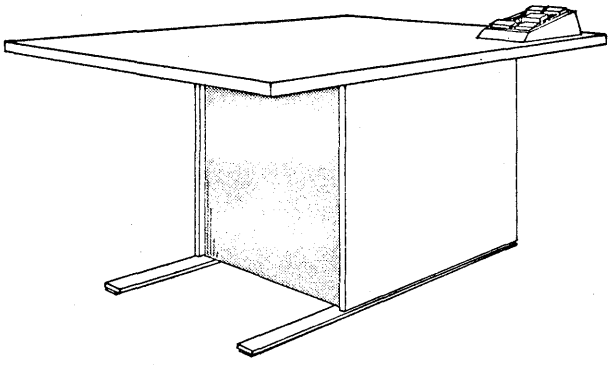
CONTROL DATA®

217-2
EQUIPMENT CONTROLLER

This Publication Includes
Information on the Listed
Equipments:

FC710-A
FC710-B
FC711-A
FC711-B



- General Description
- Operation and Programming
- Installation and Checkout
- Theory of Operation
- Maintenance
- Maintenance Aids

CONTROL DATA
CORPORATION

CUSTOMER ENGINEERING MANUAL

Book 1 of 2 Books

217-2
EQUIPMENT CONTROLLER
CUSTOMER ENGINEERING MANUAL

BOOKS IN THIS MANUAL:

Book 1 —— General Description
Operation and Programming
Installation and Checkout
Theory of Operation
Maintenance
Maintenance Aids

Book 2 —— Diagrams

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217-2

Equipment Controller

Customer Engineering Manual

Book 1

EQUIPMENT CONFIGURATION

The FCO and configuration levels for each equipment discussed in this document are listed in Book 2 (publication number 82128200) of this manual.

FOREWORD

The purpose of this manual is to provide a systematic approach to the fundamental operating principles of the 217-2 Equipment Controller. This book (Book 1 of 2) covers two major areas: Theory of Operation (Section IV) and Maintenance (Section VI). Remaining sections provide support information.

- Section I, General Description — acquaints the reader with the structure of the controller while providing physical, electrical, and environmental parameters.

- Section II, Operation and Programming — describes all switches, indicators, and controls located on or within controller cabinetry. Programming is generally on a systems basis. See the 200 User Terminal Reference Manual (publication number 82128000) for details.

- Section III, Installation and Checkout — lists the procedures required to make the controller operational from the initial uncrating state.

- Section IV, Theory of Operation — intended both for the general reader and the more experienced customer engineer. The approach used divorces the reader from the logic prints and explains internal operations with the aid of block and flow diagrams.

- Section V, Diagrams — this section is contained in Book 2 (publication number 82128200). The approach taken features detailed descriptions interlaced with the logic diagrams yielding a second "theory."

- Section VI, Maintenance — detailed description of adjustment points as well as preventive maintenance procedures. For physical orientation, cross-reference Sections I and II.

- Section VII, Maintenance Aids — additional miscellaneous information which might aid in servicing the controller.

FOREWORD (CONT)

NOTE

Refer to the 217-2 Equipment Controller Parts List (publication number 82128400) for parts information.

The characteristic feature of this controller is its ability to increase its data processing scope by adding other peripheral units. A special adapter kit is required for each i/o device added. These adapters consist mainly of additional logic boards to be installed in the controller logic rack. Accordingly, both books making up this Customer Engineering publication describe the adapters in detail. For specifications on the units, consult the associated documentation supplied.

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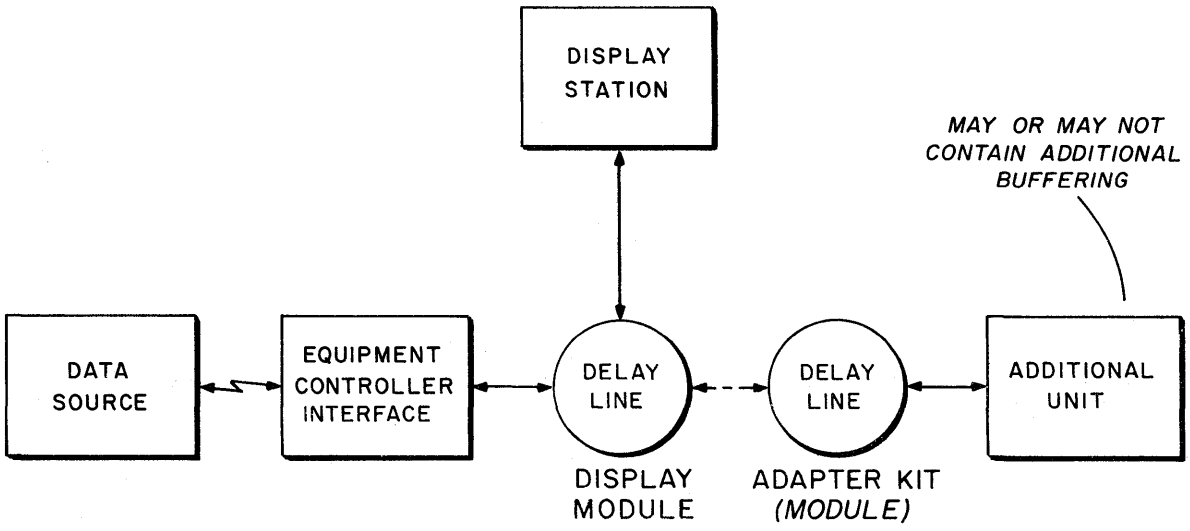
SECTION I

GENERAL DESCRIPTION

The basic Equipment Controller is designed primarily for Display Station entry and retrieval communications with a central processing site (data source). All data entered from the Display Station keyboard and all communications with the data source form a crt display.

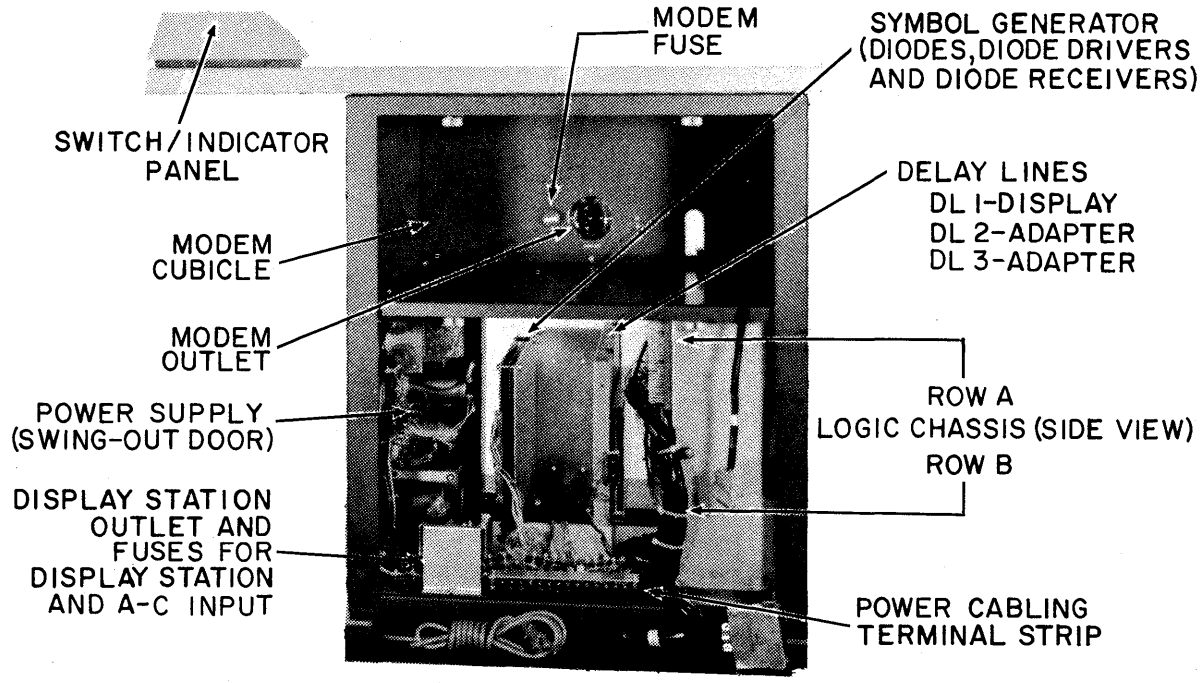
Equipment Controller design also allows for the modular addition of other entry or retrieval devices to the basic configuration. These additional devices include a card reader and/or a printer. The printer may be a typewriter or a high-speed line printer. For each unit added to the basic configuration, a special adapter kit must be installed in the Equipment Controller.

Each adapter kit contains a 10-millisecond delay-line memory and the logic necessary to form a module governing the operation of the associated unit. This memory, in addition to providing data storage facilities for the associated unit, adds to the overall buffering network. The basic module governing Display Station operation also contains a delay-line memory so the overall buffering scheme in the controller appears as:

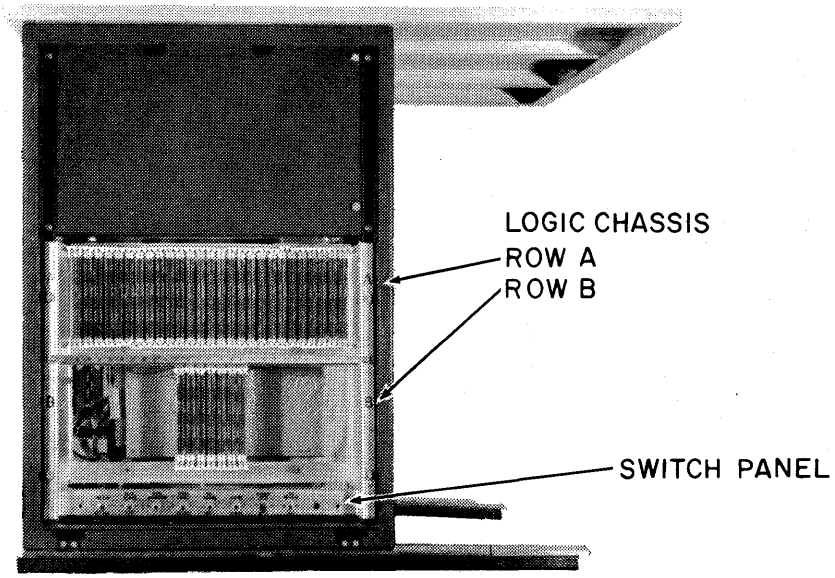


Buffering Scheme

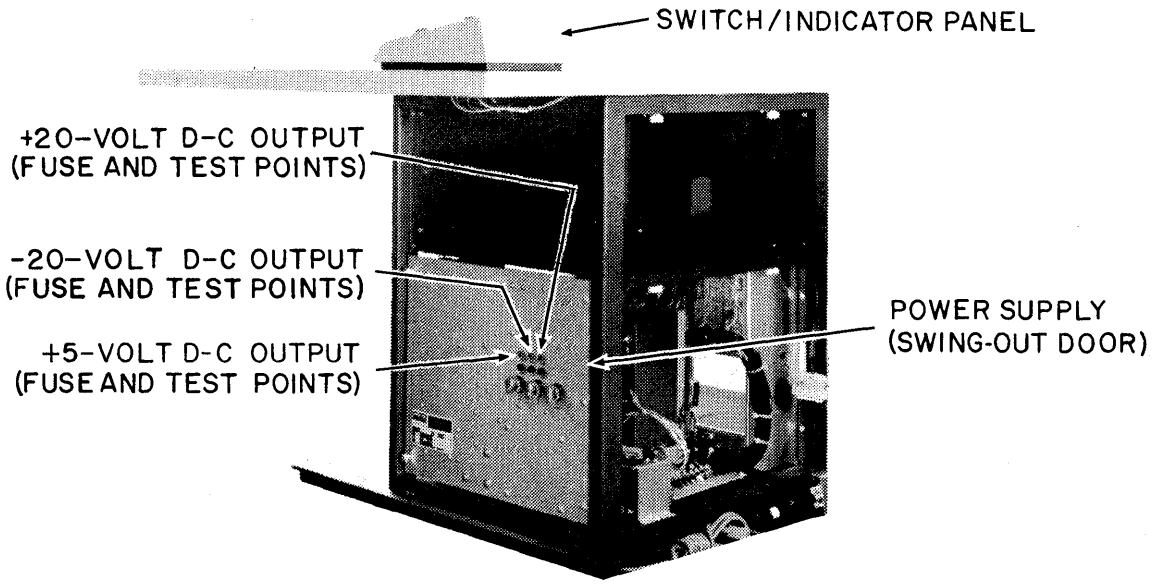
The next group of illustrations point out the structure of the controller; calling out such items as delay lines, power supply, etc.



Rear View (Panel Removed)



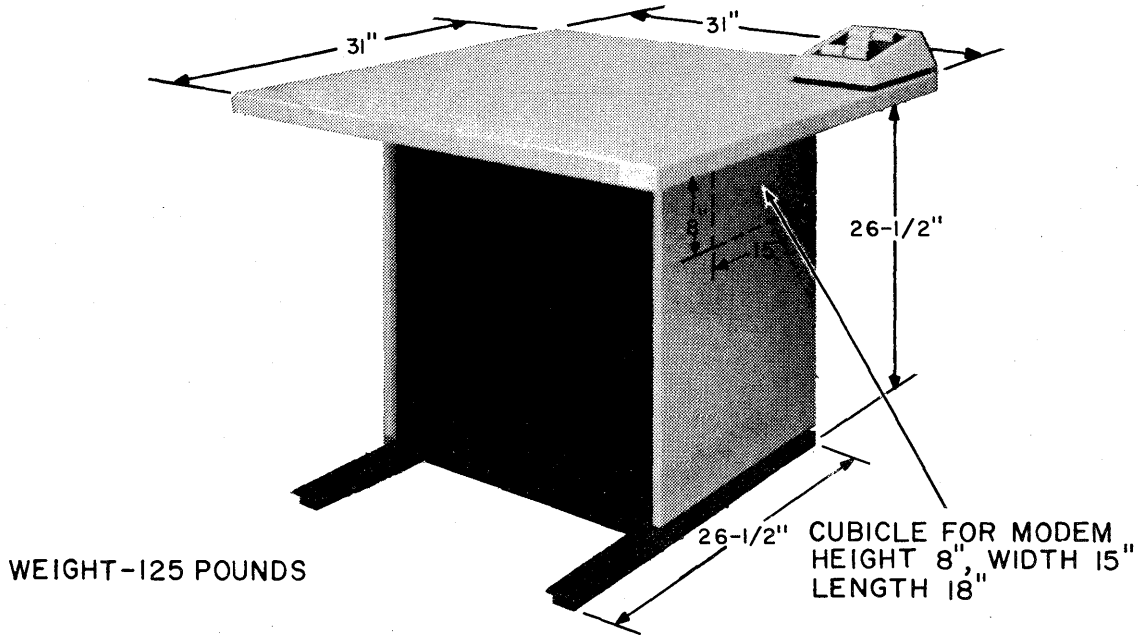
Left Side View (Panel Removed)



Right Side View (Panel Removed)

PHYSICAL DATA.

The Equipment Controller may be located as desired within the limitations of size, weight, and environmental conditions. Dimensions and weight are shown in the next illustration.



Physical Specifications

ENVIRONMENTAL DATA.

Temperature, relative humidity, and altitude limitations under both operational and nonoperational conditions are listed next. Operational condition means that the unit should function properly if normal operating procedures are followed. Nonoperational condition means that the unit is capable of operation after storage and transit under listed environmental conditions, providing it is properly packaged.

ENVIRONMENTAL CONDITIONS

CONDITION	OPERATIONAL	NONOPERATIONAL
Temperature	+60 to +85 F	-30 to +150 F
Relative Humidity (includes condensation)	10 to 90%	5 to 100%
Altitude	-1000 to +10,000 ft	-1000 to +15,000 ft

The Equipment Controller uses ambient air for cooling by radiation and convection, therefore, air ducts are not necessary. Heat dissipation is about 441 Btu per hour when equipment is in operation.

ELECTRICAL DATA.

A-c power requirements for the Equipment Controller are as follows:

105 to 125 vac, 47 to 400 hertz, 1.0 ampere
(60-hertz installations)

OR

210 to 250 vac, 47 to 400 hertz, 0.5 ampere
(50-hertz installations)

D-c outputs are fused on the power supply door (see page 1-3). The following list gives fuse types and current ratings.

D-C OUTPUT FUSES

TYPE	SIZE (Amperes)	DESCRIPTION
3AB	8.0	+5-volt d-c output (F1)
AGC	3.0	-20-volt d-c output (F2)
3AG	1.5	+20-volt d-c output (F3)

Display Station and controller power supply a-c input power is fed through the two fuses on a box in the lower rear of the controller (see page 1-2). Modem a-c input passes through the fuse in the modem cubicle (see page 1-2). The next two lists show fuse types and current ratings for both 60- and 50-hertz installations.

60-HERTZ A-C INPUT FUSES

TYPE	SIZE (Amperes)	DESCRIPTION
3AG Slo Blo	2.0	Display Station a-c input (F1)
3AG Slo Blo	5.0	Power Supply a-c input (F2)
3AG Slo Blo	0.5	Modem a-c input (F3)

50-HERTZ A-C INPUT FUSES

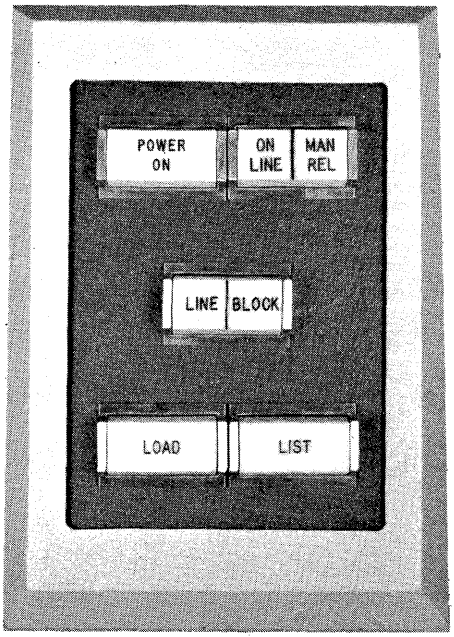
TYPE	SIZE (Amperes)	DESCRIPTION
MDX Slo Blo	1.25	Display Station a-c input (F1)
MDA Slo Blo	3.0	Power Supply a-c input (F2)
MDL Slo Blo	0.5	Modem a-c input (F3)

SECTION II

OPERATION AND PROGRAMMING

This section provides supplemental information to the discussion of the Equipment Controller's role in the Remote User Terminal operation and programming presented in the Reference Manual. The supplemental information concerns itself only with the operation of controls located on or within the Equipment Controller. Programming is generally on a total equipment basis which is the fundamental approach of the Reference Manual.

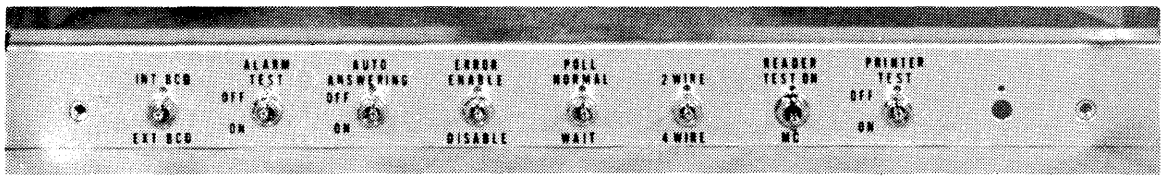
Two switch panels govern most of the controller operations. One of these is located on the right rear corner of the table top and is directly accessible to the operator.



Switch/Indicator Panel

SWITCH/INDICATOR	FUNCTION
LINE/BLOCK	Alternate action, illuminated pushbutton — when LINE is illuminated, the line indicator is used in communications and message composition. BLOCK position prevents use of the line indicator.
POWER ON	An alternate action, illuminated pushbutton. Depression results in application of primary power to the Equipment Controller and an initial master clear of logic. The lens is illuminated while power is on. A second depression turns power off.
ON LINE	Indicator illuminates when the equipment is transmitting or receiving information.
MAN REL (Manual Release)	A momentary action, lighted pushbutton unlocks the keyboard for operator use when activated. In addition, the entry marker is reset without affecting displayed data and the interface is cleared.
LIST	A momentary action, lighted pushbutton which initiates a read operation from the card reader to the printer. Data is not displayed or transmitted to the data source. Completion of printout extinguishes the light and returns the Equipment Controller to an inactive state.
LOAD	A momentary action, lighted pushbutton enables a read operation from the card reader to be performed. Subsequent data transmissions are under control of the data source. Read operation completion turns off the light.

The remaining set of switches are on the bottom of the logic assembly. This assembly is accessible through the left panel of the Equipment Controller cabinet (see page 1-2).



Logic Assembly Switches

SWITCH	FUNCTION
INT BCD/EXT BCD	INT BCD position — enables transmission and interpretation of received data in internal binary coded decimal format. EXT BCD position — enables transmission and interpretation of received data in external binary coded decimal format.
ALARM TEST	When placed in the ON position, this switch activates the ALERT light and alarm on the Display Station. The alarm cannot be turned off at the Display Station keyboard. This switch serves as a maintenance feature.
AUTO ANSWERING	Activation of this switch allows the controller to operate with the automatic answering feature.
ERROR ENABLE/DISABLE	ENABLE position — allows transmission of an error message, should an error condition arise. DISABLE position — blocks transmission of any pending error messages.
POLL NORMAL/WAIT	NORMAL position — controller transmits a reject message in response to a poll if no read message is pending. WAIT position — controller transmits an acknowledge message in response to a poll if no read message is pending. Any subsequent read message is then transmitted without the aid of another poll, as long as no other message is received in the meantime.
2 WIRE/4 WIRE	Allows modem connection in either 2- or 4-wire half duplex.
READER TEST/MC	TEST position — initiates a read operation at the card reader. Data is transferred to the display memory for observation on the crt. MC position — momentary action in which controller and adapter kits are master cleared.
PRINTER TEST	Prevents completion of print operation (except for a manual release or master clear condition) causing continual printout of a message while switch is in the ON position.

SECTION III

INSTALLATION AND CHECKOUT

This section contains unpacking, assembly, and checkout information for the Equipment Controller including adapter kits. A rigid preshipment, quality control check ensures proper performance. If any problems occur, refer to Section VI, Maintenance, in this book.

To facilitate the use of test equipment during periods of maintenance, Control Data requires that a convenience outlet be available within 15 feet of each system component cabinet. The outlets may be located in the walls or raised floor panels of the equipment room and must not be obstructed by storage racks or other furniture. The receptacles shall be of the single-phase grounded type, installed according to local electrical codes. For 60-hertz installations, the nominal voltage shall be 120 volts. For 50-hertz installations, the nominal voltage shall be 220, 230, or 240 volts as dictated by the single-phase power available at the site.

PART A

BASIC CONFIGURATION

Covering
Equipment Controllers:

FC710-A
FC710-B
FC711-A
FC711-B

For use with
Display Stations:

CC505-A
CC505-B

UNPACKING.

The Equipment Controller is shipped in a cardboard carton attached to a special skid. Remove the carton and all tape, straps, and padding. The packing materials, containers, and skid should be saved for reuse in event of reshipment.

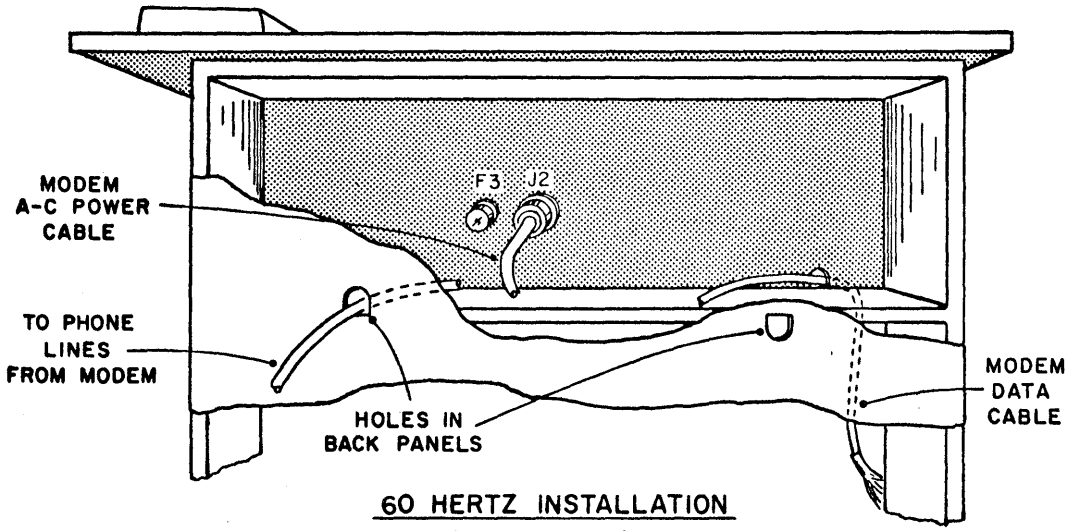
Remove the Equipment Controller side panels and check to see that all component mounting hardware is securely fastened, and that all boards are securely inserted in their respective connectors. Check the power supply door for freedom of movement.

CABLING.

One end of an 8-foot modem cable is wired directly into the Equipment Controller logic assembly. The other end is terminated in a small gray connector which plugs into the receptacle provided on the modem. Following are the modem cable pin assignments.

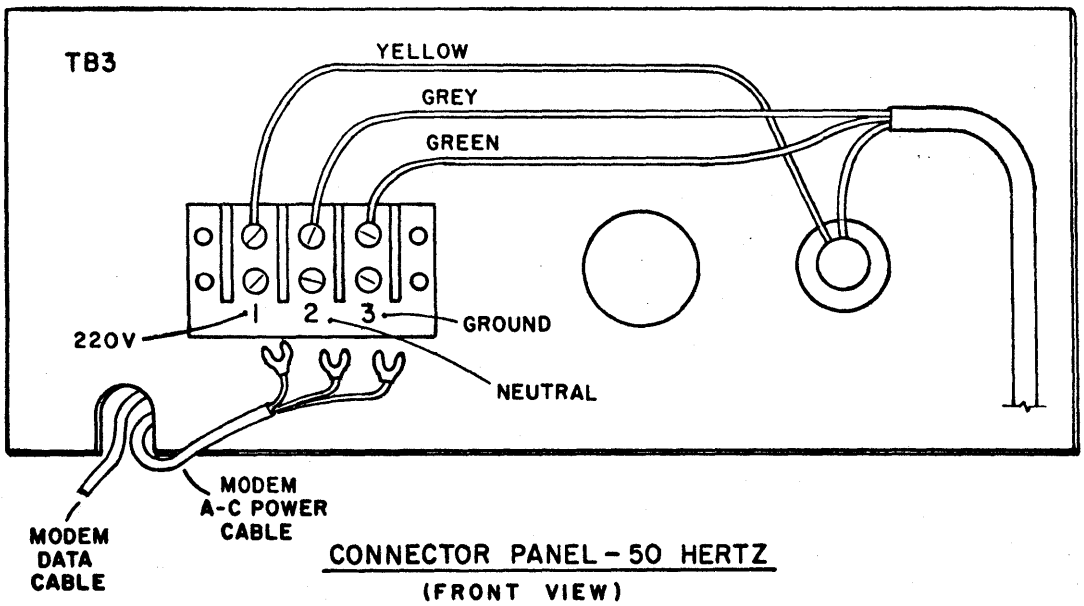
MODEM DATA CABLE

PIN	DESIGNATION	SIGNAL ORIGIN
1	Protective Ground	Modem and Controller
2	Transmitted Data	Controller
3	Received Data	Modem
4	Request to Send	Controller
5	Clear to Send	Modem
6	Data Set Ready	Modem
7	Signal Ground	Modem and Controller
8	Data Carrier Detector	Modem
9	Reserved for Data Set Testing	Not Used
10	Reserved for Data Set Testing	Not Used
11	Not Used	
12	Not Used	
13	Not Used	
14	New Synchronization	Not Used
15	Transmitter Signal Element Timing	Modem
16	Dibit Clock Transmit	Not Used
17	Receiver Signal Element Timing	Modem
18	Dibit Clock Receive	Not Used
19	Not Used	
20	Data Terminal Ready	Controller
21	Not Used	
22	Ring Indicator	Modem
23	Not Used	
24	Transmitter Signal Element Timing (External Timing Input)	Not Used
25	Not Used	



60 HERTZ INSTALLATION
(REAR VIEW)

J2 is not used in 50-hertz installations. In this case, the modem power cable must be connected to terminal strip TB3 as shown in the next illustration. The terminal strip is on the front side of the panel so the cable must be routed through one of the holes.



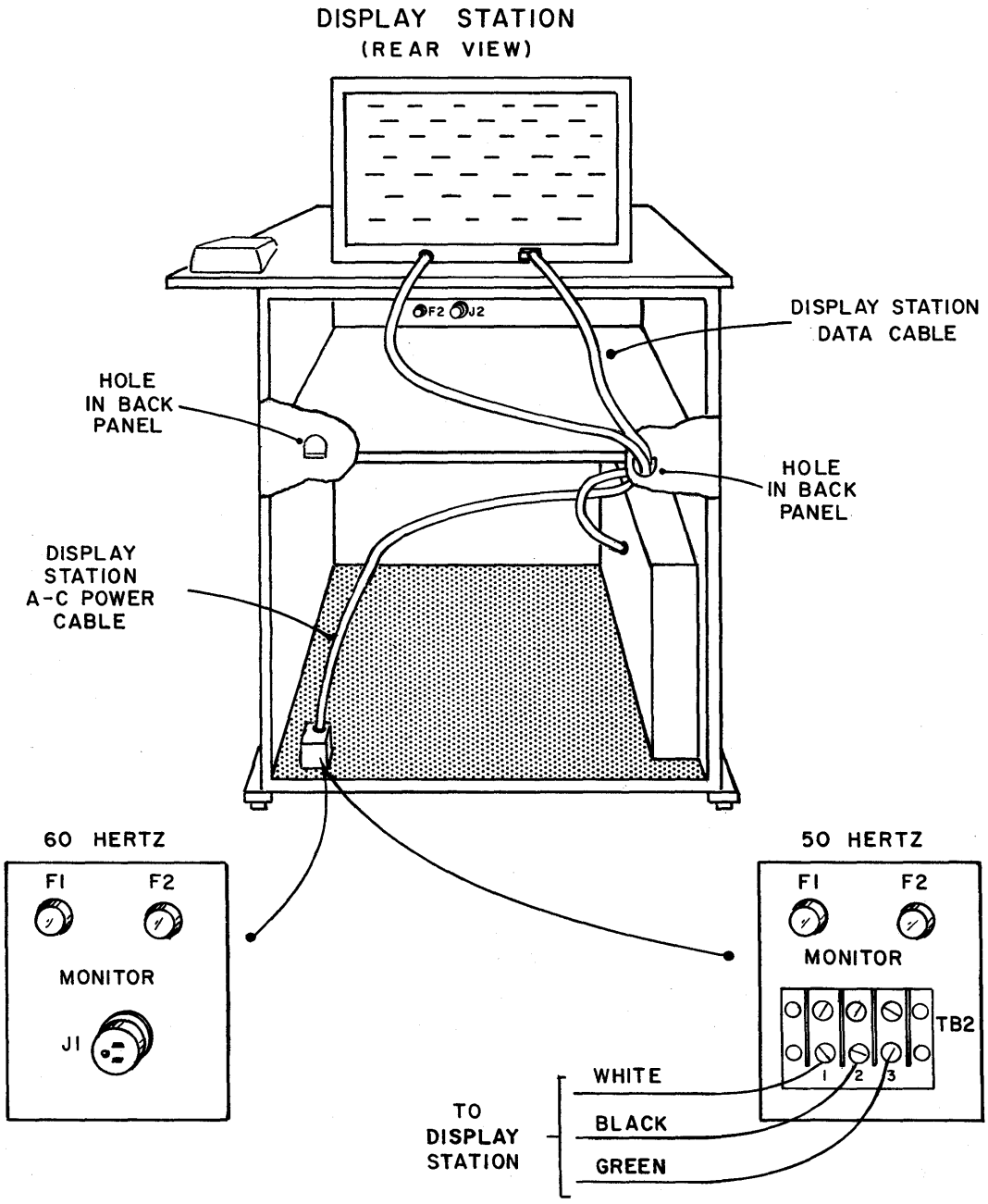
CONNECTOR PANEL - 50 HERTZ
(FRONT VIEW)

One end of a 6-foot Display Station data cable is wired directly into the logic assembly. The other end contains a large metal connector for the receptacle at the rear of the Display Station. Following are the Display Station data cable pin assignments. The cable consists of 21 twisted pair and four coaxial lines. Unlisted pin numbers are not used.

DISPLAY STATION DATA CABLE

PIN NO.	SIGNAL
1	Data Bit 0
2	Data Bit 1
3	Data Bit 2
4	Data Bit 3
5	Horizontal (Coaxial Line)
7	Vertical (Coaxial Line)
8	Data Bit 4
9	Data Bit 5
10	Data Bit 6
11	Clear Key
12	Strobe
13	Repeat Key
14	Function Strobe
15	Send Index Key
16	Interrupt Key
18	Ground
19	Ground
20	Ground
21	Ground
22	Ground
23	Ground
24	Alarm Disable
25	Alert Light
26	Unattended/Attended Light
27	Unattended/Attended Switch
34	Alert Alarm
38	Video (Coaxial Line)
40	Diddle (Coaxial Line)

The Display Station data and a-c power cables must be routed through the hole in the lower rear panel. For 60-hertz installation, connect the power cable to J1 at the bottom. The cable is connected to TB2 at the same point for 50-hertz installations.



Cabling Diagram

The Equipment Controller a-c power cable and adapter kit data cables are routed through the bottom. Adapter kit connections are described in the applicable Reference/Customer Engineering Manuals. The a-c power cable requires a standard single-phase grounded outlet for 60-hertz installations. For 50-hertz installations, the cable is not terminated in a connector. The power cable consists of 3 18-gauge wires, and for 50-hertz installations, the wire assignments are:

Black — 220 volts
White — Neutral
Green — Ground

ASSEMBLY.

The Equipment Controller is shipped fully assembled. All that remains is to install interconnecting cables.

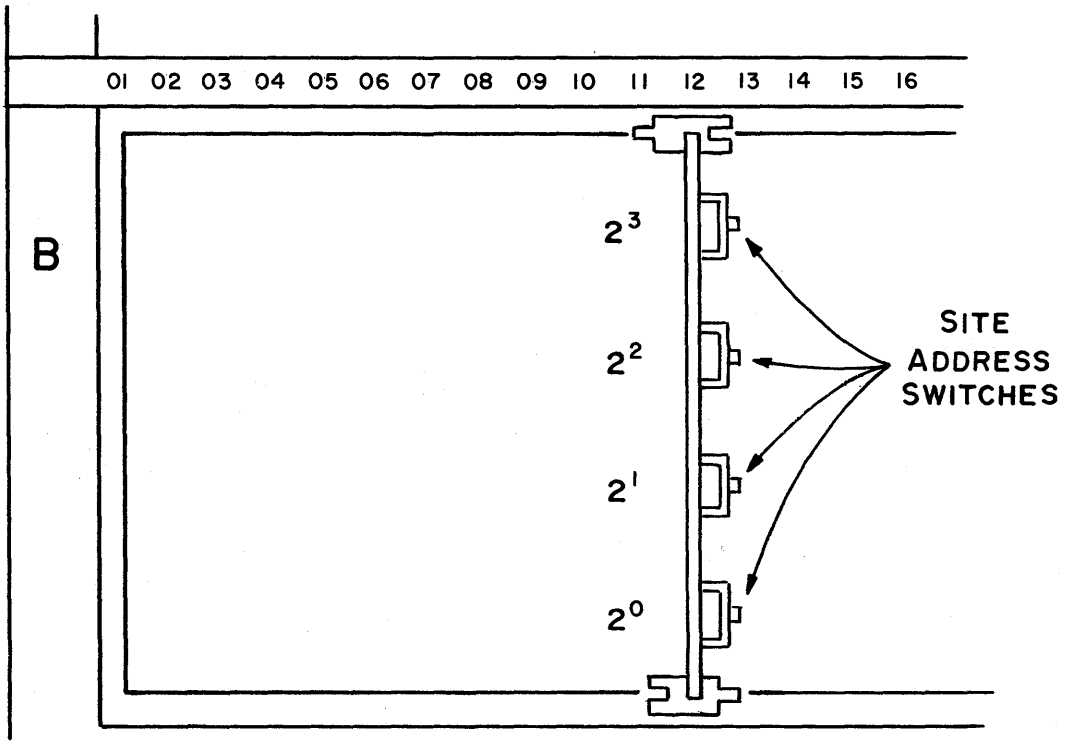
1. Refer to the Display Station Reference/Customer Engineering Manual (publication no. 82136300) for monitor assembly instructions.
2. Plug in Display Station data cable.
3. Attach Display Station a-c power cable.
4. Plug in modem data cables.
5. Connect modem power cable.

CAUTION

Modem power cable should not be connected before data cables are attached.

6. Place modem in cubicle provided in controller.
7. Reseat all logic cards.
8. Connect Equipment Controller a-c power cable.

The lower four bit positions of the controller site address are determined by the four slide switches on the board in jack B12. The least significant bit is the lowest switch position whereas the most significant bit is the top switch position. A logical 0 is entered in a bit position when the switch is in the outside position. System requirements determine what the actual address should be.



LOGIC RACK

The final steps involve the switch panel located on the logic rack (see description in Section II). System requirements determine the positions of most of these switches.

1. The position of the INT/EXT BCD switch is determined by the code set used at the central processing site.

2. AUTO ANSWERING may only be used if the modems are capable of such operation.

3. Place the ERROR ENABLE/DISABLE switch in the ENABLE position if the data source recognizes an error message. Otherwise, use the DISABLE position.

4. POLL NORMAL/WAIT can be placed in the WAIT position only if the terminal is the only site on the common carrier.

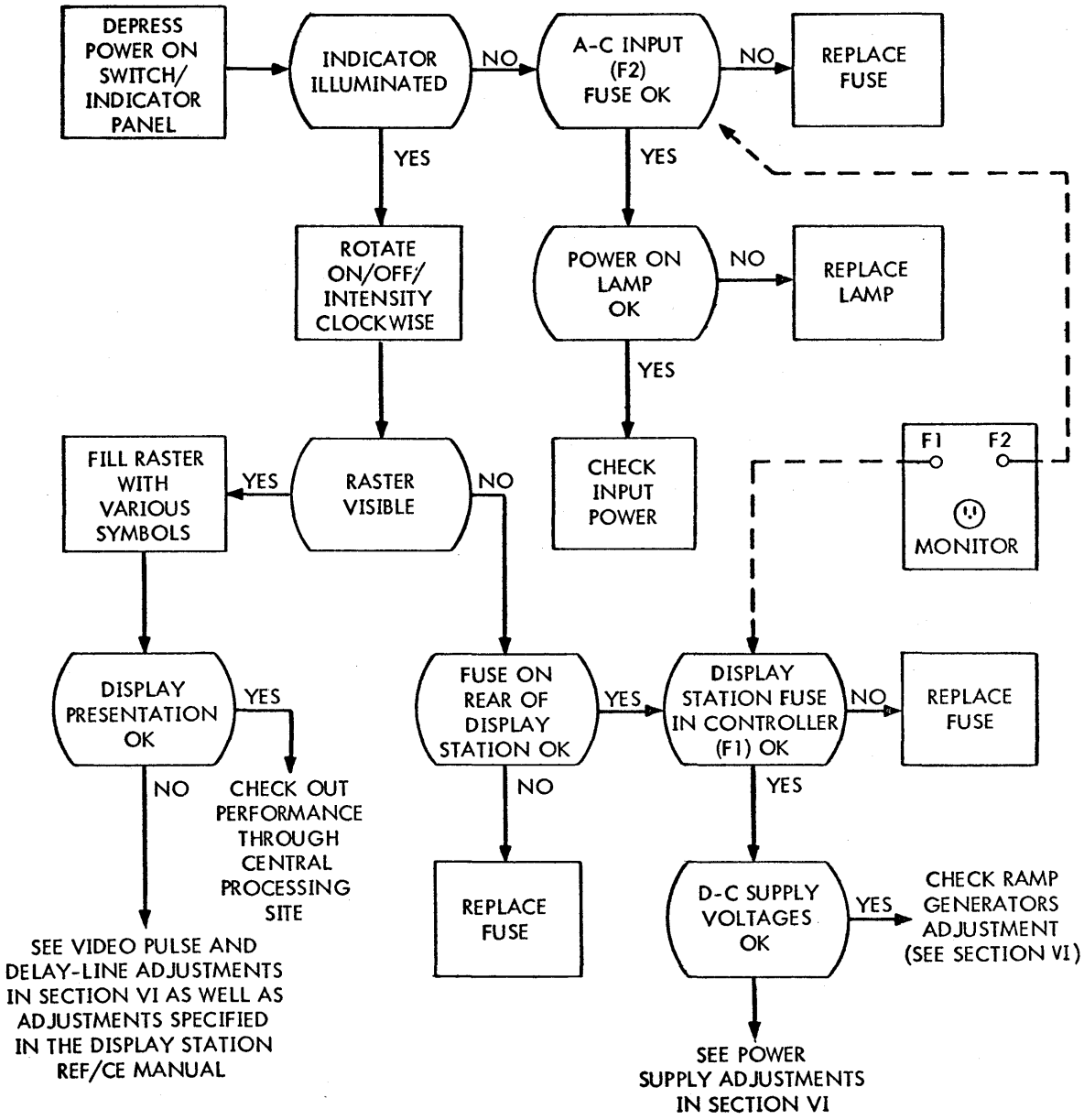
5. The 2-WIRE/4-WIRE switch should be in a position corresponding to the modem strapping option employed.

6. Use the ALARM TEST switch to turn on the Display Station alert alarm for volume adjustment purposes (see Display Station Reference/Customer Engineering Manual).

7. READER TEST and PRINTER TEST switches are explained in associated adapter kit Reference/Customer Engineering publications.

CHECKOUT.

The following chart depicts a simplified checkout procedure assuming all cables have been properly installed. Use Sections VI and VII and the Display Station Reference/Customer Engineering Manual in the event any adjustments are required or malfunctions occur.



Simplified Checkout Procedure

PART B

CARD READER ADAPTER KIT

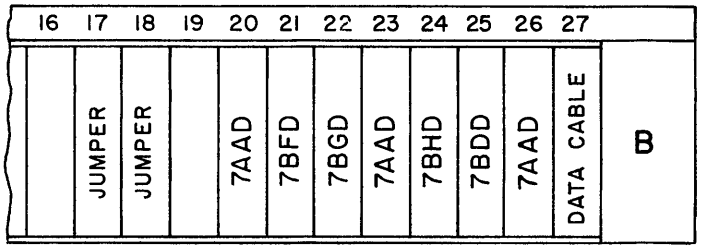
Equipment Numbers

FE105-A
FE105-B
FE106-A
FE106-B

For use with the
224-1 Card Reader
Station, Equipment
Numbers:

CE703-A
CE703-B

An adapter kit must be installed if the controller is to drive a 218-1 Typewriter Station. The following illustration points out adapter kit board, cable, and jumper locations in the controller logic rack. Refer to the 218-1 Typewriter Station Reference/Customer Engineering Manual for specifications on the typewriter.



