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3277 Display Station Models 1 and 2 Troubleshooting Guide

SY27-2314-7

Preface

The IBM 3270 Information Display System consists of control units, display stations, printers, and optional feature devices. This guide contains all the information required to maintain IBM 3277 Display Stations and features such as Data Analysis - APL, keyboards, selector-light pen, magnetic card reader, security keylock, and audible alarm. The purpose of this guide is to present maintenance and repair information rather than theory of operation information.

This guide is organized in eight sections. Sections 1 and 2 contain introductory and maintenance background material. Sections 3, 4, and 5 contain the Symptom Index, Troubleshooting Diagrams, and repair data. These three sections contain all diagnostic procedures and repair information necessary to correct a display station malfunction. Miscellaneous reference data is included in Section 6. Section 7 contains location diagrams to aid in identifying and locating the display station components referenced in other sections of this guide. Instructions for installing the display station are presented in Section 8.

To successfully use this guide and repair IBM 3277 display stations, maintenance personnel should have a level of training equivalent to the 3270 system basic FE course. Because the 3277 attaches to both local and remote control units, an understanding of the control unit to which the display station is attached is also helpful.

The titles and form numbers of the two control unit Troubleshooting Guides are listed below under "Companion Manuals". Both Troubleshooting Guides contain a glossary of terms that are applicable to control units and display stations.

Companion Manuals:

- *3271 Control Unit Models 1 and 2 Troubleshooting Guide,* SY27-2311
- *3272 Control Unit Models 1 and 2 Troubleshooting Guide,* SY27-2312
- *3274 Control Unit, Maintenance Information,* SY27-2511
- *3275/3277 Display Station Models 1 and 2 Parts Catalog,* S126-0005
- *IDR-M ID Reader-Motorized Theory-Maintenance-Parts Catalog,* SY26-4188

The following publications may also prove useful:

- *An Introduction to the 3270 Information Display System,* GA27-2739
- *IBM 3270 Information Display System Component Description,* GA27-2749

Eighth Edition (July, 1978)

This is a major revision of, and obsoletes, SY27-2314-6 with Technical Newsletter SN31-0500. Information has been added to cover attachment to an IBM 3274 Control Unit, and new information has been added throughout the guide. Significant changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

Changes are periodically made to the information herein; any such changes will be reported in subsequent revisions or Technical Newsletters.

Text for this manual has been prepared with the IBM SELECTRIC ® Composer.

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Section 1.	**Maintenance Approach**	1-1
1.1	Introduction	1-1
1.1.1	Online/Offline Maintenance	1-1
1.1.2	Field Replaceable Units (FRU)	1-1
1.1.3	Troubleshooting Aids	1-1
1.2	Trouble Analysis	1-1
1.2.1	Obvious Symptoms	1-1
1.2.2	Isolation to a Display Station	1-1
1.2.3	Offline Symptoms	1-2
1.2.4	Formatted Buffer Symptoms	1-2
1.2.5	Customer-Reported Failures	1-2
Section 2.	**Tools and Diagnostic Programs**	2-1
2.1	Maintenance Tools	2-1
2.1.1	Customer Engineer Tool Kit	2-1
2.1.2	Oscilloscope	2-1
2.1.3	Logic Probes	2-1
2.1.3.1	Description	2-1
2.1.3.2	Probe Usage	2-1
2.1.3.3	Probe Checkout	2-1
2.1.3.4	Probe Repair	2-3
2.1.4	Alignment Mask	2-3
2.1.5	IDR FE Test Card	2-3
2.2	Diagnostic Programs	2-3
2.2.1	Test Patterns	2-3
2.2.2	Requesting RFT Patterns	2-12
2.2.2.1	Local Display Stations	2-12
2.2.2.2	Remote Display Stations	2-13
2.2.3	Online Tests (OLTs)	2-13
Section 3.	**Symptom Index**	3-1
3.1	Symptom Index Usage	3-1
3.2	Developing Symptoms	3-1
3.3	Intermittent Problems	3-2
Section 4.	**Troubleshooting Diagrams**	4-1
Section 5.	**Checks, Adjustments, and Removals**	5-1
5.1	Checks	5-1
5.1.1	Display Station Test Using Test Pattern 1	5-1
5.1.2	Display Station Operational Test (without Test Pattern 1)	5-2
5.1.3	Voltage Checks	5-3
5.1.3.1	Low-Voltage DC Checks	5-3
5.1.3.2	High-Voltage Check	5-4
5.1.3.3	Arc-Suppression Check	5-4
5.1.3.4	6.3V AC Check	5-4
5.1.3.5	High-Voltage Power Supply Check	5-5
5.1.4	Keyboard Checks	5-5
5.1.4.1	Voltages	5-5
5.1.4.2	Key Module and Encoding — Type A Keyboards Only	5-5
5.1.4.3	Output Codes	5-6
5.1.4.4	Shift Key Modules — Type A Keyboards Only	5-6
5.1.4.5	Spacebar Assembly Mechanical Checks	5-6
5.2	Adjustments	5-6
5.2.1	Display Image Adjustments	5-6
5.2.1.1	Brightness	5-7
5.2.1.2	Contrast	5-7
5.2.1.3	Focus	5-7
5.2.1.4	Yoke	5-7
5.2.1.5	Magnetic Centering Rings	5-7
5.2.1.6	Model 1 Analog Card Adjustments	5-7
5.2.1.7	Model 2 Analog Card Adjustments	5-8
5.2.2	-12V Regulator Card	5-8
5.2.3	OFF-PUSH Switch (Model 2 Only)	5-8
5.3	Removals	5-9
5.3.1	Covers	5-9
5.3.2	Power Components	5-10
5.3.2.1	Low-Voltage Power Supply Assembly	5-10
5.3.2.2	-12V Regulator Card	5-10
5.3.2.3	AC Capacitor	5-10
5.3.2.4	Model 1 Prime Power Box	5-10
5.3.2.5	Model 2 Prime Power Box	5-10
5.3.2.6	Model 1 Ferro Transformer (60-Hz)	5-10
5.3.2.7	Model 1 Ferro Transformer (50-Hz)	5-11
5.3.2.8	Model 2 Ferro Transformer (60-Hz)	5-11
5.3.2.9	Model 2 Ferro Transformer (50-Hz)	5-11
5.3.2.10	High-Voltage Power Supply	5-11
5.3.2.11	Fuses	5-11
5.3.2.12	Voltage Distribution Board (Model 2 Display Stations Only)	5-11
5.3.3	Analog Components	5-12
5.3.3.1	CRT	5-12
5.3.3.2	Yoke and Shields	5-13
5.3.3.3	Model 1 Analog Card	5-13
5.3.3.4	Model 2 Analog Card	5-13
5.3.3.5	Model 1 Brightness and Contrast Controls	5-13
5.3.3.6	Model 2 Brightness and Contrast Controls	5-14
5.3.3.7	Power Control Switch	5-14
5.3.4	Logic Components	5-14
5.3.4.1	Logic Card	5-14
5.3.4.2	Logic Board	5-14
5.3.5	Keyboard Components	5-14
5.3.5.1	Keyboard from Display Station	5-14
5.3.5.2	Keyboard Top Cover	5-14
5.3.5.3	Keyboard Assembly from Bottom Pan	5-14
5.3.5.4	Audible Feedback Assembly	5-14
5.3.5.5	Keybutton	5-15
5.3.5.6	Type A Switch Module	5-15
5.3.5.7	Type A Spacebar Assemblies	5-17
5.3.5.8	Keybutton Support Modules — Type A Keyboards Only	5-18
5.3.5.9	Type B Module	5-18
5.3.5.10	Type B Spacebar	5-20
5.3.5.11	Circuit Board and Electronics Assembly — Type B Keyboards Only	5-20
5.3.6	Audible Alarm (Optional Feature)	5-20
5.3.7	Security Keylock (Optional Feature)	5-20
5.3.8	Selector Light-Pen (Optional Feature)	5-21
5.3.9	Operator Identification Card Reader (Optional Feature)	5-21
5.4	Type B Keyboard Maintenance Aids	5-21
5.4.1	Cleaning	5-21
5.4.2	Liquid Spills	5-21
5.4.3	Key Modules	5-21
5.4.4	Contamination Shields	5-21

