing the Status FF (figure 3-2). The 20 usec pulse produced by A216 and R123 clears the Error FFs at the same time.



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