Typewriter Adapter Placement

CABLING.

One end of the 15-foot typewriter data cable terminates in a 62-pin board while the other terminates for connection to the typewriter. Insert the board end in B27. The next list calls out pin assignments for the cable. Odd-numbered board pins are on the soldered side with even numbers on the other side. Pin numbering is sequential from top to bottom. As an example, the upper pin on the soldered side is pin 1, while the adjacent pin on the other side is pin 2. Unlisted pin numbers are not used.

CHECKOUT.

An operational check of the typewriter can be performed locally through the use of the Display Station.

1. Equipment Controller POWER ON to ON (illuminated) position.
2. Display Station ON/OFF/INTENSITY to ON position.
3. Typewriter ON/OFF rocker switch to ON position.
4. Feed paper from tray up through tractor assembly.
5. Compose message using Display Station keyboard.
6. Depress AUX SEND key when composition is completed.
7. Displayed message is typed up to the E2 (') symbol as an image of the crt display.

TYPEWRITER DATA CABLE

DESIGNATION	CONNECTOR PIN	BOARD PIN	SIGNAL ORIGIN
Normally Open	A	3	Typewriter
Normally Closed	C	5	Typewriter
Carriage Return	E	7	Controller
Space	F	8	↓
Upper Case	H	11	↓
Lower Case	J	12	↓
R1	K	13	↓
R2	L	14	↓
R2A	M	15	↓
R5	N	16	↓
T1	P	17	↓
T2	R	18	↓
CK	S	19	↓
Keyboard Lock	T	20	Controller
End of Line	V	56	Typewriter
+20 Volts	X	33	Controller
Paper Low (Ready)	Y	25	Typewriter
Ground	Z	31	--------
-50-Volt Ground Return	a	27	--------

If a card reader is a member of the configuration, a local printout of punched card data is possible (without display). In this case, the Display Station is not used since the message consists of punched cards. After making the reader operational and loading cards, all that remains is to depress the LIST switch. Printout is in 12-card batches until the hopper is empty. Each print line is one card in length (up to 80 symbols).

A final check can be made via programming at the central processing site. Each write message received (ending with escape and E2 codes) initiates a printout which is an exact image of the crt presentation.

If a printer is also included in the configuration, it may also be used to monitor reader operation. The same steps should be followed. Instead of rotating the Display Station ON/OFF/INTENSITY control, ensure the printer is ready. Then, depress the LIST switch on the controller table top in place of using the READER TEST/MC switch. With this method, 12-card batches of data will be read and printed (without display) until the hopper is empty. The Display Station keyboard remains unlocked during this interval.

The final check is via programming at the central processing site (LOAD mode). Here, each write message ending with an escape code followed by E3 initiates transmission of a 12-card batch of data. A simultaneous display occurs. The Display Station keyboard is locked out during LOAD mode. A write message from the data source (ending with an E1 code), master clear, or manual release is required to perform the release.

PART C

TYPEWRITER ADAPTER KIT

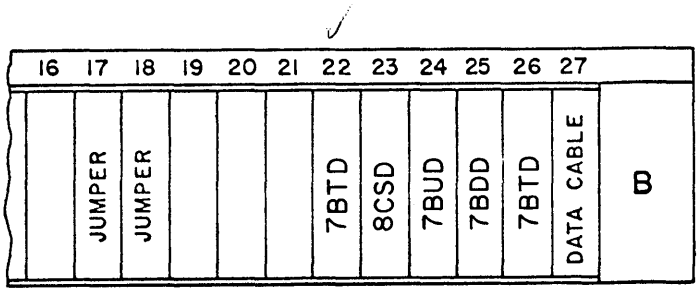
Equipment Numbers

FF305-A
FF305-B
FF306-A
FF306-B

For use with the
218-1 Typewriter
Station, Equipment
Numbers:

CK105-A
CK105-B

In order to drive a 222 Line Printer, the Equipment Controller must contain an adapter kit. Board, cable, and jumper locations in the logic rack are shown next. For information on the line printer, reference the 222 Line Printer Controller Reference/Customer Engineering Manual.



Line Printer Adapter Placement

CABLING.

One end of a 15-foot line printer cable connects to a 62-pin board while the other terminates for connection to the line printer. Insert the board end in B27. Following are pin assignments for the cable. Odd-numbered board pins are on the soldered side with even numbers on the other side. Pin numbering is sequential from top to bottom. For example, the upper pin on the soldered side is pin 1 while the adjacent pin on the other side is pin 2. Unlisted pin numbers are not used.

CHECKOUT.

The following procedure should be observed to locally check line printer operation.

1. Equipment Controller POWER ON to ON (illuminated) position.
2. Display Station ON/OFF/INTENSITY to ON position.
3. Printer POWER ON switch to ON position.
4. Depress printer PAGE EJECT.
5. Insert paper in tractor assembly.
6. Activate START button.
7. Compose message using Display Station keyboard.

8. Depress AUX SEND when composition is complete.
9. Displayed message is printed up to the E2 (') symbol.

LINE PRINTER DATA CABLE

DESIGNATION	CONNECTOR PIN	BOARD PIN	SIGNAL ORIGIN
Data Bit 0	A	3	Controller
Data Bit 1	B	4	
Data Bit 2	C	5	
Data Bit 3	D	6	
Data Bit 4	E	7	
Data Bit 5	F	8	
Data Bit 6	H	11	Controller
Ground	b	29	
Information Ready	R	18	Controller
Output Resume	S	19	Printer
Master Clear	U	21	Controller
Ready	W	23	Printer
Print Mode	X	24	Controller
Not 136 Column	V	22	Printer

The PRINTER TEST switch on the logic rack may be used to cause a continual printout of the same message. This switch blocks recognition of the E2 symbol.

If a card reader is available, punched card data may also be printed locally (without display). After making the reader operational and loading cards, all that remains is to depress the LIST switch. Printout is in 12-card batches until the hopper is empty. Each print line is one card in length (up to 80 symbols). Here, again, the PRINTER TEST switch may be used.

The final step is to check printer operation through the central processing site. Each write message received (ending with escape and E2 codes) initiates a printout which is an exact duplicate of the crt presentation. The PRINTER TEST switch may be used in this instance also.

PART D

LINE PRINTER ADAPTER KIT

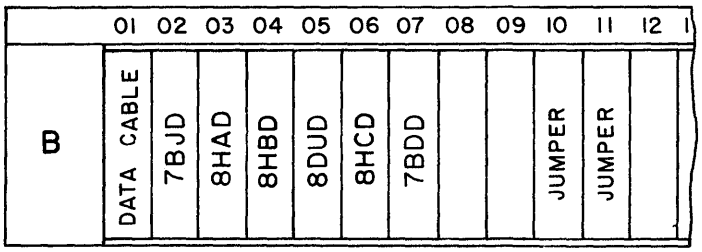
Equipment Numbers

FF512-A
FF512-B
FF513-A
FF513-B
FF514-A
FF514-B
FF515-A
FF515-B

For use with the
222-1 and 222-2
Line Printer Stations,
equipment numbers:

CL401-A
CL401-B
CL402-A
CL402-B

In the event a 224-1 Card Reader is part of the configuration, a card reader adapter kit should be installed in the logic rack. The next chart shows the location of logic boards, jumper, and cable comprising the package. Refer to the 224-1 Card Reader Station Reference/Customer Engineering Manual for details on the reader.



Card Reader Adapter Placement

CABLING.

The data cable for the card reader is 15 feet long and one end terminates in a 62-pin board while the other end contains a rectangular connector. Insert the board end in location B01. The other end connects to the card reader. Following is a list of pin assignments for the cable. Odd-numbered board pins are on the soldered side of the board with even numbers on the other side. Pin numbering is sequential from top to bottom. As an example, the upper pin on the soldered side is pin 1, while the adjacent pin on the other side is pin 2. Unlisted pin numbers are not used.

CHECKOUT.

The READER TEST/MC switch on the logic rack initiates an operational check of the reader. With the Display Station and Equipment Controller functioning properly, punched card data may be monitored at the Display Station with the switch in the TEST position. During this period, the Display Station keyboard is locked out. A power on master clear or manual release is required to perform the release, once the switch has been taken out of the TEST position.

1. Equipment Controller POWER ON to ON (illuminated) position.
2. ON/OFF/INTENSITY control to ON position.
3. READER TEST/MC switch to TEST position.
4. Load reader hopper with punched cards.

5. Reader MAN/AUTO switch to AUTO position.
6. Reader ON/OFF switch to ON position.
7. Depress reader REG switch.
8. Punched cards will be read and displayed until the hopper is empty.

CARD READER DATA CABLE

DESIGNATION	CONNECTOR PIN	BOARD PIN	SIGNAL ORIGIN
+5 Volts DC	L, P, K	1, 2, 61	Controller
Register	U	6	Card Reader
Skip	W	8	↓
Not Skip	X	11	
Pressure Rollers Down	Y	12	
Column 82	a	13	
Manual/Auto	S	4	
Card Present	m	19	
Clock	n	20	
Field	p	21	
Row 12	HH	43	
Row 11	FF	42	
Row 0	EE	41	
Row 1	DD	40	
Row 2	CC	39	
Row 3	BB	38	
Row 4	AA	37	
Row 5	z	36	
Row 6	y	35	
Row 7	x	28	
Row 8	w	27	
Row 9	v	26	Card Reader
Escapement	d	14	Controller
Ready	s	23	↓
Check Reader	r	22	
-20 Volts DC	E, M	29, 30	
+20 Volts DC	J	33	Controller

PART E

CARD READER ADAPTER KIT

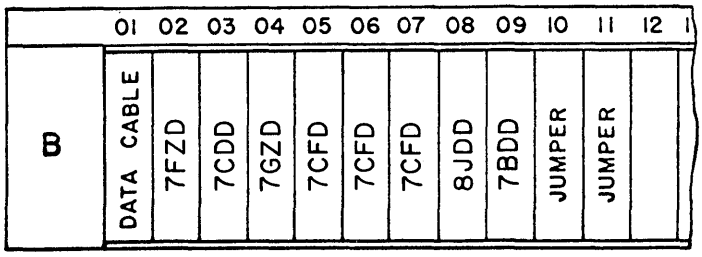
Equipment Numbers

FE108-A
FE108-B
FE109-A
FE109-B

For use with the
224-2 Card Reader
Station, Equipment
Numbers:

CE304-A
CE304-B

A 224-2 Card Reader Station becomes a member of the configuration when this adapter is properly installed. The next chart shows the location of logic boards, jumper, and cable comprising the package. Refer to the 224-2 Card Reader Station Reference/Customer Engineering Manual for details on the reader.



Card Reader Adapter Placement

CABLING.

The data cable for the card reader is 15 feet long and one end terminates in a 62-pin board. Insert the board end in location B01. The other end connects to the card reader. Following is a list of pin assignments for the cable. Odd numbered board pins are on the soldered side of the board with even numbers on the other side. Pin numbering is sequential from top to bottom. As an example, the upper pin on the soldered side is pin 1, while the adjacent pin on the other side is pin 2. Unlisted pin numbers are not used.

CHECKOUT.

The READER TEST/MC switch on the logic rack initiates an operational check of the reader. With the Display Station and Equipment Controller functioning properly, punched card data may be monitored at the Display Station with the switch in the TEST position. During this period, the Display Station keyboard is locked out. A power-on master clear or manual release is required to unlock the keyboard once the switch has been removed from the test position.

CARD READER DATA CABLE

DESIGNATION	CONNECTOR PIN	BOARD PIN	SIGNAL ORIGIN
Feed	C	59	Controller
Ground	H	60	
Ready	A	51	Reader
Ground	E	52	
Check Error	D	58	Reader
Ground	J	57	
Strobe	B	50	Reader
Ground	F	49	
End Data	M	07	Reader
Ground	S	08	
Channel 1	K	14	Reader
Ground	P	13	
Channel 2	N	19	Reader
Ground	T	20	
Channel 3	L	22	Reader
Ground	R	21	
Channel 4	W	25	Reader
Ground	$\overline{a}$	26	
Channel 5	U	28	Reader
Ground	Y	27	
Channel 6	X	35	Reader
Ground	$\overline{b}$	36	
Channel 7	V	38	Reader
Ground	Z	37	
Channel 8	$\overline{e}$	41	Reader
Ground	$\overline{k}$	42	
Channel 9	$\overline{c}$	44	Reader
Ground	$\overline{h}$	43	
Channel 0	$\overline{f}$	11	Reader
Ground	$\overline{m}$	12	
Channel 11	$\overline{d}$	06	Reader
Ground	$\overline{j}$	05	
Channel 12	$\overline{r}$	03	Reader
Ground	$\overline{v}$	04	
Ground	$\overline{p}$	09	
Ground	$\overline{u}$	31	
Ground	$\overline{z}$	32	
Ground	DD	54	

1. Equipment Controller POWER ON to ON (illuminated) position.
2. ON/OFF/INTENSITY control to ON position.
3. READER TEST/MC switch to TEST position.
4. Load reader hopper with punched cards.
5. Reader MAN/AUTO switch to AUTO position.
6. Reader ON/OFF switch on front panel to the ON (up) position.
7. Depress READY/CHECK (READY should light).
8. Depress FEED/ERROR (FEED should light).
9. Punched cards will be read and displayed until the hopper is empty or an error occurs. Since a hopper-empty situation is created before the last card can be scanned, this card should be blank or contain non-essential information.

If a printer is also included in the configuration, it may also be used to monitor reader operation. The same steps should be followed. However, instead of rotating the Display Station ON/OFF/INTENSITY control, ensure the printer is ready. Then, depress the LIST switch on the controller table top in place of using the READER TEST/MC switch. With this method, 12-card batches of data will be read and printed (without display) until the hopper is empty. The Display Station keyboard remains unlocked during this period.

The final check is via programming at the central processing site (LOAD mode). Here, each write message ending with an escape and E3 code initiates transmission of a 12-card batch of data. A simultaneous display occurs. The Display Station keyboard is locked out during LOAD mode. A write from the data source (ending with an E1 code), master clear, or manual release is required to unlock the keyboard.

SECTION IV

THEORY OF OPERATION

The approach taken in the theory of operation for the Equipment Controller is from a functional viewpoint. Such a systematic approach eliminates the necessity for considering each of the multitude of relationships shown in the logical diagrams (Section V, Book 2).

With this approach, it is only necessary to consider the general structure of the controller in order to develop a concept of the factors which govern operation of the remote terminal. The basic structure of the controller features the functional areas of INTERFACE, MAIN TIMING, SYMBOL GENERATION, and DISPLAY CONTROL. Other areas discussed are adapter kits containing logic inserted in the controller to permit attachment of additional input/output devices.

PART A

BASIC CONFIGURATION

Covering
Equipment Controllers:

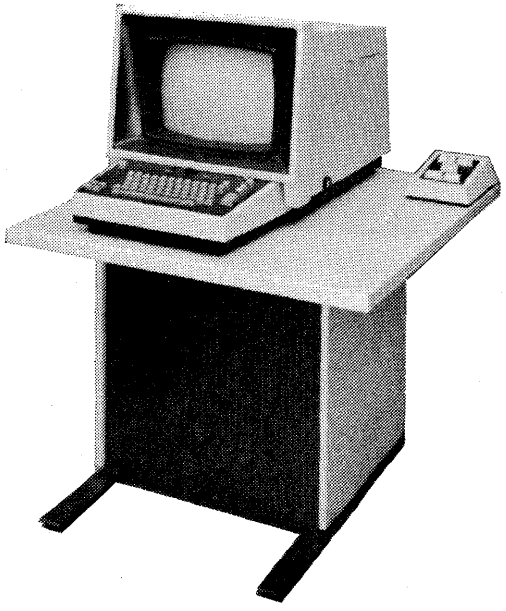
FC710-A
FC710-B
FC711-A
FC711-B

and for use with
Display Stations:

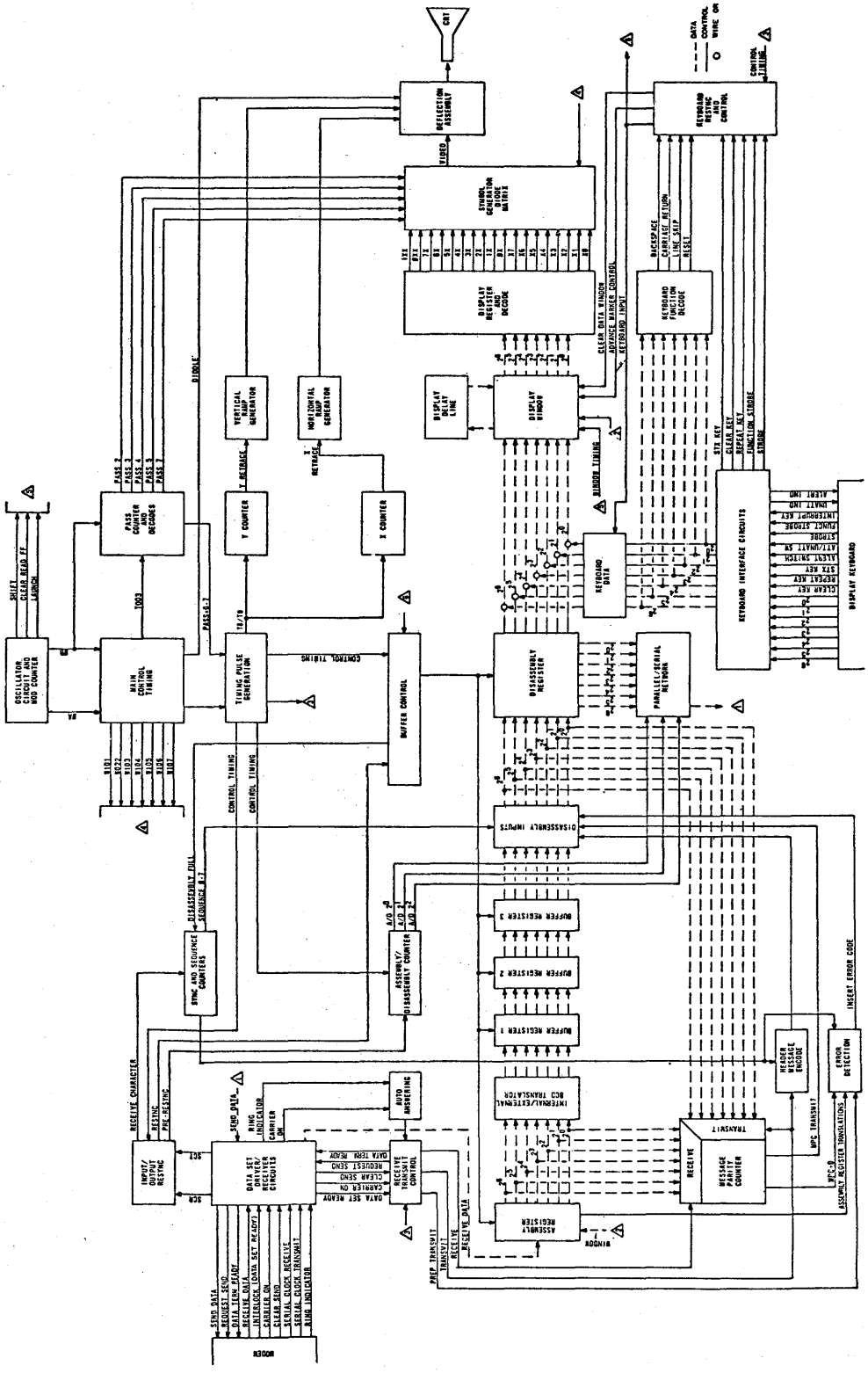
CC505-A
CC505-B

In its basic configuration, the 217-2 Equipment Controller has been designed to control Display Station crt displays, process Display Station keyboard signals, and handle communications with the central processing site (data source). Actually, a given controller may be one of four types. The differences appear in display page format (number of symbols per line and number of lines per page) and power requirements (120 volt, 60 hertz or 220 volt, 50 hertz).

EQUIPMENT NUMBER	PAGE FORMAT	POWER REQUIREMENTS
FC710-A	20 Lines of 50 Symbols	120 Volts, 60 Hertz
FC710-B	20 Lines of 50 Symbols	220 Volts, 50 Hertz
FC711-A	13 Lines of 80 Symbols	120 Volts, 60 Hertz
FC711-B	13 Lines of 80 Symbols	220 Volts, 50 Hertz



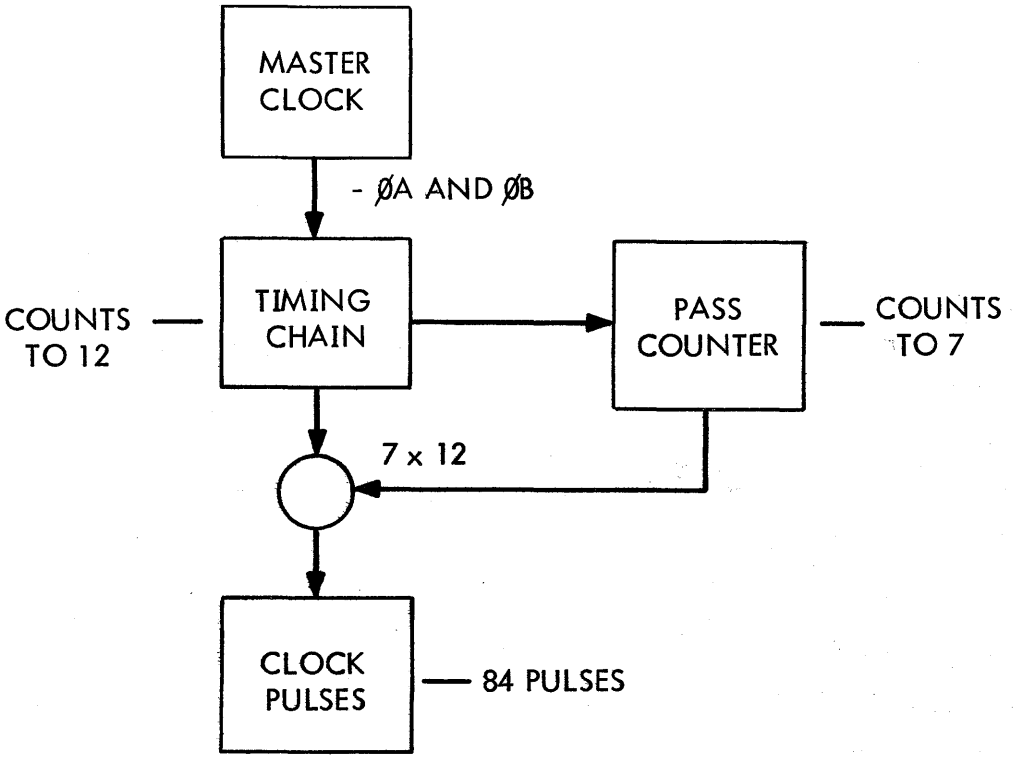
217-2 Equipment Controller with Display Station



Basic Configuration Block Diagram

MAIN TIMING.

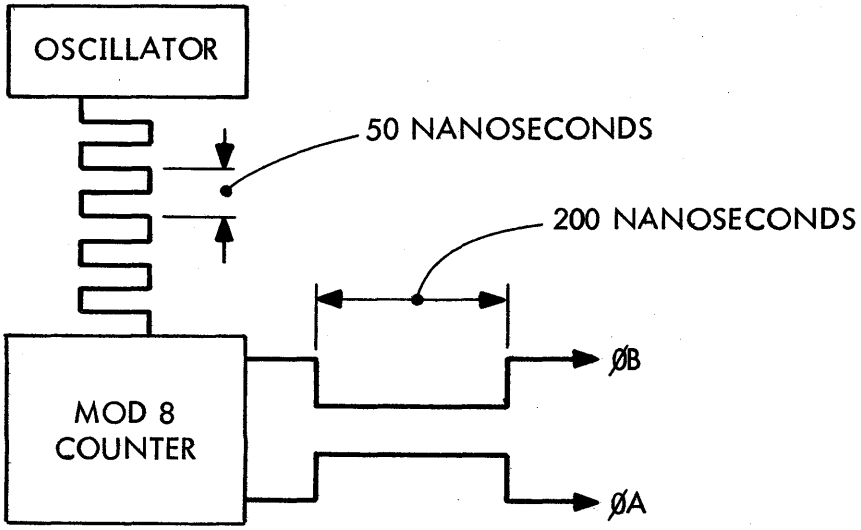
Equipment Controller internal timing is based on the symbol transfer interval (symbol time), or time required to display one symbol. This interval is 16.8 microseconds long and is formed by 84 200-nanosecond pulses. These pulses are labeled time 1 (t1) through time 84 (t84) and are formed by a network consisting of a master clock, timing chain, and pass counter. Following is an illustration showing the interrelationships involved in this timing network.



Timing Block Diagram

MASTER CLOCK.

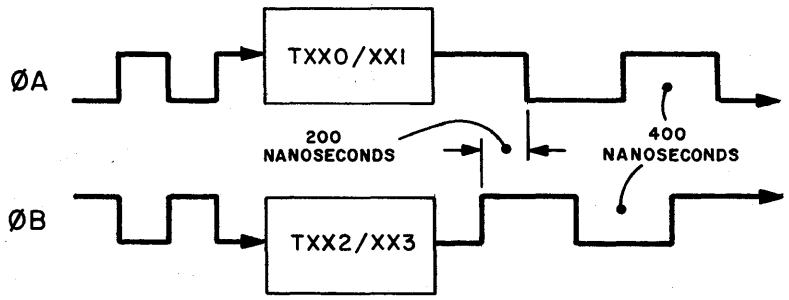
An oscillator circuit and mod 8 counter form the master clock network shown next. The mod 8 counter converts the 20 MHz square wave from the crystal-controlled oscillator into two continuous streams of 200-nanosecond pulses. These two outputs are 180 degrees out of phase, forming phase A and phase B of the master clock.



Simplified Master Clock Operation

TIMING CHAIN.

Each 200-nanosecond pulse emanating from the master clock is registered in a timing chain. Actually, the chain is divided into two 6-step segments. Phase A is registered in one half while the other half records phase B. In each half, the clock ff's set (for 400 nanoseconds) in succession with the previous ff clearing at the same time its succeeding ff sets. After the last ff in the entire chain sets, the sequence begins again. Since the sequences for each half are 180 degrees out of phase, they are displaced by 200 nanoseconds. Consequently, the ff's in one half overlap the ff's in the other half by 200 nanoseconds and twelve overlapping 400-nanosecond pulses are produced on each pass through the entire chain. These pulses are used to advance a pass counter and form the basic clock pulses by ANDing with the pass counter decoded outputs.



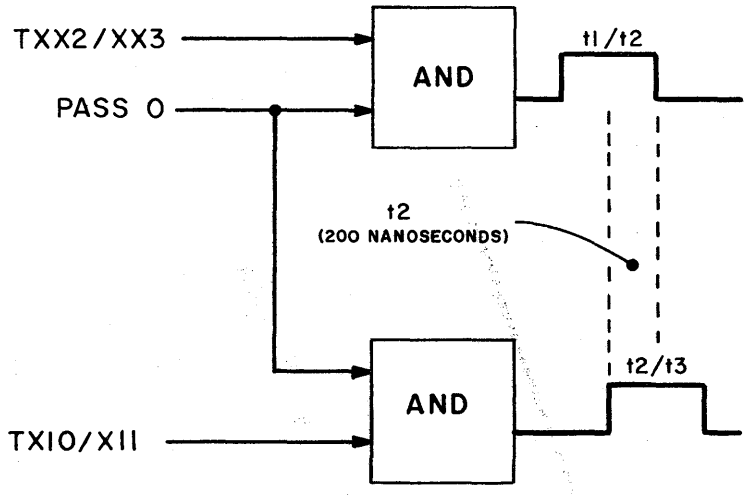
Timing Chain Overlapping

PASS COUNTER.

Each pass through the timing chain increments the pass counter. This counter is initially cleared by the power-on master clear condition. Advent of the first phase B during each pass of the timing chain allows the pass counter to advance (a count of 6 is skipped). On a count of 7, the pass counter clears and begins again. The seven complete passes yield 42 overlapping 400-nanosecond pulses, the amount required for one complete symbol time.

CLOCK PULSES.

Outputs of the timing chain and pass counter are ANDed whenever necessary to form the basic clock pulses. This process identifies each clock pulse by its relative position in the symbol transfer interval. The assigned positions are t1 through t84. Since sequential pulses overlap one another by 200 nanoseconds, the assigned positions for the pulses must also overlap. Consequently, any discrete 400-nanosecond pulse has two time positions; such as t1/t2, t2/t3, etc. Each time position then has a value of 200 nanoseconds and the 16.8-microsecond requirement for a symbol transfer interval is established. The following diagram illustrates the relationship between clock pulses formed by two successive timing chain steps.



Clock Pulse Derivation

DISPLAY CONTROL.

The display module uses a magnetostrictive delay line with an approximate length of 10 milliseconds for temporary data storage and buffering purposes. Data entering and leaving the delay line may be from:

- The card reader for transfer to the modem.
- The Display Station keyboard.
- The modem for display alone or display and printout.

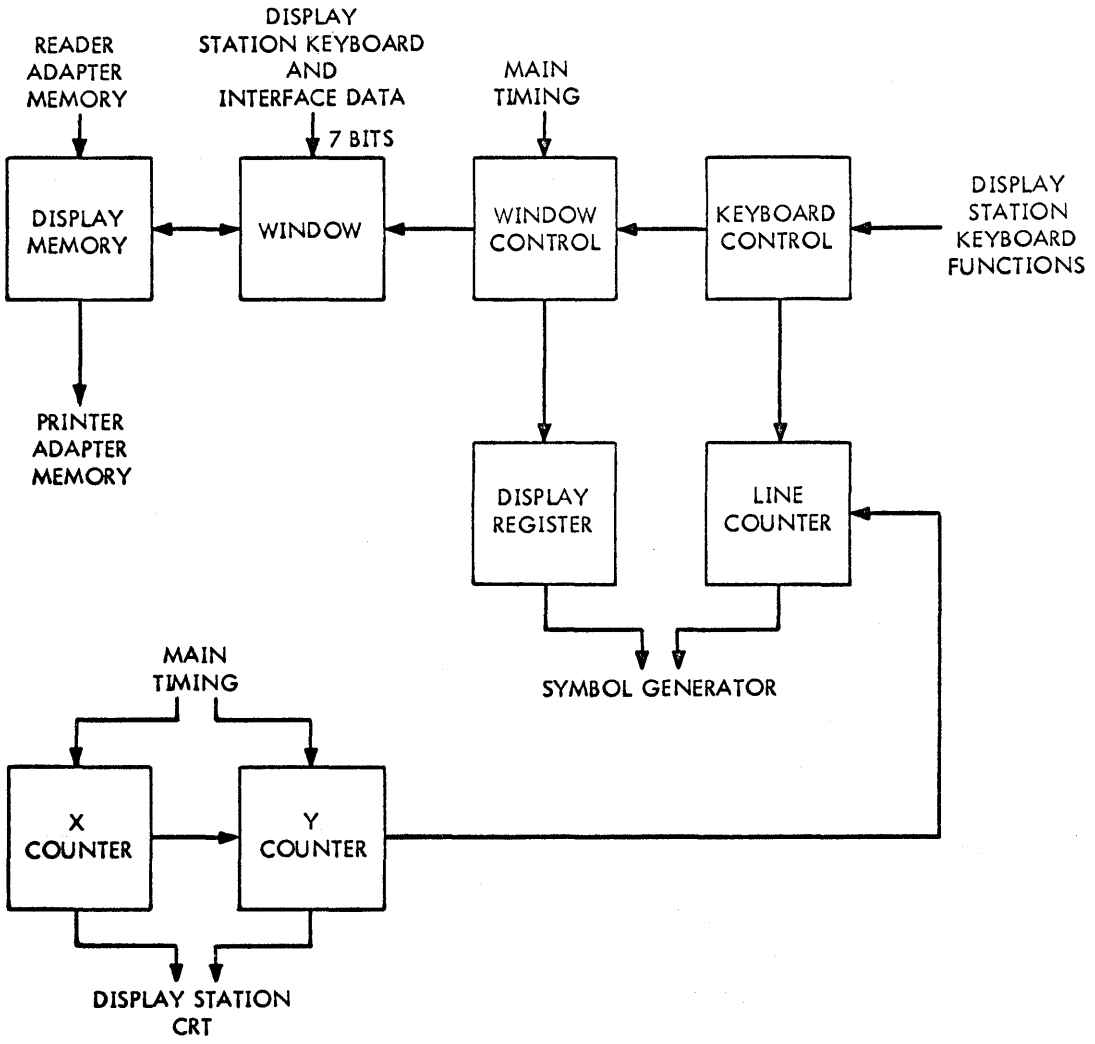
Each word is written into and read out of the delay line in serial, bit by bit, and displayed on the Display Station crt. Data is updated or changed between the time it is read out and the time it is rewritten. Two passes through the delay line are required to complete one full scan of a display page. Since two passes are required, upper and lower-half display page data must be interlaced in memory. Following is a block diagram representing the display control area in the Equipment Controller.

As already established, basic machine timing utilizes a symbol transfer interval (symbol time) of 16.8 microseconds. This means that the delay line must supply one symbol every symbol time. Each symbol time is divided into 16 equal divisions of 1.05 microseconds, allowing two 8-bit words (7 bits plus a marker bit) to be stored during the same 16.8-microsecond interval. The two words are displaced on the crt raster by one-half page (including retrace time). Hence, the first position of line 1 in a 20 by 50 format is interlaced with the first position in line 11. In a 13 by 80 format, the first position in line 1 interlaces with the 46th position in line 7.

WINDOW.

Data bits leaving the delay line pass through the read ff and shift into a 17-bit window every 1.05 microseconds. This action provides parallel assembly of two interlaced 8-bit words. The window shift pulses are provided by the mod 21 counter. A 150-nanosecond pulse is provided by this counter every 1.05 microseconds. The counter is cleared by a power-on master clear and regulated by the crystal oscillator.

Access is provided to one word, in the window, between successive window shift pulses. Only one word is available for gating from the window (to the display register) during each symbol time. This stipulation is necessary in order to provide a relationship between a word position in memory and its image on the crt raster.



Display Control Block Diagram

In order to see how all symbol positions in the delay line may be referenced, it becomes necessary to analyze the total timing cycle of the machine. Considering an 80 by 13 raster, there are:

(80 symbols + 10 retrace) (13 lines) + 1 retrace symbol position = 1171

symbol times in a complete machine timing cycle. Since two passes of the delay line are required, the total delay time (storage time) of the delay line and window

is 1171/2, or 585.5 symbol times. So, 1171 symbols must be stored at the rate of two symbols per symbol time. In a 20 by 50 format, this would become a:

$$\frac{(50 \text{ symbols} + 9 \text{ retrace})\ (20 \text{ lines}) + 1 \text{ retrace symbol position} = 590.5}{2}$$

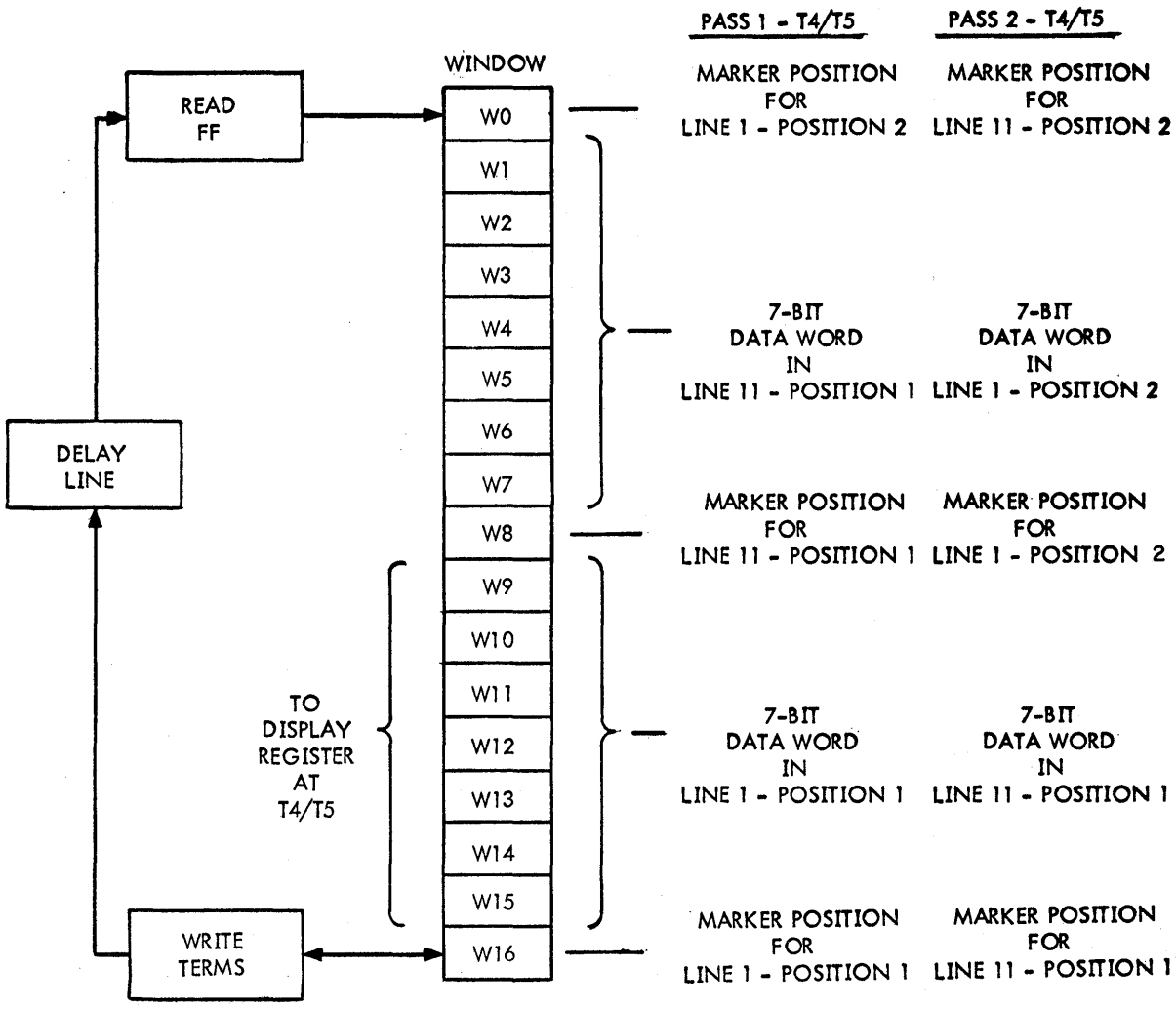
symbol times delay.

As seen by this analysis, there is a half-symbol skew to the delay line. This means that a symbol written in at the beginning of a specific symbol time is rewritten, during the next pass, one-half symbol time later. Referring to the 84-time symbol transfer interval, data is sampled for display during the 400-nanosecond interval, t4/t5. Hence, a symbol referenced during one pass at t4/t5 is referenced in the same window position at t46/t47 of the next pass (an 8.4-microsecond displacement) of the delay line. "Referencing" (at t4/t5 or t46/t47) indicates the 8 bits (including marker) in the last 8 positions in the window. The term does not necessarily mean a memory transfer has taken place but is used to indicate when a symbol appears in these positions in the window.

The next illustration indicates the contents of the window at t4/t5 and t46/t47. The interlaced symbols of line 11 (position 1) and line 1 (position 1) in the 20 by 50 format are assumed for this presentation. Actually, any two interlaced symbols would serve the same purpose. It should be emphasized, however, that transfer to the display register only occurs at t4/t5. This means that the symbol in the upper half of the window at t4/t5 cannot be transferred until the next pass.

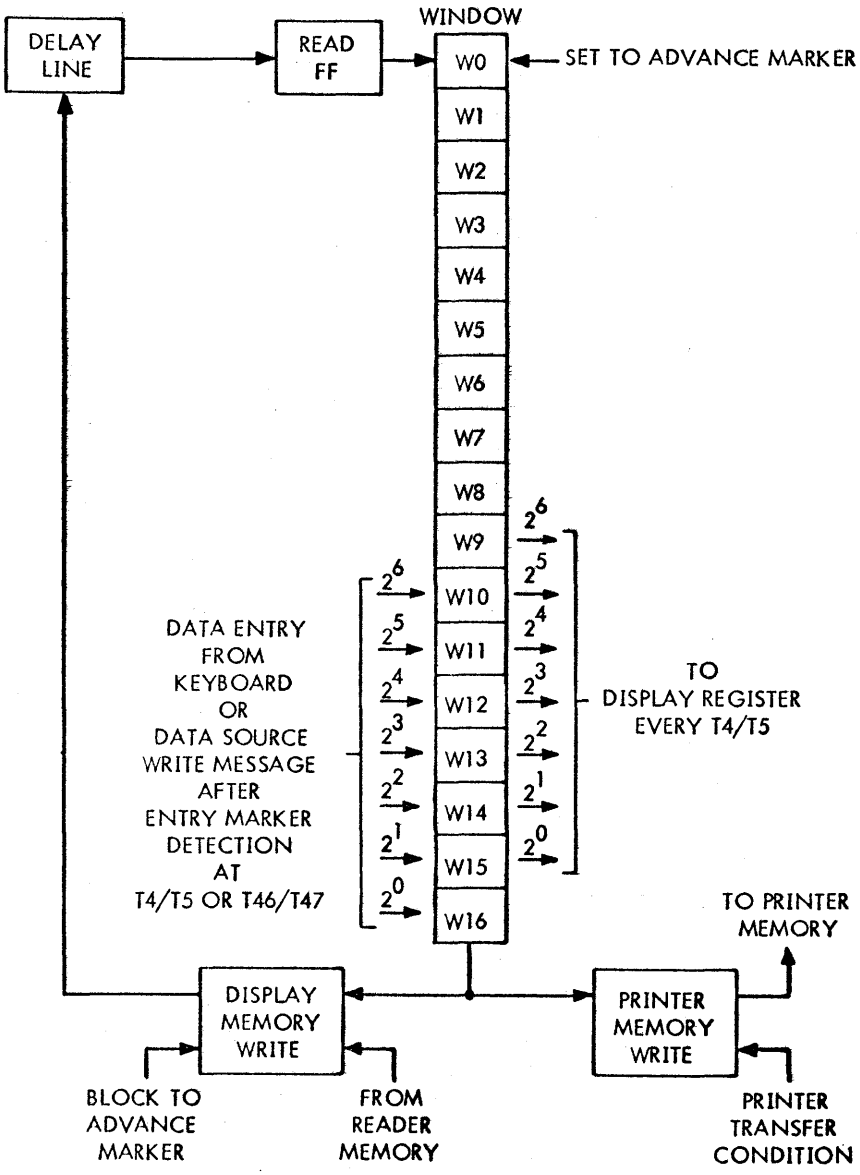
Bits leaving the delay line are picked up by the read ff. Each bit then proceeds through the window, leaving one ff and entering the next every 1.05 microseconds. Timing for the window shift operation is provided by the mod 21 counter. Bits become available for transfer to the delay line when they enter the last ff (W16) in the window.

Each 8-bit symbol reserves one bit position for a marker. The marker is used to reference the symbol position available for memory transfer (data entry or change). This is the symbol position directly above the entry marker on the display page. Since there is only one entry marker per display page, only one marker bit may reside in memory. Due to the half symbol time skew, a marker referenced in the last ff (W16) in the window at t4/t5 of one pass is next referenced in the same ff during the second pass at t46/t47. Since this ff can be sampled at both t4/t5 and t46/t47, search for the marker should never take longer than one pass of the delay line (approximately 10 milliseconds).