5.4.5 Protective Membrane/Shield 5-22
5.4.6 Ground Check 5-22
5.4.7 Ground Loop Isolation 5-22
5.4.8 Crooked or Loose Keytops 5-22

Section 6. Reference Data 6-1
6.1 Controls 6-1
6.1.1 External Controls 6-1
6.1.2 Internal Controls 6-2
6.2 Indicators 6-2
6.2.1 External Indicators 6-2
6.2.2 Internal Indicator (SWEEP INDIC) 6-3
6.2.3 Arc-Suppression Neon 6-3
6.3 Keyboards (Optional Feature) 6-3
6.3.1 Types of Keyboards 6-3
6.3.2 EBCDIC Keyboard Codes 6-3
6.4 ASCII Options 6-3
6.4.1 ASCII Character Generators (Optional Features) 6-3
6.4.2 ASCII Keyboards (Optional Features) 6-4
6.5 APL Options 6-4
6.5.1 Line Buffer and Character Generator Card 6-4
6.5.2 APL Keyboard 6-4
6.5.3 Text Keyboard 6-5
6.6 Reference Diagrams 6-5

Section 8. Installation Instructions 8-1
8.1 General 8-1
8.2 Installation 8-1
8.2.1 Line Voltage Check 8-1
8.2.2 Feature Installation 8-1
8.2.3 Prepower-On Checks 8-2
8.2.4 Power-On Checks 8-2
8.2.5 Hexadecimal Address Label 8-2

Appendix A. Offline Selector Light Pen Test A-1

Index X-1

Diagrams

1-1 3277 Maintenance Approach 1-2
2-1 Logic Probes 2-2
2-2 Alignment Mask, Model 1 2-3
2-3 Alignment Mask, Model 2 2-4
2-4 Test Pattern 1 (USA EBCDIC) 2-5
2-5 Test Pattern 2 2-7
2-6 Test Pattern 3 2-8
2-7 Test Pattern 5 (USA EBCDIC) 2-9
2-8 APL Keyboard Test Pattern 2-11
2-9 Character Differences for ASCII and WTC Languages 2-12
2-10 Test Pattern ID Numbers 2-12
3-1 Test Pattern 1, Model 1 3-8
3-2 Test Pattern 1, Model 2 3-8
3-3 Test Pattern 2 3-8
3-4 Test Pattern 3 3-8
3-5 Yoke Back Too Far on CRT Neck 3-8
3-6 Yoke Tilted 3-8
3-7 Centering Rings Not Adjusted Properly 3-9
3-8 Character Height Too Small 3-9
3-9 Glow Only on CRT 3-9
3-10 Single Horizontal Line on CRT 3-9
3-11 Model 1 Raster 3-9
3-12 Model 2 Raster 3-9
3-13 Cursor in Every Row 3-10
3-14 Box in Every Character Position 3-10
3-15 No Horizontal Sync 3-10
3-16 No Interrow Spacing 3-10
3-17 Correct Display after POR 3-10
3-18 Out of Focus Image 3-10
3-19 Yoke Horizontal Return Line Open 3-11
3-20 Open in Yoke Horizontal Winding 3-11
3-21 1/2 Vertical Yoke Open 3-11
3-22 Horizontal Yoke Open 3-11
3-23 Vertical Yoke Open 3-11
4-1 Display Station Troubleshooting Diagrams (29 Sheets) 4-3
5-1 OFF-PUSH Switch Adjustment 5-9
5-2 Switch Module Removal (Type A) 5-15
5-3 Unsoldering Lead Frame Terminals (Type A) . . 5-15
5-4 Lead Frame Removal (Type A) 5-16
5-5 Switch Plunger Return Spring Positioning (Type A) 5-16
5-6 Switch Module Orientation (Type A) 5-16
5-7 Torsion Bar Removal (Type A) 5-17
5-8 Spacebar Guide Module Removal (Type A) . . . 5-17
5-9 Screw Loosening (Type B) 5-18
5-10 Keyboard Assembly Separation (Type B) 5-18
5-11 Module Removal (Type B) 5-19
5-12 Circuit Board and Electronics Assembly (Type B) 5-19
5-13 Base Plate Ground Studs (Type B) 5-19
5-14 Spacebar Pivot Removal (Type B) 5-20
6-1 External Controls and Indicators 6-1
6-2 Typewriter Keyboard 6-6
6-3 APL Keyboard — US 6-6
6-4 Operator Console Keyboard 6-7
6-5 Data Entry Keyboards 6-7
6-6 Text Feature Keyboard 6-8
6-7 USA EBCDIC Keyboard Codes (2 Sheets) 6-9
6-8 APL Modified EBCDIC Keyboard Codes (2 Sheets) 6-11
6-9 Text Keyboard Codes (EBCDIC) (2 Sheets) . . . 6-13
6-10 3277 APL Keyboard Codes with APL Turned OFF 6-15
6-11 3277 APL Keyboard Codes with APL Turned ON (2 Sheets) 6-16
6-12 3277 APL Keyboard Codes with — US EBCDIC 6-18
6-13 Text Feature Keyboard Code — US EBCDIC (2 Sheets) 6-20
6-14 WTC Language Keyboard Codes 6-22
6-15 ASCII and WTC Language Keyboard Codes . . . 6-22
6-16 Logic Card Data (2 Sheets) 6-23

6-17 Probe Pin Data 6-25
6-18 Keyboard Feature Jumpers 6-26
6-19 Type A Keyboard Encoding 6-26
6-20 Board Layout by Card Function — Without Features (Card Side View) 6-27
6-21 Board Layout by Card Function — With Features (Card Side View) 6-28
6-22 Board Layout Pin Identification Data (Pin Side View) 6-29
6-23 Data Flow (foldout; at back of manual) FO-1
7-1 Model 1 Locations, Front View 7-1
7-2 Model 1 Locations, Left-Side View 7-2
7-3 Model 1 Locations, Rear View 7-3
7-4 Model 2 Locations, Front View 7-4
7-5 Model 2 Locations, Right-Side View 7-5
7-6 Model 2 Locations, Left-Side View 7-6
7-7 Type A Keyboard Locations 7-7
7-8 Type A Keyboard Pin Assembly and Terminal Location 7-8
7-9 Low-Voltage Printed Circuit Board 7-9
7-10 Low-Voltage Printed Circuit Board Shield 7-10
7-11 Model 2 Voltage Distribution Board 7-10
7-12 Model 1 Prime Power Box 7-11
7-13 Brightness and Contrast Control Terminals . . . 7-11
7-14 High-Voltage Power Supply 7-12
7-15 Model 1 Arc-Suppression Board 7-12
7-16 Analog Card (2 Sheets) 7-13
7-17 Type B Keyboard Locations 7-15
7-18 Type B Keyboard Assembly 7-16
7-19 Type B Keyboard Assembly Pin and Terminal Locations 7-17
7-20 Type B Keyboard Assembly Pin and Terminal Locations (3270 Data Analysis — APL Feature) 7-18
7-21 Type B Keyboard Assembly Pin and Terminal Locations (Text Feature) 7-19
8-1 50-Hz Ferro TB-1 8-1

Abbreviations

AID	attention identification
ALD	automated logic diagram
APL	A Programming Language
ASCII	American Standard Code for Information Interchange
CE	Customer Engineer
CK	check
CNCL	cancel
CPU	control processing unit
CRT	cathode-ray tube
CU	control unit
CW	control word
DEL	delete
DUP	duplicate
EBCDIC	extended binary-coded-decimal interchange code
EC	engineering change
EOF	end of field
FE	Field Engineering
Ferro	ferro-resonant transformer
FRU	field replaceable unit
GLP	General Logic Probe
HV	high voltage
IDR	identification reader
INS MODE	insert mode
I/O	input/output
KB	keyboard
LV	low voltage
MDT	modified data tag
NL	new line
OLT	online test
PA	program access
PC	printed circuit
PCBD	printed circuit board
PF	program function
POR	power on reset
PS	power supply
RFT	request for test
SLT	solid logic technology
SMS	standard modular system
SOR	start of record
TB	terminal board
TCU	transmission control unit
TEST REQ	test request
TP	test pattern, test point
VOM	volt-ohmmeter

Safety Notices

General:

DANGER: Safety glasses must be worn when working on the machine with power on and covers removed.

DANGER: High voltage can be present at the CRT when power is off.

The following DANGER notices are located in the applicable procedures:

DANGER
All persons handling a CRT or who are near an exposed CRT under vacuum must wear safety glasses and long-sleeved garments.

DANGER
This pin (P1-6 on the analog card) has 600V on it. No attempt should be made to measure this voltage.

DANGER
The 3277 Model 2 Display Station weighs about 90 pounds. Two men should be used to move this unit. Separate the upper chassis from the lower chassis before trying to move the Model 2 display station alone. (See paragraph 5.3.2.8, steps 1–7, to separate the two chassis.)

DANGER
All power component removal and replacement procedures must be performed with power turned off and with the power cord removed from the wall or from the input jack at the display station.

CE Safety Practices

All Customer Engineers are expected to take every safety precaution possible and observe the following safety practices while maintaining IBM equipment:

1. You should not work alone under hazardous conditions or around equipment with dangerous voltage. Always advise your manager if you MUST work alone.
2. Remove all power AC and DC when removing or assembling major components, working in immediate area of power supplies, performing mechanical inspection of power supplies and installing changes in machine circuitry.
3. Wall box power switch when turned off should be locked or tagged in off position. "Do not Operate" tags, form 229-1266, affixed when applicable. Pull power supply cord whenever possible.
4. When it is absolutely necessary to work on equipment having exposed operating mechanical parts or exposed live electrical circuitry anywhere in the machine, the following precautions must be followed:
   a. Another person familiar with power off controls must be in immediate vicinity.
   b. Rings, wrist watches, chains, bracelets, metal cuff links, shall not be worn.
   c. Only insulated pliers and screwdrivers shall be used.
   d. Keep one hand in pocket.
   e. When using test instruments be certain controls are set correctly and proper capacity, insulated probes are used.
   f. Avoid contacting ground potential (metal floor strips, machine frames, etc. – use suitable rubber mats purchased locally if necessary).
5. Safety Glasses must be worn when:
   a. Using a hammer to drive pins, riveting, staking, etc.
   b. Power hand drilling, reaming, grinding, etc.
   c. Using spring hooks, attaching springs.
   d. Soldering, wire cutting, removing steel bands.
   e. Parts cleaning, using solvents, sprays, cleaners, chemicals, etc.
   f. All other conditions that may be hazardous to your eyes. REMEMBER, THEY ARE YOUR EYES.
6. Special safety instructions such as handling Cathode Ray Tubes and extreme high voltages, must be followed as outlined in CEM's and Safety Section of the Maintenance Manuals.
7. Do not use solvents, chemicals, greases or oils that have not been approved by IBM.
8. Avoid using tools or test equipment that have not been approved by IBM.
9. Replace worn or broken tools and test equipment.
10. The maximum load to be lifted is that which in the opinion of you and management does not jeopardize your own health or well-being or that of other employees.
11. All safety devices such as guards, shields, signs, ground wires, etc. shall be restored after maintenance.
12. Each Customer Engineer is responsible to be certain that no action on his part renders product unsafe or exposes hazards to customer personnel.
13. Place removed machine covers in a safe out-of-the-way place where no one can trip over them.
14. All machine covers must be in place before machine is returned to customer.
15. Always place CE tool kit away from walk areas where no one can trip over it (i.e., under desk or table).
16. Avoid touching mechanical moving parts (i.e., when lubricating, checking for play, etc.).
17. When using stroboscope – do not touch ANYTHING – it may be moving.
18. Avoid wearing loose clothing that may be caught in machinery. Shirt sleeves must be left buttoned or rolled above the elbow.
19. Ties must be tucked in shirt or have a tie clasp (preferably nonconductive) approximately 3 inches from end. Tie chains are not recommended.
20. Before starting equipment, make certain fellow CE's and customer personnel are not in a hazardous position.
21. Maintain good housekeeping in area of machines while performing and after completing maintenance.

Artificial Respiration

General Considerations

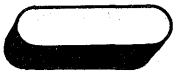
1. Start Immediately, Seconds Count
   Do not move victim unless absolutely necessary to remove from danger. Do not wait or look for help or stop to loosen clothing, warm the victim or apply stimulants.
2. Check Mouth for Obstructions
   Remove foreign objects – Pull tongue forward.
3. Loosen Clothing – Keep Warm
   Take care of these items after victim is breathing by himself or when help is available.
4. Remain in Position
   After victim revives, be ready to resume respiration if necessary.
5. Call a Doctor
   Have someone summon medical aid.
6. Don't Give Up
   Continue without interruption until victim is breathing without help or is certainly dead.

Rescue Breathing for Adults
Victim on His Back Immediately

1. Clear throat of water, food, or foreign matter.
2. Tilt head back to open air passage.
3. Lift jaw up to keep tongue out of air passage.
4. Pinch nostrils to prevent air leakage when you blow.
5. Blow until you see chest rise.
6. Remove your lips and allow lungs to empty.
7. Listen for snoring and gurglings, signs of throat obstruction.
8. Repeat mouth to mouth breathings 10-20 times a minute.
   Continue rescue breathing until he breathes for himself.

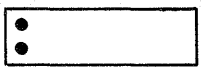
Reprint Courtesy Mine Safety Appliances Co.

LEGEND



Terminal

Indicates beginning point of a Troubleshooting Diagram.

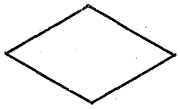


Action

Indicates a major action. When more than one action is described, bullet symbols appear to left of each action.

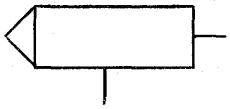
Annotation

Gives descriptive comment or explanatory note.



Decision

Indicates a point in a Troubleshooting Diagram where a branch to alternate data paths is possible.



Probe

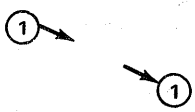
Indicates a point in a Troubleshooting Diagram where a logic pin should be probed with the logic probe. Pin is specified in the symbol. Path to be followed after probing is determined by probe result.

Card Change

Indicates that card or cards specified in symbol should be changed and new ones installed.

Off-Page Connector

Indicates connection point between different sheets of the Troubleshooting Diagrams.



On-Page Connector

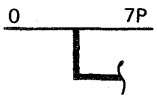
Indicates connection between two parts of the same sheet or diagram. Arrow leaving symbol points to correspondingly-numbered symbol (line-of-sight).

Major Data Path

Minor Data Path or Control Line

Data Bus

Number of lines on bus is identified in circle.



Data Transfer

Identifies data bits transferred to or from a logic element.

Screwdriver Adjustment

Switch

1.1 INTRODUCTION

Maintenance of IBM 3277 Display Stations (including repair and adjustment of Model 1 and Model 2 units) and of attached features is described in this guide. Features that can be attached to a 3277 include Data Analysis - APL (available on the 3277 Model 2 only), keyboards, a selector light-pen, and an operator identification card reader.

The objective of display station maintenance is to return the failing unit to customer service as quickly as possible. This guide leads the Customer Engineer through procedures that enable him to adjust or replace a malfunctioning component.

1.1.1 Online/Offline Maintenance

Display Station maintenance and testing can be performed online and/or offline. It is better, however, to service the unit offline when possible because it eliminates the possibility of interaction with other units of the display system. Unnecessary delays in normal customer information processing are thereby avoided. The maintenance approach described in this guide is structured to perform offline analysis first to resolve reported troubles.

1.1.2 Field Replaceable Units (FRU)

Component replacement is limited to certain field-replaceable units (FRU). When the trouble is isolated to an FRU the unit should be replaced immediately rather than repaired. The FRU parts replacement philosophy is practical because functionally packaged logic and densely packed components are used throughout the display station.

1.1.3 Troubleshooting Aids

Several tools are available to the Customer Engineer to simplify trouble analysis. The following paragraphs describe these aids.

1.1.3.1 Symptom Index

The Symptom Index (Section 3) lists (by category) malfunctions that may be encountered on display stations. The categories include such areas as display malfunctions, power malfunctions, keyboard malfunctions, etc. In each category, subcategories specify unique trouble areas. The subcategories direct the Customer Engineer to an entry in the Troubleshooting Diagrams (Section 4), which contain step-by-step isolation procedures. In some cases, the Symptom Index points directly to a replaceable unit causing the problem.