Window Shift Sequence

Probably the first question that comes to mind is how to enter data into the delay line or how to change that already present. Consider the following window representation.



Window Entry Sequence

Assuming the marker is detected at t4/t5 in W16, the 7 bits following are shifted in parallel to the display register. If new data is to be entered, original data must be erased and the marker must advance one symbol position. Disabling the "Display Memory Write" term and setting W0 allows the marker to reference the

next sequential symbol position while clearing W9 through W15 erases the original word. When the next window shift pulse is received, the new 7-bit word is inserted in the last 7 window positions (W10 through W16). However, since display can only occur at t4/t5, this symbol must wait for two more passes (20 milliseconds) before it is transferred to the display register.

The characteristic feature of this window is that data may enter at either t46/t47 or t4/t5. Hence, even though transfer to the display register occurs at t4/t5, data may be entered into the last 7 window positions following entry marker detection at t46/t47. Subsequent display then occurs one pass (10 milliseconds) later when these bits appear in positions W9 through W15 at t4/t5.

Entry through the window is possible only for the Display Station keyboard and information received in write messages. Memory transfer from the reader adapter kit is a direct feed through the "Display Memory Write" term. Transfer to the printer adapter kit memory occurs in much the same manner.

DISPLAY REGISTER.

Data to be displayed is gated in parallel from window positions W9 through W15 to a 7 flip-flop display register at t4/t5 of each symbol time, regardless of whether the marker is sensed. With the one-half symbol skew, data in the lower window positions at t46/t47 of the first pass arrives in the same positions at t4/t5 of the second pass. The display register is cleared each t84/t1 allowing entry of the next word. Information in the display register is decoded and transferred to a symbol generation network for ultimate crt display. In this way, two passes through the delay line enable all stored symbols to be displayed.

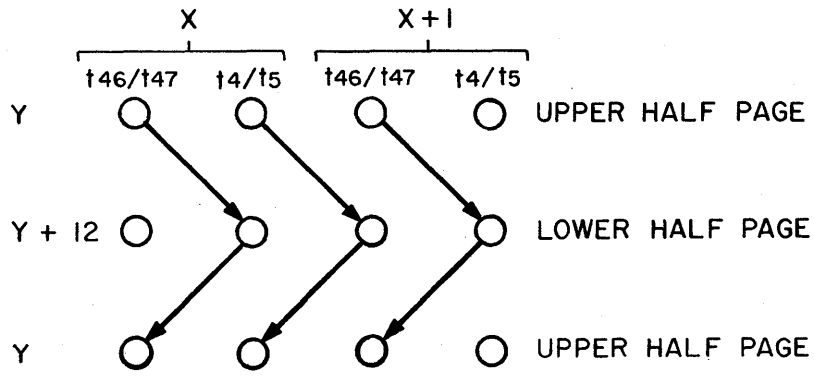
POSITION COUNTERS.

A chain of markers (underlines of symbol positions) indicate the number of symbol positions left in a line. Initially, the markers extend from the left to right edge in the uppermost line of the crt raster. In this case, the marker in the upper left corner is called the entry marker. Once a symbol enters that position, the marker is erased and the next marker to the right becomes the entry marker. The entry marker is always the marker closest to the left edge of the raster. When the end of a line is reached, display begins at the left edge of the next lower line (after a horizontal retrace period). The horizontal (X) position counter records the current position in the line as the electron beam moves across the page. At the end

of the line, an end of line condition is created to prevent any further display until the beginning of the next line is reached. A vertical (Y) counter records the current line being scanned. As each new line begins, the vertical counter increments. At the end of the last line, both counters clear and begin again.

Since the delay line has an 8.4-microsecond skew, a full symbol time is gained after two passes. Unless compensation is made by the counters, a symbol referenced in one position during the first two passes will arrive one position later during the next scan. The horizontal counter prevents this situation by incrementing one extra time (another 16.8 microseconds) at the end of the last line before both counters clear and begin to count positions for the next scan.

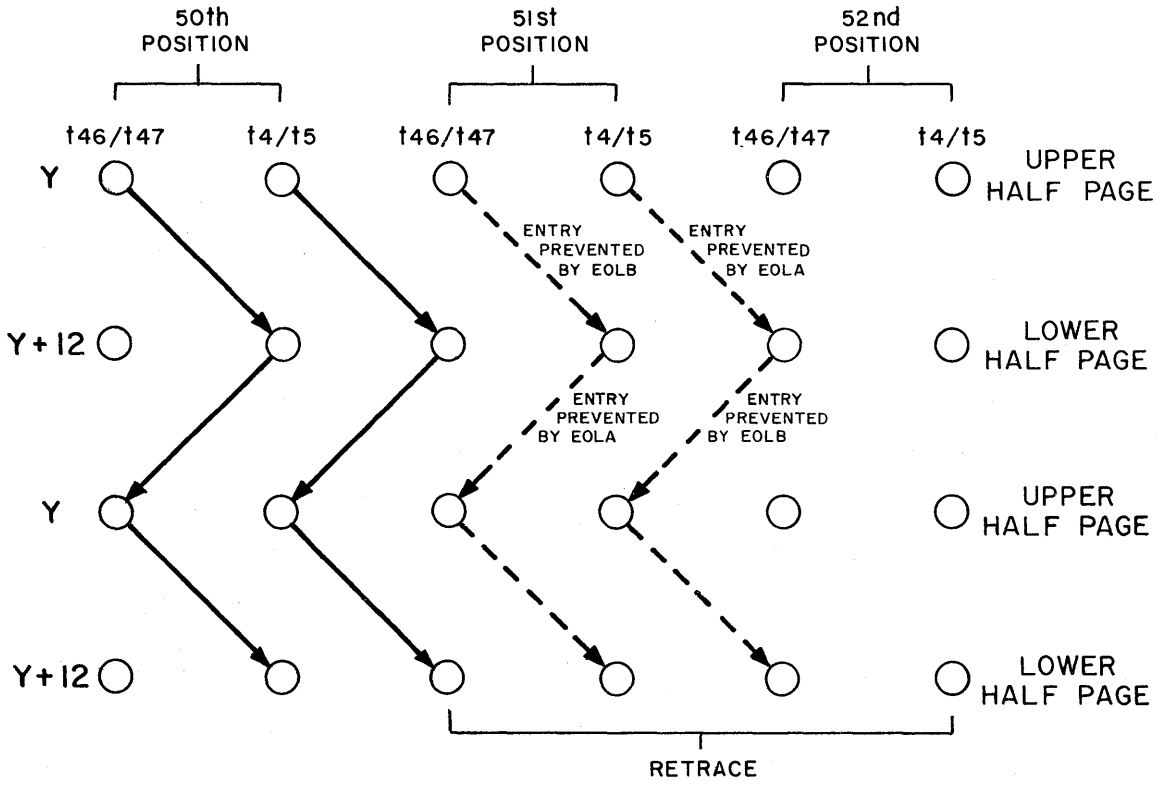
The following illustration points out the delay-line skew and compensation provided by the position counters. Assuming a 50 by 20 format and symbol positions of X and X + 1 in an upper half-page line, positions referenced for data entry at t46/t47 shift by 8.4 microseconds for display during the next pass (lower half page) at t4/t5. Positions referenced at t4/t5 must wait for two passes before display back in the upper half page at t4/t5. In the process of going from lower half page to upper half page they are delayed one extra symbol time. Consequently, instead of advancing (relative to the position counters) 8.4 microseconds at the end of the page, data is actually delayed 8.4 microseconds (16.8-microsecond extra horizontal count minus 8.4-microsecond delay-line skew). Although the illustration is shown for a 50 by 20 format, the 80 by 13 format operates on the same principle.



The delay-line skew and extra symbol count create the need for a pair of end of line conditions. A 50 by 20 format is again assumed in the following illustration to point out these conditions. The 51st symbol position marks the beginning of the retrace period during which display must be prevented. Data entry at t4/t5 of the 50th symbol position is possible in upper half page even though the delay-line

skew shifts this symbol into the retrace period during the next pass. Since display occurs only at t4/t5 (two passes later) and there is an extra symbol count at the end of the page, data entered at this time will actually be back in the 50th position after two passes. Data entry at t46/t47 of the 51st position in upper half page must be prevented, since display would occur during the retrace period. The end of line B condition prevents this possibility. End of line A is used to prevent entry at t4/t5 of the 51st position because display would occur two passes later in the same position.

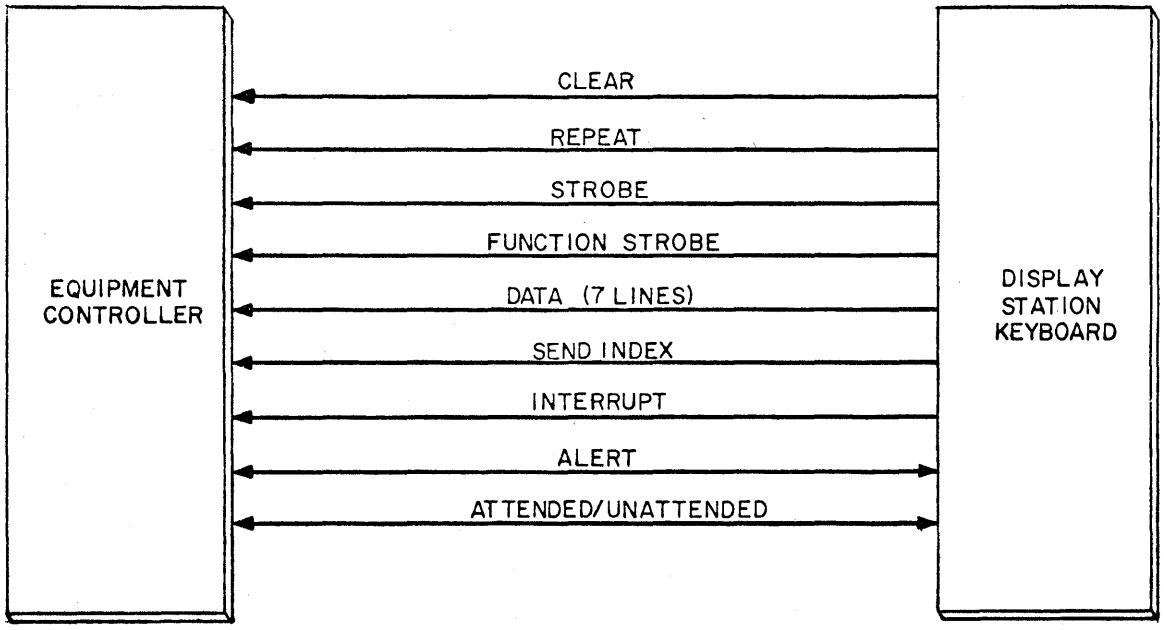
Entry at t46/t47 during the 51st position is possible in the lower half page because the extra symbol count shifts the symbol into the 50th position at t4/t5 during the next pass. However, entry at t4/t5 of the 51st position and t46/t47 of the 52nd position is prevented by end of line A and end of line B, respectively.



To briefly summarize, the end of line conditions for any half page and any page format prevent the possibility of data entry into memory when the entry position shifts into the retrace period at t4/t5.

KEYBOARD CONTROL.

Information from the Display Station keyboard may be either symbol data, editing functions, or transmission control data. In most instances, a 7-bit octal code is entered on the 7 Data lines. A Strobe signal from the keyboard identifies this information as displayable data unless accompanied by a Function Strobe signal. Data accompanied only by Strobe enters memory through the window as previously described. There is a minimum 10-millisecond delay, in any event, between the time a key is depressed and the time data actually enters the window. This delay allows for switch bounce. Use the previous window illustrations as references for the following discussions of the editing and transmission control functions. Data entry (including keyboard) was handled in the discussion of the window.



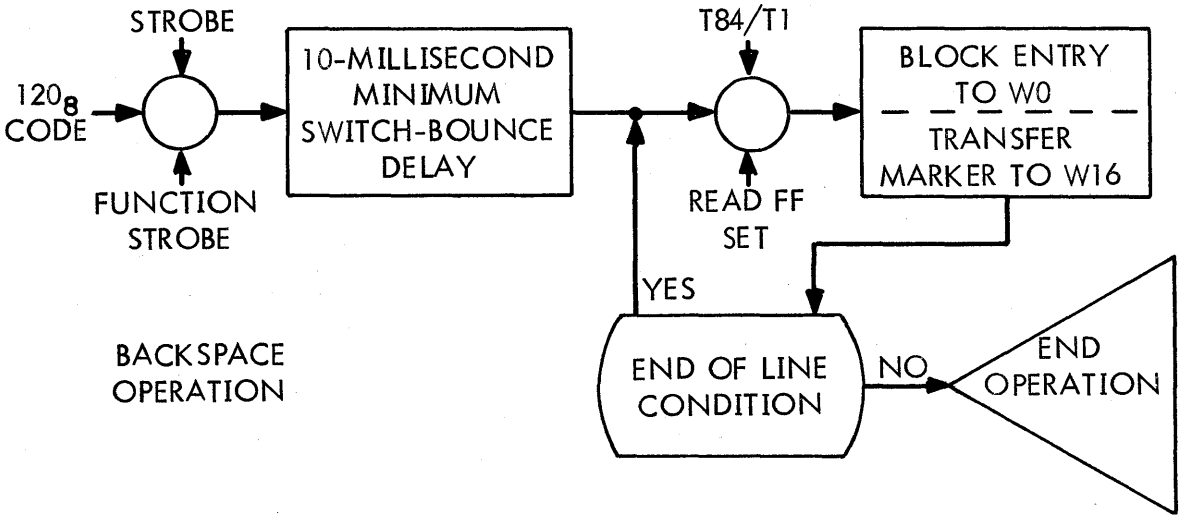
Backspace.

An octal code of 120 is placed on the 7 Data lines when the BKSP key is depressed. Both Function Stobe and Strobe lines are tagged to identify this data as a function not to be stored in memory. After the 10-millisecond switch-bounce delay, the backspace operation begins. When the delay-line read ff sets at t84/t1 (indicating a marker bit), entry into W0 is prevented at t4/t5 and the marker is

KEY	OCTAL CODE	FUNCTION STROBE	STROBE
Symbol	XXX	No	Yes
RETURN	101	No	Yes
SEND	102	No	Yes
BKSP	120	Yes	Yes
LINE SKIP	122	Yes	Yes
SKIP	131	Yes	Yes
RESET	132	Yes	Yes
AUX SEND	140	No	Yes
SEND INDEX	None	Yes	Yes
REPT	None	No	No
CLEAR	None	No	No
INT	None	No	No

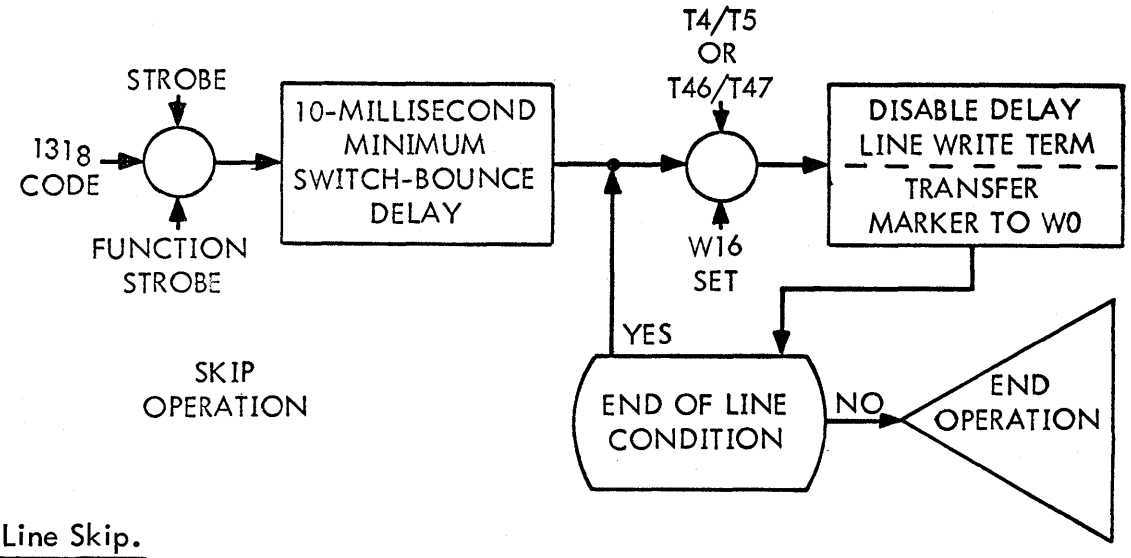
Display Station Keyboard Signals

transferred to W16 instead. This places the marker one full symbol position behind in memory without affecting displayed data. The backspace operation normally ends at this point. However, if the operation places the marker in a retrace period (backspace from beginning of line), the operation must continually repeat until a displayable position has been reached. Since each operation requires 10 milliseconds, a total of 100 milliseconds (50 by 20 format) would be required from the time the BKSP key is depressed until the marker references a displayable position. An 80 by 13 format requires 110 milliseconds.



Skip.

The SKIP key advances the marker in the same manner as a window entry. An octal code of 131 accompanied by Function Strobe and Strobe identifies the skip operation. In this case, detection of the marker in W16 disables the delay-line write term. The marker is inserted in W0, placing it one full position ahead, without affecting displayed data. During a retrace period, the marker continues to advance in this manner until the next displayable position is reached.

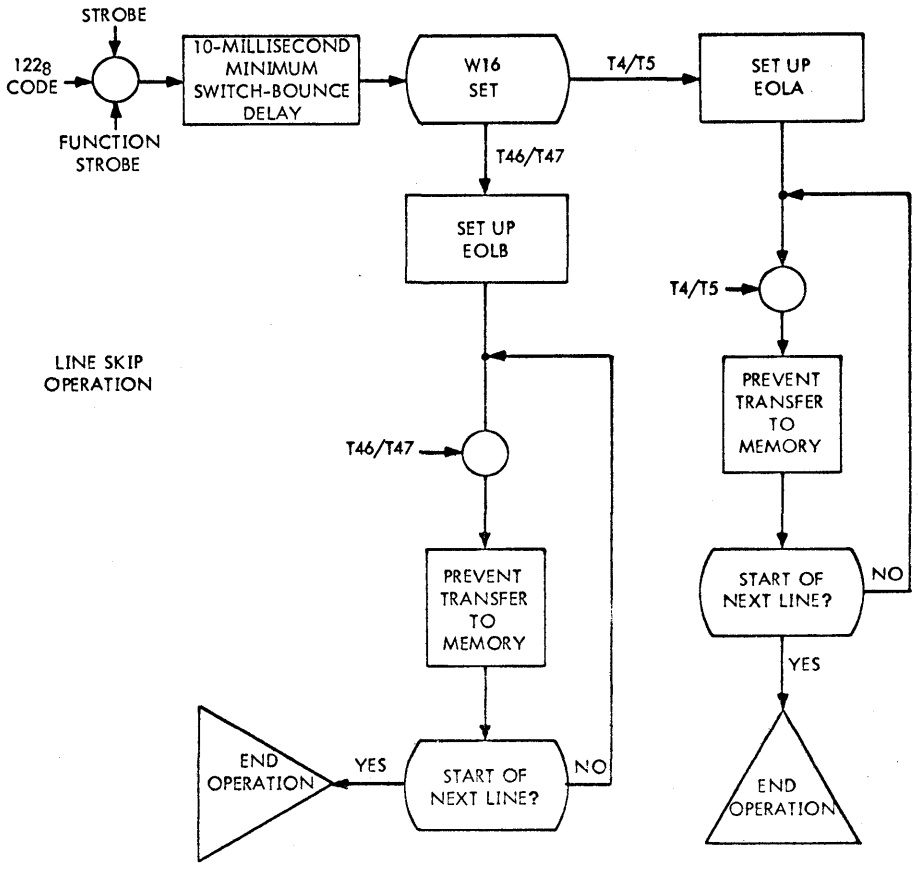


Line Skip.

Depression of the LINE SKIP key (122 octal on Data lines along with Strobe and Function Strobe) sets up an EOLA or EOLB condition, depending upon when the marker is detected. If detection occurs at t46/t47, EOLB prevents subsequent data words being written in the lower half of the window at t46/t47 from entering memory until the X counter recycles and begins a new count (start of next line). The same action occurs every t4/t5 if EOLA is set up by marker detection at t4/t5. In addition to this performance, the marker is continually advanced until the beginning of the next line is reached. Displayed data is not affected.

Carriage Return.

The RETURN key places 101 octal on the Data lines and performs the same operations described for line skip. However, in this case the octal code 101 replaces the word referenced by the marker (Function Strobe not used). The result



is display of the carriage return symbol ($\bar{}$) at the original entry marker position while remaining data in the line is erased. The marker subsequently references the first symbol position in the next line.

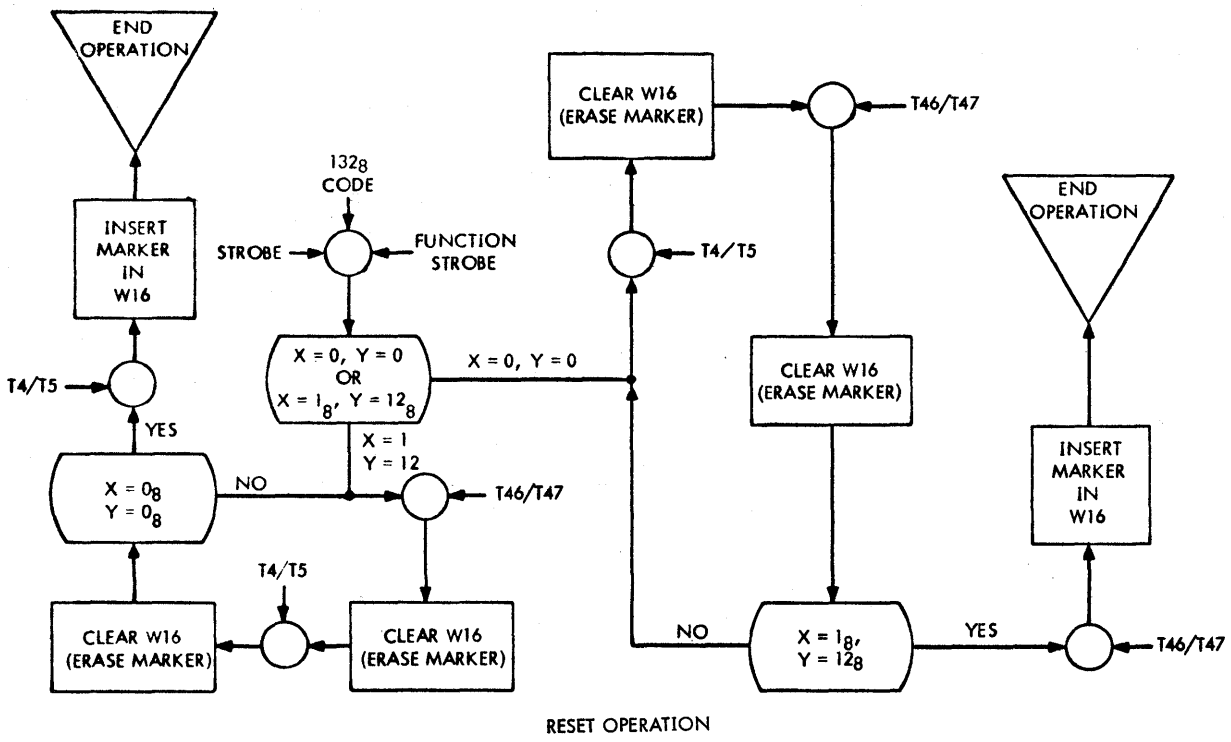
Reset.

An octal code of 132 on the Data lines (along with Strobe and Function Strobe) informs the Equipment Controller of RESET key depression. W16 is cleared each marker reference time (t4/t5 and t46/t47) for an entire pass of the delay line. Consequently, the original marker is erased without an initial search. After one

pass through memory, the marker bit is reinserted in W16 when the position counters indicate that the position referenced is in the upper left corner of the display. This means that at the time the marker is inserted in W16:

(1) X = 0 and Y = 0 if detection was originally at t46/t47.

(2) X = 1 and Y = 12 if detection was originally at t4/t5.



RESET OPERATION

Clear.

The CLEAR key enables a Display Station operator to clear the crt raster and memory while performing a reset operation. This function is identified by a Clear signal from the keyboard (Data lines, Strobe, and Function Strobe not used). To perform the clear operation, the delay-line write term is disabled for the entire reset.

Send.

An E1 code (102 octal) on the Data lines accompanied by Strobe is an indication of SEND key depression. Since Function Strobe is not used, the E1 code (Δ)

is entered in the lower half of the window after the initial switch-bounce delay. Simultaneously, a reset operation begins (BLOCK mode only) and a read request condition is established. This read request locks out the keyboard and informs the interface of the activated SEND key.

In LINE mode, the complete reset operation is not performed. Instead, an EOLA condition is established and the marker continually advances until a comparison is made between the Y counter and a line mode register. This register records the current position of the line indicator. When the two compare, the Y counter has reached the position of the line indicator. The reset operation ends at the beginning of that line (X = 0). Consequently, the entry marker references the first symbol position to the right of the line indicator.

Interrupt.

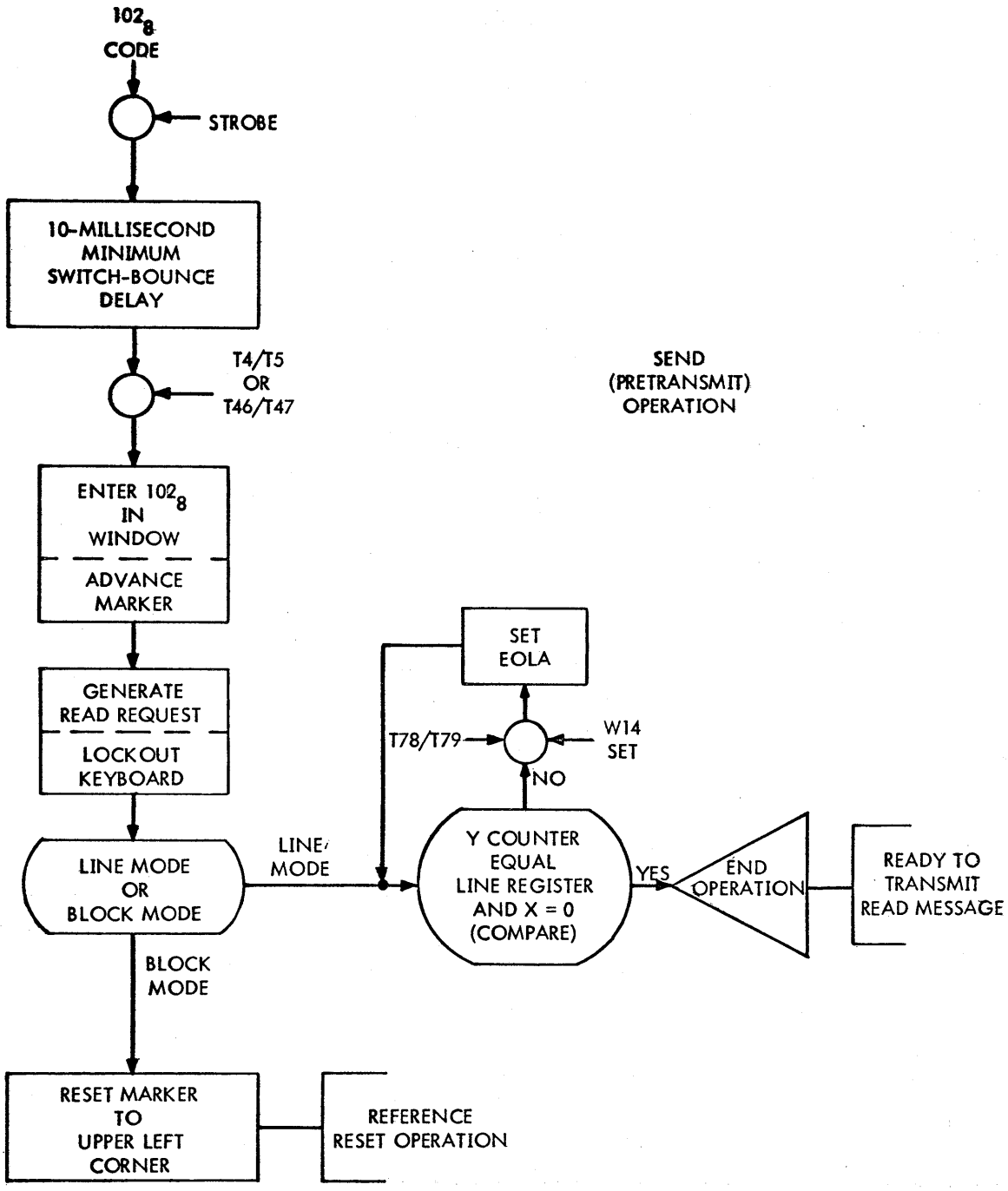
The main function of the INT (interrupt) key is to allow operator intervention in a card read or print sequence governed by the data source. It also unlocks the Display Station keyboard as soon as the data source requests more card data (write message ending with E3) or another printout (write message ending with E2). For further details on an interrupt condition refer to the description of the applicable adapter kit.

Print.

A depressed AUX SEND key is signified by an octal code of 140 (E2) on the Data lines along with Strobe. The absence of Function Strobe allows E2 (') to enter the window after the switch-bounce delay. This key sets up a print request condition which initiates transfer of data from display buffer memory to printer buffer memory and locks out the keyboard. A reset operation is performed which repositions the entry marker to the upper left corner of the crt raster regardless of the LINE/BLOCK switch position. Data transferred is from the upper left corner position to the E2 code.

Repeat.

A repeated action may be performed by depressing the REPT key in conjunction with a key which initiates the action to be repeated. For example, depressing REPT along with SKIP enables the entry marker to continually advance until one of the keys is released. A Repeat signal from the keyboard identifies a depressed REPT key and a 2-stage oscillator enables the repetitive performance.


102_8 CODE
STROBE
10-MILLISECOND MINIMUM SWITCH-BOUNCE DELAY
T4/T5 OR T46/T47
SEND (PRETRANSMIT) OPERATION
ENTER 102_8 IN WINDOW
ADVANCE MARKER
GENERATE READ REQUEST
LOCKOUT KEYBOARD
SET EOLA
T78/T79
W14 SET
NO
LINE MODE OR BLOCK MODE
LINE MODE
Y COUNTER EQUAL LINE REGISTER AND X = 0 (COMPARE)
YES
END OPERATION
READY TO TRANSMIT READ MESSAGE
BLOCK MODE
RESET MARKER TO UPPER LEFT CORNER
REFERENCE RESET OPERATION

Any keys using the Strobe signal may be used in conjunction with REPT (excluding SEND and AUX SEND which lock out the keyboard). Most keys use the first stage of the oscillator (25 hertz) for the repeated action. However, RETURN, LINE SKIP, and SEND INDEX operate off the second stage at an approximate rate of 12.5 hertz. The switch-bounce delay is incorporated with each new cycle.

LINE COUNTER.

The LINE/BLOCK switch determines the operating mode of the controller. A read message in LINE mode begins with the symbol position to the immediate right of the line indicator (■). The position of the indicator is recorded in a line mode register which increments each time the indicator is advanced to the next line. Each depression of the SEND INDEX key advances the indicator one line.

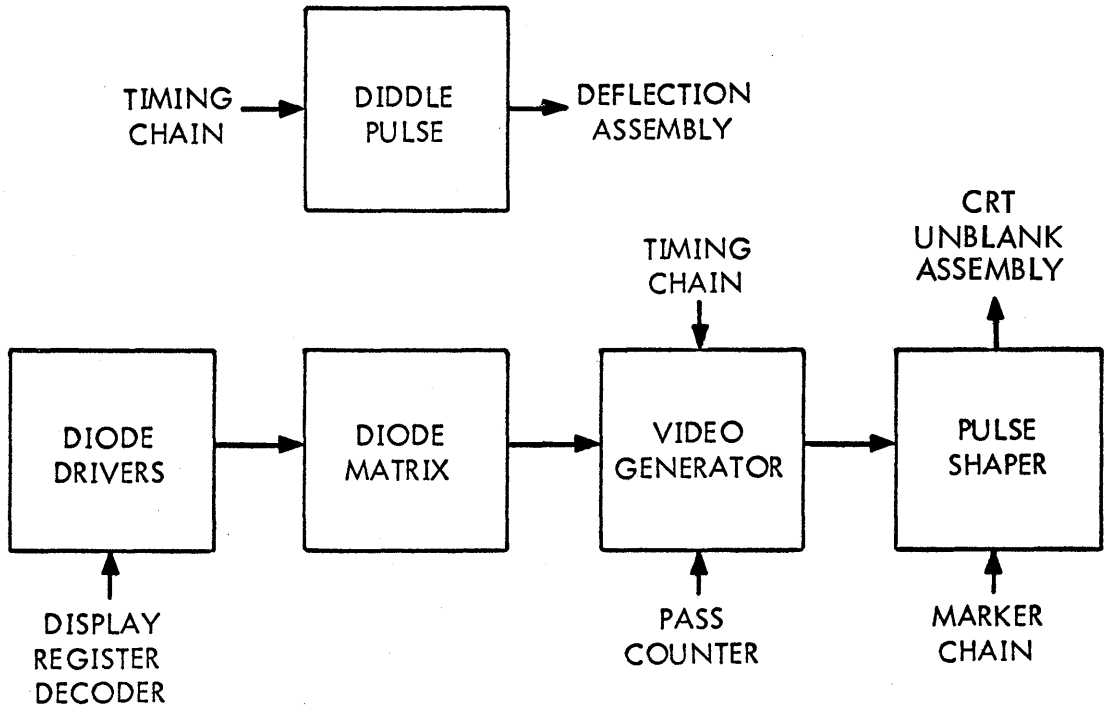
A special network compares the contents of the vertical (Y) counter with that of the line mode register. When the two are equal, a compare condition exists. Depression of the SEND key repositions the entry marker when the horizontal (X) counter is clear and the compare condition is reached. Consequently, the marker references the first symbol position to the right of the indicator.

The indicator is also advanced following receipt of a write message containing an E1 code. At the end of the write message, the line mode register is cleared. Next, the current position of the vertical counter (last line of the write message) is established in the line mode register. Finally, the register is incremented to complete the operation and leave the indicator referencing the line following the last line of the write message. The marker chain is also moved to this line.

A compare condition initiates display of the indicator. The vertical counter increments at the beginning of the horizontal retrace period. Display of the indicator is initiated at the end of the horizontal retrace period when the vertical counter and line mode register have reached similar counts. This places the indicator in the left margin of the raster immediately preceding the first symbol position in a line.

SYMBOL GENERATOR.

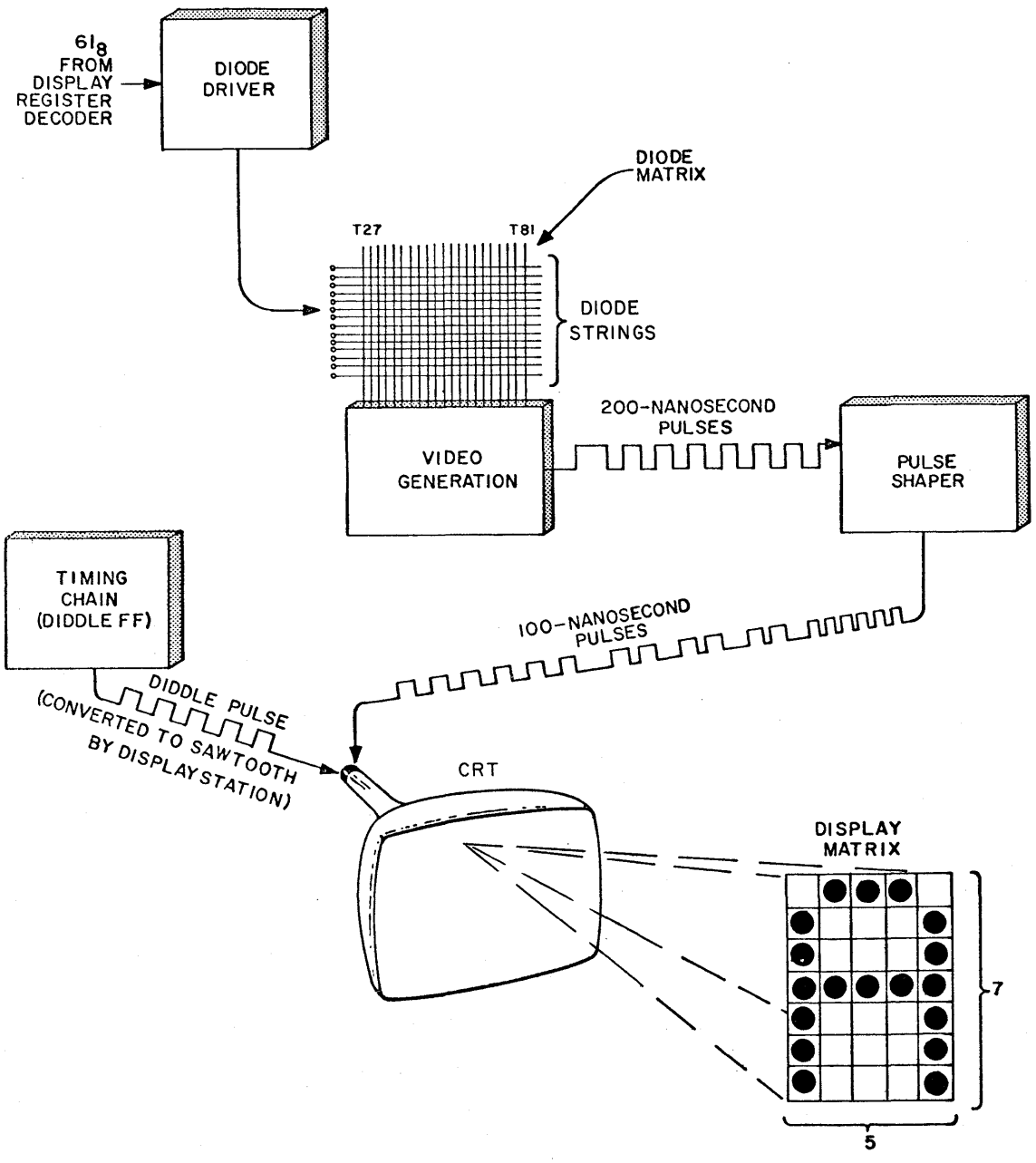
Each symbol is represented on the crt raster by a 5 by 7 dot matrix of energized phosphor. As the electron beam moves across the raster, a sawtooth wave (diddle pulse) is superimposed on the horizontal sweep. The beam is unblanked at periodic intervals during each ramp of the sawtooth in the formation of a symbol.



Symbol Generator Block Diagram

Information reaching the display register is decoded and fed to a network of diode drivers. Each unique octal translation enables this network to select the associated string of diodes in the diode matrix. The diode matrix feeds a video generation network which ANDs the outputs of the matrix with clock pulses. There is a maximum of 35 diodes in each string and each diode is ANDed with a separate clock pulse in the video generation network. The result is an unblank pulse for each diode in the string selected forming a pulse train. Each pulse is 200 nanoseconds long. Successive diodes, then, create successive pulses with no separation. This pulse train passes through a pulse delay and shaper where it is converted to a train of 100-nanosecond pulses with 100 nanoseconds between pulses initiated by successive diodes. These pulses are transmitted to the Display Station crt. The next diagram shows the sequence just described using the symbol "A" as an example.

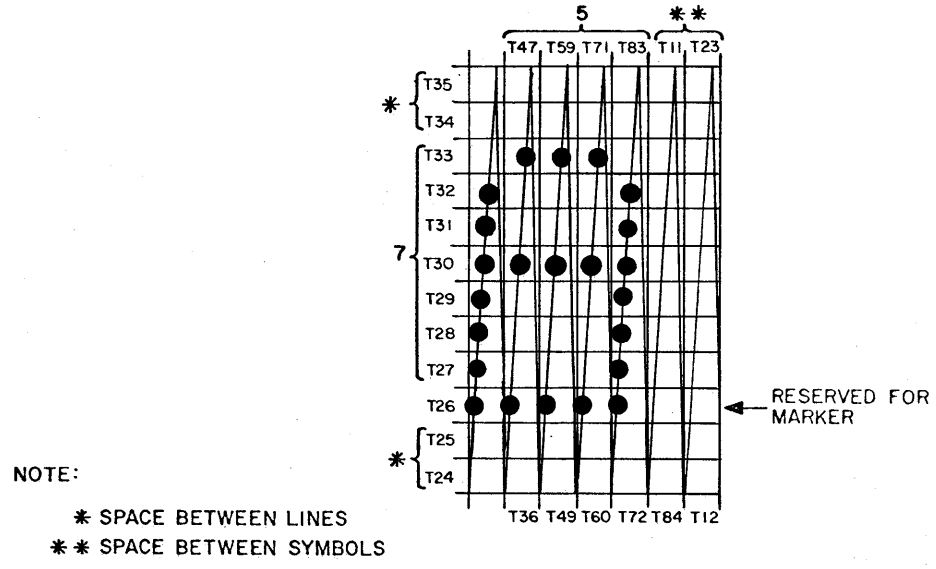
All images appearing on the crt raster are formed in this manner with the exception of the line indicator and marker chain. The line indicator, since it is not stored in memory, never enters the display register. Instead, when the controller is in LINE mode and the Y counter and line mode register compare, the display register decode network selects the string of diodes representing an octal



Symbol Generation Sequence

code of 76. This string contains the full complement of diodes (35) resulting in display of a 5 by 7 rectangle. The symbol is displayed in the left margin of the raster since selection occurs near the end of the horizontal retrace period.

Since the marker chain is displayed below the 5 by 7 matrices, the diode matrix cannot be used to form a pulse train. In this case, a special marker chain network feeds the pulse shaper to initiate a train of 5 pulses for each marker. The following illustrates the timing relationship between the 5 by 7 matrix and the marker including the sawtooth.

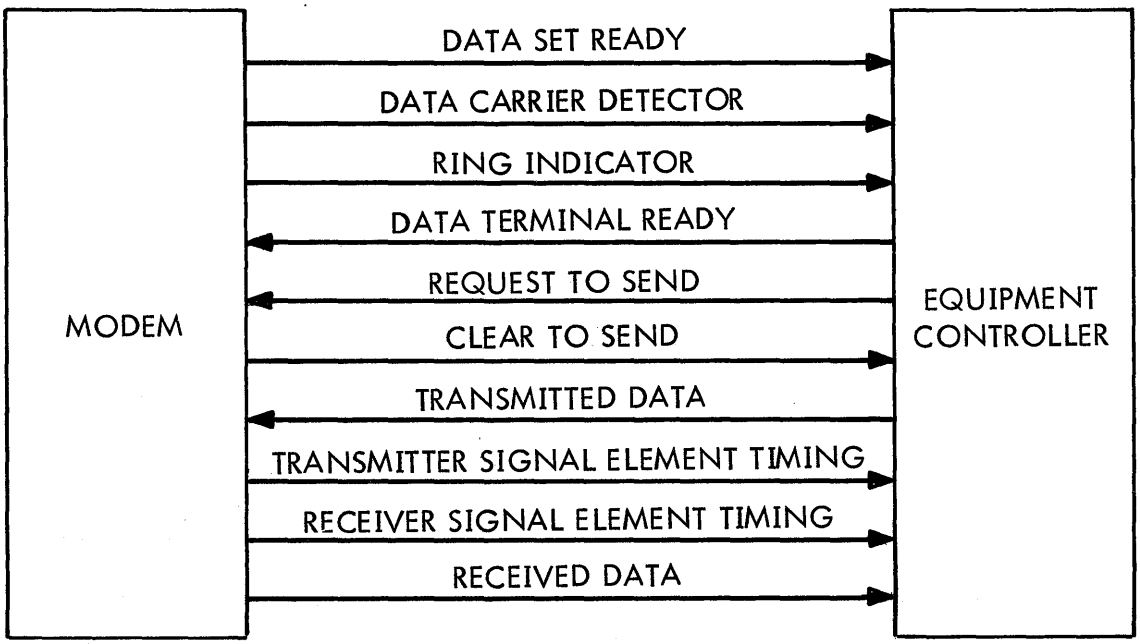


Symbol and Marker Timing

INTERFACE.

To appreciate the principles of remote site communications, it is first necessary to consider the interface signal characteristics. The Equipment Controller has been designed to interface with most modems conforming to EIA Standard RS 232B; at data rates up to 2400 baud. Operation is half duplex, 2 or 4-wire mode. Half duplex means that the controller may transmit or receive, but not both simultaneously. A 4-wire connection offers the advantage of a reduction in turnaround time. The following illustration lists interface signals and indicates signal origin. Modem operations described throughout the remainder of this text are similar to

that of the Bell System's DATA-PHONE * Data Set 201B. Other modems operating at the same bit rate may differ to some degree.



Interface Signals

INITIAL CONTACT.

A positive 6 volts on the Data Set Ready line indicates the modem is in an operable condition. If controller power is up, the Data Terminal Ready line is at a positive 6-volt potential (automatic answering not employed). If the controller initiates communications by raising the Request to Send line (see illustration), modem A responds by enabling Carrier to modem B and returning a Clear to Send signal to the controller after a turnaround delay. When Carrier appears at modem B, a Data Carrier Detector signal is sent to the data source. The same is true if the data source initiates communications. In this instance, the Data Carrier Detector signal appears at the controller interface after modem A has received a Carrier signal from modem B.

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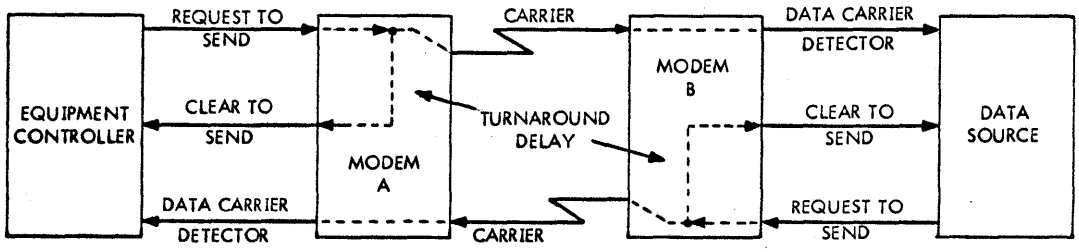
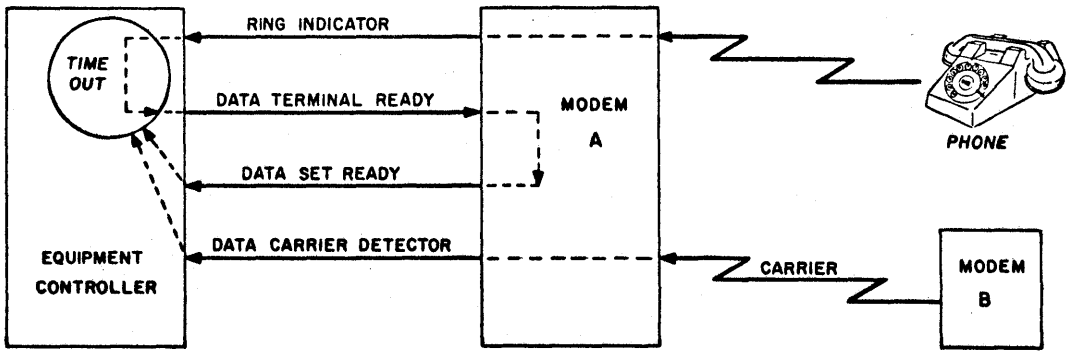
*Trademark of AT&T and the Bell System.



Initial Contact

AUTOMATIC ANSWERING.

If the operating system has provisions for dialed connections, the controller may be used to automatically answer when the site is left unattended (AUTO ANSWERING switch in the ON position). A dialed call results in a Ring Indicator signal to the controller interface. The controller responds with Data Terminal Ready. To complete this sequence, modem A (see following illustration) activates the Data Set Ready line. The Data Carrier Detector line is turned on when a Carrier signal is received from modem B. If Carrier is not received within 30 seconds after the Ring Indicator line is activated, a special timeout circuit in the controller interface disables the Data Terminal Ready line breaking the connection.



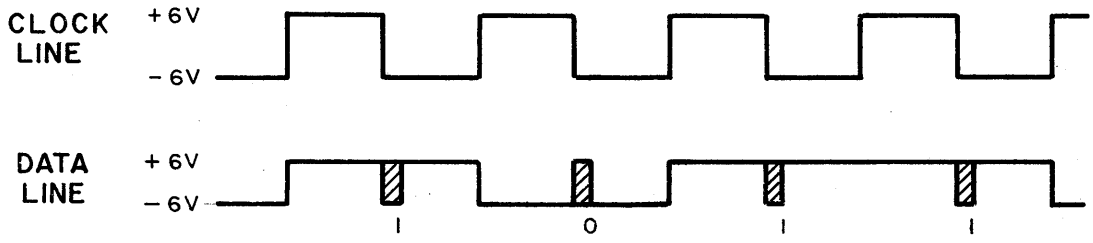
Automatic Answering

DATA TRANSMISSION.

Modem timing differs from that of the Equipment Controller. For this reason a pair of clock signal lines (Transmitter Signal Element Timing and Receiver Signal Element Timing) are used to enhance synchronization for both transmit and receive

operations. During a receive sequence, the Receiver Signal Element Timing line (normally designated SCR) enables synchronization of incoming data on the Received Data line. The SCR signal is a symmetrical square wave of +6- to -6-volt amplitude derived from the Carrier. During a transmit operation, the Transmitter Signal Element Timing line (normally referred to as SCT) governs the rate at which the controller gates serial data to the Transmitted Data line. This timing signal is also a +6- to -6-volt square wave but is normally internally generated by the modem and on-line to the controller interface at all times.

Data on both the Received and Transmitted Data lines is initiated during the positive transition of the SCT signal while the receiving unit samples it during the negative half cycle of the SCR signal. The illustration given points out the relationships between Transmitted Data and SCT, and Received Data and SCR. Shaded areas represent the times at which the Data line is sampled.



Data Transmission and Recovery

MESSAGE FORMAT.

Communications between the modem and controller interface are bit-serial, with 8-bit words. Bit 0 (least significant bit) is transmitted and received first, while the parity bit marks the end of a word transfer. Parity is odd, consequently, the total number of logical 1's in an 8-bit word must be odd.

Messages received and sent by the controller consist of several codes in a defined sequence (see following two lists). Any deviations from the established sequence can result in an aborted operation, depending upon the point at which the deviation occurred.

PARITY	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Word Format

RECEIVED MESSAGES

CODE	7-BIT OCTAL
Sync	026
Sync	026
Sync	026
Sync	026
Start of Header	001
Site Address	16X
Station Address	140 or 160
Poll	005
USASCII End of Text	003
Message Parity Code	XXX
Sync	026
Sync	026
Sync	026
Sync	026
Start of Header	001
Site Address	16X
Station Address	141 or 161
Write	021
Data	(See Note)
USASCII End of Text	003
Message Parity Code	XXX
Sync	026
Sync	026
Sync	026
Sync	026
Start of Header	001
Site Address	16X
Station Address	141 or 161
Clear-Write	022
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Data	(See Note)
USASCII End of Text	003
Message Parity Code	XXX

NOTE

Consists of 0 to 999 words (50 by 20 format) or 0 to 1039 words (80 by 13 format). Data must end with escape code followed by an "E" code.

CODE	7-BIT OCTAL
Sync	026
Sync	026
Sync	026
Sync	026
Start of Header	001
Site Address	16X
Station Address	141 or 161
Alert	007
USASCII End of Text	003
Message Parity Code	XXX
Sync	026
Sync	026
Sync	026
Sync	026
Start of Header	001
Site Address	16X
Station Address	141 or 161
Reset-Write	014
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Data	(See Note)
USASCII End of Text	003
Message Parity Code	XXX
Sync	026
Sync	026
Sync	026
Sync	026
Start of Header	001
Site Address	16X
Station Address	141 or 161
Diagnostic Write	020
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Sync	026
Data	(See Note)
USASCII End of Text	003
Message Parity Code	XXX

TRANSMITTED MESSAGES

CODE	7-BIT OCTAL	CODE	7-BIT OCTAL
Sync	026	Sync	026
Sync	026	Sync	026
Sync	026	Sync	026
Sync	026	Sync	026
Start of Header	001	Start of Header	001
Site Address	16X	Site Address	16X
Station Address	141 or 161	Station Address	141 or 161 *
Acknowledge	006	Reject	030
USASCII End of Text	003	USASCII End of Text	003
Message Parity Code	XXX	Message Parity Code	XXX
Sync	026	Sync	026
Sync	026	Sync	026
Sync	026	Sync	026
Sync	026	Sync	026
Start of Header	001	Start of Header	001
Site Address	16X	Site Address	16X
Station Address	141 or 161	Station Address	141 or 161
Error	025	Read	023
USASCII End of Text	003	Data	(See Note)
Message Parity Code	XXX	USASCII End of Text	003
		Message Parity Code	XXX

NOTE

Consists of 0 to 999 words (50 by 20 format) or 0 to 1039 words (80 by 13 format). Data must end with escape code followed by an "E" code.

* 140 or 160 in response to a poll message.

RECEIVE OPERATION.

The controller is normally in the receive mode. Data sampled on the Received Data line is fed to an assembly register (refer to block diagram at the beginning of this interface discussion). As each bit enters, the register is examined for the presence of a sync code (026 octal). Once this code is discovered, a special sync counter records the fact.

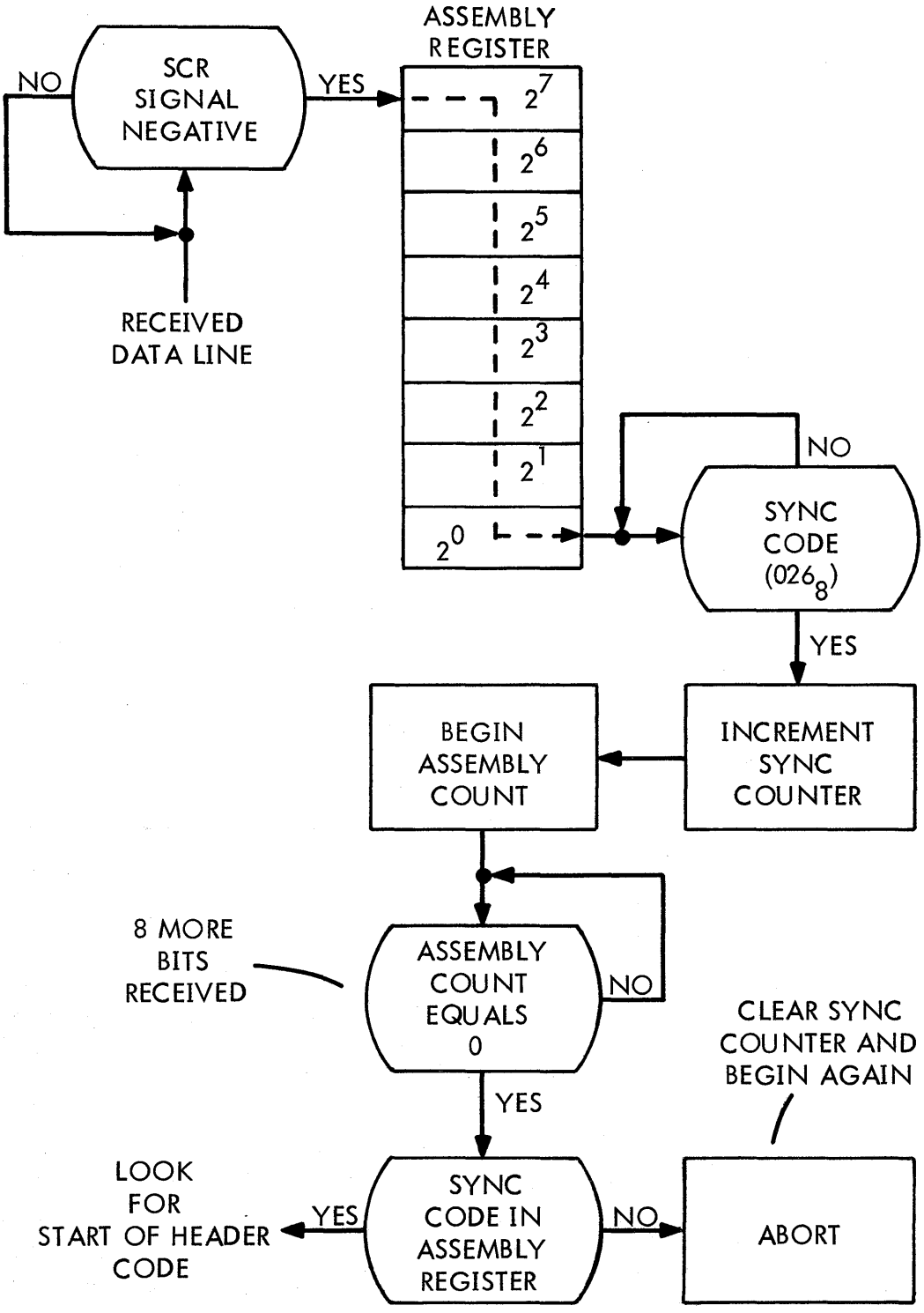
At this point, the controller should be synchronized with the modem so an assembly/disassembly counter begins counting the number of bits received. The count increments with each negative transition of the SCR signal, running 0 through 7 to provide 8-bit word groupings.

If the second word following initial sync detection is not also a sync code, an abort condition is created. This clears the sync counter and the search for two successive sync codes begins again.

Assuming detection of a minimum of two successive sync codes, the controller expects the following word in the assembly register to be the start of header code (001 octal). If this is the case, a sequence count begins; if not, an abort situation clears the sync counter and synchronization must begin again.

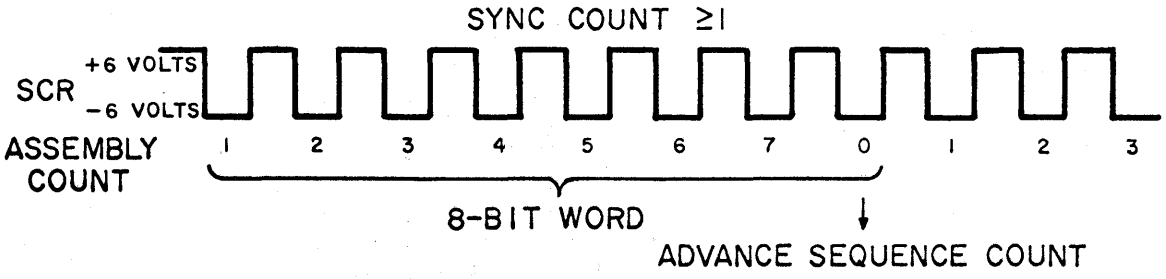
The sequence counter increments for each message sequencing code received in the proper order. Deviations from the defined sequence can result in an abort condition which clears both sync and sequence counters. The following list relates the sequence count to the code which is present in the assembly register when the counter is incremented.

COUNT	CODE
0	Two (or more) Successive Sync Codes
1	Start of Header
2	Site Address
3	Station Address
4	Control Code
5	USASCII End of Text
6	Message Parity



Sync Code Detection

When the count reaches 4, advancement temporarily halts if the control code is a write, reset write, clear write, or diagnostic write. This is to allow subsequent receipt of sync codes and data. Once the USASCII end of text code is received, however, the counter begins incrementing again. Shortly after receipt of the message parity code (sequence count of 6) the controller switches to a transmit mode (clearing the sequence counter) and a reply message is generated.

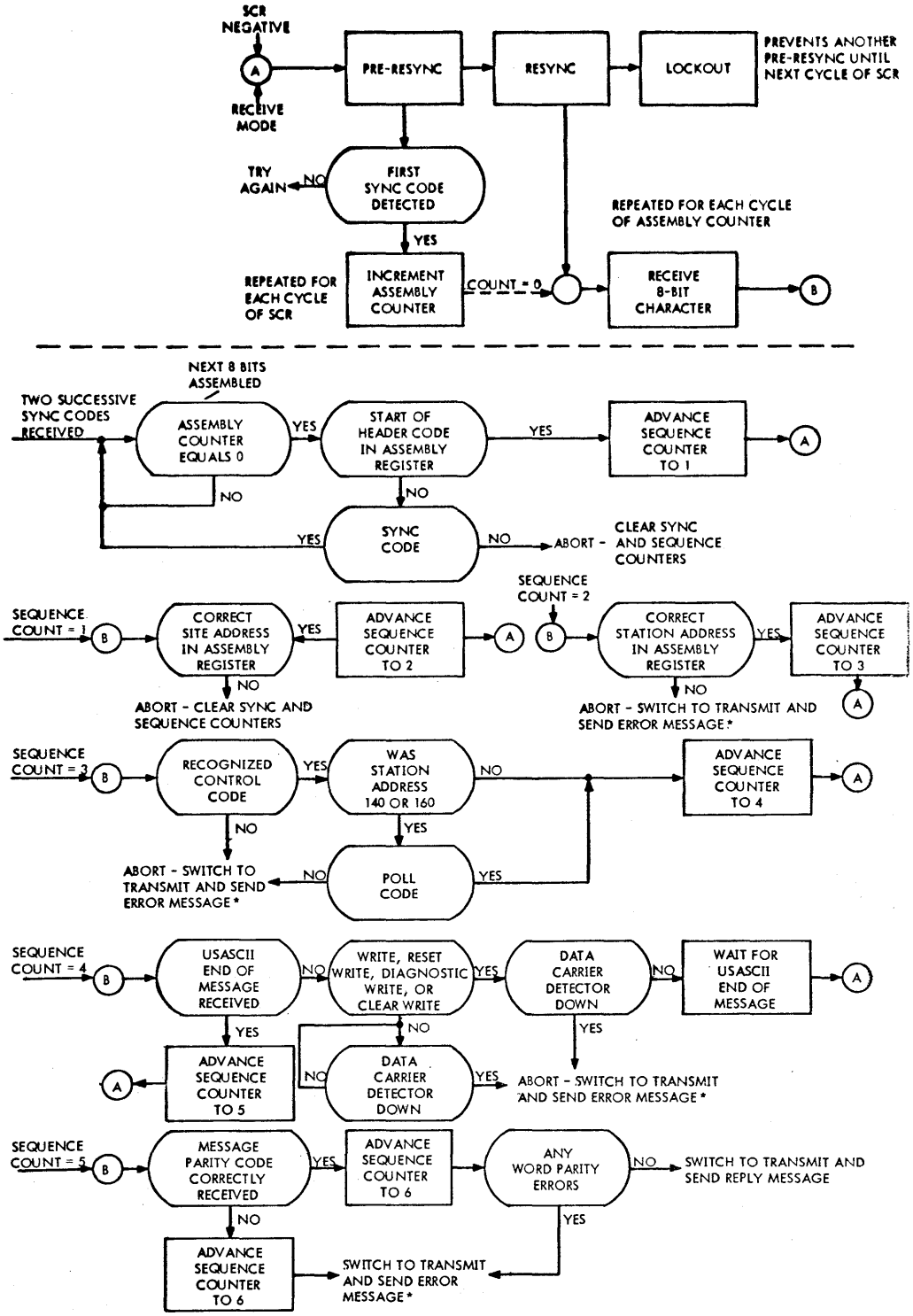


Word Parity.

Each word received from the data source experiences a parity check. Odd parity is employed so the total number of logical 1's in any 8-bit word must be odd. Parity errors may or may not cause transmission of an error message. Error messages hinge upon the position of the ERROR MESSAGE ENABLE/DISABLE switch and the point in the message sequence at which the parity error occurred. Diagnostic write messages feature an exact retransmission of the received data. In this instance, an error condition is blocked after detection of the diagnostic write code, and all parity errors occurring in the remaining portion of the message sequence appear as spaces in the subsequent read message. The following list points out conditions resulting from parity errors, according to the points at which they are discovered in the message sequence.

Message Parity.

Message parity is checked at the end of a receive operation. A message parity counter records the number of logical 1's received in every bit position except parity beginning with the start of header code and ending with the USASCII end of message code. All sync codes are excluded. The message parity code follows USASCII end of message in the sequence and should ensure that the controller receives an odd number of logical 1's in each bit position. If the message parity code received is not correct, an error condition exists and an error message is



*ERROR MESSAGE SENT ONLY IF ERROR MESSAGE ENABLE/DISABLE SWITCH IS IN ENABLE POSITION. OTHERWISE, NO RESPONSE IS GIVEN.

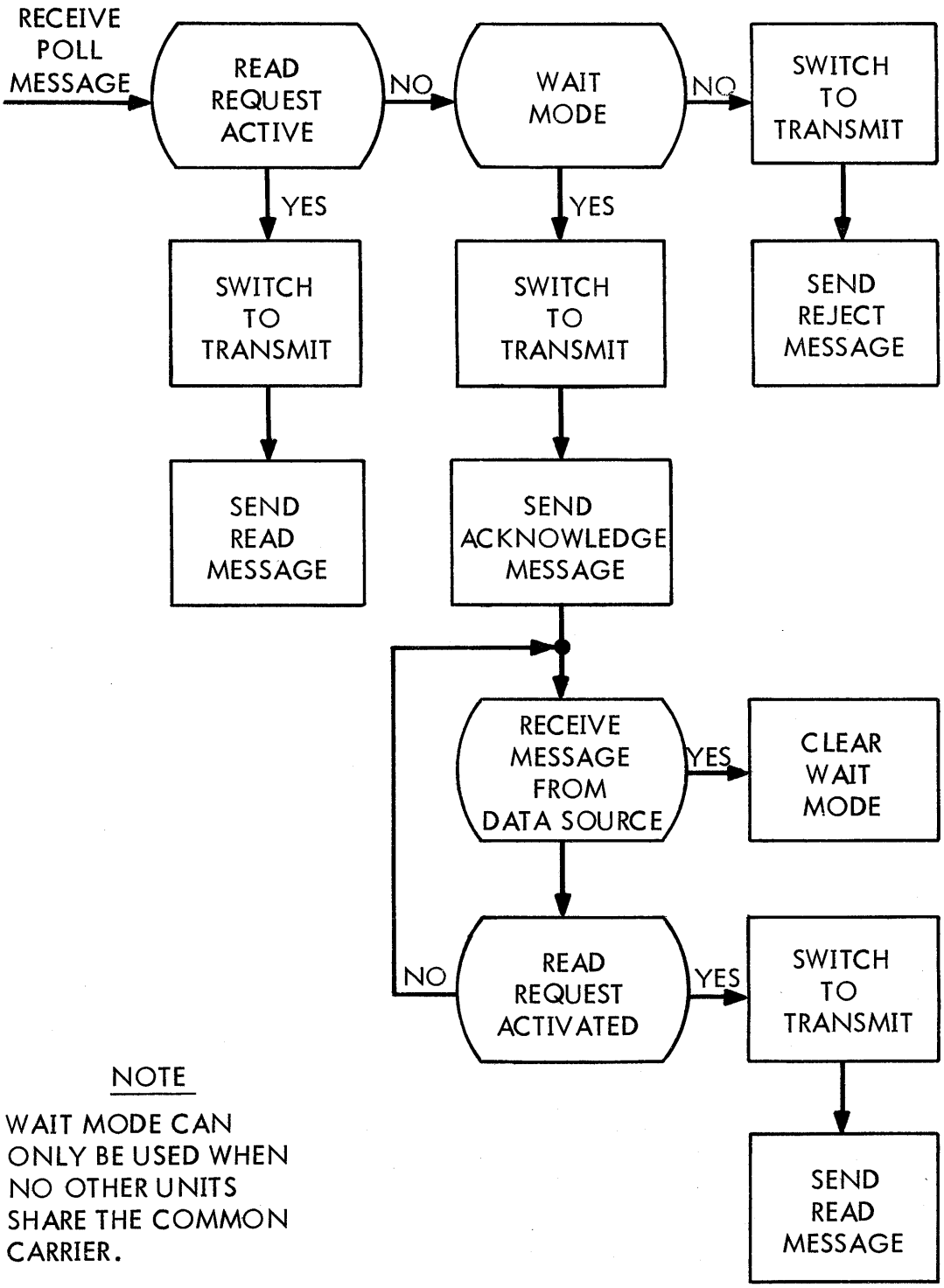
WORD PARITY ERRORS

CODE	CONDITION CAUSED
Sync	Code not recognized
Sync Sync Sync Start of Header Site Address	Abort — clear sync and sequence counters and begin search again.
Station Address Control Code	Abort — transmit error message.
Sync Sync Sync Sync Sync Sync Sync	Transmit error message at end of receive operation.
Data	Display parity error symbols (▮) wherever errors occur and transmit error message at end of receive operation.
USASCII End of Message Message Parity Code	Abort — and transmit error message (Poll and Alert). Transmit error message at end of receive operation (write, reset write, and clear write).

transmitted in response. A chart follows which attempts to show how a poll message affects the message parity counter. A 7-bit site address of 161 and station address of 140 are assumed. A word parity bit must accompany the message parity code so the 8-bit code should be 351 octal. Initially, the counter contains all logical 1's.

Poll Message.

Since the remote terminal is, generally, one of many sites involved in a remote communications system, the data source must sequentially scan each site in the search for read messages. The poll message is used to achieve this end. It interrogates the remote sites looking for a read request.



NOTE

WAIT MODE CAN ONLY BE USED WHEN NO OTHER UNITS SHARE THE COMMON CARRIER.

MESSAGE PARITY COUNTER

CODE	COUNTER BIT POSITIONS 6	5	4	3	2	1	0
Initial Contents	1	1	1	1	1	1	1
Start of Header (001)	1	1	1	1	1	1	0
Site Address (161)	0	0	0	1	1	1	1
Station Address (140)	1	1	0	1	1	1	1
Poll (005)	1	1	0	1	0	1	0
USASCII End of Message (003)	1	1	0	1	0	0	1
Message Parity Code (151)	0	0	0	0	0	0	0

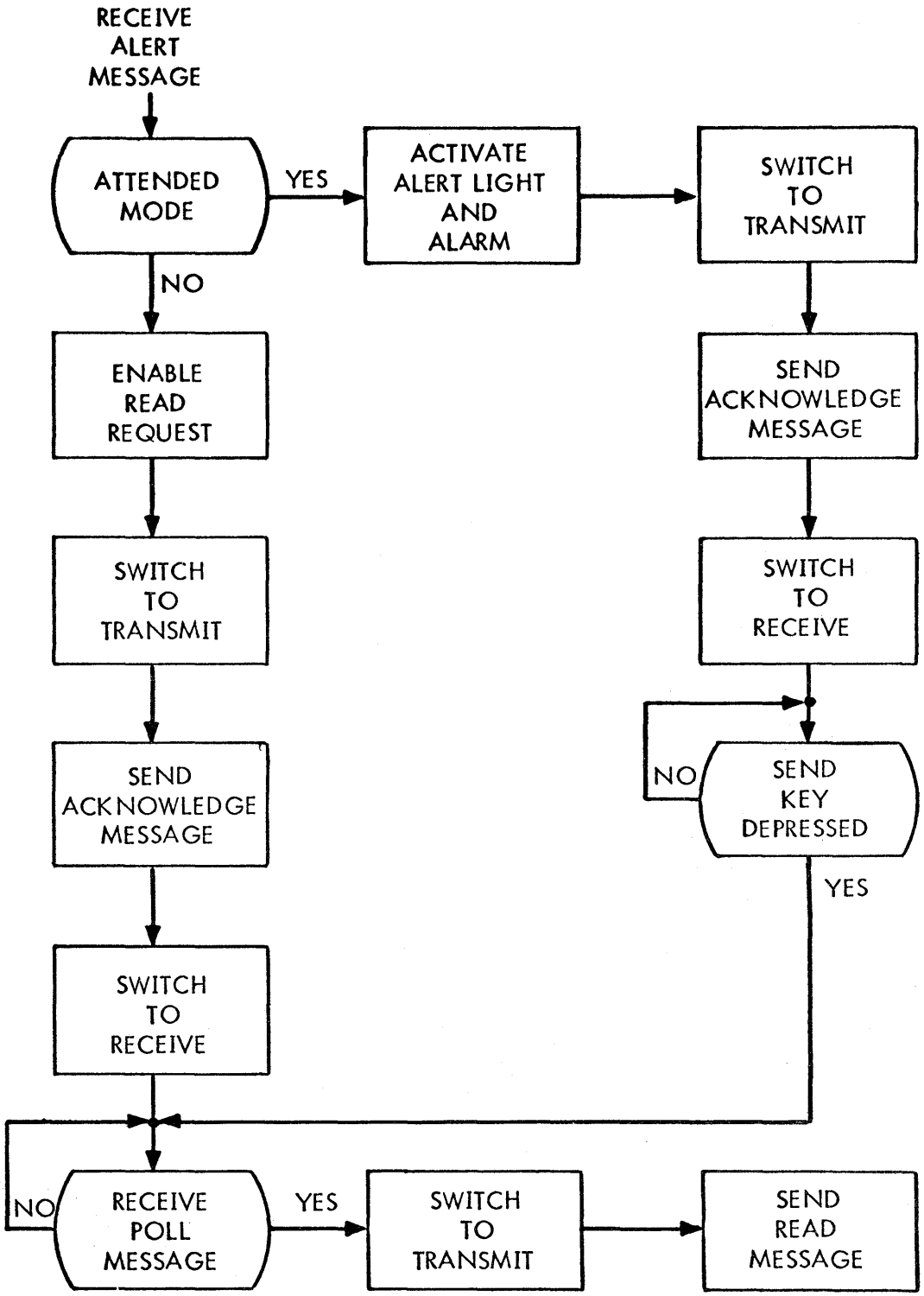
If a read request is present at the polled site, the controller switches to the transmit mode and responds with a read message. If no read request is evident, the response is either a reject message (NORMAL mode) or acknowledge message (WAIT mode). In the WAIT mode, a read message is transmitted without benefit of a poll should a read request be activated some time later. This WAIT condition, however, may be cleared by either a power on master clear, manual release, or receipt of another message from the data source. This brings up the possibility of a message from the data source destroying an operator-generated message if the SEND key has not been depressed.

Alert Message.

An alert message is a means of contacting the remote site other than an unsolicited write message which may destroy a message being composed by the remote site operator.

The position of the Display Station ATTENDED/UNATTENDED switch directly determines the response of the remote site to an alert condition. In the ATTENDED mode, the remote site responds to an alert message by activating the Display Station ALERT light and alarm and returning an acknowledge message. To deactivate the light and alarm, the operator must depress the SEND key. This act inserts an E1 code at the current entry marker position and resets the marker chain to the upper line (BLOCK mode) or line preceded by the line indicator (LINE mode). Consequently, the read message is transmitted the next time the site is polled.

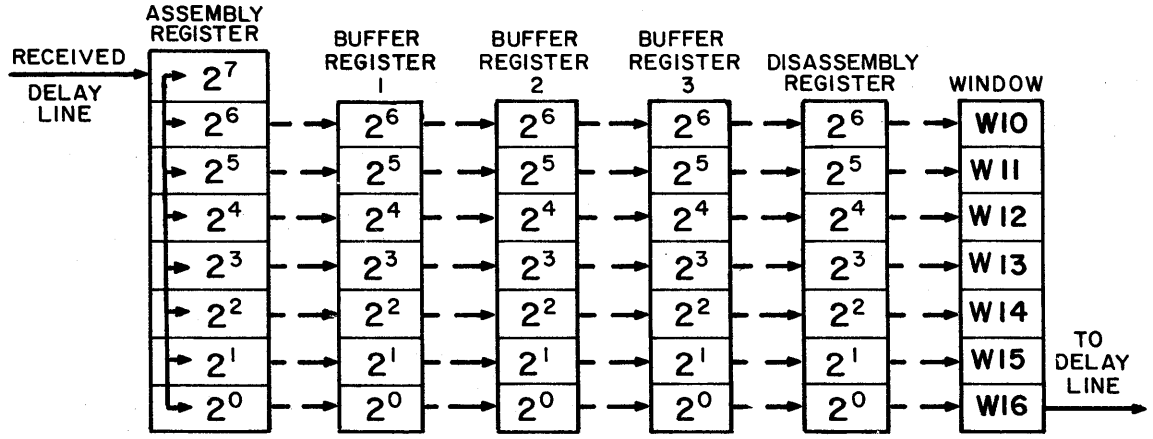
Both the ALERT light and alarm are not functional in UNATTENDED operation. An alert message activates a read request and an acknowledge message is transmitted. A subsequent poll operation enables a one-word (E1) read response.


RECEIVE ALERT MESSAGE
ATTENDED MODE
YES
ACTIVATE ALERT LIGHT AND ALARM
SWITCH TO TRANSMIT
NO
ENABLE READ REQUEST
SEND ACKNOWLEDGE MESSAGE
SWITCH TO TRANSMIT
SWITCH TO RECEIVE
SEND ACKNOWLEDGE MESSAGE
NO
SEND KEY DEPRESSED
YES
SWITCH TO RECEIVE
NO
RECEIVE POLL MESSAGE
YES
SWITCH TO TRANSMIT
SEND READ MESSAGE

Write Message.

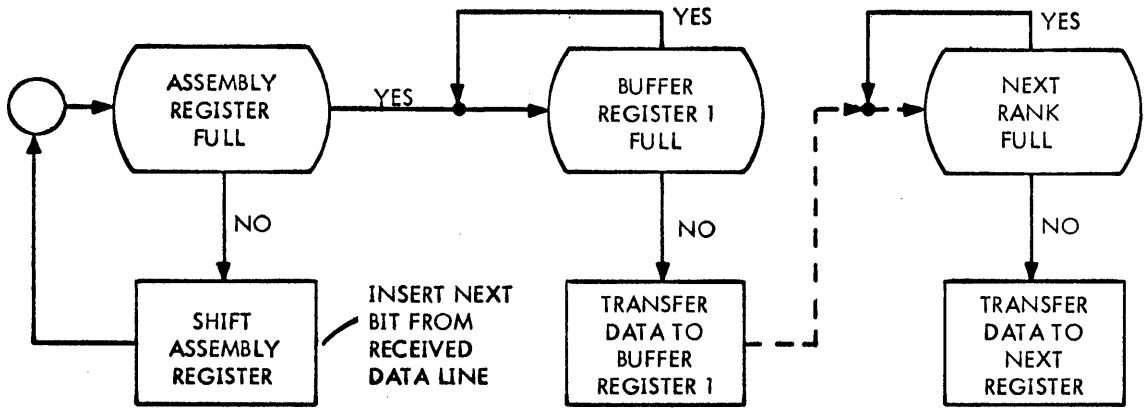
A write code (021 octal) requests the remote site to begin writing data into display buffer memory at the present position of the entry marker. Immediately following the write code are the 8-bit data words. These bits are shifted into an 8-bit assembly register where word parity is checked and the assembled code translated.

Since there is a 10-millisecond maximum access time to the display buffer memory, the interface must be able to temporarily store data until the entry marker is detected in the window. In the worst case (2400 baud) the data source transmits one word every 3.3 milliseconds. This means that the interface must be able to store 4 words in the 10-millisecond access time. In addition, there must be sufficient time allowed for horizontal retrace in the event the incoming data specifies an initial carriage return operation. To provide the temporary storage facilities, the interface has an assembly register, 3 buffer registers, and a disassembly register.



Buffer Chain

Assembled data is fed through the buffer register chain to the disassembly register in a word-serial operation. A data word enters one buffer register and leaves another every half-symbol time (8.4 microseconds). Once the first word reaches the disassembly register, a buffer control network signifies that this register is full and prevents entry of another word from buffer register 3. The disassembly register remains full until the stored word can be transferred to the window (entry marker detection). In the meantime, additional words are transferred from the assembly register to the buffer register chain, and stack up until transfer can occur.



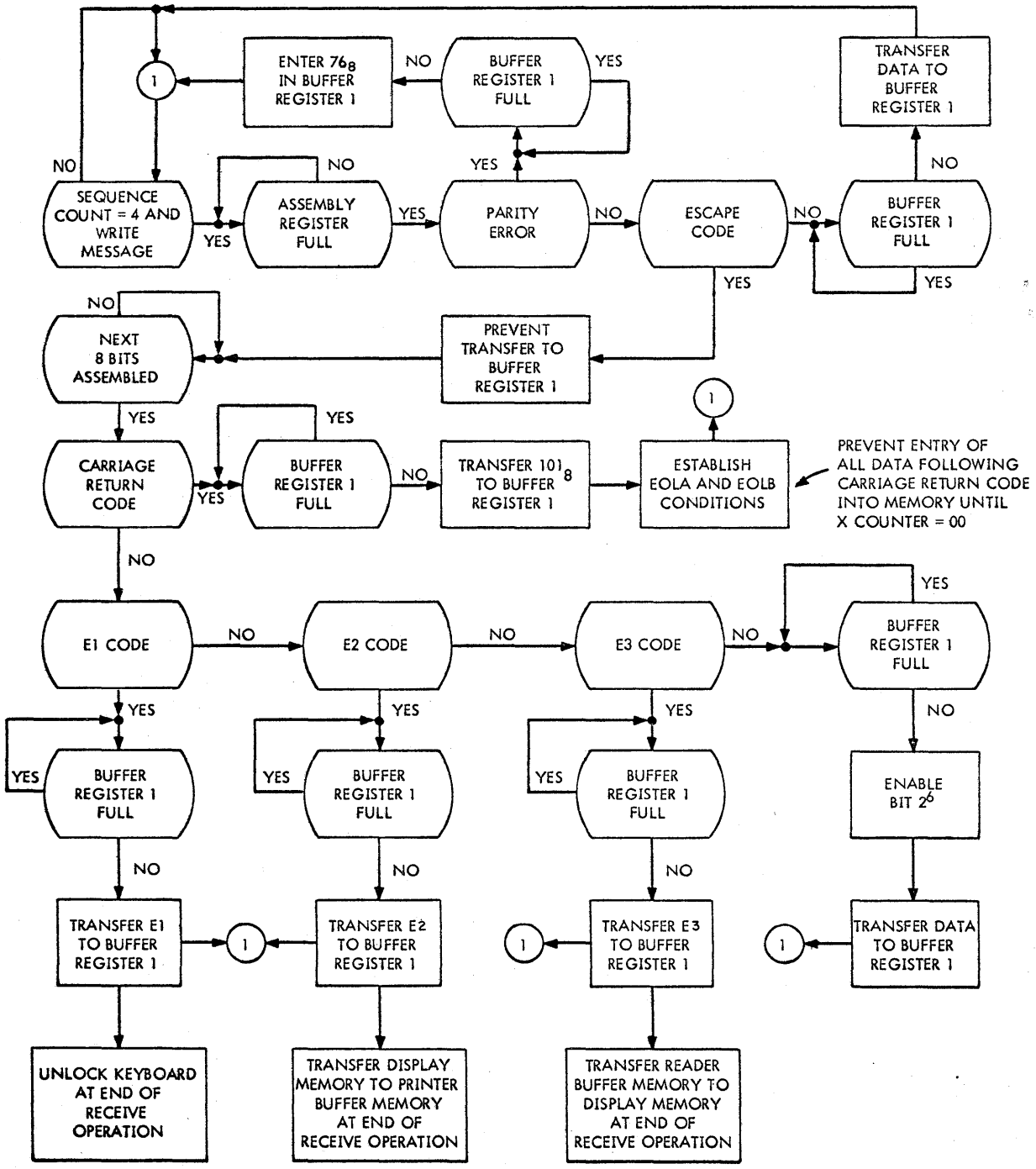
The contents of the assembly register are examined for parity errors and escape codes (these two codes require extra consideration). In addition, a BCD conversion is made. If the assembled word has a parity error and is part of the data subset, an octal code of 76 is entered in buffer register 1, and subsequently, display buffer memory. This results in display of the parity error symbol (■) for the particular code in error.

Any time an escape code is encountered (076 external BCD or 136 internal BCD) in the assembly register, the following code is assumed to be a member of the function repertoire. In this case, the escape code is prevented from entering buffer register 1. The following code then establishes the required condition in the interface and is also transferred to buffer register 1.

The entry marker advances each time a word is entered into memory. Consequently, the entry marker resides one symbol position after the "E" symbol at the end of the message. A special case arises for write messages ending with E1 during LINE mode operations. Refer to page 4-21 (Part A) for a description of this special case.

Data subset information received from the data source must be in either internal or external BCD form. A switch on the logic chassis selects that code set interpreted. In the EXTERNAL mode, the assembly register is examined for two specific codes (other than escape and parity error) which must be converted to a new form before transfer to buffer register 1.

Assembled Form	Transferred Form
00	20
20	00



Parity Error and Escape Code Detection

A more elaborate conversion process takes place if the switch is in the INTERNAL BCD position.

Assembled Form	Transferred Form
2X	6X
3X	7X
6X	2X
7X	3X
60	00
00	12
12	20

Data is continually entered into display buffer memory until a USASCII end of message code (003) is assembled. At this point, the sequence counter increments to 5 preventing any further transfer to buffer register 1. Meanwhile, data already in the buffer chain is transferred to memory. The next code received should be message parity which advances the sequence counter to 6; the receive operation terminates and the controller switches to a transmit mode.