1.1.3.2 Troubleshooting Diagrams

The Customer Engineer is directed to Troubleshooting Diagrams from the Symptom Index. The diagrams detail procedures to isolate a failing FRU or an out-of-tolerance adjustment. The diagrams call out specific checks and observations that should be made during the diagnostic procedure. The logic probe test device is used in many of the diagrammed procedures.

1.1.3.3 Diagnostic Programs

Two types of diagnostic programs may be available to the Customer Engineer. Diagnostic program aids are described in Section 2 of this manual.

These diagnostic programs are not applicable to 3277 Display Stations attached to 3274 Control Units. Offline procedures for formatting the buffer for selector light-pen tests for these 3277's are contained in Appendix A.

1.1.3.4 Customer Engineer Tool Kit

Special tools are not required to maintain 3277 Display Stations. The basic Customer Engineer tool kit, the IBM volt-ohmmeter, and the logic probe can successfully isolate most display station problems. An oscilloscope may be required in some instances when the basic tools fail to resolve a problem.

1.2 TROUBLE ANALYSIS

The sequence in which display station trouble analysis is performed is important in minimizing machine down-time. Diagram 1-1 shows the five-step procedure that should be used to isolate display station failures. The main points of the display station maintenance approach are summarized below.

1.2.1 Obvious Symptoms

Obvious symptoms are those that do not require any operator or Customer Engineer action to become evident. Failures that could cause obvious symptoms to occur include display image quality and positioning, mechanical problems, and component breakage. These failures should be remedied by going directly to the Symptom Index or to the appropriate adjustment or removal procedure in Section 5. Use the *first* entry that matches the failure.

1.2.2 Isolation to a Display Station

If an obvious symptom does not exist on a display station, the cause of the failure must be isolated between the

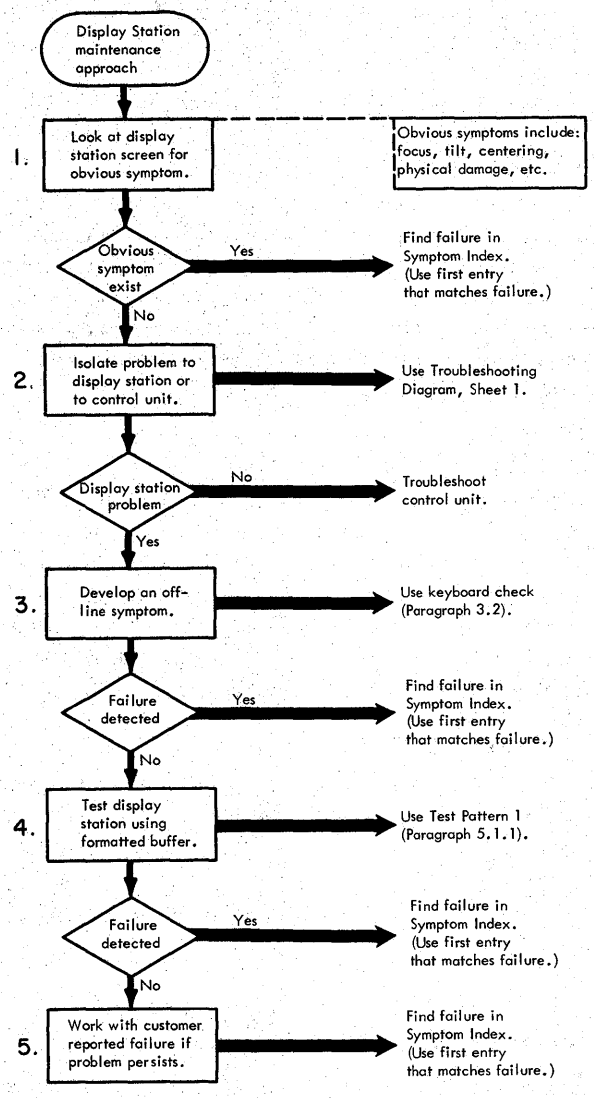


Diagram 1-1. 3277 Maintenance Approach

control unit and the display station. Sheet 1 of the Troubleshooting Diagrams describes the procedure for isolating the cause of a failure to either the control unit, connecting coaxial cable, or display station.

1.2.3 Offline Symptoms

Once it is determined that the display station is the cause of a failure, an offline symptom should be developed. A quick offline test of the display station is described in paragraph 3.2. That test should expose a repairable symptom. Stop the test as soon as a symptom becomes evident, and match the symptom with one listed in the Symptom Index. Use the *first* entry that matches the failure. The Symptom Index tells what corrective action should be taken.

1.2.4 Formatted Buffer Symptoms

If an offline symptom does not become evident, the entire display station, including features, must be tested with the buffer formatted. The procedure described in paragraph 5.1.1 should be used with Test Pattern 1 to develop a symptom. Stop the test as soon as a symptom becomes evident, and match it in the Symptom Index. Use the *first* entry that matches the failure. The Symptom Index tells what corrective action should be taken.

1.2.5 Customer-Reported Failures

It may be necessary to work with a customer-reported failure if a symptom cannot be developed offline or with Test Pattern 1 using the procedures described in the preceding paragraphs. Try to duplicate the conditions that existed when the customer failure occurred. Match the duplicated symptom in the Symptom Index and perform the corrective action indicated. Use the *first* entry that matches the failure. If the originally reported failure cannot be duplicated, it must be assumed that it was an operator error or an intermittent failure that has failed to reappear.

This section describes the tools and programmed diagnostic aids used to maintain 3277 Display Stations. A comprehensive description of the logic probe is included because proper use of this tool is essential to successful display station maintenance.

2.1 MAINTENANCE TOOLS

2.1.1 Customer Engineer Tool Kit

The Customer Engineer tool kit contains all basic tools necessary to maintain IBM 3277 Display Stations. The standard IBM volt-ohmmeter (VOM) is adequate for all voltage measurements. The meter's input impedance of 20,000 ohms per volt causes an erroneous reading when checking the 400V dc power supply. This effect is noted when a check of that power supply is called out.

Note: When using the VOM, all dc voltage measurements should be referenced to dc return rather than to frame ground. DC return and frame ground are at different levels when the display station is not connected to a control unit.

2.1.2 Oscilloscope

In some cases of trouble analysis, it may be necessary to use an oscilloscope. The Tektronix* model 453 oscilloscope, or equivalent, should be used when an oscilloscope is required. However, the logic probe is recommended for use, whenever possible, rather than an oscilloscope.

2.1.3 Logic Probes

Either of two styles of logic probes can be used to probe signal levels while using the Troubleshooting Diagrams or FE ALDs. The older-style probe (PN453652) is described completely in the following paragraphs and shown in Diagram 2-1A. The newer General Logic Probe (GLP) is shown in Diagram 2-1B. An available GLP Kit (PN 453212) includes the GLP, standard accessories, and the *General Logic Probe Manual,* SY27-0113. The manual describes the features of the GLP, the functions and limitations of each feature, and a checkout procedure. (That information is not duplicated here, so the user is referred to SY27-0113.)

A probe should be obtained from Mechanicsburg by all Customer Engineers who service 3270 units. Normal tool-ordering procedures should be used to obtain the probe.

*Trademark of Tektronix, Inc.

2.1.3.1 Description

The logic probe (Diagram 2-1A) is a self-contained device consisting of an anodized aluminum tube with a red and green indicator incorporated near the probe end. A cable containing two wires and SLT-type push-on terminals leads from the sealed top end of the probe. A plastic head with a threaded stud is at the probe end of the device. Red and green indicators tell the state of the net being probed. The three signal states that can be distinguished are: (1) a solid plus level, (2) a solid minus level, and (3) a pulse or the presence of pulses. The two wires with the SLT-type push-on connectors are attached to pins on the back of the logic board being probed. They carry the operating voltage (+5V dc and ground) for the probe. An oscilloscope probe tip screws on the threaded stud at the tip of the probe. This carries the input signals to the indicators.

2.1.3.2 Probe Usage

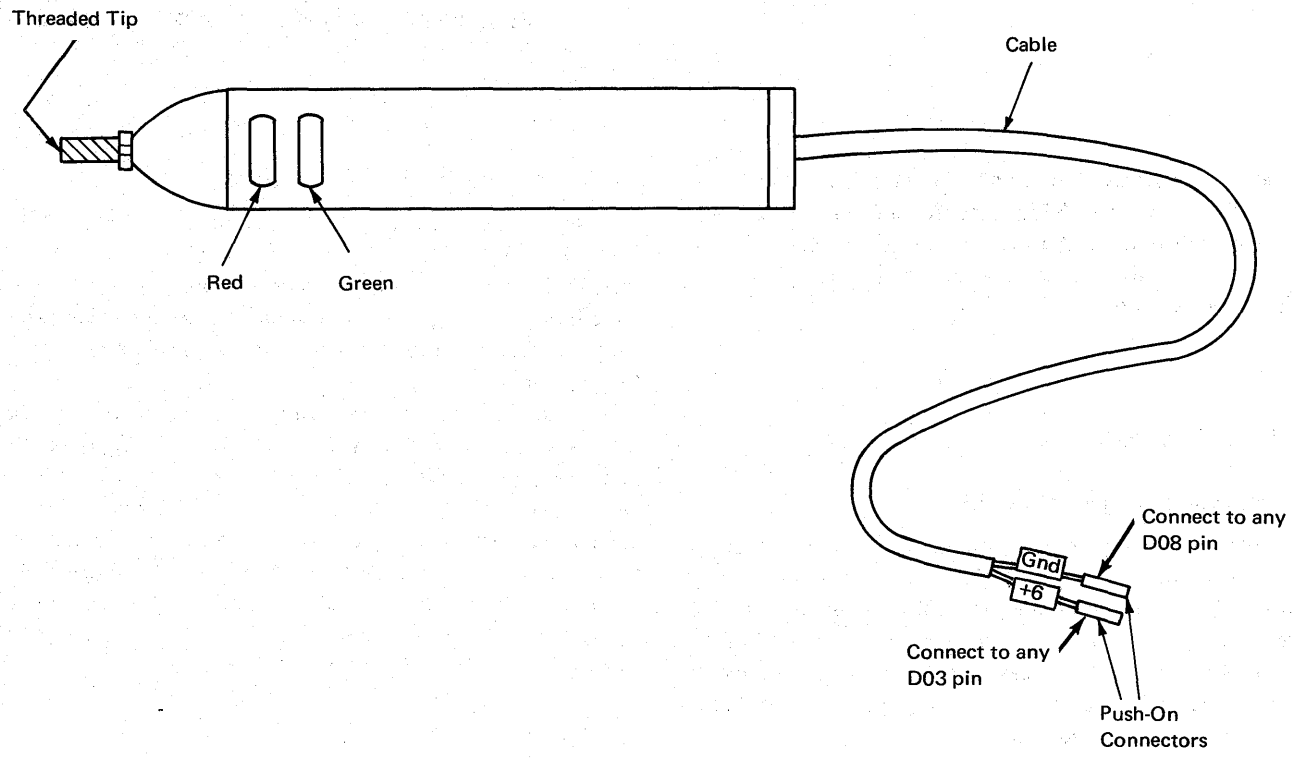
To use the logic probe, a probe tip must be attached to the threaded stud. An SLT probe tip (PN 453163, or equivalent) should be used. The two wires at the top of the probe are attached to the back of the logic board being probed. The leads are clearly labeled: GND and +6V. Connect the GND lead to any D08 pin, and connect the +6V lead to any D03 pin (+5V dc). The leads are connected to the board by pushing the connector at the end of each lead onto the designated pin. When the last wire is connected, the red indicator should light.

Connect the oscilloscope probe tip to the pin designated in the Troubleshooting Diagrams or as determined in logic. The following conditions can be observed by the logic probe:

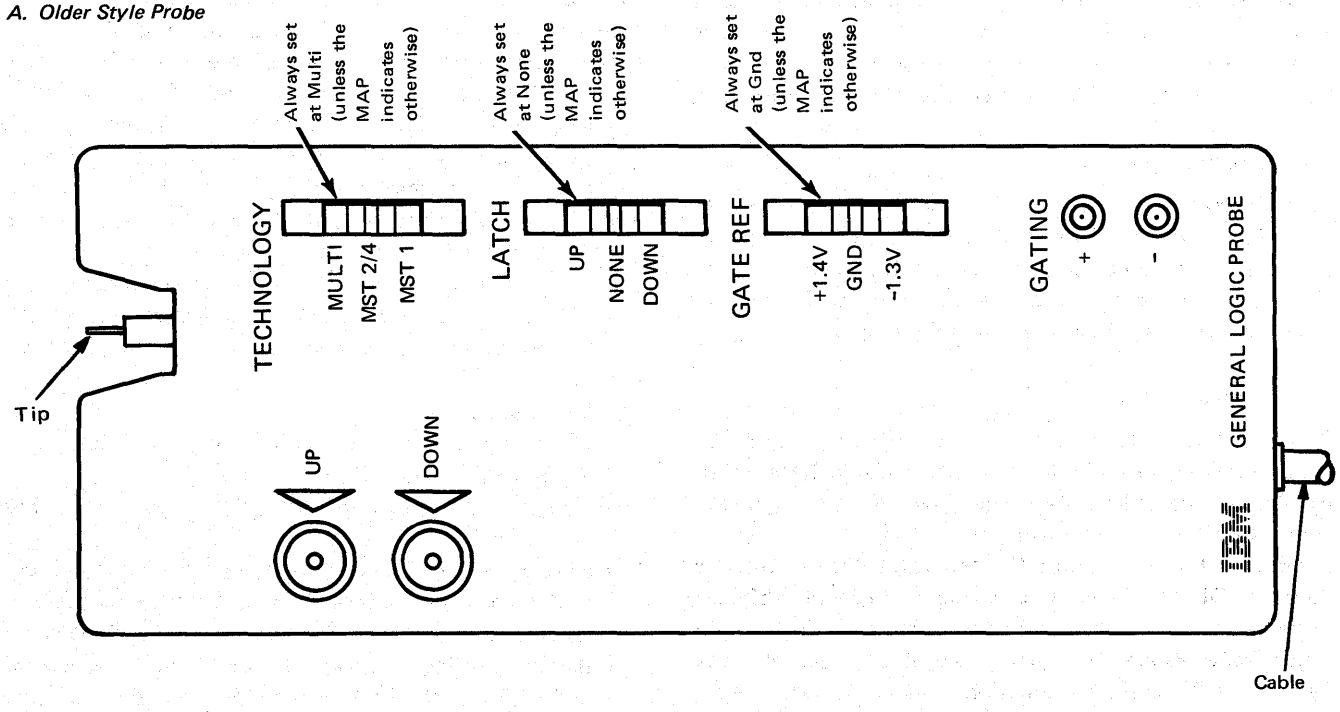
1. Red indication
   a. Probe not attached to a pin (floating condition), or
   b. Plus signal on the net being probed.
2. Green indication – Ground (negative) signal on the net being probed.
3. Red and green indication – A pulsing signal (alternately plus and ground) is present on the net being probed. This condition can appear either as the red and the green indicator pulsing on and off, or as both indicators seemingly on at the same time (depending on the frequency of the pulsing signal). Single pulses can also be seen.

2.1.3.3 Probe Checkout

Note: This checkout procedure applies to the older-style logic probe (PN 453652). GLP checkout is described in *General Logic Probe Manual,* SY27-0113, which accompanies the GLP.



A. Older Style Probe



B. IBM General Logic Probe

Diagram 2-1. Logic Probes

Power must be applied to the 3277 during this procedure.

1. Attach probe tip to probe. Use SLT probe tip PN 453163 or similar.
2. Connect probe GND lead wire to any D08 pin.
3. Connect probe +6V lead wire to any D03 pin. Probe's red indicator should light as soon as this wire is attached.
4. Touch probe tip to any D03 pin. Probe's red indicator should remain lighted.
5. Touch probe tip to any D08 pin. Probe's green indicator should light and remain lighted as long as probe is on D08 pin.
6. Remove probe tip from D08 pin. Probe's red indicator should light again.