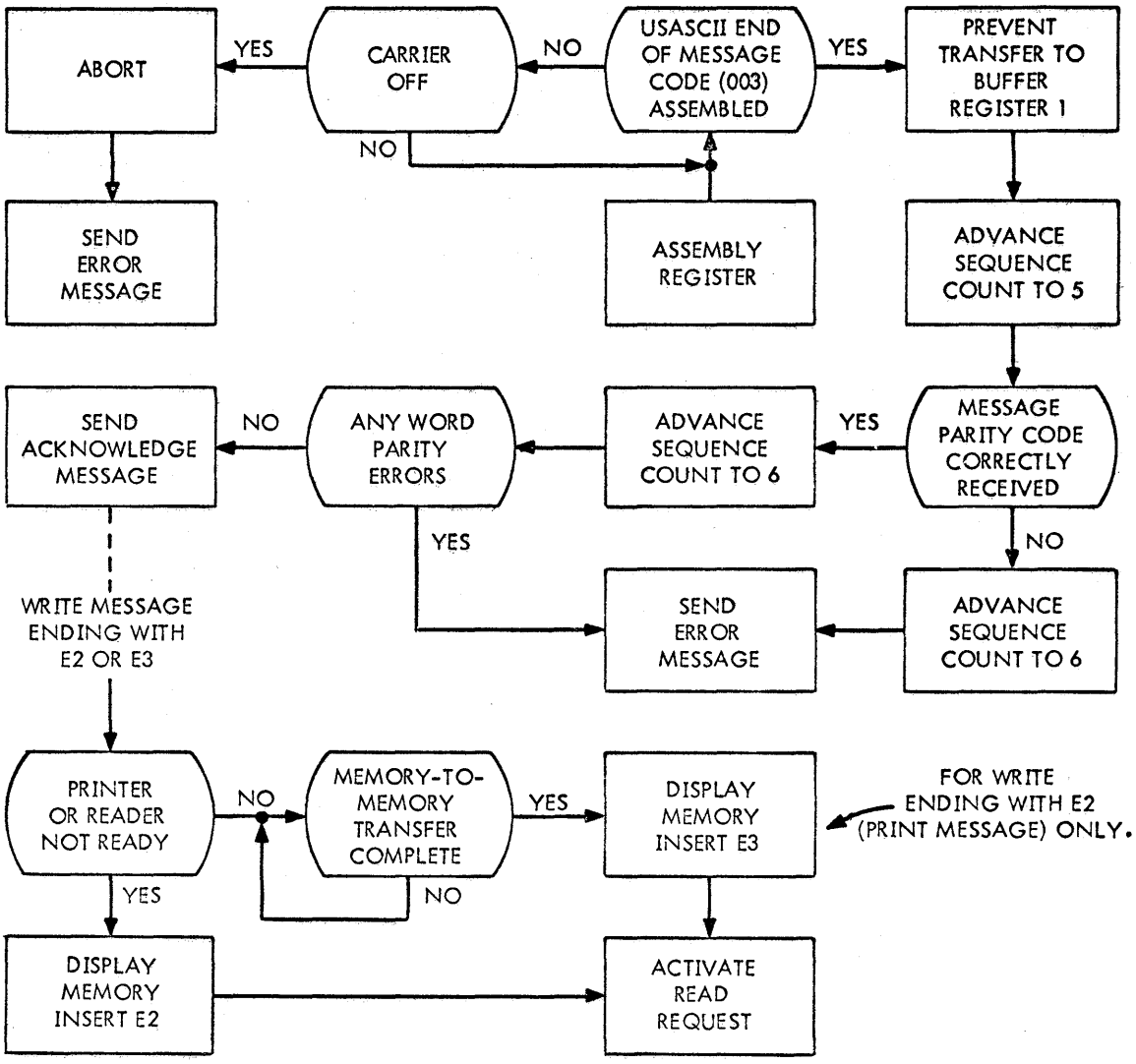
The normal response to a write (021) message is an acknowledge (006) message, providing there are no errors. However, if the remote site is busy and the write cannot be processed, a reject (030) response is given. If errors exist in a processed message, the response is an error (025) message.

Reset-Write and Clear-Write Messages.

Both reset-write (014) and clear-write (022) messages are processed in the same manner as the write (021) message. The main difference is that seven sync codes must immediately follow the reset-write and clear-write control codes to allow time for resetting the marker. These sync codes are prevented from entering the buffer register chain, nor are they considered for purposes of message parity. In one instance (clear write), display buffer memory is cleared and the marker chain reset before data is entered. A reset operation, only, is performed when a reset-write code is detected.

Diagnostic Write Message.

The intended purpose of the diagnostic write message is to check remote site operation. This task is accomplished by sending a diagnostic write control code (020)

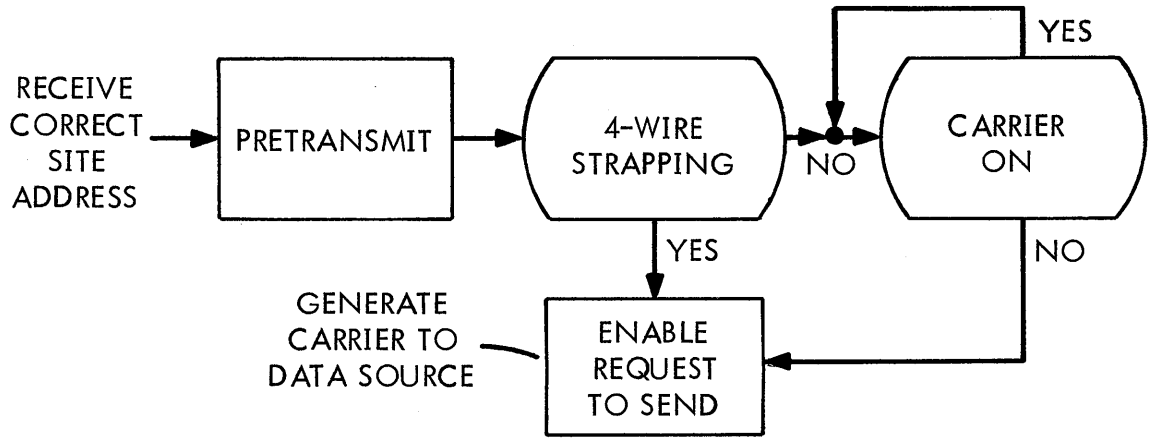


followed by seven sync codes and data. Basically, this message is processed as a reset-write message with a few unique exceptions. First, the diagnostic write establishes a poll and write condition which activates a read request. This means that a read message is sent in response (instead of acknowledge) regardless of any word parity errors in the data subset, lack of an "E" code, or incorrect message parity. Word parity errors reside in memory (76 octal) and are retransmitted in the subsequent read message as spaces (120 external BCD and 060 internal BCD).

A diagnostic write message may be terminated with either an E1, E2, or E3 code, however, it does not accomplish a print or card reader operation.

TRANSMIT OPERATION.

The controller switches to a transmit mode only in response to a message from the data source (with one exception described later). Initially, a pretransmit condition is established when the correct site address is detected during a receive operation. If the controller utilizes the 4-wire modem strapping option (2-WIRE/4-WIRE switch on logic chassis), this pretransmit condition enables the Request to Send signal. After a short turnaround delay (actual delay depending upon type of modem used) the modem returns a Clear to Send signal. Request to Send enables Carrier between modems activating the Data Carrier Detector signal to the data source. In 2-wire operation, the controller must wait until Carrier drops before activating the Request to Send signal.



Pretransmit Condition

A poll message may indirectly result in a pretransmit condition. If the POLL NORMAL/WAIT switch on the logic chassis is in the WAIT position, a poll message creates a WAIT condition in the interface. Subsequent depression of the Display Station SEND key activates a read request. Assuming the controller is not performing another operation, this read request in the WAIT mode establishes the pretransmit condition. Request to Send is given immediately, regardless of the position of the 2-WIRE/4-WIRE switch since a Carrier signal should not be present if an operation is not in process.

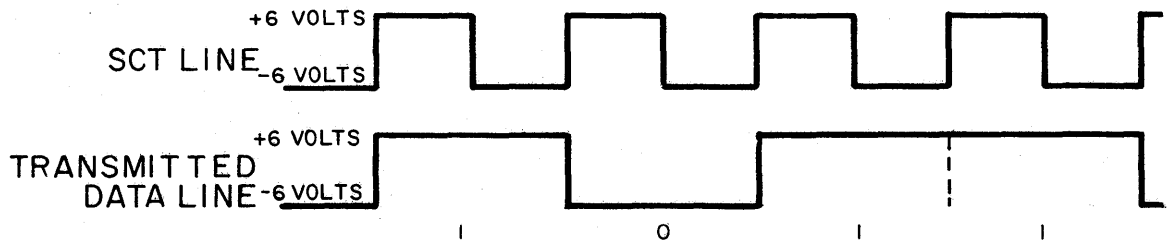
Normally, an indication of receive termination is given when the controller decodes the message parity word in the assembly register (sequence count of 6). At

this time, the controller switches to transmit and a response message is generated. A read request in WAIT mode automatically switches the controller to a transmit mode.

By switching to transmit, the controller initiates a sync and sequence count which generates the message in the fashion shown in the following list.

SYNC COUNT	SEQUENCE COUNT	CODE
0	0	Sync
1	0	Sync
2	0	Sync
3	0	Sync
X	1	Start of Header
X	2	Site Address
X	3	Station Address
X	4	Control Code
X	5	Data from BR3 (Read Message only)
X	6	USASCII End of Message
X	7	Message Parity Code

Each count enters the corresponding code in the disassembly register. The rate at which the counters increment is directly related to the rate at which the disassembly register can enter the code on the Transmitted Data line in a bit-serial operation. Each time the disassembly register is filled, the count is incremented and the new code entered as soon as the present is disassembled. A bit is placed on the Transmitted Data line at the positive transition of the SCT signal.

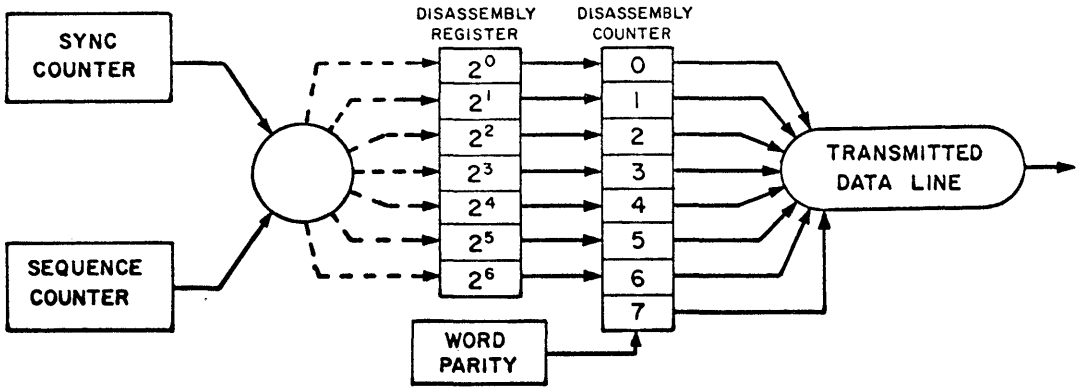


Serial Data Transmission

The disassembly process is actually governed by a disassembly counter which increments with each cycle of the SCT signal. On a disassembly count of 0, bit 0 in the disassembly register is placed on the Transmitted Data line. Data placed on the line is examined for logical 1's. If the number of logical 1's in a given word is even when the disassembly counter reaches 6, another logical 1 is added on a count of 7, making odd parity.

On a sequence count of 4, the interface is examined to determine which type of response is to be generated. Unless the control code is a read, a count of 5 exists only momentarily and the counter is incremented again to produce the USASCII end of message code.

The message parity counter performs in the same manner as described for the receive operation (page 4-32, Part A). However, it acts as a generator in this case, counting the number of logical 1's inserted in each bit position in the disassembly register. A message parity count begins with the start of header code and ends with the USASCII end of message disregarding all sync codes. A word parity bit is added. On a sequence count of 7, this word is transmitted and the controller returns to the receive mode.



Transmit Block Diagram

Acknowledge Message.

Under any of the listed conditions an acknowledge code (006) is entered in the disassembly register on a sequence count of 4.

1. Response to a correctly received write, reset-write, or clear-write message.

2. Response to an alert message.

3. Response to a poll message when no read request is active and POLL NORMAL/WAIT switch is in the WAIT position.

Reject Message.

A reject code (030) is inserted on a sequence count of 4 in response to:

1. A write, clear-write, diagnostic write, or reset-write message when the controller is busy.

2. A poll message when there is no read request active and the POLL NORMAL/WAIT switch is in the NORMAL position.

The controller is busy under any of the following circumstances:

1. Message in display buffer memory queued for printout.

2. Card data stored in display buffer memory as a result of a write message containing an E3 code.

3. Backspace, clear, or reset operation in progress.

Error Message.

Anytime one or more of the following errors occur during a receive operation, an error code (025) is inserted in the disassembly register on a transmit sequence count of 4.

1. Incorrect station address.

2. Unrecognized control code.

3. Poll or diagnostic write code not received following a station address of 140 or 160 octal.

4. Carrier drops before receipt of USASCII end of message code.

5. Incorrect message parity.

6. Incorrect word parity.

7. No "E" code in write message.

8. Illegal code.

The error code is only entered if the ERROR MESSAGE ENABLE/DISABLE switch on the logic chassis is in the ENABLE position. Otherwise the controller remains in the receive mode and no response is given.

Read Message.

Read messages are generated as a result of read requests. If a poll message is received and a read request is active, the read code (023) is entered in the disassembly register. A read request is activated under any of the following conditions:

1. Display Station SEND key depressed.

2. In response to a write message ending with E2 (print message).

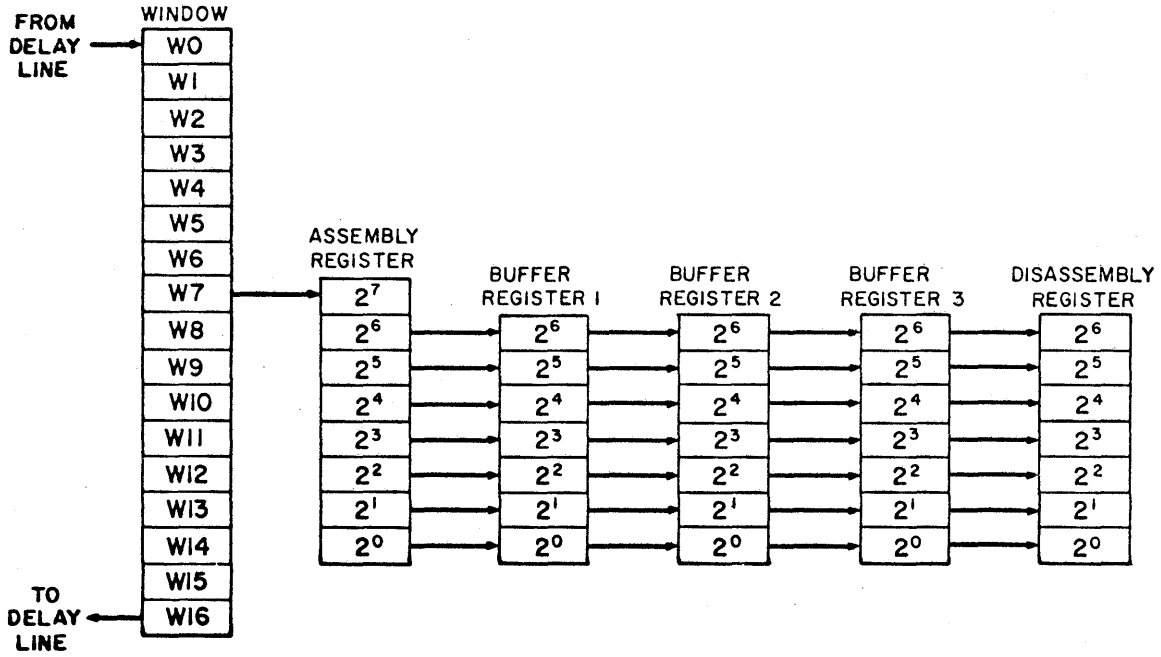
3. In response to a write message ending with E3 (read more cards request).

4. In response to a diagnostic write message.

5. In response to an alert message received while the terminal is in the UNATTENDED mode.

A poll message is not required to enable read message generation in the case of a diagnostic write or a SEND key depressed when the controller is in the WAIT mode. The read is an automatic response to a diagnostic write and contains the original data received. In the case of WAIT mode, the poll message establishes a WAIT condition if the POLL NORMAL/WAIT switch is in the WAIT position and no read request is active. Any subsequent depression of the SEND key results in an automatic read message.

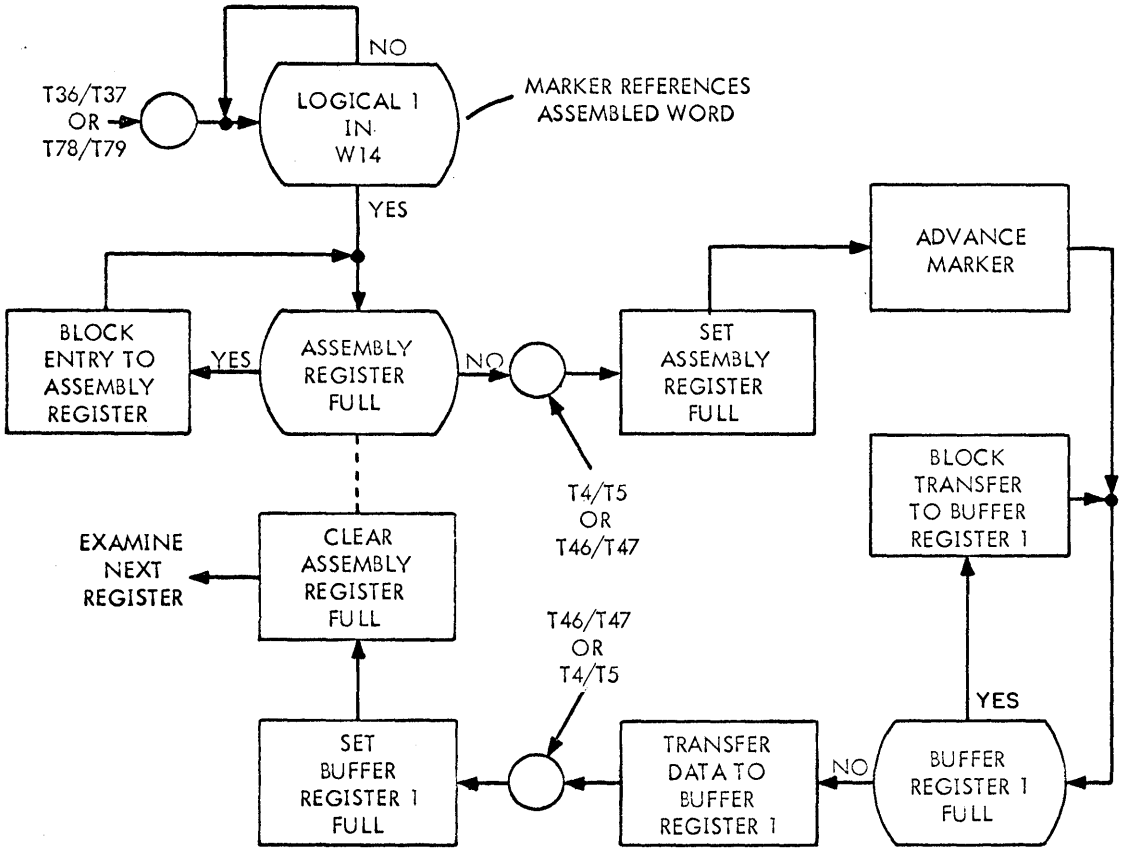
Once the read code has been inserted in the disassembly register and the sequence counter incremented to 5, data stored in display buffer memory is assembled and transferred through the buffer register chain to the disassembly register. During the period the stored data is being transmitted, the sequence counter remains at a count of 5.



Read Buffer Transfer

Before data can be transferred through the buffer register chain the entry marker must be found. This requires a maximum of 10 milliseconds, during which time bits entering W7 are shifted through the assembly register. However, it is not until the marker is actually found in W14 (by sampling at t36/t37 and t78/t79) that transfer is allowed to take place. Marker detection sets up an assembly register full condition which exists for one-half symbol time.

Due to the interlacing feature of memory, two codes are stored within one symbol time. Actually, these two codes are one-half page apart on the crt raster. Consequently, the assembly register full condition allows transfer of the code referenced by the marker but prevents assembly of the next sequential code by remaining active during the assembly interval. Transfer of the first code advances the marker to reference the next code in the same half page (one symbol time later in memory). This code is the next to be assembled and the assembly register full condition is established again.



Read Data Transfer Timing

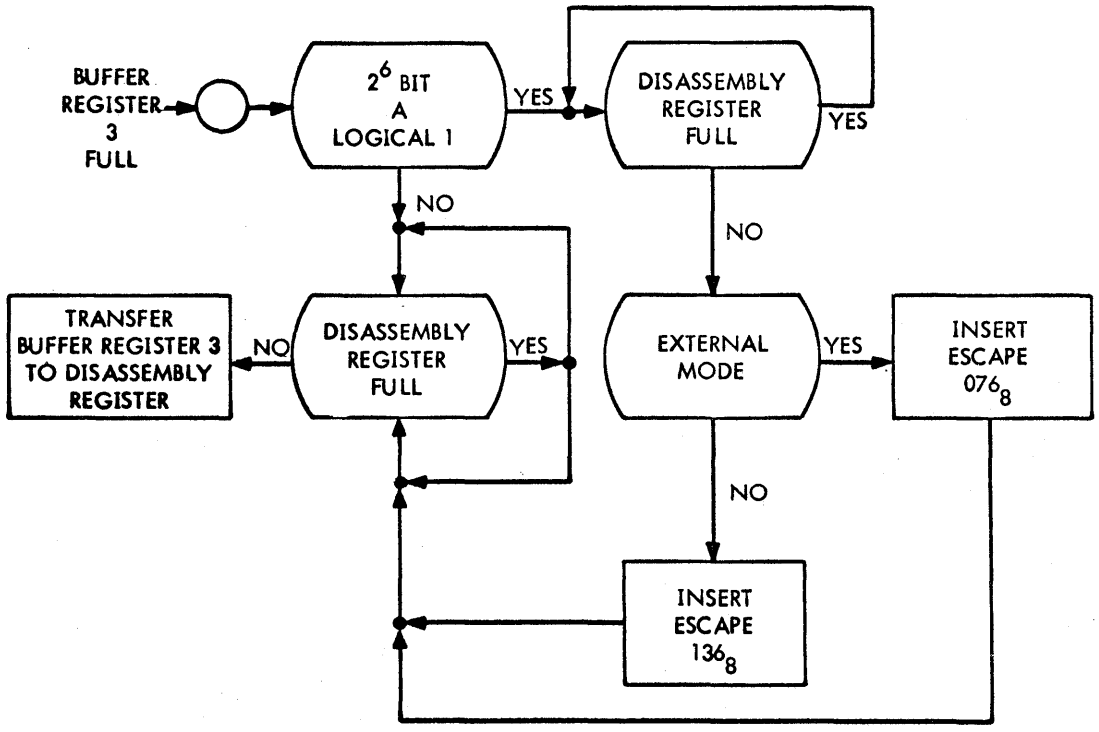
Stored data must also be converted to the applicable BCD form. As in the receive operation, the assembly register is examined in the conversion process and changed codes are entered in buffer register 1. In the EXTERNAL BCD mode, the following changes occur:

Assembled Form	Transferred Form
00	20
20	00

If the switch on the logic chassis is in the INTERNAL position, the following list shows the conversion process.

Assembled Form	Transferred Form
2X	6X
3X	7X
6X	2X
7X	3X
00	60
12	00
20	12

Any code containing a 2^6 bit must be preceded on the Transmitted Data line by an escape code. Buffer register 3 is examined with this intended purpose in mind. When this condition is encountered, the escape code is inserted in the disassembly register at the time the contents of buffer register 3 would normally be transferred. A buffer register 3 full condition then remains active until the escape code has been transmitted and transfer can take place.



Escape Code Entry

The end of a read message is indicated whenever an "E" code is detected in the assembly register, in which case a terminate read condition is activated. This condition prevents any further transfer between memory and the assembly register. If no "E" code is detected before the marker reaches the end of the page, the message automatically terminates. In either case, the sequence counter is advanced to 6 when all remaining data in the buffer register chain and disassembly register has been transmitted. The USASCII end of message code and message parity are transmitted and the controller switches back to a receive mode.

REDUNDANT RESPONSES.

Through proper programming, the data source may determine if a write message was correctly received, should a telephone channel error burst wipe out the response message from the remote site. The data source should alternate station addresses in successive write messages (between 141 and 161 octal). If the write message is correctly received, the response contains the same address; if incorrectly received, the alternate address is issued.

RECEIVED MESSAGE	STATION ADDRESS	RESPONSE MESSAGE	STATION ADDRESS
Write	141	Acknowledge	141
Write	161	Acknowledge	161
Write	141	Error	161
Write	161	Acknowledge	161
Write	141	Acknowledge	141

Assuming that a response message is destroyed, the data source should then transmit a poll or alert message. If the write message had been correctly received, the response to either a poll or alert contains the same station address as the write (except least significant bit).

RECEIVED MESSAGE	STATION ADDRESS	RESPONSE MESSAGE	STATION ADDRESS
Write	141	Acknowledge	141
Write	161	Acknowledge	161
Write	141	Acknowledge	141
Poll	(140 or 160)	Reject	140
Write	161	Acknowledge	161

If the destroyed response message indicated an error in processing, a poll or alert message solicits an alternate station address.

RECEIVED MESSAGE	STATION ADDRESS	RESPONSE MESSAGE	STATION ADDRESS
Write	141	Acknowledge	141
Write	161	Acknowledge	161
Write	141	Error	161
Poll	(140 or 160)	Reject	160
Write	161	Acknowledge	161

PART B

CARD READER ADAPTER KIT

Equipment Numbers

FE105-A
FE105-B
FE106-A
FE106-B

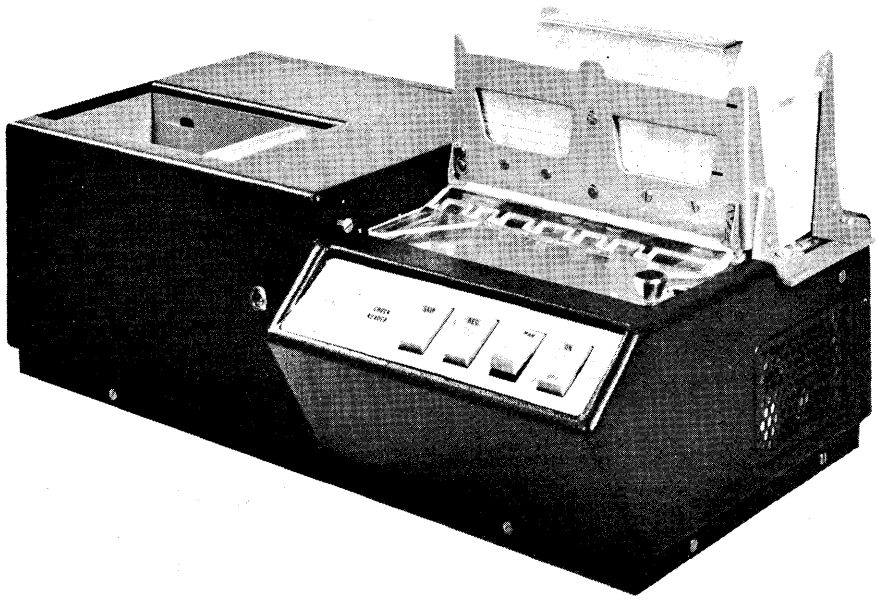
For use with the
224-1 Card Reader
Station, equipment
numbers:

CE703-A
CE703-B

Card Reader Adapter Kit

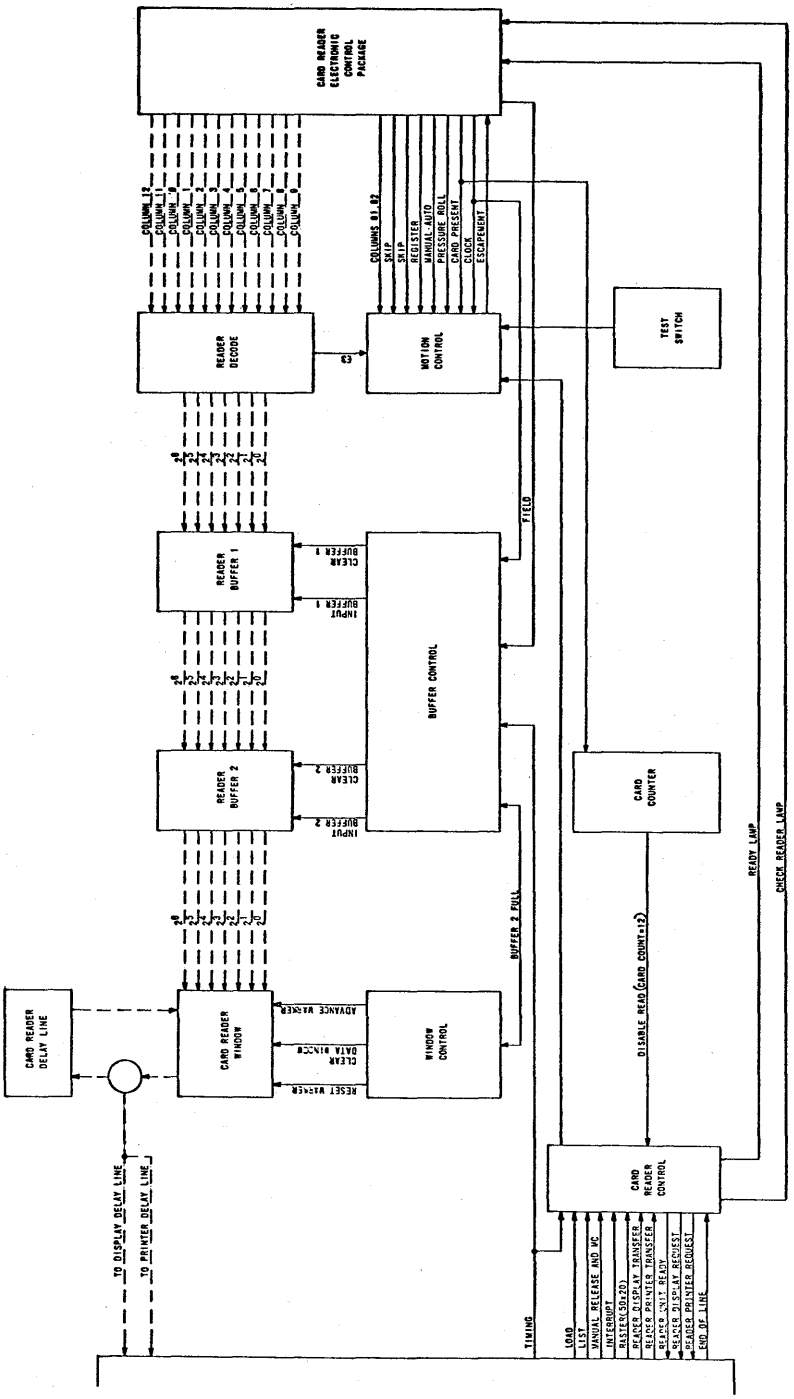
This adapter kit provides the means whereby punched card data from a 224-1 Card Reader Station may be transferred to the controller for local printout or communications with the central processing site (data source). There are four different card reader adapter kits offered; one for each of the four types of Equipment Controllers. Accordingly, the 224-1 Card Reader Station comes in two varieties. The following list relates the various equipment numbers. Refer back to the description of the Basic Configuration for an explanation of differences.

EQUIPMENT CONTROLLER	ADAPTER KIT	CARD READER STATION
FC710-A	FE105-A	CE703-A
FC710-B	FE105-B	CE703-B
FC711-A	FE106-A	CE703-A
FC711-B	FE106-B	CE703-B



224-1 Card Reader

In the reader block diagram shown, the electronic control package is actually part of the Card Reader Station. It has been included only to illustrate signal lines used between the reader and adapter kit in the controller.

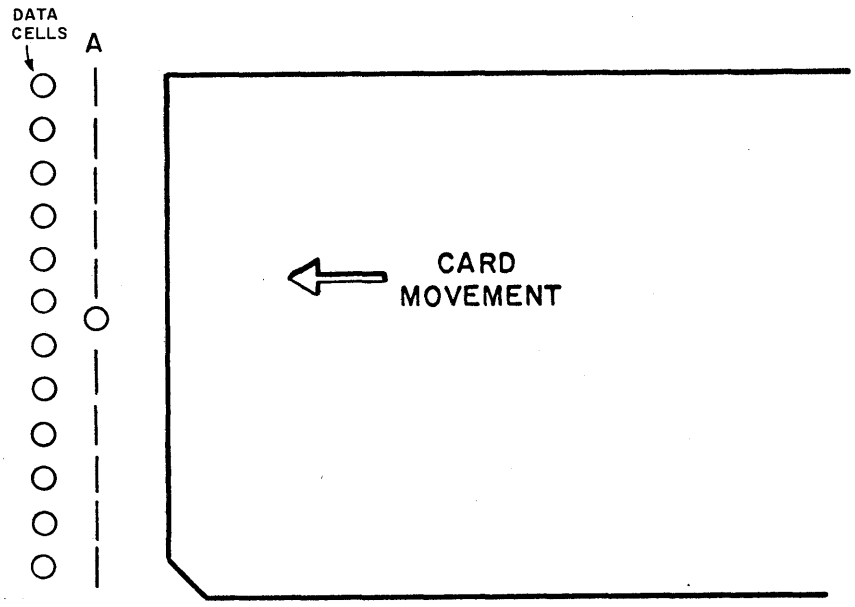


Card Reader Adapter Kit Block Diagram

GENERAL OPERATION.

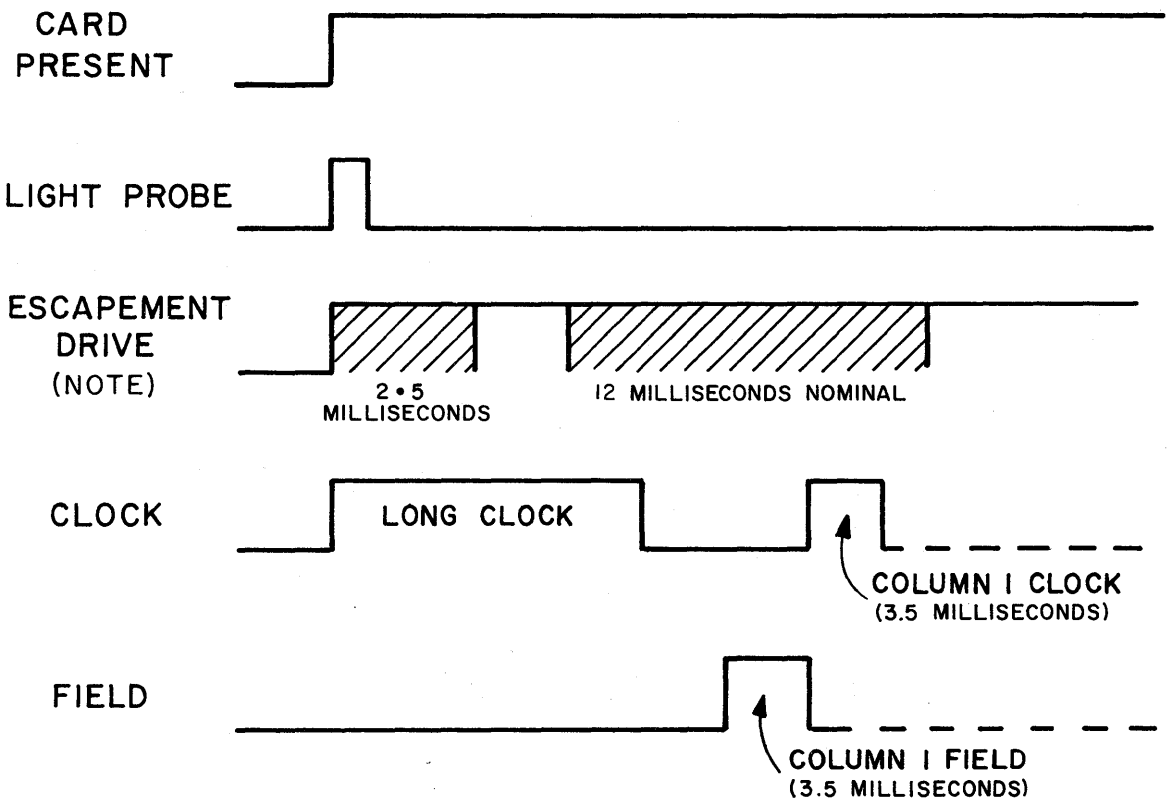
The Card Reader Station provides external timing to the adapter kit. In addition, it offers the user many facilities for governing operating modes. For more detailed discussions on the reader unit, consult the 224-1 Card Reader Station Reference/Customer Engineering Manual and the associated NCR documentation.

The reader station may operate in either MAN (manual) or AUTO (automatic) mode. In the first case, cards must be manually inserted on the read table. Then, by depressing the REG (register) switch, card movement begins. A row of solar cells is used to check the condition of each channel for every column. One solar cell is located immediately in front of the data cells. As the card moves, it first covers the preceding cell (position "A" in the following illustration). At this point, a Card Present signal is generated.



Since the card does not cover any of the data cells at this time, all cells should indicate a light condition. The controller samples the Data lines to provide this check. If a light condition does not exist in all cells, an error is evident. In any event, the adapter issues an Escapement Drive signal and card movement continues, with each column being read by the data cells.

A Clock signal is used to indicate when a column is over the photocells. The Field line is used in conjunction with this Clock signal to identify which columns are to be read. A Field pulse precedes the field of information to be read, while another pulse on the same line follows the field.

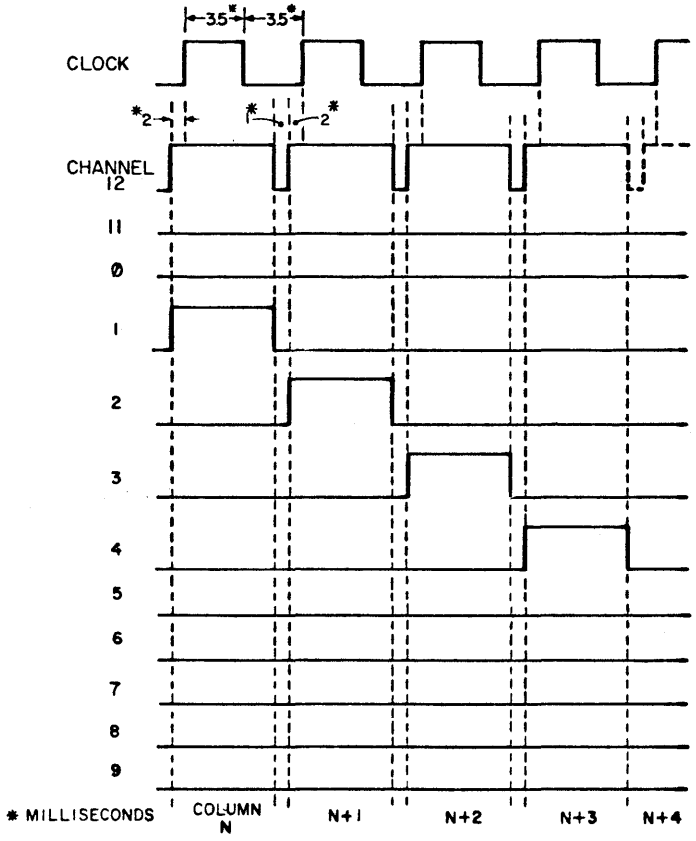


Initial Sequence

NOTE

The Escapement Drive signal starts and stops card motion. A period from 2 to 5 milliseconds is required to deenergize and 12 milliseconds are required to energize the escapement solenoid in the reader.

As the card passes over the data cells, the 12 Data lines indicate light conditions in each channel. Each Clock pulse identifies a new column. In the next chart, 4 characters are used (A, B, C, and D) to illustrate the pulses on Data lines as well as the relationship to the Clock signal.

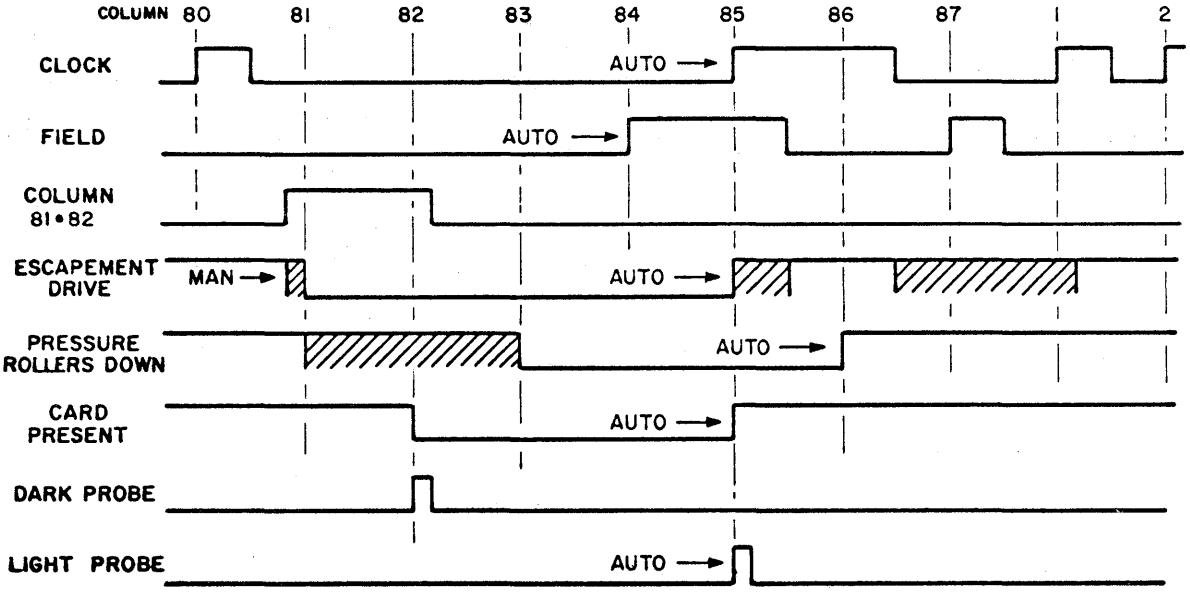


Data Transmission

Motion control in the reader is based on a cycle of 87 columns. The first 80 are used for data while the remaining make up the interval until the beginning (column 1) of the next card. A signal is received by the controller when the reader is passing through the column 81 and column 82 stage; clearing the Escapement Drive signal in MAN mode. Also at this position, the reader pressure rollers raise and the Card Present signal drops shortly after. A raised pressure rollers condition

clears the Escapement Drive signal in both AUTO and MAN modes while the Column 81.82 signal prevents reactivation of Escapement Drive (in AUTO mode) until the next Card Present signal is received.

A dark check is made once the trailing edge of the card leaves the card present cell exposed (disabling Card Present signal). At this position, the data cells are still covered by the remaining portion of the card. Consequently, all Data lines should indicate a dark condition. The controller samples the lines at this time and any cell failing to register dark causes an error condition in the controller.



End of Card Sequence

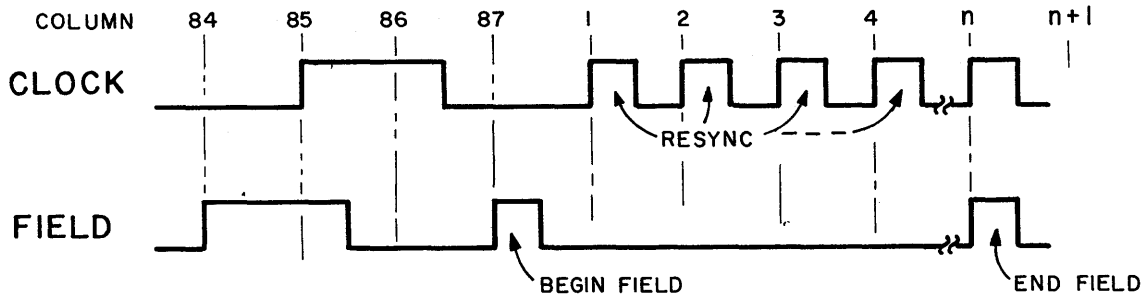
In MAN mode, insert another card on the read table and depress the REG switch again to initiate another card scan. Cards are automatically registered in AUTO mode after the first card has been read. The read operation continues until either a card becomes jammed or the card hopper empties. In either case, another Card Present signal is not received until the situation is remedied. After one Card Present signal drops, the controller waits approximately 60 milliseconds for another. If another signal is not received during this period, the controller assumes a hopper empty or card jam condition and an error condition is activated.