2.1.3.4 Probe Repair

The logic probe is not field-repairable. If trouble is experienced during probe checkout, check for the following conditions:

1. Power is applied to the 3277.
2. Probe leads are on proper source pins.
3. Proper pins are being probed.

If the above conditions are met and the probe fails to operate correctly, obtain a new probe before trouble-shooting the display station.

2.1.4 Alignment Mask

Alignment masks are provided for both display station models. The mask is used during all display image adjustments. Diagram 2-2 illustrates the Model 1 alignment mask (PN 2577899), and Diagram 2-3 illustrates the Model 2 alignment mask (PN 2565170). The mask is constructed of thin, clear plastic. Horizontal and vertical lines printed on the mask serve as boundaries when the display image adjustments described in Section 5 are being performed. Each line is identified by an arrow and a letter designation.

The mask is centered against the CRT, and the tabs on each edge are tucked under the CRT bezel to keep the mask in position while adjusting the display image. When the mask is not being used, it should be stored with the control unit logic.

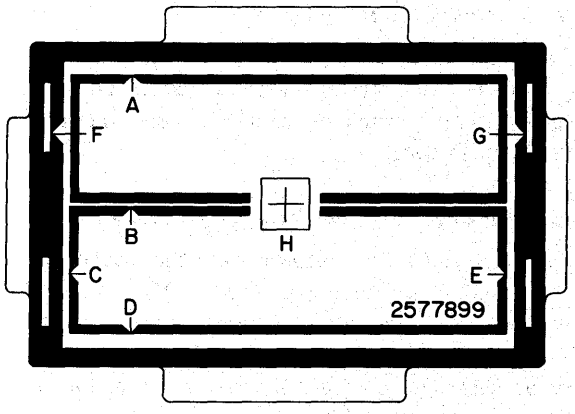


Diagram 2-2. Alignment Mask, Model 1

2.1.5 IDR FE Test Card

This tool (PN 2143816) is a magnetically encoded, plastic test card which conforms to American Banking Association specifications in respect to size, format, and coding. A 37-character test message is encoded on the magnetic stripe on the back of the card. A start-of-record (SOR) character precedes the message, and an end-of-card character and a check character follow the message. The SOR character initiates the read operation but is not transferred to the display station. The card is used to check the performance of the operator identification card reader. Two test cards are shipped with each card reader.

2.2 DIAGNOSTIC PROGRAMS

Diagnostic programs provide test patterns and interactive tests to align and exercise 3277 Model 1 and Model 2 Display Stations on both local and remote control units. The programs reside in the host CPU program and can be called in by the display station when they are required.

When the 3277 Display Station is attached to a 3271 or 3272 Model 1 or 2 Control Unit, two diagnostic programs are available: Request for Test (RFT) and Online Test (OLT). When the display station is attached to a 3271 Model 11 or 12 Control Unit, diagnostic programs consist of OLTs, and Link and Echo tests. These diagnostic programs are optional to the customer; however, most systems will have RFT capability.

Note: The diagnostics described in this section do not apply to 3277 Display Stations attached to a 3274 Control Unit. Refer to Appendix A for offline procedures for these 3277s.

The following paragraphs describe the RFT and OLT test patterns that are provided for the 3277 Display Station when attached to either the 3271 or 3272 Model 1 or 2 Control Unit, or to the 3271 Model 11 or 12 Control Unit. The methods for calling the test patterns into the display station when the latter is attached to the 3271 or 3272 Model 1 or 2 Control Unit are also described.

2.2.1 Test Patterns

Procedures required for calling the OLT test patterns into the 3277 Display Station that is attached to the 3271 Model 11 or 12 Control Unit are contained in the *3271 Control Unit, Models 1 and 2, Troubleshooting Guide,* SY27-2311. Refer to Diagram 7-30 of SY27-2311 to invoke the OLTs residing in the host CPU or to Section 2 of SY27-2311 for procedures to run the OLTs from the test tape that is provided with the control unit.

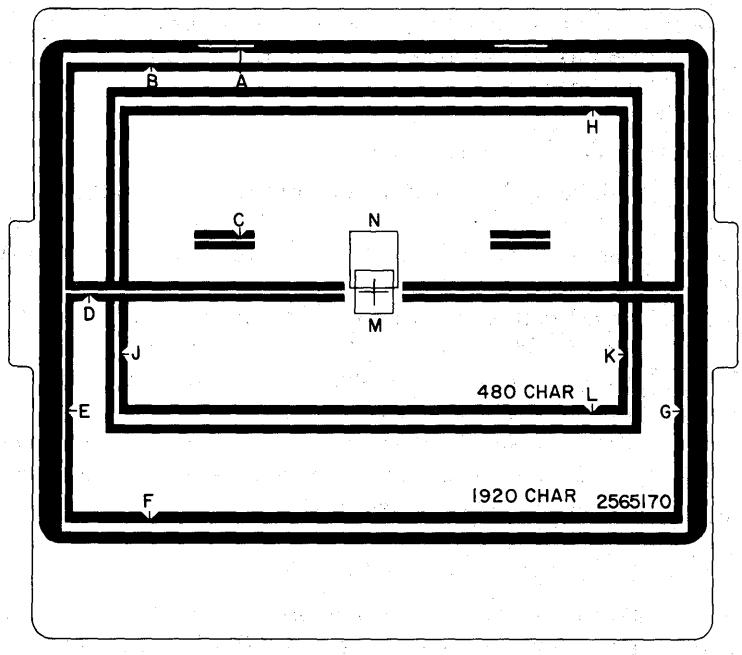


Diagram 2-3. Alignment Mask, Model 2

Procedures required for calling the OLT test patterns into the 3277 Display Station that is attached to the 3271 Model 11 or 12 Control Unit are contained in the *3271 Control Unit, Models 11 and 12, Troubleshooting Guide,* SY27-2409. Refer to Appendix D of SY27-2409 to invoke the OLTs residing in the host CPU or to Section 1 of SY27-2409 for procedures to run the OLTs from the test tape that is provided with the control unit.

Seven test patterns are included in RFTs and OLTs. Up to five patterns are used to troubleshoot and align 3277 Display Stations. Model 1 display stations use patterns 1, 2, and 5; Model 2 display stations use patterns 1, 3, and 5 (if the 3270 Data Analysis - APL Feature is installed, the Model 2 display station also uses the APL keyboard test pattern). (Patterns 4 and 6 are used by printers and are not described here.) EBCDIC, ASCII, and World Trade Corporation display stations use these patterns. Test patterns are slightly different when the 3277 Display Station is attached to a 3271 Model 11 or 12 Control Unit. EBCDIC test patterns are shown in Diagrams 2-4 through 2-7. Some characters will differ from those shown for patterns 1 and 5 if the display station uses the ASCII code or a WTC language. The differences for those patterns are summarized in Diagram 2-9. The APL keyboard test pattern is shown in Diagram 2-8.

2.2.1.1 Test Pattern 1 (Diagram 2-4)

Test Pattern 1 is a functional test that thoroughly checks the display station. All available characters are displayed. The pattern contains protected data fields, numeric fields, high-intensity fields, nondisplay fields, and selector-pen-detectable fields. The field marked "NON DISPLAY" in Diagram 2-4 is not displayed on the screen but is included in the illustration to show that a programmed nondisplay field is in the display buffer. The audible alarm feature is also tested by this pattern.

Paragraph 5.1.1 describes the comprehensive checkout procedure that uses Test Pattern 1. This pattern is also used during the execution of several Troubleshooting Diagrams.

2.2.1.2 Test Pattern 2 (Diagram 2-5)

Test Pattern 2 is used to align the Model 1 display image as described in paragraph 5.2.1. All data is protected and displayed in normal intensity. The audible alarm (if installed) sounds when this pattern appears on the screen.