DATA ENTRY.

The reader adapter temporarily stores data while a search is made for the entry marker in the reader buffer memory. Maximum access time to memory is 10 milliseconds during which time two columns of data could possibly be received. Two buffer registers are used for temporary storage. Previous to entering buffer register 1, the punched card data is converted from Hollerith coding to a binary form compatible with the Equipment Controller repertoire.

Once the marker is found, data is transferred from buffer register 2 to the reader delay-line window (reference reader block diagram). From here, data is inserted in the delay line and continually recirculates through the window. The marker advances with each new entry.

Transfer through the buffer and entry into the window is governed by a resync pulse which is a direct derivative of the Clock and Field lines.



Resynchronization

Each Clock pulse following the beginning Field pulse creates a resync condition and data advances through the buffer and into the window if the marker is detected. Every card must experience the same resynchronization sequence since each contains a pair (or more) of Field pulses.

Errors are a result of light/dark check faults, card jams, or hopper empty conditions. A light/dark check fault blocks transmission of Escapement Drive; stopping further reader motion after the present card is ejected. A card jam or hopper empty situation is indicated if no Card Present signal is received within 60 milliseconds after the previous card is read. Any error extinguishes the READY indicator and

illuminates CHECK READER after the 60-millisecond timeout period. A master clear, manual release, or LOAD switch depression is required to clear a light/dark error indication after the fault is remedied. Card jam and hopper empty conditions are mechanical situations and require remedial measures to allow operation to continue.

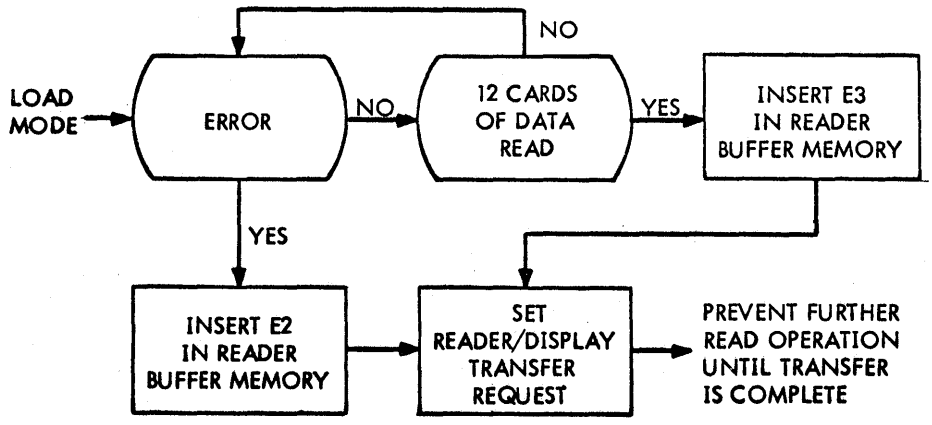
DATA TRANSFER.

A preread error automatically terminates a card data message in memory by inserting an E2 code (140 octal) after the present card has been read. Normally, however, a card counter terminates the message after the 12th card is read by blocking Escapement Drive and inserting E3 (141 octal) in LOAD mode or E2 in LIST mode. A light/dark fault on the 12th card has no effect on message termination for the present data. When these "E" codes enter the window, they set up a transfer request.

LOAD.

When operating under data source control (LOAD key depressed), a write message ending with E3 must be received in order to transfer reader buffer memory contents to the display buffer memory once a transfer request is activated. After completing a memory-to-memory dump, the transfer request is dropped and reader operation begins again.

If an error is indicated for transferred data and is not remedied, the next write message ending with E3 sets up a one-word read message (E2) in display buffer memory. This signifies that the reader is not ready.

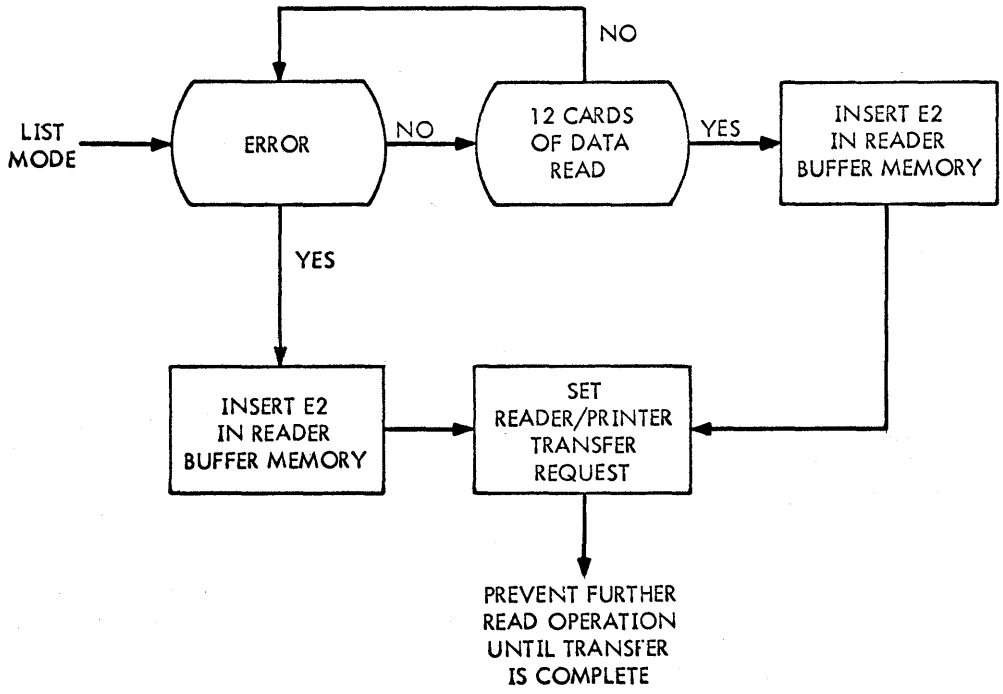


LOAD Mode Message Termination

LIST.

A depressed LIST key enables transfer from reader buffer memory to printer buffer memory for local printout when the printer is ready. After the memory dump, transfer request is dropped and the reader resumes normal operation unless an error exists.

If a 136-column line printer is used for printout, the reader adapter inserts an end of line code (100 octal) into memory after each card is read. Consequently, an 80-column format is established for printout.



LIST Mode Message Termination

TEST.

The READER TEST/MC switch enables display of card data in the TEST position. In this position, the card counter is cleared and prevented from incrementing. Cards are read in the normal fashion and entered in reader buffer memory. However, the switch maintains a constant reader-to-display transfer enable, hence, data

written into reader buffer memory is also entered in display buffer memory. By disabling the card counter, E3 message terminations are prevented. However, any error will terminate the message and operation with an E2 code. During this operation, the Display Station keyboard remains locked out. A master clear or manual release is required to unlock the keyboard, once the switch has been removed from the TEST position.

SKIP.

Initial depression of the SKIP switch on the reader halts card motion at the column 86 position. In addition, the reader adapter extinguishes the READY light and flashes the CHECK READER lamp. Escapement Drive signals are blocked at this time. A second depression is required to return conditions to normal. Even though the READY light is not illuminated during a SKIP function, the reader is still considered ready at the interface.

INTERRUPT.

The INT (interrupt) key on the Display Station keyboard may be used to interrupt a card read sequence during a LOAD operation. In this instance, a reader-to-display transfer is prevented allowing the operator to change a stack of cards. During the interval, the LOAD light remains illuminated but depressing the switch again continues the sequence. The second depression clears all data stored in reader buffer memory from the previous operation and resets the card counter to 0. INT has no effect on a LIST operation.

PART C

TYPEWRITER ADAPTER KIT

Equipment Numbers

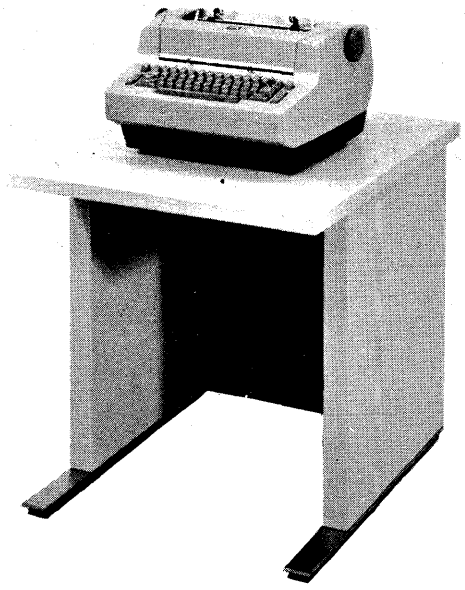
FF305-A
FF305-B
FF306-A
FF306-B

For use with the
218-1 Typewriter
Station, equipment
numbers:

CK105-A
CK105-B

This module permits the controller to drive a 218-1 Typewriter Station (using a Selectric * typewriter). Printout may be initiated from the display, data source, or card reader (in a LIST mode). There are four typewriter adapter kits offered; one for each of the four types of Equipment Controllers. Accordingly, the 218-1 Typewriter Station is available in two varieties. The following list relates the various equipment numbers. Consult the Basic Configuration description for an explanation of differences.

EQUIPMENT CONTROLLER	ADAPTER KIT	TYPEWRITER STATION
FC710-A	FF305-A	CK105-A
FC710-B	FF305-B	CK105-B
FC711-A	FF306-A	CK105-A
FC711-B	FF306-B	CK105-B



218-1
TYPEWRITER

* Trademark of IBM

GENERAL OPERATION.

Actual hard copy is an exact image of the crt representation with the exception of a LIST operation where each 80-column card is represented by one typed line.

DISPLAY FORMAT	TYPEWRITER FORMAT
50 by 20	50-symbol line (80 symbols in LIST mode)
80 by 13	80-symbol line

For further information concerning the Typewriter Station, reference the 218-1 Typewriter Station Reference/Customer Engineering Manual. This document does not, however, go to any great lengths on actual typewriter performance. Such information must be obtained from IBM.

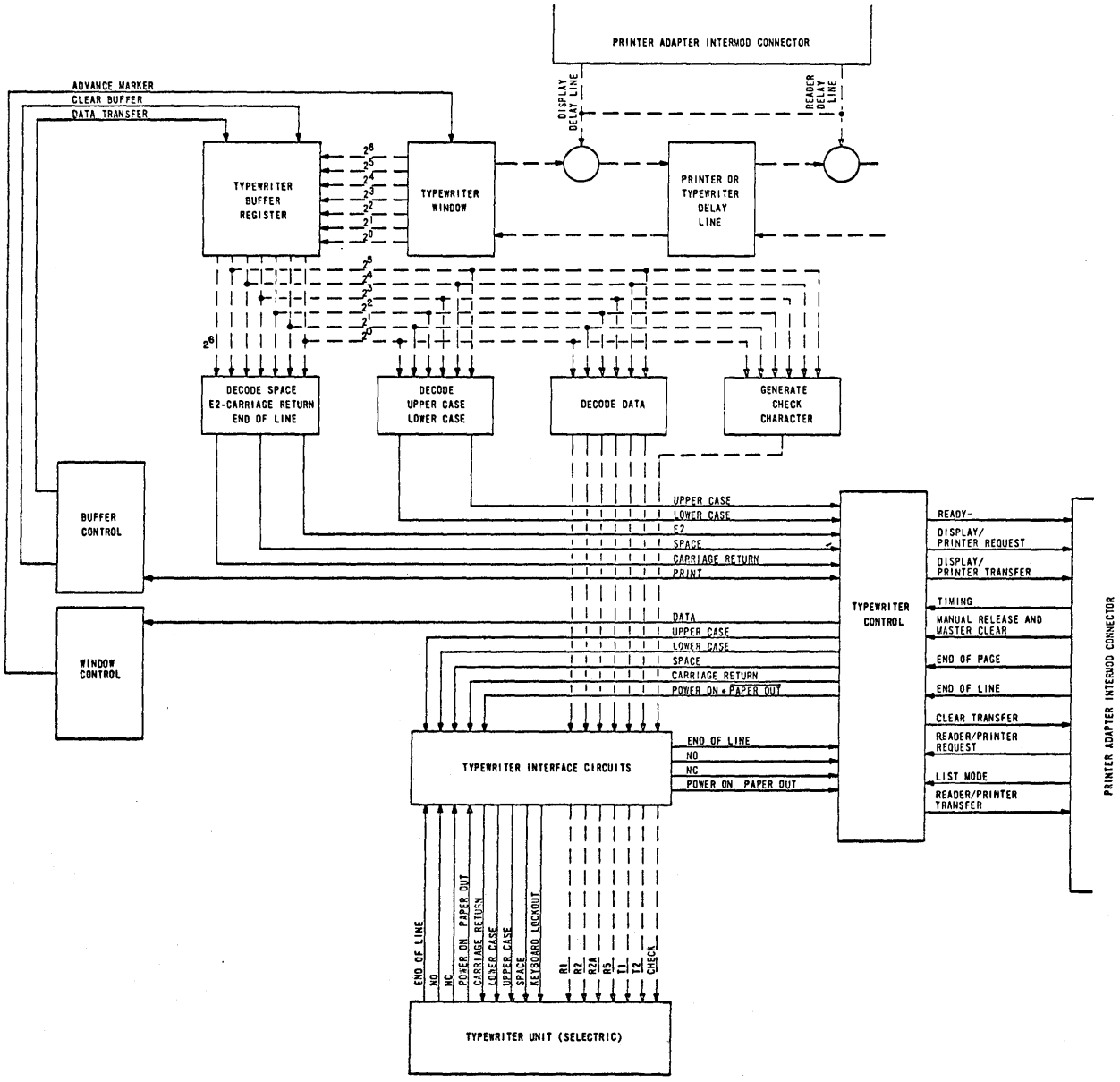
Printout is initiated when a transfer request is received from another module. If the typewriter is not busy and able to process the information, data from the requesting assembly is directly entered in an associated typewriter delay line. The window is not used for data entry.

When transfer begins, the controller grounds the Carriage Return line. This sets up a carriage return operation within the typewriter during which time a Normally Open (NO) response is given. Once the typewriter reaches the position corresponding to the beginning of a new line, the Normally Open condition is removed and Normally Closed (NC) response is issued. During a Normally Open interval, the typewriter is considered busy and communications with the adapter kit are blocked.

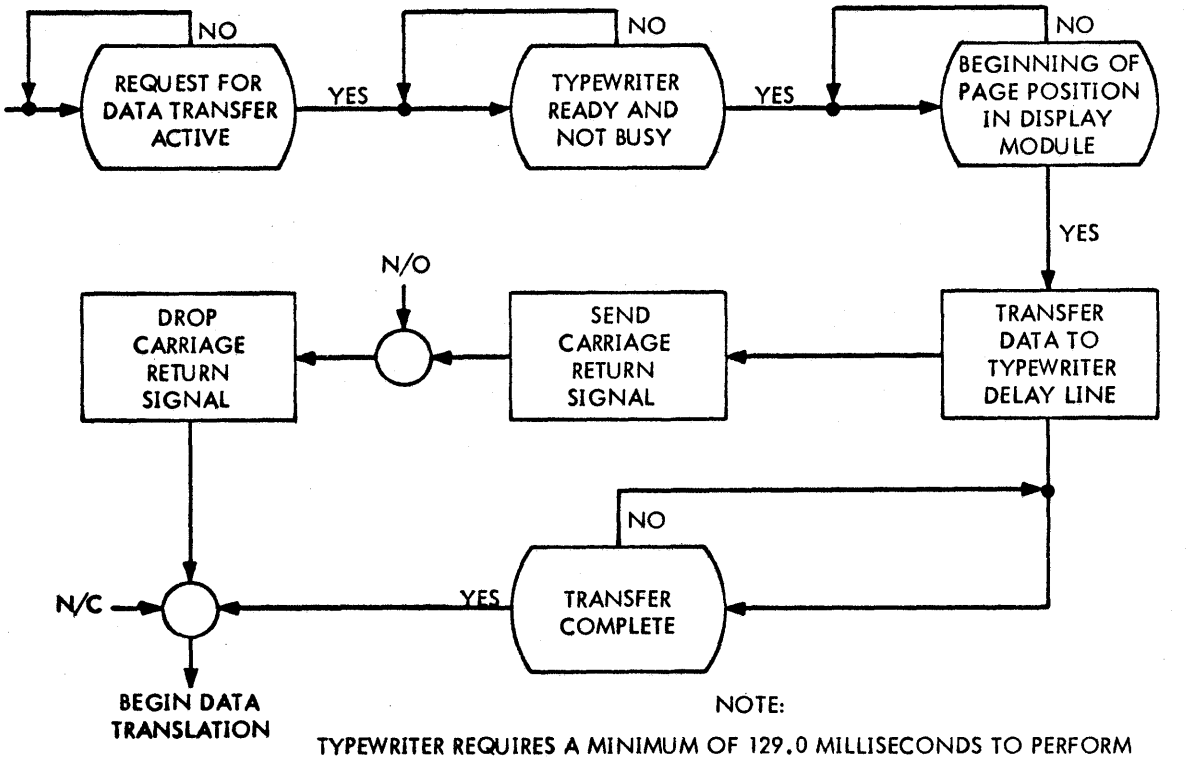
Translation of stored data begins after the transfer operation is successfully completed and the typewriter returns to a Normally Closed situation. When the marker is detected in the last window position, data in the seven window positions, immediately above, is transferred to a buffer register.

UPPERCASE/LOWERCASE.

Some symbols have the same typeball rotate and tilt positions in an uppercase-lowercase situation such as is commonly found on all typewriters. These relationships should not be confused with the dual-symbol keys on the Display Station keyboard — there is no similarity! In any event, the typewriter starts out in lowercase and



Typewriter Adapter Block Diagram

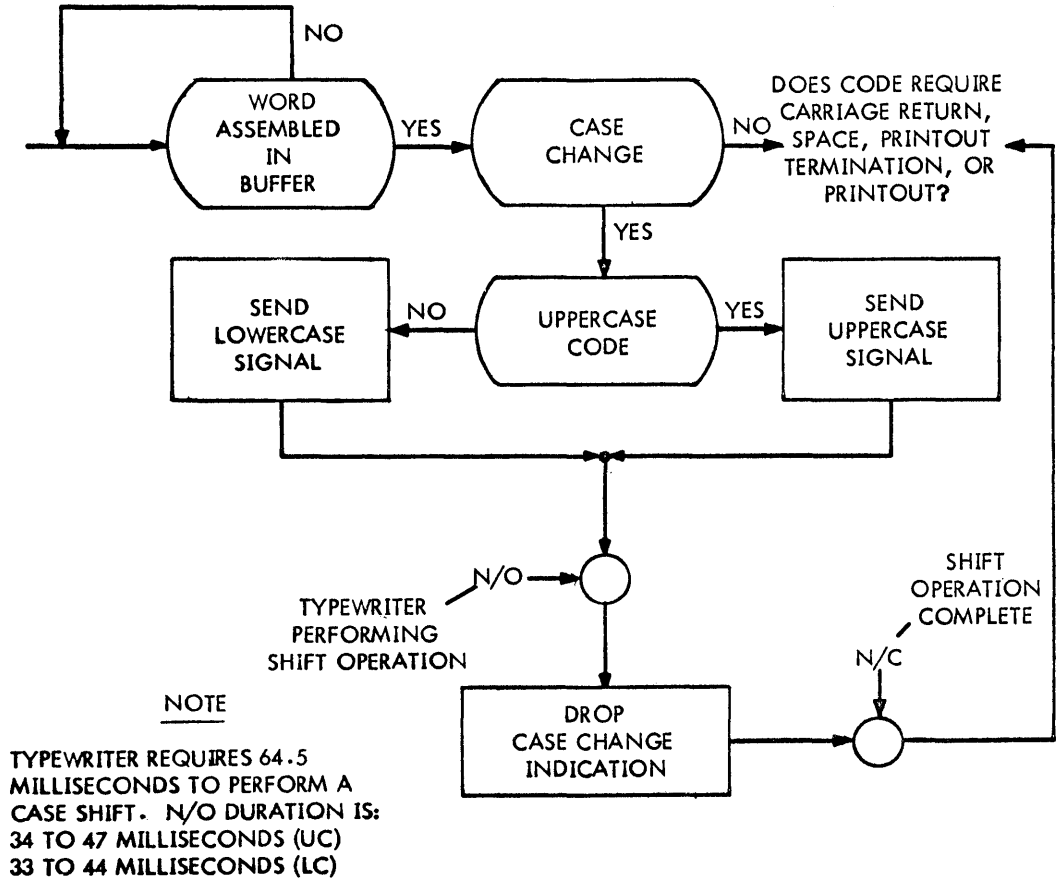


Initial Data Transfer

maintains that condition until an uppercase code is encountered. At this point the typewriter switches and remains in an uppercase mode until a lowercase code is detected. Correspondingly, the adapter kit only pulses a case line when a shift is to be made and a Normally Closed/Normally Open signal sequence during the shift prevents any other typewriter operation until Normally Closed is evident again. Case shifting is performed before any other translations are made.

SPACE.

The typewriter leaves a space in a line each time an E1 (102 octal), E3 (141 octal), or space (000 octal) code is discovered in the buffer register. A space operation is also performed previous to a carriage return when either a carriage return (101 octal) or end of line (100 octal) code is detected.

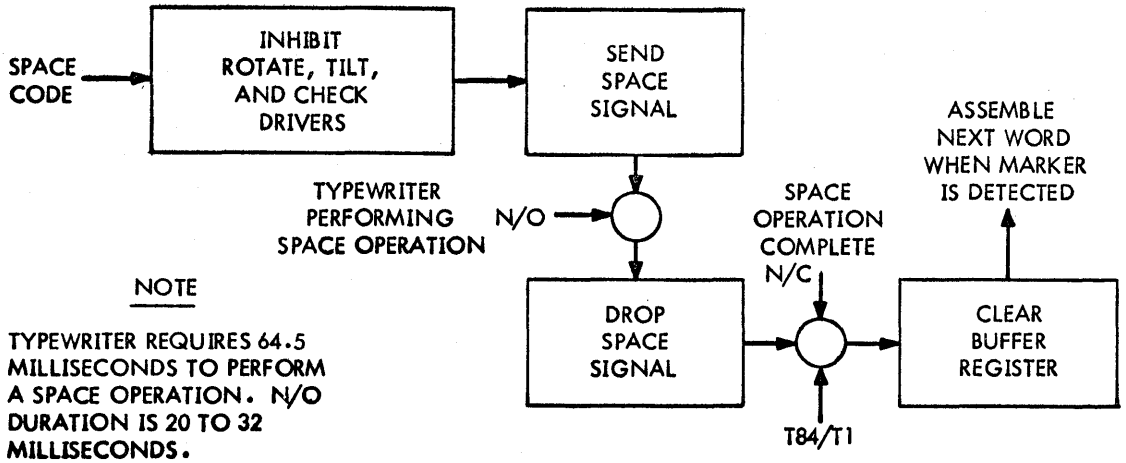


Case Changes

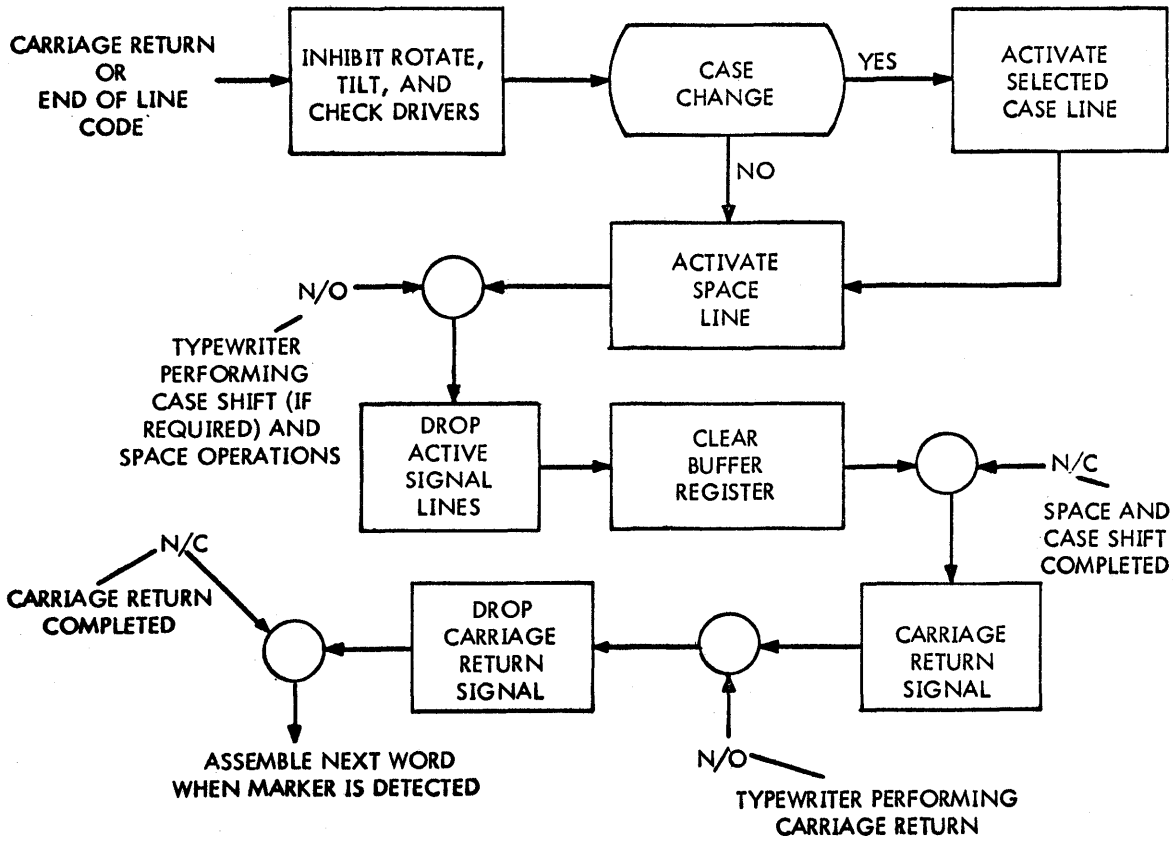
No rotate, tilt, or check magnets are pulsed for this operation. Instead, the adapter kit grounds the Space line and the Normally Closed/Normally Open sequence results.

CARRIAGE RETURN.

A carriage return is performed during initial data transfer as mentioned in earlier paragraphs for this adapter kit discussion. Subsequent carriage return operations result from controller format restrictions, typewriter end of line indications, and any carriage return (101 octal) or end of line (100 octal) codes entered in memory. Either of these two codes in the buffer register first initiates a case shift (if one is required) and a space operation. The buffer is cleared during these operations but the next data word from memory is blocked. Instead, the Carriage Return line is grounded upon a return to Normally Closed conditions.

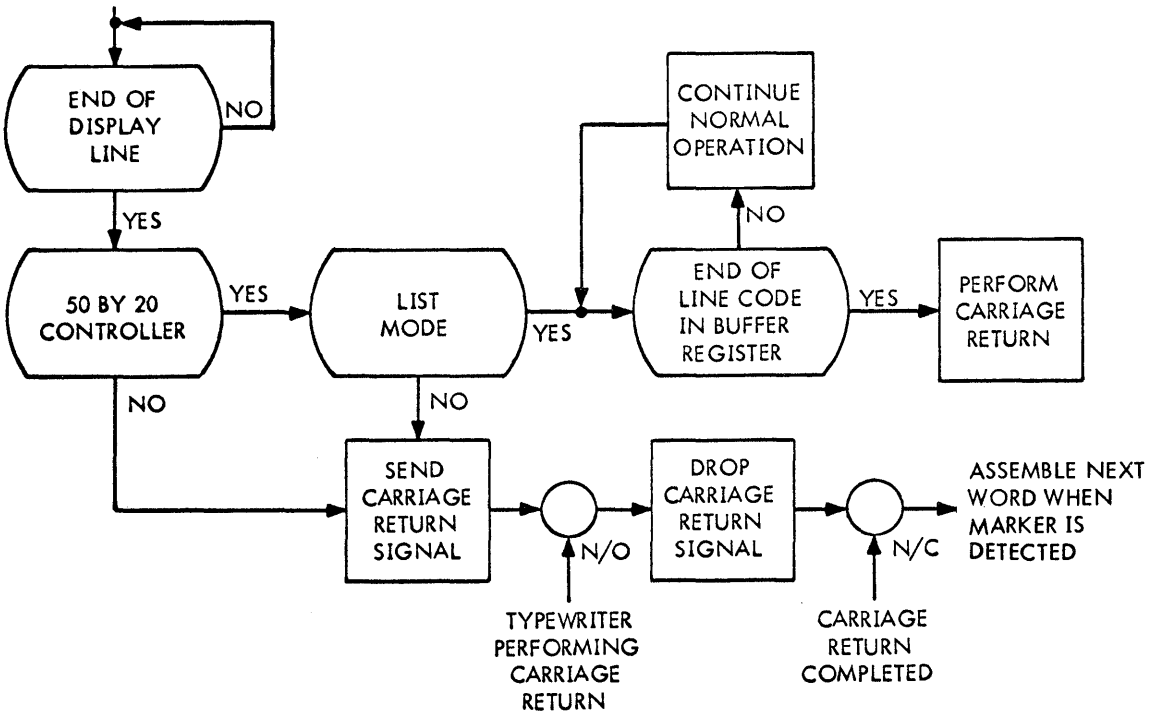


Space Operation



Carriage Return and End of Line Decode

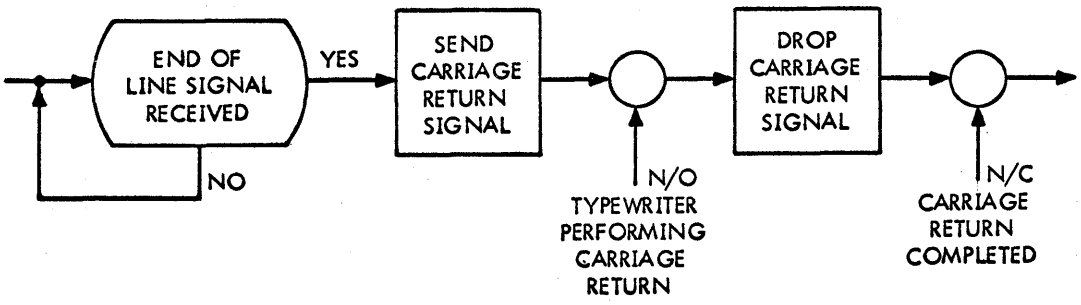
When the end of the display line is reached in the controller, a typewriter carriage return is initiated without a preceding Space signal. One exception exists; a 50 by 20 formatted controller operating in LIST mode does not initiate a carriage return since printout must extend beyond the 50th symbol position. In this instance, the card reader adapter is wired to insert an end of line code (100 octal) at the end of each 80-column card. Consequently, when this code is detected in the buffer register, a carriage return is performed.



Carriage Return by Format Restriction

The typewriter may also initiate a carriage return by sending an End of Line signal. This normally occurs when the end of a print line is reached which may be varied through the use of the margin stops above the typewriter keyboard.

During carriage return operations, the marker in the typewriter delay line continually advances until the beginning of the next display line. This synchronizes the beginning of a display line with the beginning of a print line.



End of Line Signal

DATA TRANSLATIONS.

Each word assembled in the buffer register moves the typeball to a position where the correct symbol may be reproduced if the code does not specify a function (carriage return, space, etc). In translated form, the word becomes a code made up of Rotate (R1, R2, R2A, and R5) and Tilt (T1 and T2) signals which energize associated solenoids causing the typeball movement. A Check (CK) line accompanies the Rotate and Tilt signals in an odd parity relationship (the number of Rotate, Tilt, and CK lines used must be odd). Printout of each symbol is accomplished through the Normally Open/Normally Closed sequence described for the functions. The typewriter is considered busy during the 64.5 milliseconds it takes to print one symbol. Translations for the entire octal repertoire, as stored in typewriter memory, are shown in the following list.

PRINTOUT TERMINATION.

The print operation may be terminated by three methods. Normally, detection of an E2 (140 octal) code in the buffer register marks the end of the message. There is no printout or case indication for the E2 code and the buffer is returned to a not busy condition. Data stored in the typewriter buffer memory remains and is not destroyed until either a master clear or transfer of another message occurs.

If an E2 is not detected by the time the marker in typewriter buffer memory has advanced to a position corresponding to the last display symbol position, printout is terminated nevertheless. This feature ensures that printout will not wrap around the delay line and begin repeating the same message.

TYPEWRITER ADAPTER REPERTOIRE

CODE	CASE	R1	R2	R2A	R5	T1	T2	CK	SYMBOL
00	L	NOT TRANSLATED							SPACE
01	L	X	X	X	X	X	X	X	1
02	L		X	X		X	X	X	2
03	L		X	X	X	X	X		3
04	L	X		X		X	X	X	4
05	L	X		X	X	X	X		5
06	L			X		X	X		6
07	L			X	X	X	X	X	7
10	L	X			X	X	X	X	8
11	L	X				X	X		9
12	L	X	X	X		X	X		0
13	L					X	X	X	=
14	U	X			X	X	X	X	≠
15	U	X				X	X		≤
16	U	X	X	X		X	X		%
17	U					X	X	X	[
20	L	X	X	X			X	X	:
21	L	X	X	X	X		X		/
22	L		X	X			X		S
23	L		X	X	X		X	X	T
24	L	X		X			X		U
25	L	X		X	X		X	X	V
26	L			X			X	X	W
27	L			X	X		X		X
30	L	X			X		X		Y
31	L	X					X	X	Z
32	U			X	X		X		]
33	L						X		,
34	U	X			X		X		(
35	U	X					X	X	↱
36	U	X	X	X			X	X	≡
37	U						X		∧
40	L	X	X	X		X		X	-
41	L	X	X	X	X	X			J
42	L		X	X		X			K
43	L		X	X	X	X		X	L

CODE	CASE	R1	R2	R2A	R5	T1	T2	CK	SYMBOL
44	L	X		X		X			M
45	L	X		X	X	X		X	N
46	L			X		X		X	O
47	L			X	X	X			P
50	L	X			X	X			Q
51	L	X				X		X	R
52	U			X	X	X			V
53	L					X			$
54	U	X			X	X			*
55	U	X				X		X	↑
56	U	X	X	X		X		X	↓
57	U					X			>
60	L	X	X	X					+
61	L	X	X	X	X			X	A
62	L		X	X				X	B
63	L		X	X	X				C
64	L	X		X				X	D
65	L	X		X	X				E
66	L			X					F
67	L			X	X			X	G
70	L	X			X			X	H
71	L	X							I
72	U			X	X			X	<
73	L							X	.
74	U	X			X			X	)
75	U	X							≥
76	U	X	X	X					■
77	U							X	;
100	L	NOT TRANSLATED							CARRIAGE RETURN
101	L	NOT TRANSLATED							CARRIAGE RETURN
102	L	NOT TRANSLATED							SPACE
141	L	NOT TRANSLATED							SPACE
140		NOT TRANSLATED							PRINT END

The third method for terminating is a manual release or master clear condition. Here, the MAN REL and POWER ON keys on the controller switch/indicator panel perform the task. The READER TEST/MC switch may also be used to obtain the same results.

INTERRUPT.

The INT (interrupt) key on the Display Station keyboard may be used to interrupt a print sequence under data source control. In this instance, data in a write message ending with E2 is transferred from display buffer memory if the printer is ready. The INT key blocks formation of the one-word (E3) read message following transfer and allows the operator to gain control of the terminal. However, if transfer cannot be accomplished (printer not ready), an interrupt condition cannot be established and a one-word (E2) read response is issued on the next poll. The INT key has no effect in LIST mode or when the print message originates at the Display Station keyboard.

PART D

LINE PRINTER ADAPTER KIT

Equipment Numbers

FF512-A
FF512-B
FF513-A
FF513-B
FF514-A
FF514-B
FF515-A
FF515-B

For use with the
222-1 and 222-2
Line Printer Stations,
equipment numbers:

CL401-A
CL401-B
CL402-A
CL402-B

Installation of this module provides the controller with the capability to drive either a 222-1 or 222-2 Line Printer Station. Printout may be initiated from the display, data source, or card reader (in a LIST mode). Since all four Equipment Controllers have been designed to function with both models of the line printer, eight adapter kits must be offered with two adapter kits for each type of Equipment Controller. The following list relates the various equipment numbers. Refer to the Basic Configuration description for an explanation of differences.

EQUIPMENT CONTROLLER	ADAPTER KIT	LINE PRINTER STATION
FC710-A	FF512-A	CL401-A *
FC710-A	FF514-A	CL402-A **
FC710-B	FF512-B	CL401-B *
FC710-B	FF514-B	CL402-B **
FC711-A	FF513-A	CL401-A *
FC711-A	FF515-A	CL402-A **
FC711-B	FF513-B	CL401-B *
FC711-B	FF515-B	CL402-B **

GENERAL OPERATION.

The actual hard copy is an exact image of the crt representation if the print message originates at the Display Station keyboard. In LIST mode, each 80-column card is represented by one print line. Truncation in TERMINAL mode (write message from data source ending with E2) must be programmed. The end of each print line in this mode must be designated with an escape code followed by either an end of line or carriage return code.

For further information concerning the Line Printer Station, refer to the 222 Line Printer Controller Reference/Customer Engineering Manual.

Printout is initiated when a transfer request is received from another module. If the line printer is not busy and able to process the information, data from the requesting assembly is directly entered in an associated line printer adapter delay line. The window is not used for data entry.

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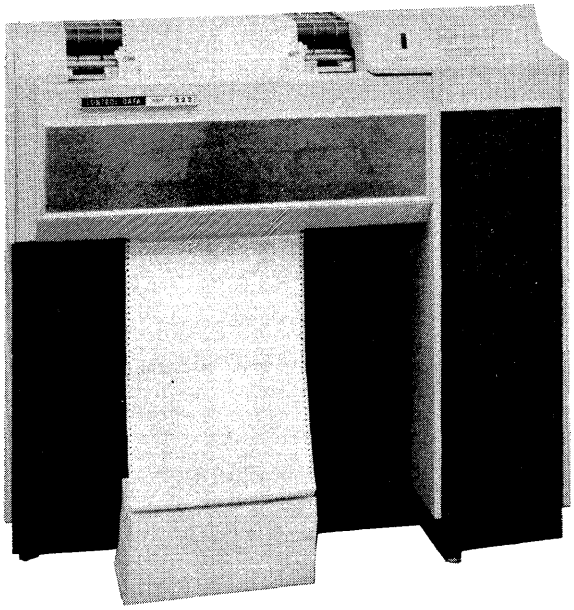
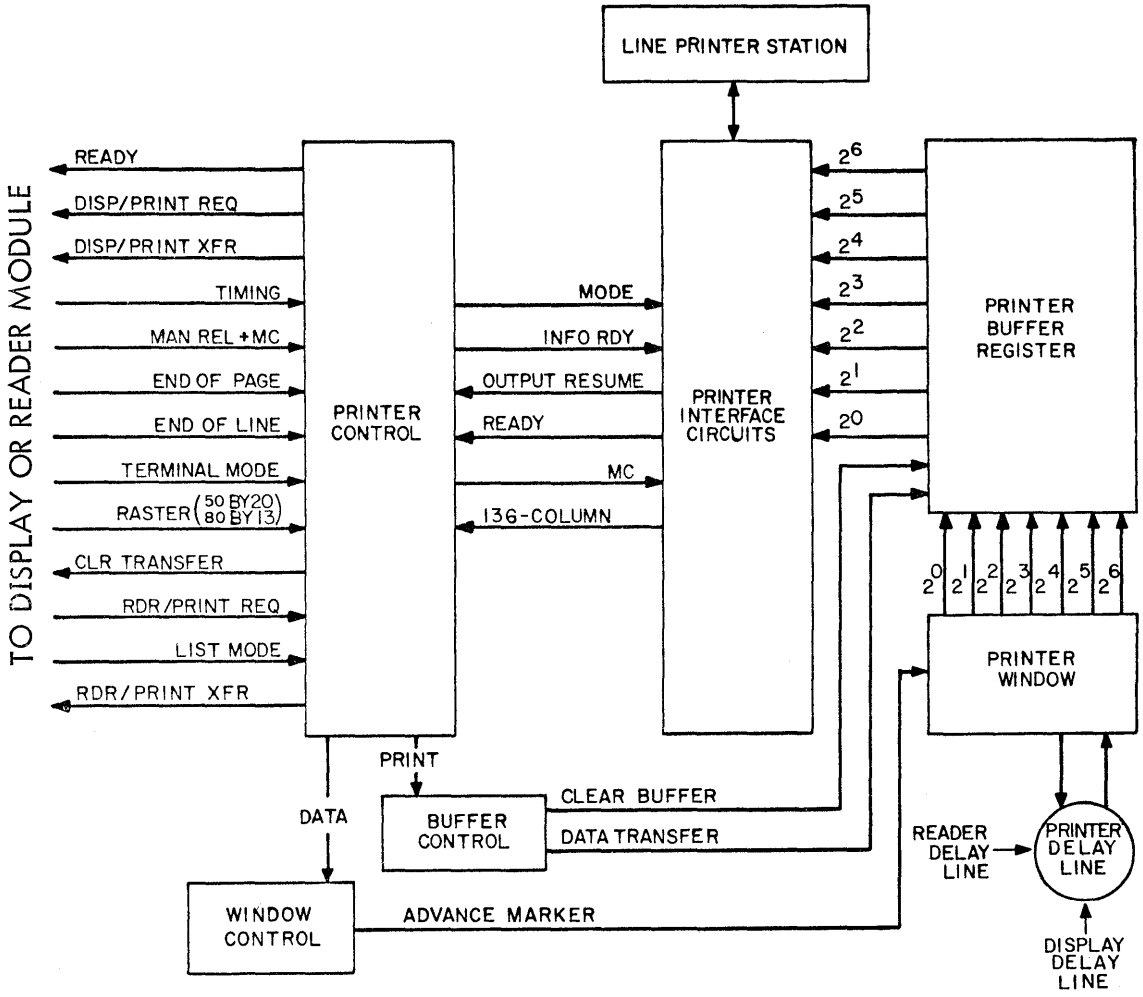
* 222-1 Line Printer Station
** 222-2 Line Printer Station



222
LINE PRINTER

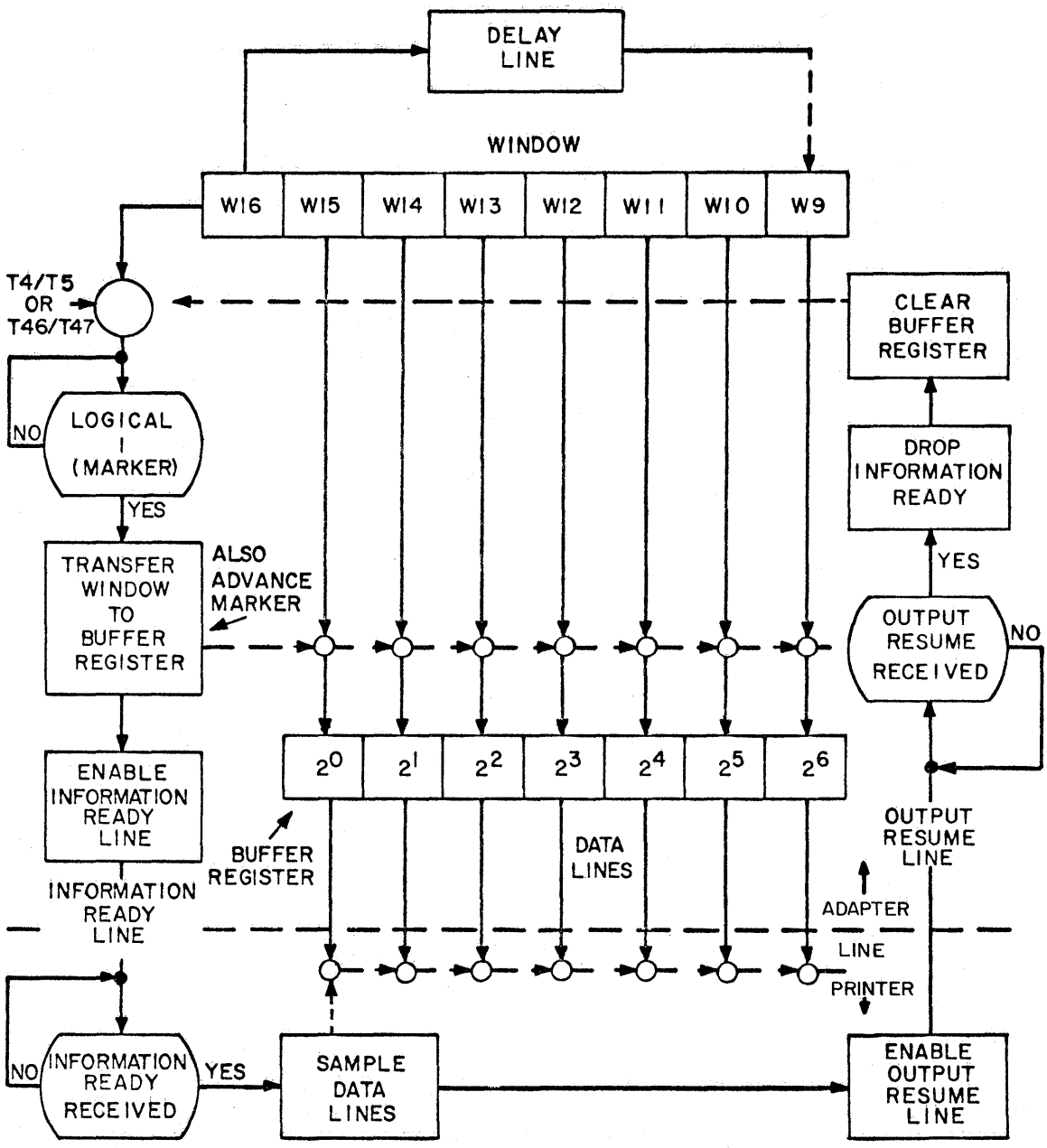
A memory-to-memory dump begins at a point synchronized with the beginning of page in the display module and ends when that point is regained (10 milliseconds later). This means that the entry marker in the adapter memory references a symbol position corresponding to the upper left corner position on the crt raster. When the marker is referenced in the last window position after transfer has been completed, the 7 bits immediately above are gated to a buffer register. At the same time, an Information Ready signal is sent to the line printer. This buffer register places the information on the seven Data lines. Upon receipt of Information Ready, the line printer samples the Data lines and returns an Output Resume signal. Output Resume clears the buffer register and Information Ready signal and another word is gated from the window when the marker is referenced again. The marker advances for each window/buffer register transfer.