2.2.1.3 Test Pattern 3 (Diagram 2-6)

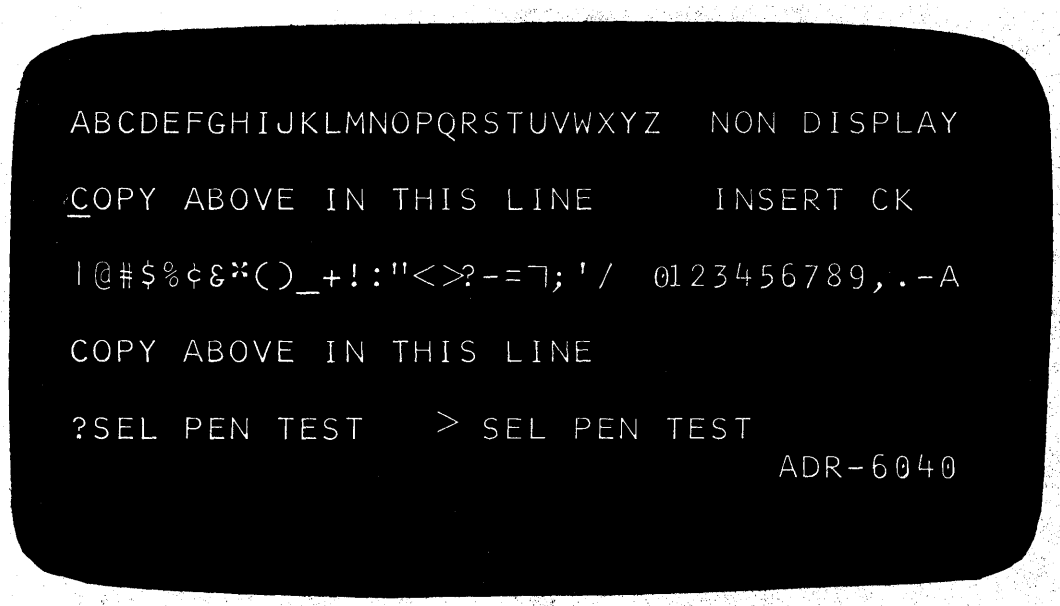
Test Pattern 3 is used to align the Model 2 image as described in paragraph 5.2.1. All data is protected and displayed in normal intensity. The audible alarm (if installed) sounds when this pattern appears on the screen.

2.2.1.4 Test Pattern 5 (Diagram 2-7)

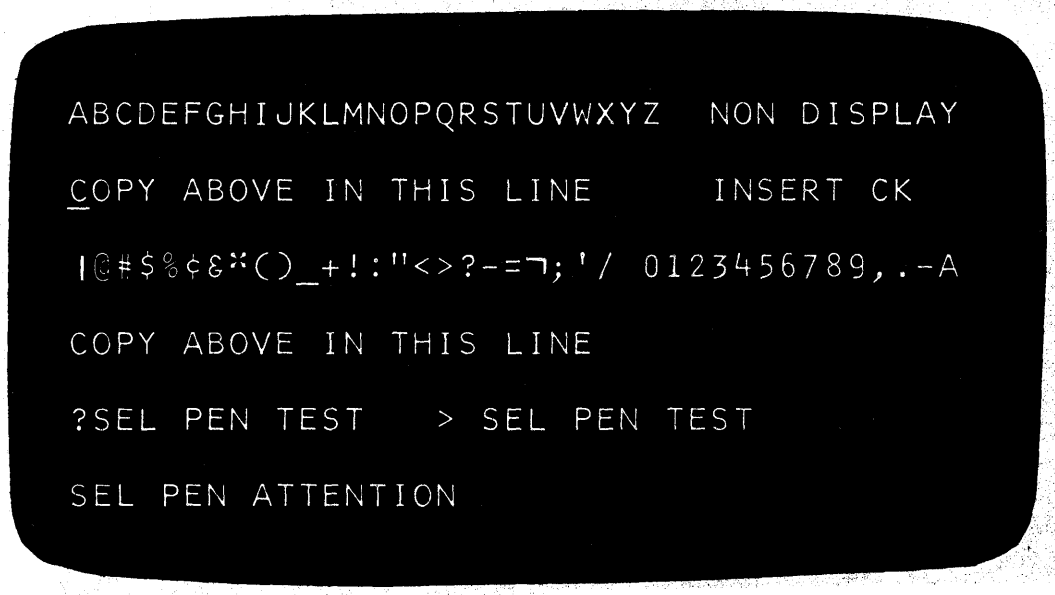
Test Pattern 5 loads the display station buffer with all available uppercase and lowercase character codes. The audible alarm (if installed) sounds when this pattern appears on the screen.

2.2.1.5 APL Keyboard Test Pattern (Diagram 2-8)

The APL Keyboard Test Pattern loads the display station buffer with all available upper, lower, APL upper, APL lower, and APL alternate character codes. The CE is instructed to enter each of these characters from the keyboard. After all codes are entered, a depression of the ENTER key causes the system to read and compare each character for picked or dropped bits. An 'X' is displayed beneath each character that is in error.



3277 Model 1 — Attached to 3271 or 3272, Model 1 or 2

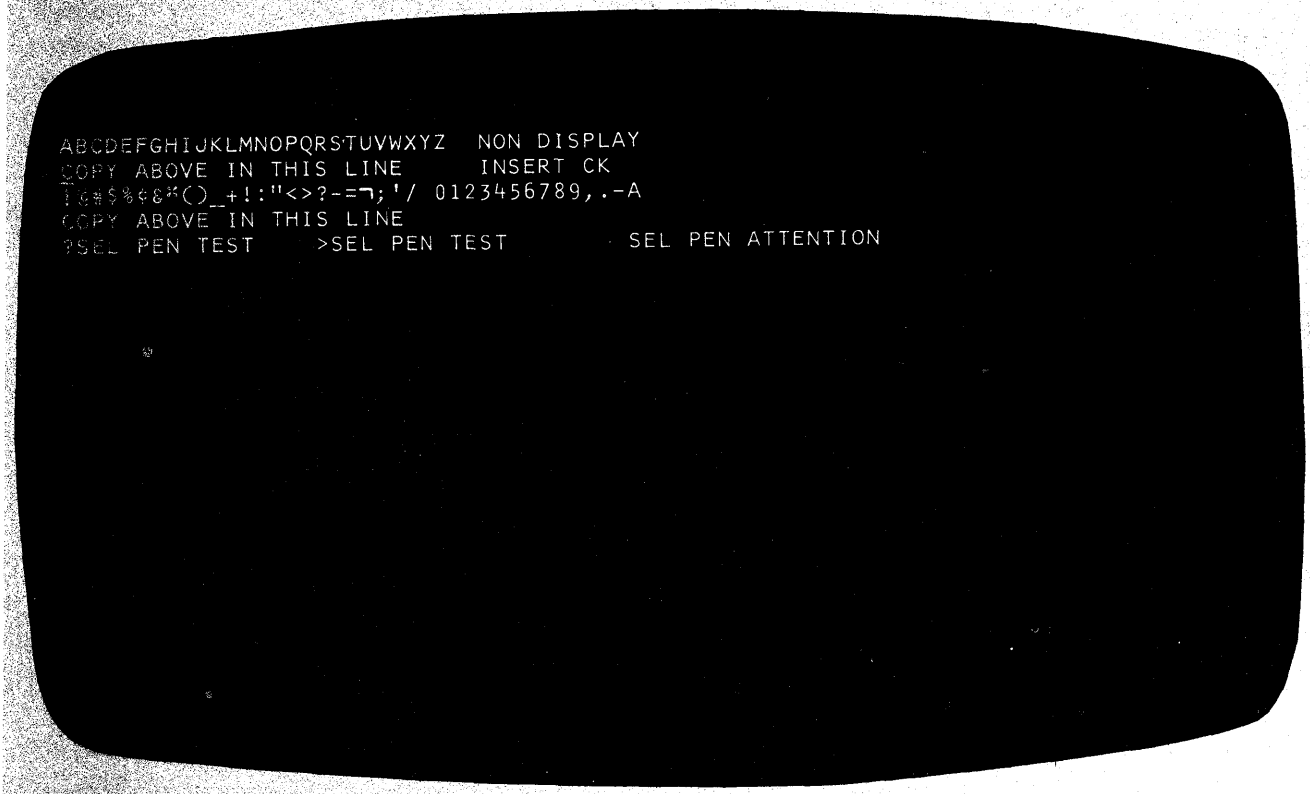


3277 Model 1 — Attached to 3271, Model 11

Diagram 2-4. Test Pattern 1, USA EBCDIC (Sheet 1 of 2)

3277 Model 2 — Attached to 3271 or 3272, Model 2

Notes:
1. ADR — appears only when pattern is called in from OLTEP.
2. NON DISPLAY is not displayed.
3. Use Diagram 2-9 to determine unique character replacements when ASCII or WTC languages are used.