Line Printer Adapter Block Diagram

LINE TRUNCATION.

The line printer does not automatically truncate lines; it must be programmed to do so. Two codes — carriage return (101 octal) and end of line (100 octal) — perform this function. Both codes are transmitted to the line printer after transfer to the buffer register. However, in order to maintain compatibility with the display,



Normal Data Transfer Procedure

the carriage return code blocks further transfer operations between the window and buffer register until the beginning of the next display line is reached. During this period, the marker is continually advanced. The end of line code does not momentarily halt the operation, since it is of no significance to the display! In either case, the remaining portion of the print line following transmission of a truncation code is filled with blanks.

The print line is automatically truncated at the end of a display line if the message originates at the Display Station keyboard. In this case, an end of line code is hardware-inserted in the buffer register. Since compatibility with the crt image is of the essence, the marker in adapter kit memory advances through the display retrace period.

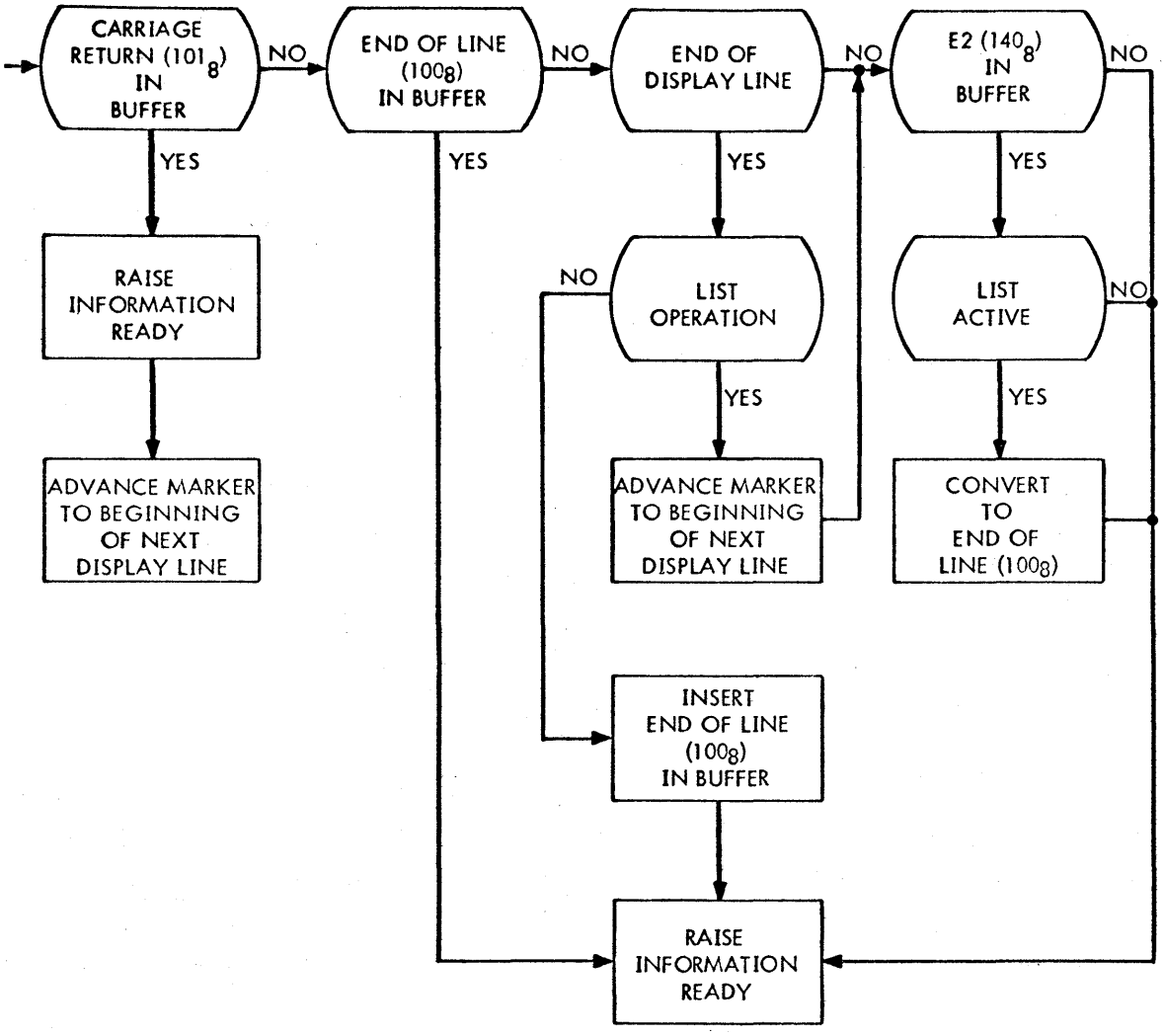
During a LIST operation, an end of line code (100 octal) follows each 80 columns of data from the reader adapter kit. Since, in an 80 by 13 display module, the end of a display line is reached at the same time the end of line code is inserted, the marker is advanced through display retrace and compatibility with display format is maintained. However, in a 50 by 20 display module, the end of a display line is reached before 80 card columns are printed. In this instance, 9 retrace symbol times are stored in memory and the marker advances through this period. When the beginning of the next display line is reached, printout begins again. However, since no end of line code was sent, the line printer resumes printout on the same leaving no blanks for the retrace period; Information Ready was not tagged. Then, when the end of line code is detected, a new print line begins.

FORMAT CONTROL.

A line printer operates in either of two modes; LOCAL (Display Station or reader-initiated printout) or TERMINAL (data source-controlled printout). A Terminal Mode signal is sent to the line printer when under data source control. As a result, vertical spacing must be programmed.

The first symbol of a print message and the first symbol following an end of line or carriage return code in TERMINAL mode is interpreted as a format control character. There is no format control in LOCAL mode since single spacing between lines is automatic. The four format control characters are:

CHARACTER	OCTAL CODE	FUNCTION
Blank	00	Single space (vertical)
0	12	Double space (vertical
1	01	Page eject — advance to top of next form.
+	60	Suppress space — maintain current line (do not space).



Line Truncation

Any character, other than those shown, are interpreted as blank characters unless preceded by an escape code, ie, the single-space operation is performed. In TERMINAL mode, all operations are performed before subsequent printout of data (preprint). If the format control character is preceded by an escape code, it is disregarded and the next character is examined. The format is established when a character not preceded by an escape code is found.

PRINTOUT TERMINATION.

The print operation may be terminated in a variety of ways. First, a master clear or manual release condition returns the entire adapter to the initial not busy state, and selection must take place again.

Printout normally ends when an E2 code (140 octal) is encountered in the buffer register. This code is transmitted but not printed. When the Output Resume response is received, the adapter is returned to the initial condition. If, due to malfunction, the E2 code is not discovered before the entry marker reaches a position corresponding to the end of the display page (lower right corner of the raster), the operation is terminated.

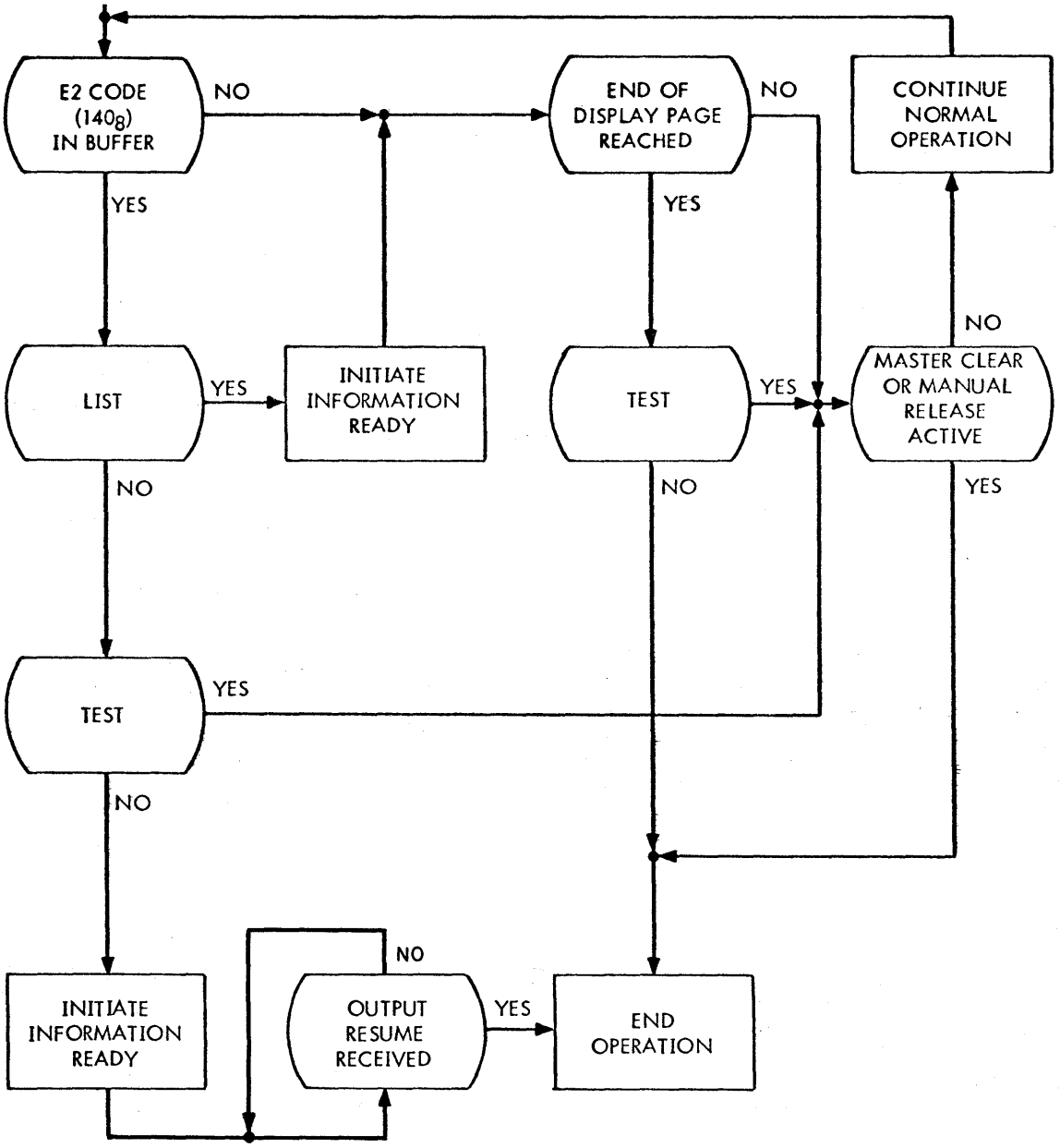
TEST MODE.

The LINE PRINTER TEST/MC switch on the logic chassis may be used to check operation of the printer. In the TEST position, this switch prevents an E2 code or end of display page position in memory from ending the operation. Consequently, any message stored in the adapter kit memory experiences a continual printout until the switch is returned to its normal position.

INTERRUPT.

The INT (interrupt) key on the Display Station keyboard may be used to interrupt a print sequence under data source control. In this instance, data in a write message ending with E2 is transferred from display buffer memory if the printer is ready. The INT key blocks formation of the one-word (E3) read message following transfer, and allows the operator to gain control of the terminal. However, if

transfer cannot be accomplished (printer not ready), an interrupt condition cannot be established and a one-word (E2) read response is issued on the next poll. The INT key has no effect in LIST mode or when the print message originates at the Display Station keyboard.



Printout Termination

PART E

CARD READER ADAPTER KIT

Equipment Numbers

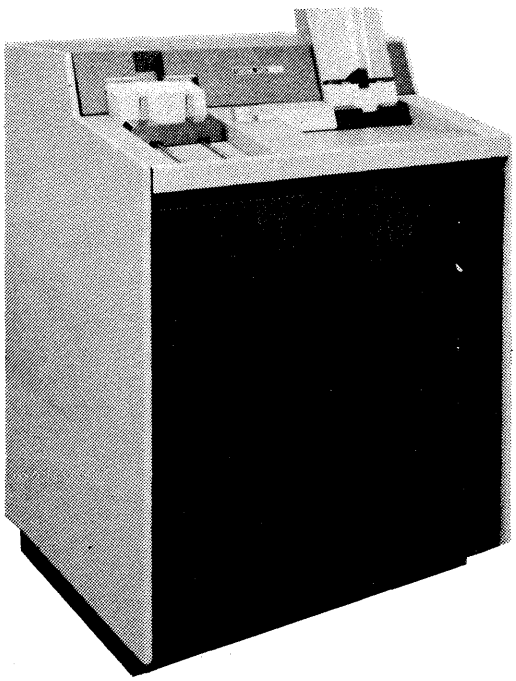
FE108-A
FE108-B
FE109-A
FE109-B

For use with the
224-2 Card Reader
Station, Equipment
Numbers:

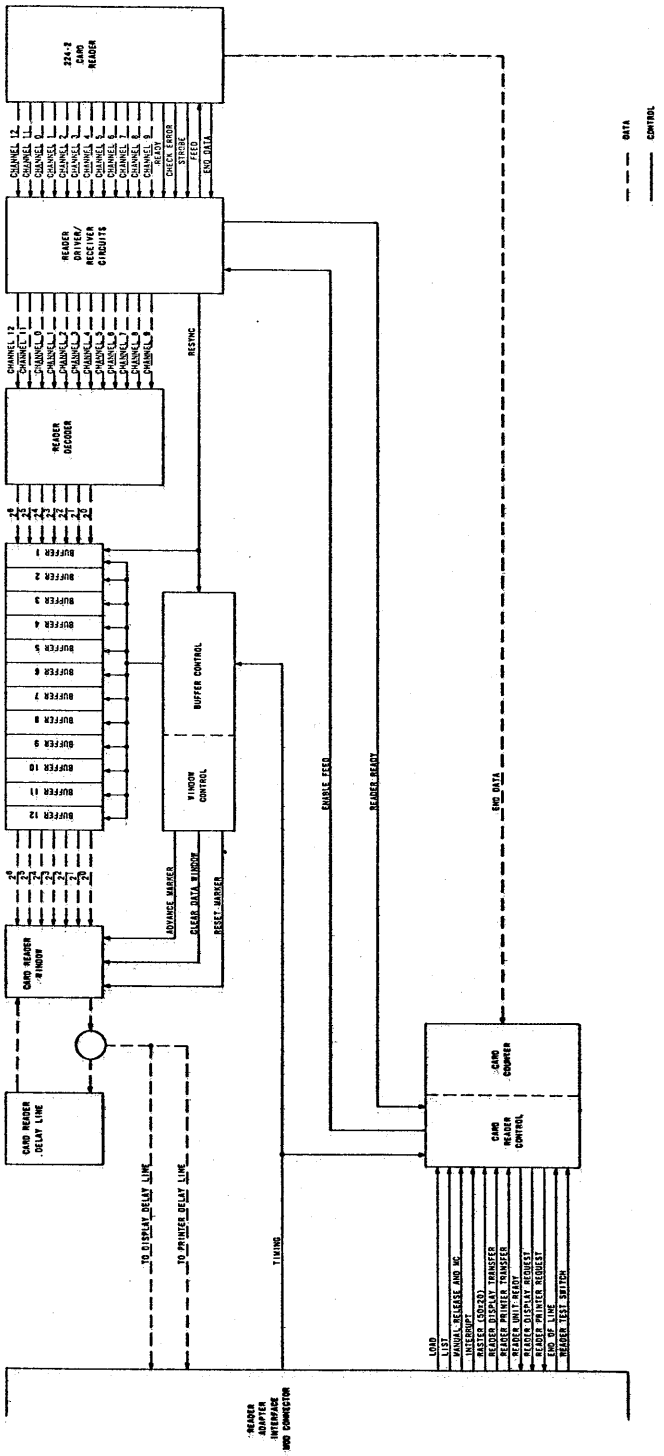
CE304-A
CE304-B

A 224-2 Card Reader Station becomes an integral member of the terminal if the proper adapter is used which adds a punched card data input to the present processing capabilities. For each of the four Equipment Controllers there is an assigned adapter kit. Equipment relationships are defined in the following list. Differences are explained in the Basic Configuration.

EQUIPMENT CONTROLLER	ADAPTER KIT	CARD READER STATION
FC710-A	FE108-A	CE304-A
FC710-B	FE108-B	CE304-B
FC711-A	FE109-A	CE304-A
FC711-B	FE109-B	CE304-B



224-2 Card Reader

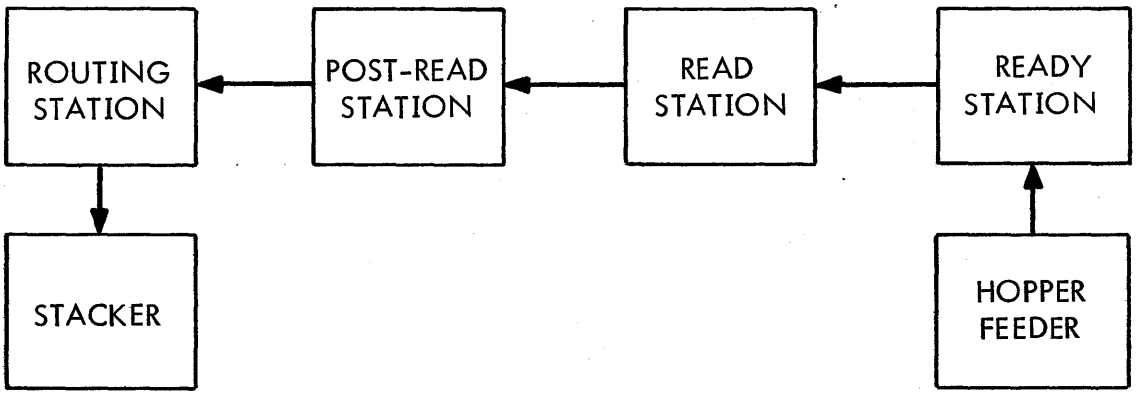


224-2 Card Reader Adapter Block Diagram

GENERAL OPERATION.

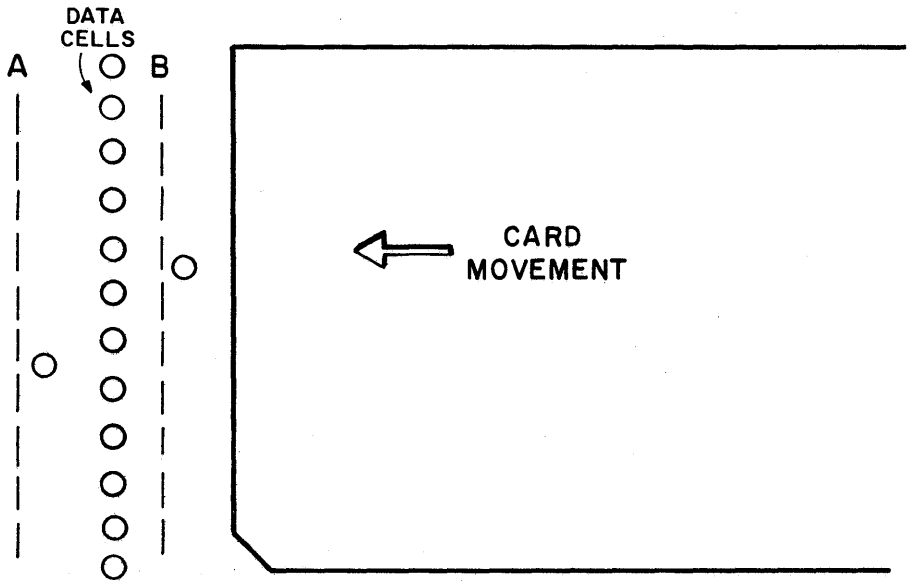
A 224-2 Card Reader may operate in either MAN (manual) or AUTO (automatic) mode. In the first instance, the entire stack of punched cards is read without passing information to the adapter kit. AUTO mode must be used to transfer punched card data to the controller for processing.

Photodiodes are used to guide card movement and scan the data channels. As a card leaves the hopper feeder, it enters a ready station covering a photodiode. Card movement stops at this point until a Feed signal is received from the adapter. The adapter issues a Feed signal in response to a Ready signal from the reader if the full complement (12) of cards have not already been stored. Ready and Feed will drop until the beginning of the next card cycle.



Card Reader Station Simplified Block Diagram

When the preceding card is moved to the post-read station, the card in the ready station moves to the read station. Here, a row of photodiodes is used to check the condition of each channel for every column. One photodiode is located immediately following the 12 data cells. As the card moves forward, the leading edge passes over this cell along with the data cells (position "A" in the following illustration). At this point, all data cells are covered and should indicate a dark condition. In any event, card movement continues and each column is read by the data cells.



Read Station Diagram

A Strobe signal is used to indicate when a column is over the data cells. As the card passes over these cells, the 12 Data lines indicate light conditions in each channel. A Strobe pulse accompanies each new column of data. In the next chart, four characters are used (A, B, C, and D) to illustrate the pulses on Data lines as well as the relationship to the Strobe signal.

After the last column has been read (80th Strobe pulse transmitted), the reader issues an End Data signal. This should occur when the trailing edge of the card reaches position B (see Read Station diagram). Then, at position "A", the trailing edge leaves all cells uncovered implementing a light check. The next stop is the post-read station where it is temporarily held until the preceding card can be ejected to the stacker. Once entered in the routing station, the card covers a photodiode. If it becomes jammed and cannot be ejected to the stacker, the card drive mechanism halts. In addition, a Check Error signal is issued. The same situation is created in the event of a jam in the feed portion of the cycle.

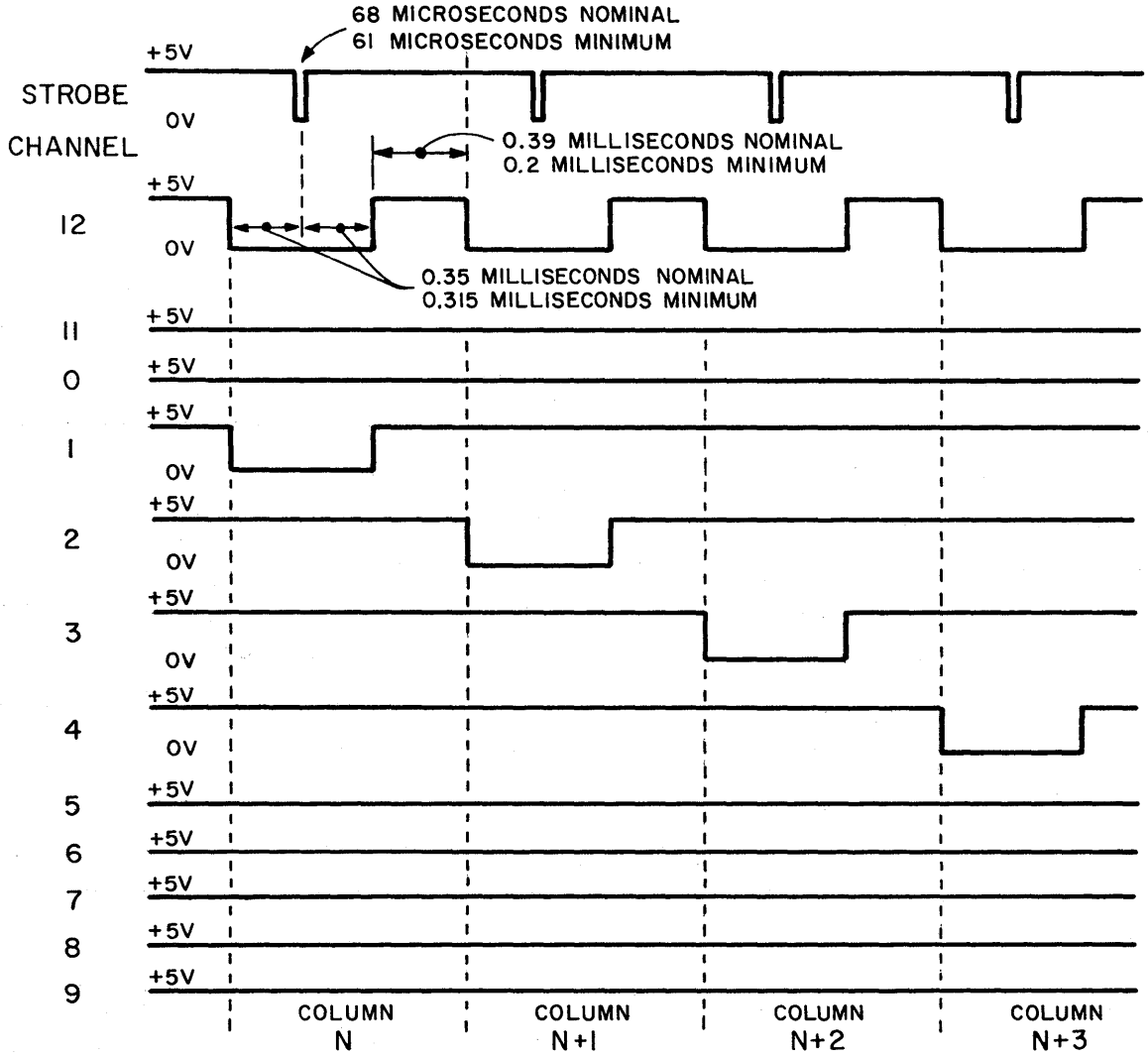
Assuming the card can be properly ejected to the stacker, certain other conditions can also halt card motion and flag the Check Error line. These conditions are:

(a) Stacker full.

(b) Hopper empty.

(c) Light or dark check error.

(d) Any routing error.



Data Transmission

DATA ENTRY.

The reader adapter temporarily stores data while a search is made for the entry marker in reader buffer memory. Maximum access time to memory is 10 milliseconds during which time 11 columns of data could possibly be received. Twelve buffer registers are used for temporary storage. Previous to entering buffer register 1, the punched card data is converted from Hollerith coding to a binary form compatible with the Equipment Controller repertoire.

Once the marker is found, data is transferred from buffer register 12 to the reader delay line window (reference reader adapter block diagram). From here, data is inserted in the delay line and continually recirculates through the window. The marker advances with each new entry. Transfer through the buffer chain and entry into the window is governed by a resync pulse which is a direct derivative of the Strobe pulse from the reader.

The marker is advanced in reader buffer memory through the end of line periods in the display module. During this marker advance period, no data may be stored. Consequently, in a 50 by 20 format, storage of consecutive columns will be interrupted by a 9-symbol position retrace period. In the 80 by 13 format, 10 retrace symbol positions precede the first column of the next card.

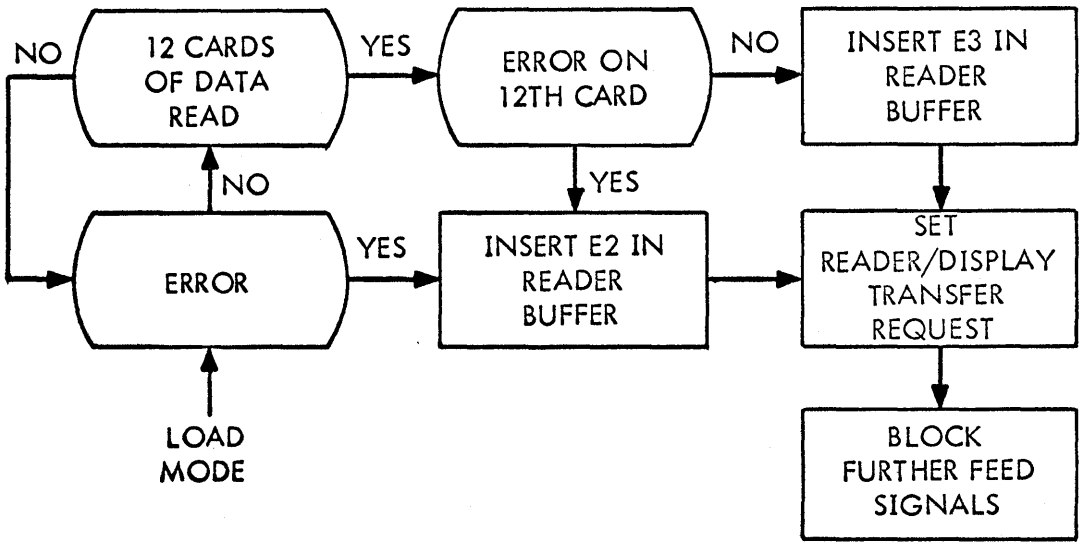
DATA TRANSFER.

A Check Error signal automatically terminates a card data message in memory by clearing buffer register 1 and creating a resync condition. When the octal code of 000 reaches buffer register 5, the upper 2 bits are toggled resulting in an E2 code (140 octal). This code is entered into memory from buffer register 12. Normally, a card counter terminates the message after the 12th card has been read by blocking further Feed signals and inserting E3 (141 octal) in LOAD mode or E2 in LIST mode. The card counter increments with each End Data signal received. When an "E" code enters the window, a transfer request is established.

LOAD.

When operating under data source control (LOAD key depressed), a write message ending with E3 must be received by the controller in order to transfer reader buffer memory contents to the display buffer memory once a transfer request is activated. After completing a memory-to-memory dump, the transfer request is dropped and the adapter kit responds to the next Ready signal with a Feed signal.

If an error condition was indicated for the data transferred (Check Error signal received), and not remedied, the next write message ending with E3 sets up a one-word read message (E2) in display buffer memory. This signifies that the reader is not ready.



LOAD Mode Message Termination

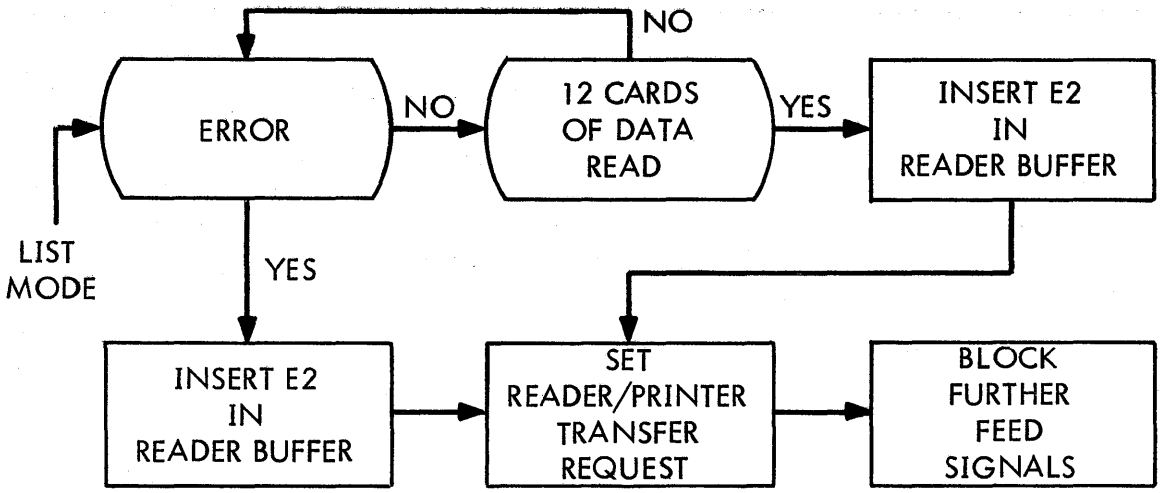
LIST.

A depressed LIST key enables transfer from reader buffer memory to printer buffer memory for local printout when the printer is ready. After the memory dump, transfer request is dropped and the reader resumes normal operation unless an error condition exists.

If a 136-column line printer is used for printout, the reader adapter inserts an end of line code (100 octal) into the buffer after each card has been read. Consequently, an 80-column format is established for printout. This is the only page format restriction established by the reader adapter.

INTERRUPT.

The INT (interrupt) key on the Display Station keyboard may be used to interrupt a card read sequence during a LOAD operation. In this instance, a



LIST Mode Message Termination

reader-to-display transfer is prevented and the keyboard is released allowing the operator to change a stack of cards and/or compose a message. During this interval the LOAD light remains illuminated and the switch may be depressed again if the card stack change is desired. The second depression clears all stored data from the previous read and resets the card counter to 0. INT has no effect on a LIST operation. If memory is not cleared in this manner, the first block of data transferred after the interrupt consists of stored information from the previous stack of cards.

TEST.

The READER TEST/MC switch enables display of card data in the TEST position. In this case, the card counter is cleared and prevented from incrementing. Cards are read in the normal fashion and entered in reader buffer memory and the switch maintains a constant reader-to-display transfer enable so data written into reader buffer memory is also entered in display buffer memory. By disabling the card counter, E3 message terminations are prevented. However, any error will terminate the message and operation with an E2 code.

SECTION VI

MAINTENANCE

Preventive and corrective maintenance procedures described in this section improve the usefulness and extend the service life of the Equipment Controller. Digital computer troubleshooting techniques apply for most troubles. This section should be used in conjunction with the Diagrams section (Book 2) and the Parts Data Book.

PREVENTIVE MAINTENANCE.

Preventive maintenance requires dusting of exteriors with a lint-free cloth, visual inspection, and vacuum cleaning. Vacuum the cabinet interior weekly with power removed.

On a monthly basis, visually inspect the cards and boards to determine that they are properly inserted. Check interconnecting cable ends for any indication of fraying if cables are subjected to abuse. Inspect the power supply and Equipment Controller components for leaky capacitors, wire damage, and corrosion.

TEST EQUIPMENT REQUIRED.

Maintenance of the controller requires the use of an oscilloscope with probes and a multimeter (not furnished) as listed:

Multimeter — Simpson 269 or equivalent
Oscilloscope — Tektronix Type 545A, or equivalent
X10 probes (two) — Tektronix or equivalent
X100 probes (two) — Tekfronix or equivalent
Board extender — 62 pin (Part No. 90000243)
Card extender — 15 pin (Part No. 51006005)

The oscilloscope should be dual-trace and external-triggering facilities, allowing comparison of two traces while using a third pulse for a trigger. Various

corrective maintenance functions require the use of the multimeter. The card and board extenders permit easy access to logical functions and mounted component leads.

CAUTION

Extreme care must be exercised if using multimeters near integrated circuits because the d-c voltages induced by some meters create an overvoltage situation.

CORRECTIVE MAINTENANCE.

Use the following aids to isolate a suspected faulty integrated circuit on a board:

- Overvoltage — denotes shorted integrated circuit
- Overcurrent — denotes open integrated circuit

All logic for the controller is arranged on 62-pin printed circuit boards. Each board contains a maximum of 12 easily accessible logic test points along with a ground test point. The test points are numbered consecutively starting from the top, with the last being ground. Pin numbering is also consecutive, from top to bottom. Even numbered pins are on the component side of the board, with odd numbers on the other. Components on a board are referenced within a 5 x 4 alpha-numeric matrix. Assembly drawings of all board types may be found in the Parts Data Book. Figure 6-1 illustrates one such drawing in an attempt to point out the features just described.

Adjustments discussed in the following paragraphs are for corrective maintenance. Normal adjustment of each maintenance control is made during initial installation of the equipment. These adjustments should not require resetting except when replacing a component, or if display deterioration has occurred. Adjustments required for the Display Station and other i/o devices are described in associated Hardware Reference/Customer Engineering Manuals.

Areas of corrective maintenance, other than logical circuit troubleshooting are adjustments of the video pulse, power supplies, ramp generators, delay lines, and automatic answering. Video pulse adjustment involves time duration settings.

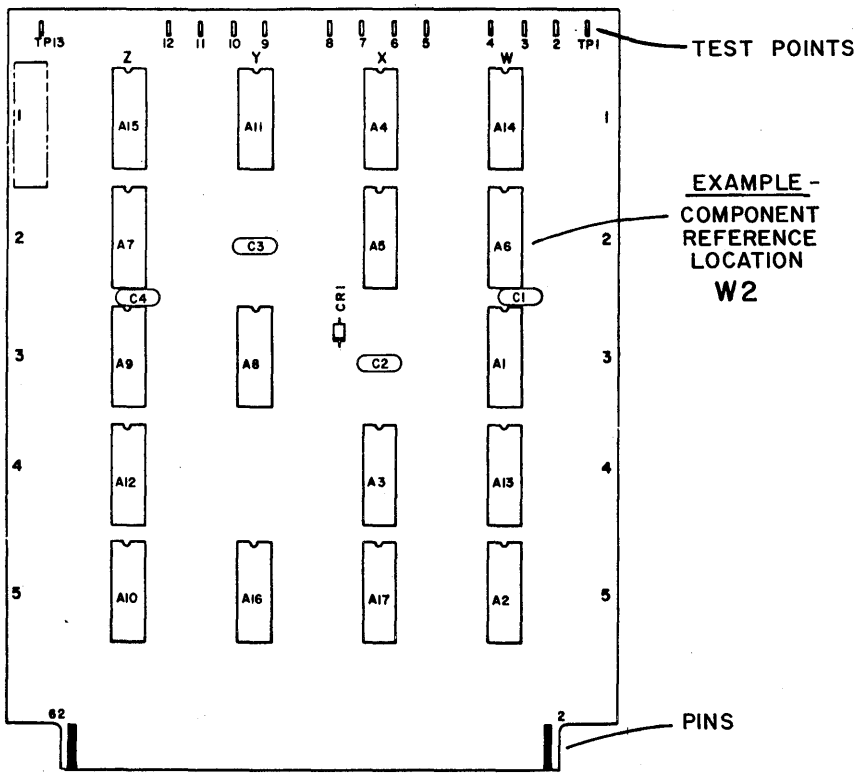


Figure 6-1. Typical Board Assembly

Power supplies are adjusted for logical circuit supply voltages. Delay-line outputs are synchronized with main timing. An oscilloscope is required to align the delay lines. A voltmeter is needed to adjust power supply output voltages. Logical circuit troubleshooting requires determining the area of malfunction and circuit tracing this area using the logical diagrams and an oscilloscope.

VIDEO PULSE ADJUSTMENTS.

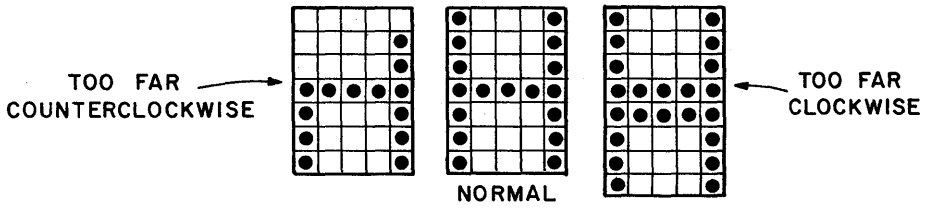
The Display Station uses 100-nanosecond video pulses for symbol formation. For proper video generation, there should be one video gating pulse for each 100-nanosecond video timing pulse for the symbols and marker chain. A circuit on the board in jack location A4 in the controller logic rack is used to provide pulse delay and shaping. Two potentiometers, R3 and R5, are used to adjust pulse delay and pulse width, respectively. R3 is the upper pot. on the board with R5 immediately below.

To adjust for proper symbol and marker unblank, the following procedure is recommended:

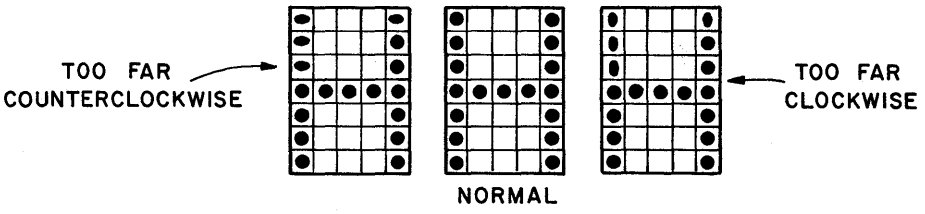
1. Display a full raster, using the entire symbol repertoire.

2. Turn the two pot's. all the way clockwise, to obtain maximum pulse width and delay.

3. Adjust the upper pot., counterclockwise, to decrease the video gating pulse delay until optimum video unblank is observed on the crt. If the pot. is turned too far in the counterclockwise direction, dots will begin to disappear. The result of misadjustment are shown below.



4. Adjust the lower pot., counterclockwise, to decrease the video gating pulse width — further optimizing the video unblank. Oblong-shaped dots appear when the pot. has been rotated too far counterclockwise. Results of misadjustment are shown next.



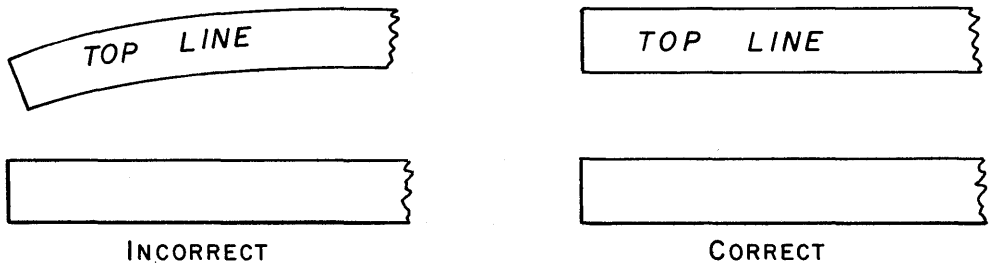
5. Further adjustments of the two pot's. may be necessary to obtain the optimum dot size for video unblank and to prevent extra or not enough dots from appearing on the raster.

RAMP GENERATOR ADJUSTMENTS.

The crt beam positioning is controlled by horizontal and vertical ramp generators in the Equipment Controller, as well as the deflection assembly on the crt. A pair of potentiometers on the board in jack location A8 in the controller govern the output of the ramp generators. The vertical ramp generator controls vertical positioning of the left side of the first line. To correctly adjust the ramp generators:

1. Adjust the intensity control on the Display Station until the raster is visible.

2. Adjust the upper pot. until the upper line is parallel to the next lower line.



Squaring of the raster is accomplished by the horizontal ramp generator. To correctly adjust this circuit:

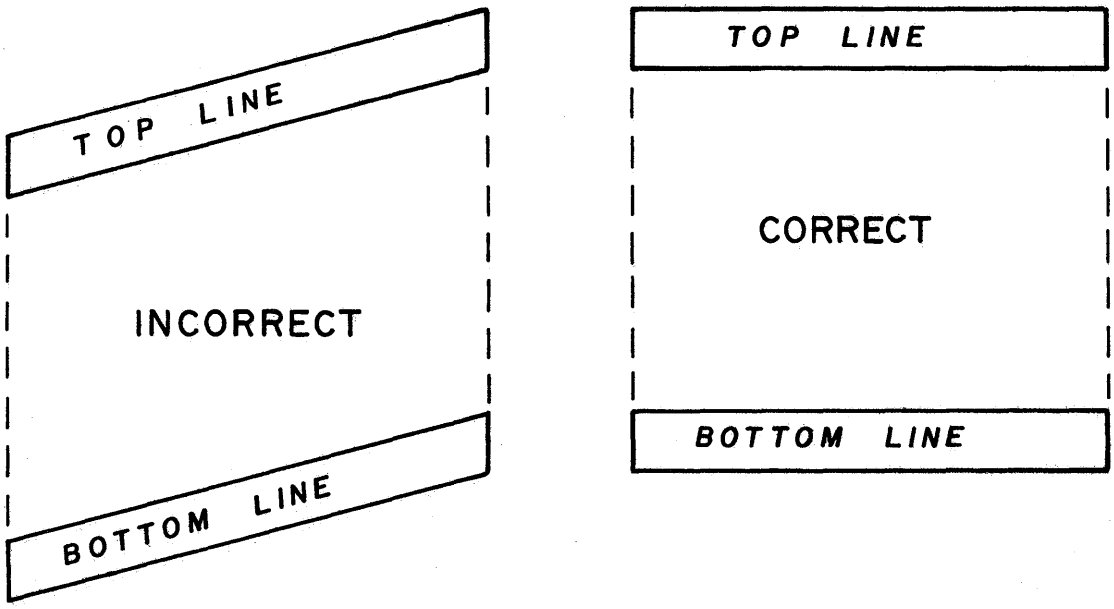
1. Turn the lower pot. clockwise until the raster is a parallelogram.

2. Rotate the pot. counterclockwise until the raster is just square.

For further adjustments regarding raster size and positioning relative to the facemask, consult the Display Station Hardware Reference/Customer Engineering Manual.

AUTOMATIC ANSWERING ADJUSTMENT.

Automatic answering permits communications between the Equipment Controller and the modem when the site is unattended. The automatic answering



adjustment governs the period of time in which these automatic communications may take place. A circuit on the board in jack location A13 is used to establish this time period.

1. Set AUTO ANSWERING to the ON position.

2. Remove the board in A13 and replace inserted in a 62-pin extender (be sure power is off when performing this step).

3. Monitor the Data Terminal Ready line (tp2 at B15). If it is at -6 volts, manually set K870/871 (see diagram 030) by momentarily placing a ground on the set input. Ground is available on the last tp on the board. Data Terminal Ready should then go to +6 volts.

4. Still monitoring Data Terminal Ready, attach a lead from pin 1 at A13 to tp6. This step puts +5 volts on the input to the delay circuit.

5. Now, note the time it takes from the initial application of the +5 volts to tp6 until Data Terminal Ready drops to -6 volts. The total elapsed time should be approximately 30 seconds. To increase the time, rotate the pot. (R4) clockwise, then go back to step 3 and check.

6. Once the delay period has been correctly adjusted, place the AUTO ANSWERING switch in the OFF position. Data Terminal Ready should register +6 volts and the setting and clearing of K870/871 should have no effect.

DELAY-LINE MEMORY ADJUSTMENT.

Data storage for display and buffering purposes is accomplished via magnetostrictive delay lines. Two passes of the display module delay line are required to complete one full scan of the display page. Since two passes are required, upper and lower-half display page data must be interlaced.

Basic machine timing establishes a symbol transfer interval (symbol time) of 16.8 microseconds. This means that the delay line must supply one symbol every symbol time. Each symbol time is divided into 16 equal divisions of 1.05 microseconds, allowing two 8-bit words to be stored during the same 16.8-microsecond interval. Data bits leaving the delay line shift into a 17-bit window every 1.05 microseconds. This action provides parallel assembly of the two interlaced 8-bit words. Access is provided to one word, in the window, between successive window shift pulses. Figure 6-2 shows the physical arrangement of the delay lines. The following procedure is recommended for proper adjustment.

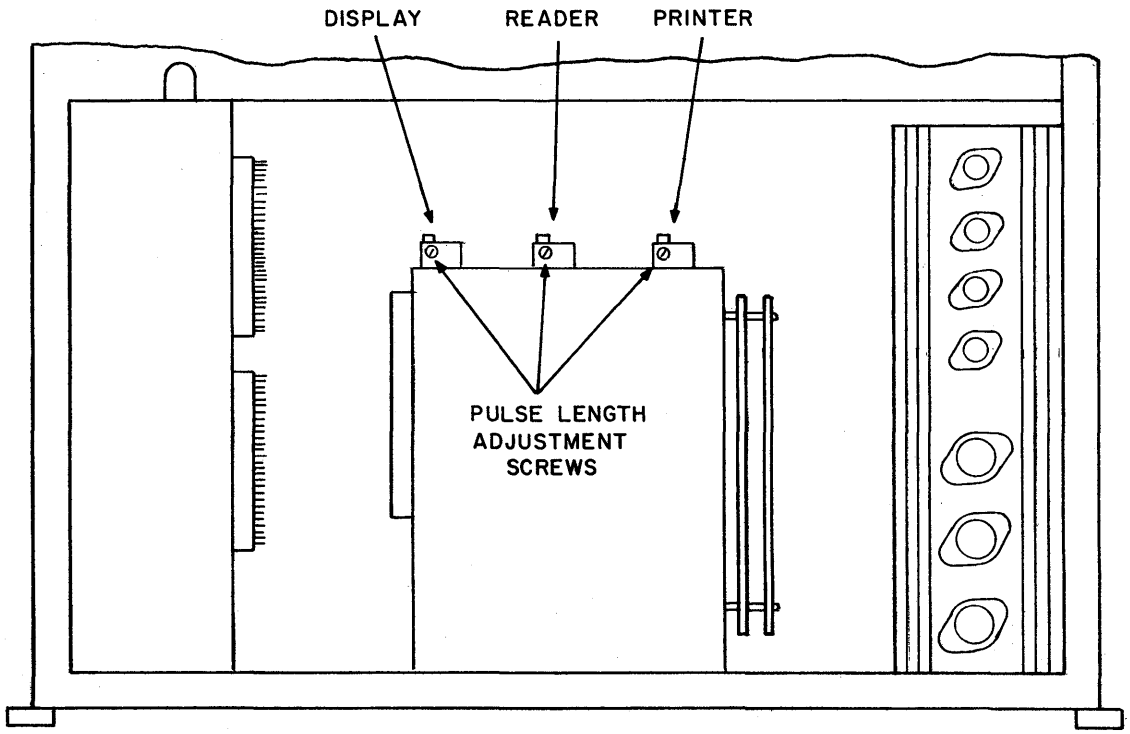


Figure 6-2. Delay Lines (Front Panel Removed)

1. Remove the front panel.

2. If the symbols will not remain on the display, repeatedly depress an alphanumeric key and adjust the pulse length screw until the symbol remains on the display.

3. Connect oscilloscope probe B to tp2 on the board in jack A1. This connection allows observation of the window shift pulses.

4. Connect oscilloscope probe A to tp2 on the board in jack A10. Delay-line pulses may be observed at this location.

5. Store a full raster of semi-colon (;) symbols, octal code 77, in memory.

6. Adjust the LENGTH screw until the delay line pulses (probe A) are positioned between successive window shift pulses (probe B) as shown in figure 6-3. This adjustment is necessary to allow for maximum amount of drift caused by temperature variations.

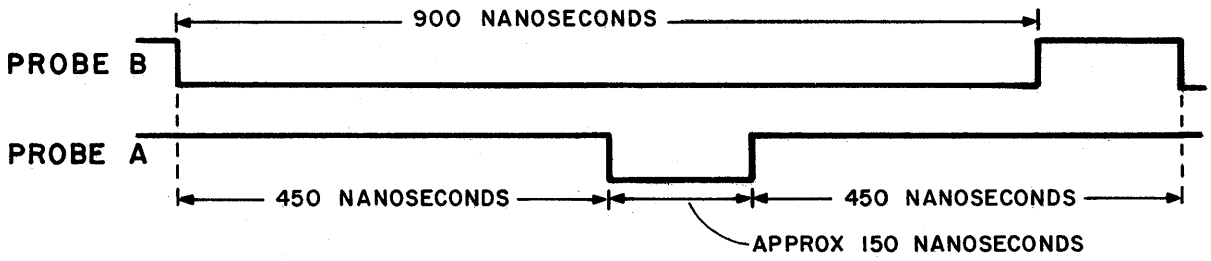


Figure 6-3. Delay-Line Adjustment Waveforms

All adapter kit delay lines may be adjusted by substituting them for the display module delay line and repeating the previous steps. The substitution procedure requires switching connectors. In order to perform this step, the cable clamps should be removed to allow enough movement of the connectors.

POWER SUPPLY ADJUSTMENTS.

The Equipment Controller uses a regulated power supply containing three, separate, plug-in cards. The supply is mounted on a swing-out, hinged door

permitting easy access to adjustments. Figure 6-4 shows the power supply adjustment potentiometers located on the cards. The 534 card plugs into jack A1, while the 525 and 535 cards plug into jacks A2 and A3, respectively.

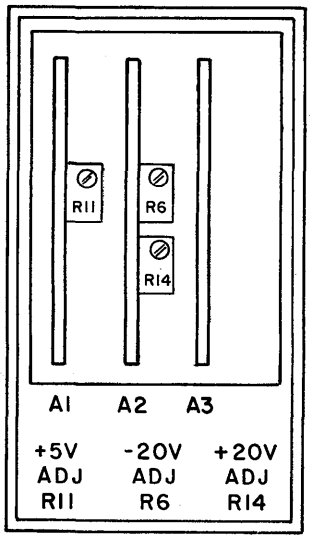


Figure 6-4. Power Supply Adjustments

Test points are on the swing-out door. Use these locations (see figure 6-5) for the following adjustments.

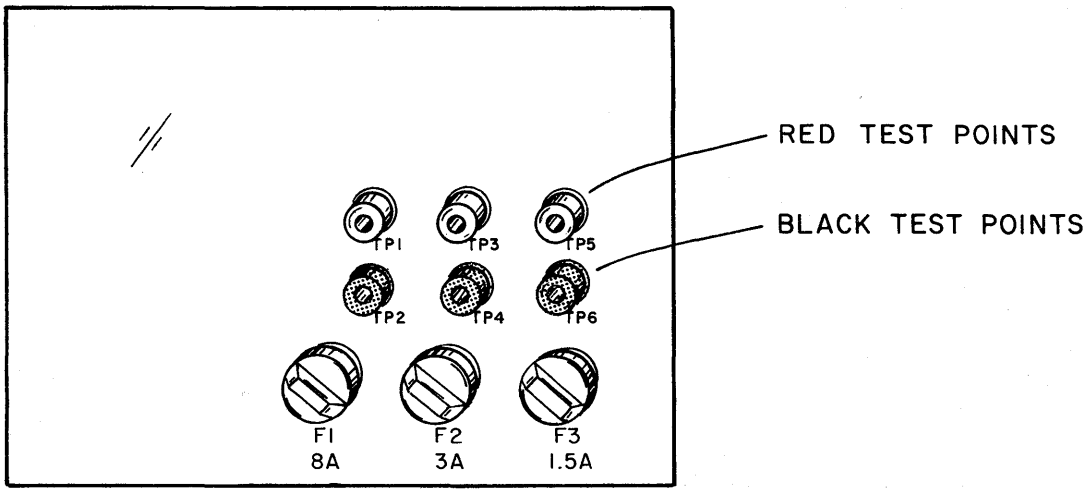


Figure 6-5. Power Supply Test Points

To adjust the +20-volt supply:

1. Connect the voltmeter negative lead to the black test point and the positive lead to the red test point above F3 (figure 6-5).

2. Adjust R14 (figure 6-4) for a reading of 20 volts.

To adjust the - 20-volt supply:

1. Connect the voltmeter negative lead to the black test point and the positive lead to the red test point above F2 (figure 6-5).

2. Adjust R6 (figure 6-4) for a reading of 20 volts.

To adjust the +5-volt supply:

1. Connect the voltmeter negative lead to the black test point and the positive lead to the red test point above F1 (figure 6-4).

POWER SUPPLY TROUBLESHOOTING.

The customer engineer should familiarize himself with the schematic and interconnection diagrams in Section V before attempting to troubleshoot this power supply.

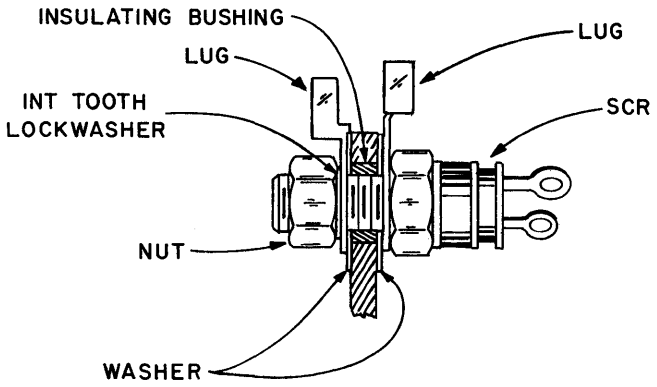
+5-Volt Supply.

If F1 continuously blows, the problem can be isolated to the 534 card in A1. The SCR (CR2, in this case) must be disconnected to disable the "crowbar" circuit and prevent the fuse from blowing.

1. Remove a-c power cord from outlet. Depressing the POWER ON switch does not completely remove power.

2. Disconnect power-out bus connector at J2 to prevent any possible damage to the logic boards.

3. Disconnect CR2 (immediately below F1) by removing the bottom nut.



4. Tape the two attached lugs together, after removing from the SCR. Make sure they do not short against the chassis or any terminals.

5. Position the SCR so that it will also not short against the chassis or any other terminal. It would be a good idea to reinsert the SCR in the mounting plate, using the mica washers and bushing for insulation.

6. Plug the AC power cord back into the outlet and turn power back on.

7. Using a 15-pin card extender, monitor pin 5 and tp1 of the 534 card in A1 with an oscilloscope.

8. Adjust R11 for +5 volts at tp1.

9. If tp1 will not hold at +5 volts, the problem is in the regulator portion of the 534 card. If +5-volt pulses appear at pin 5 even though tp1 registers 5 volts, the problem is with the overvoltage protection circuit on the card. In either case, the card should be replaced.

10. Assuming tp1 registers 5 volts and no pulses appear at pin 5, the problem can be isolated to the +5-volt circuitry not on the card.

+20-Volt Supply.

There is a problem in the +20-volt supply if F3 continuously blows. Step 1 through 6 for the +5-volt supply also apply here, with the exception that the SCR

is CR8 and there is only one lug attached. After disconnecting the crowbar circuit and turning power on:

1. Monitor pin 8 of the 535 card (A3), using a card extender, and tp3 on the 525 card (A2) with an oscilloscope.

2. Adjust R14 for 20 volts.

3. If tp3 will not hold at 20 volts the problem is on the 525 card, which should be replaced.

4. If tp3 will hold at 20 volts, but 5-volt pulses appear at pin 8, the problem is on the 535 card and it should be replaced.

5. Assuming tp3 registers 20 volts and no pulses appear at pin 8, the problem can be isolated to the +20-volt circuitry not on the cards.

-20-Volt Supply.

When F2 continuously blows, there is a problem in the -20-volt circuitry. The method used for disconnecting the crowbar circuit for the +5-volt supply (steps 1 through 6) also apply here. However, the SCR is CR6 and there is only 1 lug attached. After disconnecting the crowbar and returning power:

1. Monitor pin 1 of the 535 card (A3), using a card extender, and tp2 on the 525 card (A2) with an oscilloscope.

2. Adjust R6 for 20 volts.

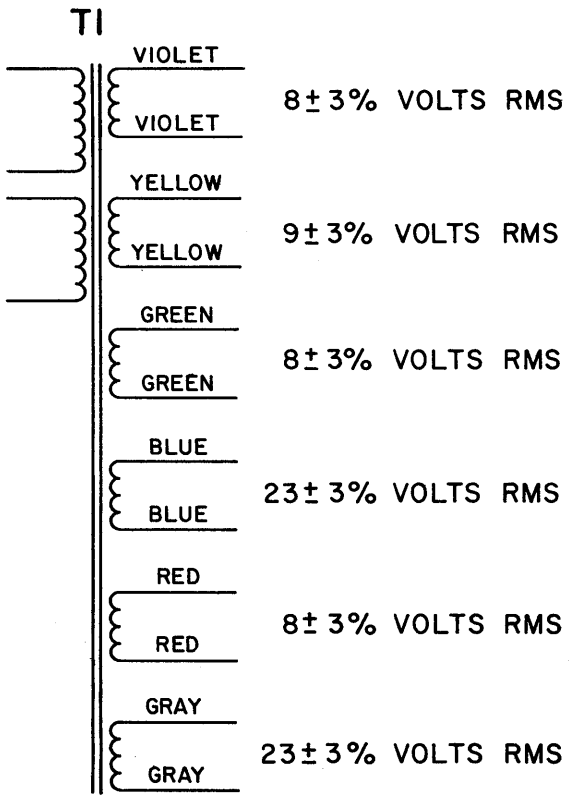
3. If tp2 will not hold at 20 volts the problem is on the 525 card, which should be replaced.

4. If tp2 will hold at 20 volts, but 5-volt pulses appear at pin 1, the problem is on the 535 card and it should be replaced.

5. Assuming tp2 registers 20 volts and no pulses appear at pin 1, the problem can be isolated to the -20-volt circuitry not on the card.

Transformer.

Secondary voltages might also be of some value when troubleshooting this power supply. The next illustration provides this information.



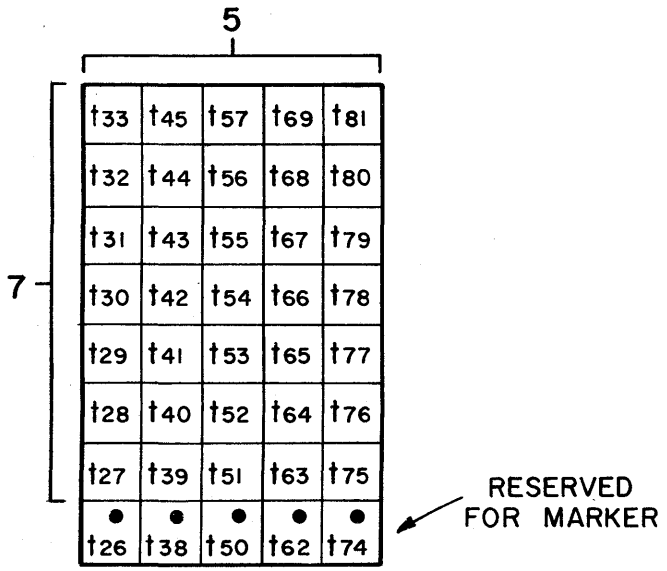
SECTION VII

MAINTENANCE AIDS

This section contains data necessary to support maintenance of the Equipment Controller. Section VI explains how to perform maintenance procedures.

SYMBOL TIMING AND FORMATION MATRIX.

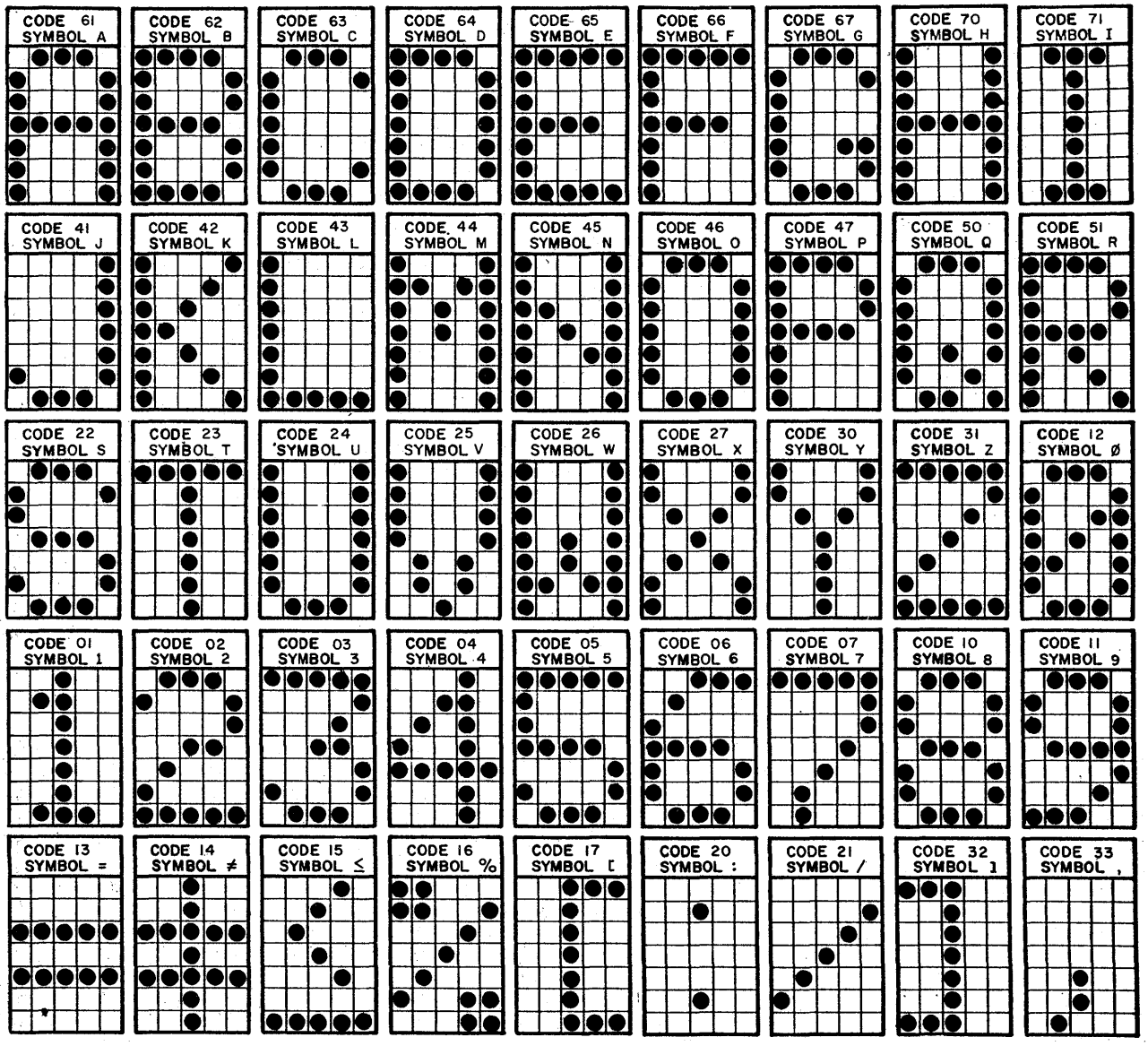
With the exception of the marker chain, symbols are formed by unblanking the electron beam within a 5 by 7 matrix. Each word in display memory is decoded when it is read out. This decoding results in selection of one string of diodes on the diode matrix board. Each diode allows one video pulse to be transmitted to the crt. The number and position of diodes determine the number and position of unblank pulses for each symbol. Hence, a string of diodes creates a video pulse train which results in the formation of a symbol. The next illustration shows timing for the 5 by 7 matrix formation of a symbol and the marker.

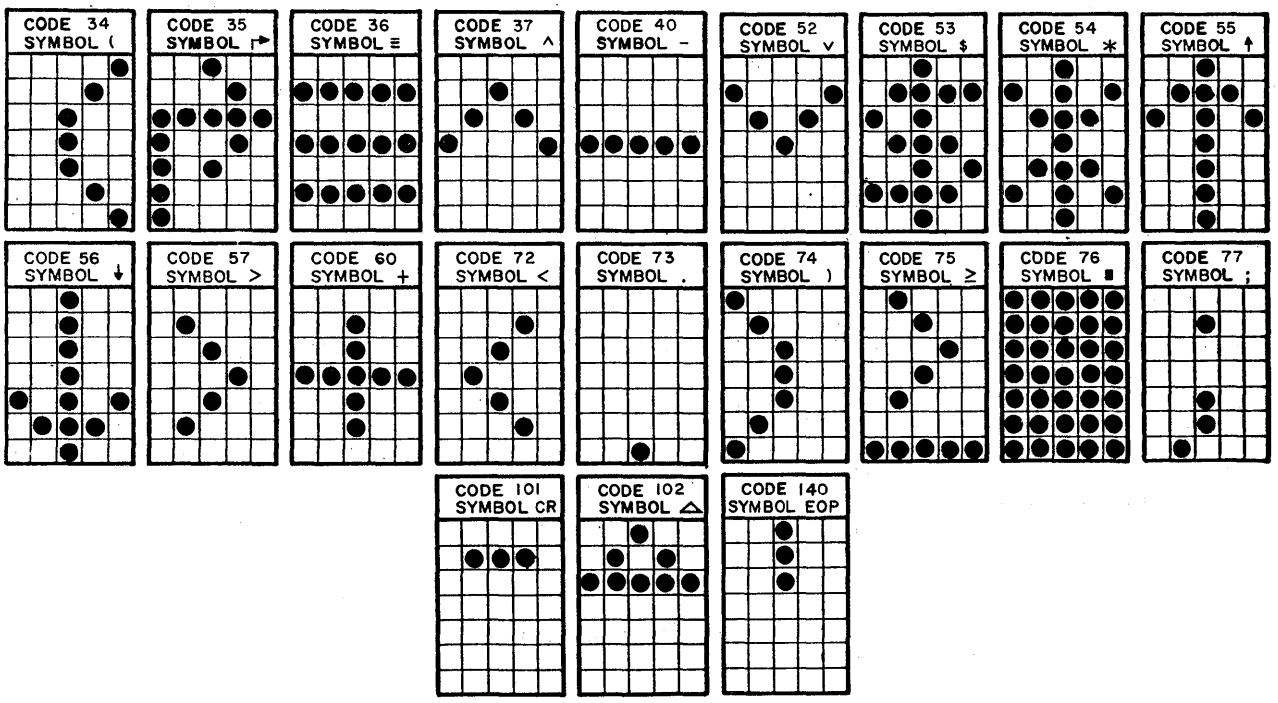


Symbol Formation Matrix

Actual symbol formation starts in the lower left corner of the matrix at t27 and ends in the upper right corner at t81. The entire symbol repertoire follows in dot matrix form. The codes are those stored in display memory.

SYMBOL REPERTOIRE

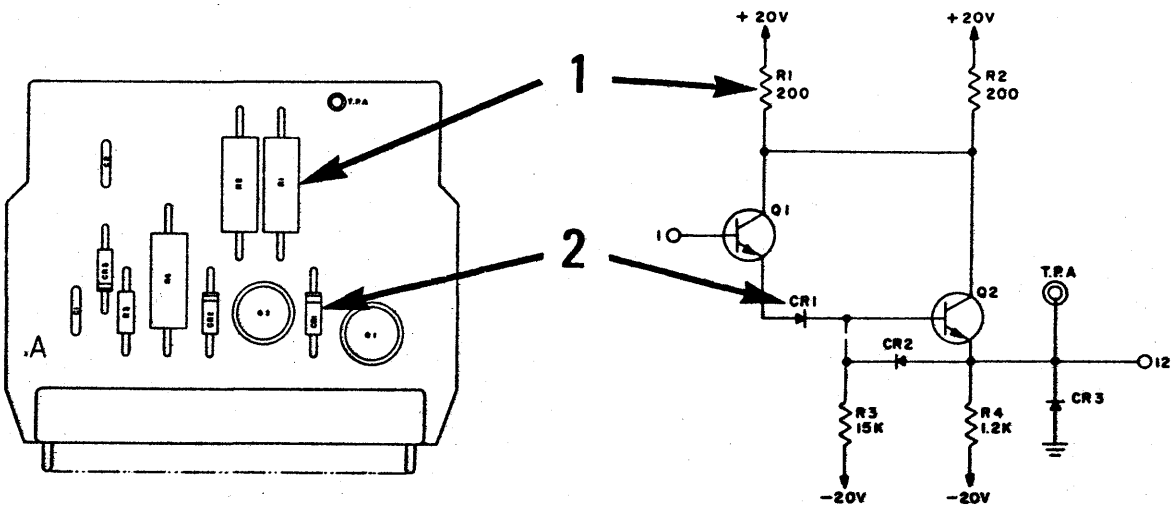




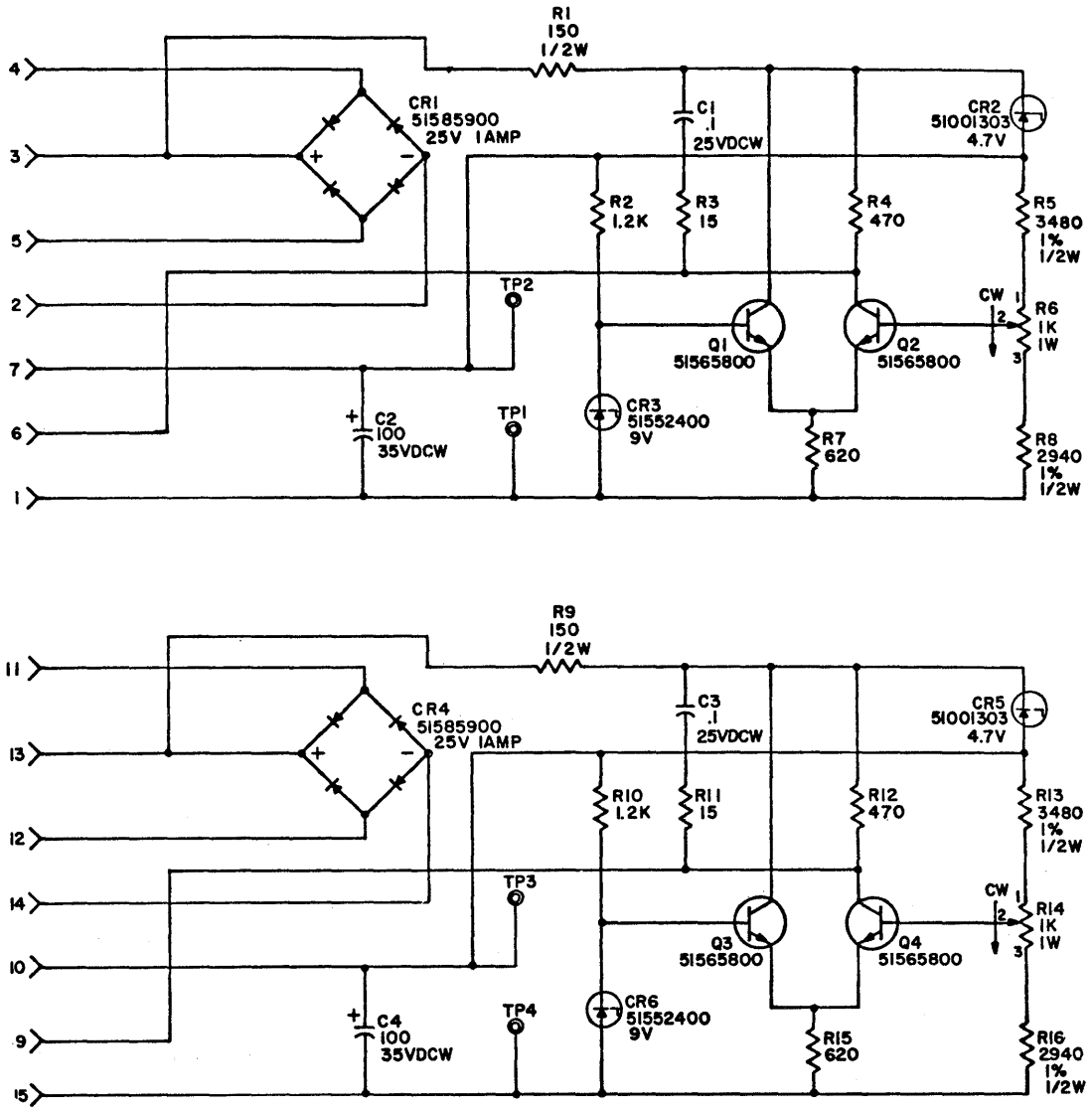
CARD SCHEMATIC DIAGRAMS AND ASSEMBLY DRAWINGS.

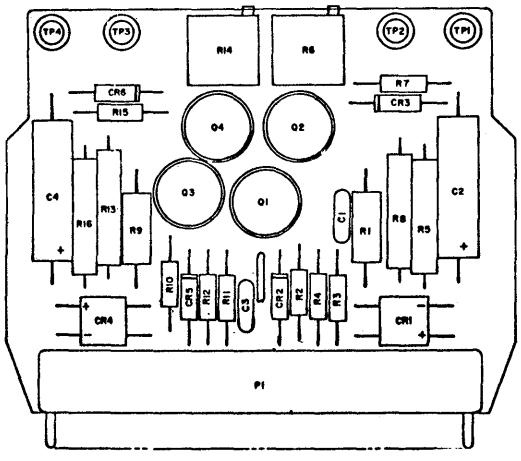
A schematic diagram and an assembly layout drawing appear on each card figure. The assembly layout drawing shows where each component is physically located on the card. Each drawing gives the part number of the card. Use this part number and the card type number when referring to parts data or when ordering a replacement card. These cards are used only in the power supply.

Following is a typical card schematic diagram and associated layout drawing. Item 1 points out resistor R1, both on the schematic diagram and assembly drawing. Item 2 points out diode CR1 in a similar manner.



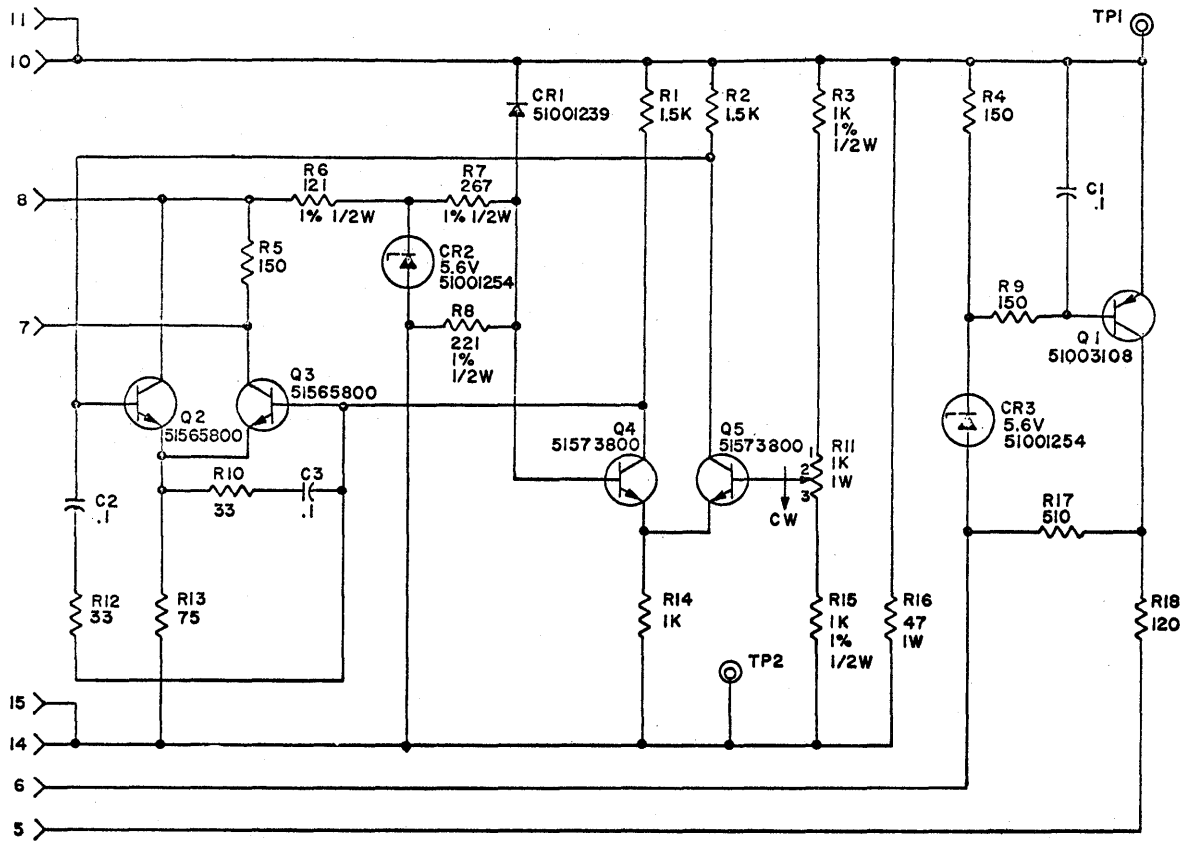
Card Identification

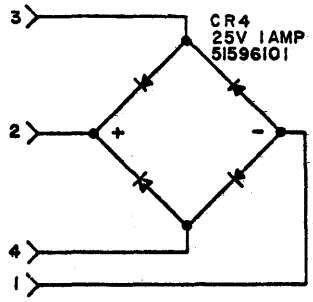


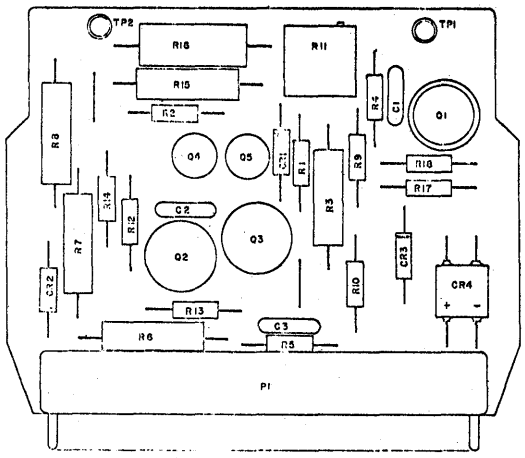


Regulator
Dual 20 Volts

REV. B/A
PART NO. 90001442
CARD TYPE **525**

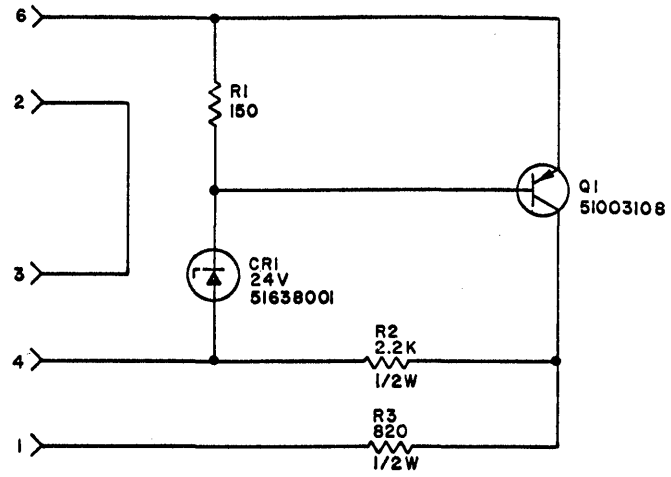


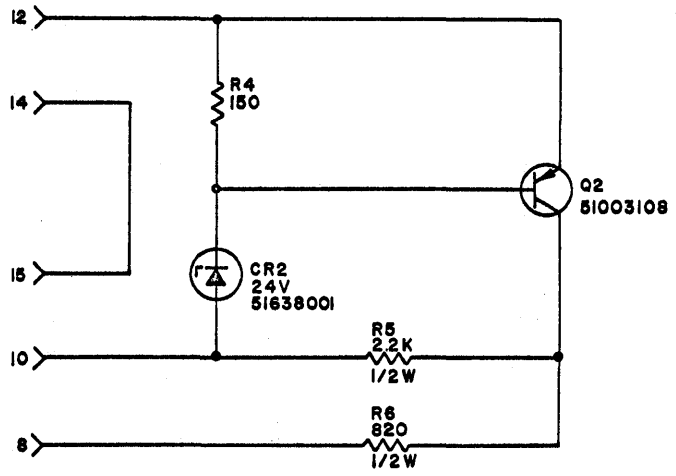


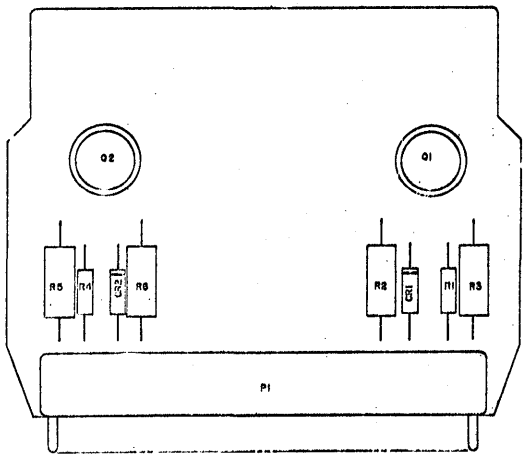


5-Volt Regulator with Overvoltage Protection

REV. -/-
PART NO. 90007569
CARD TYPE **534**







Dual 20-Volt Overvoltage Protection Sensor

REV. -/-
PART NO. 90007572
CARD TYPE **535**

>>> CUT OUT FOR USE AS LOOSE-LEAF BINDER TITLE TAB

CONTROL DATA
CORPORATION

8100 34th AVE. SO., MINNEAPOLIS, MINN. 55440

LITHO IN U.S.A.