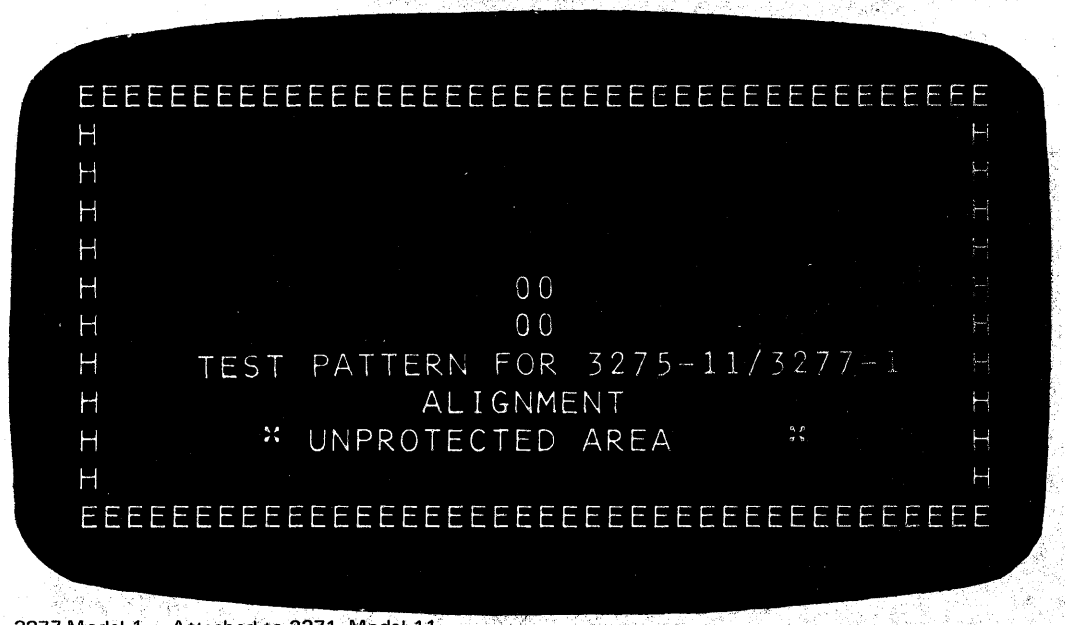


3277 Model 2 — Attached to 3271, Model 12

Diagram 2-4. Test Pattern 1, USA EBCDIC (Sheet 2 of 2)

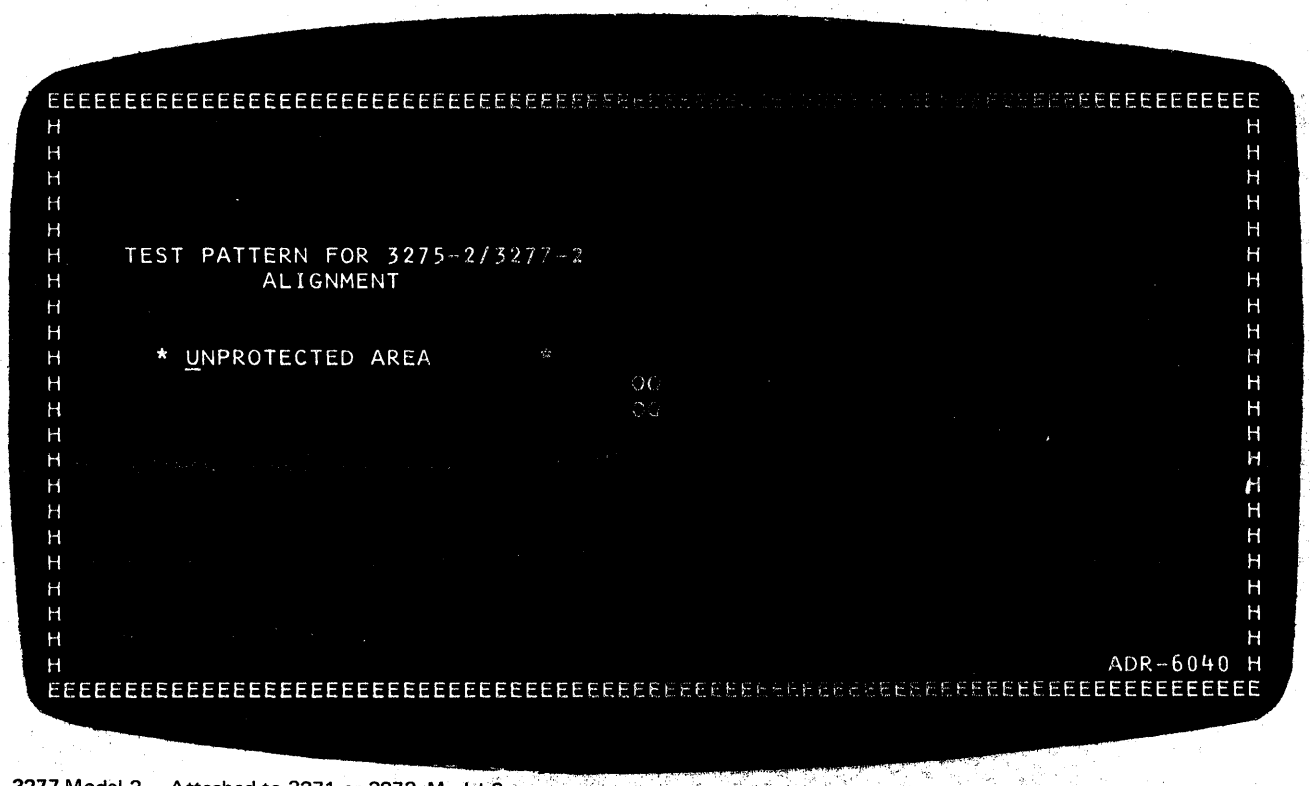
3277 Model 1 — Attached to 3271 or 3272, Model 1 or 2

Note: ADR — appears only when pattern is called in from OLTEP.



3277 Model 1 — Attached to 3271, Model 11

Diagram 2-5. Test Pattern 2

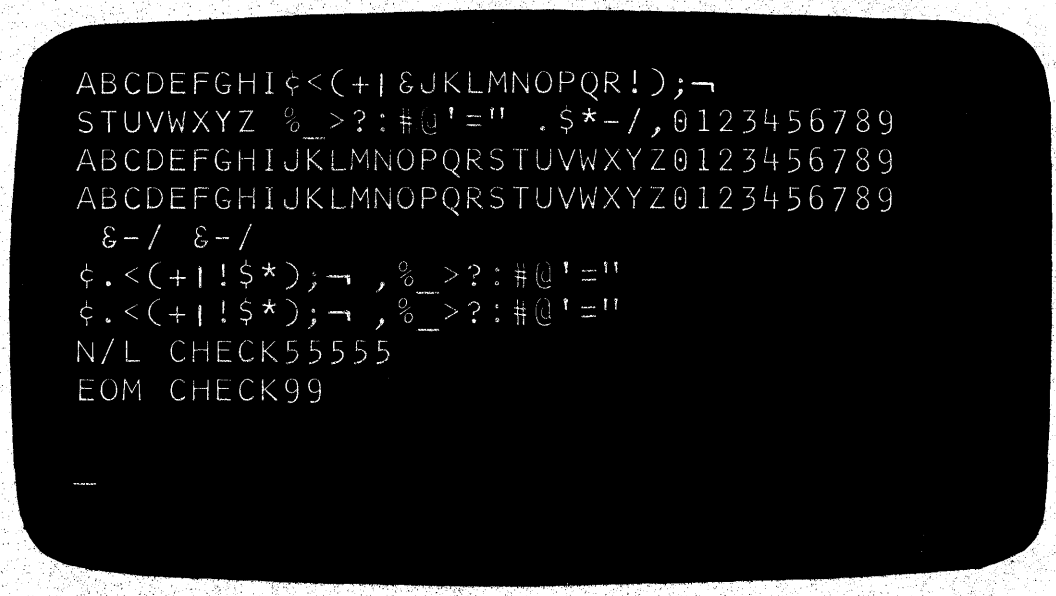


3277 Model 2 — Attached to 3271 or 3272, Model 2

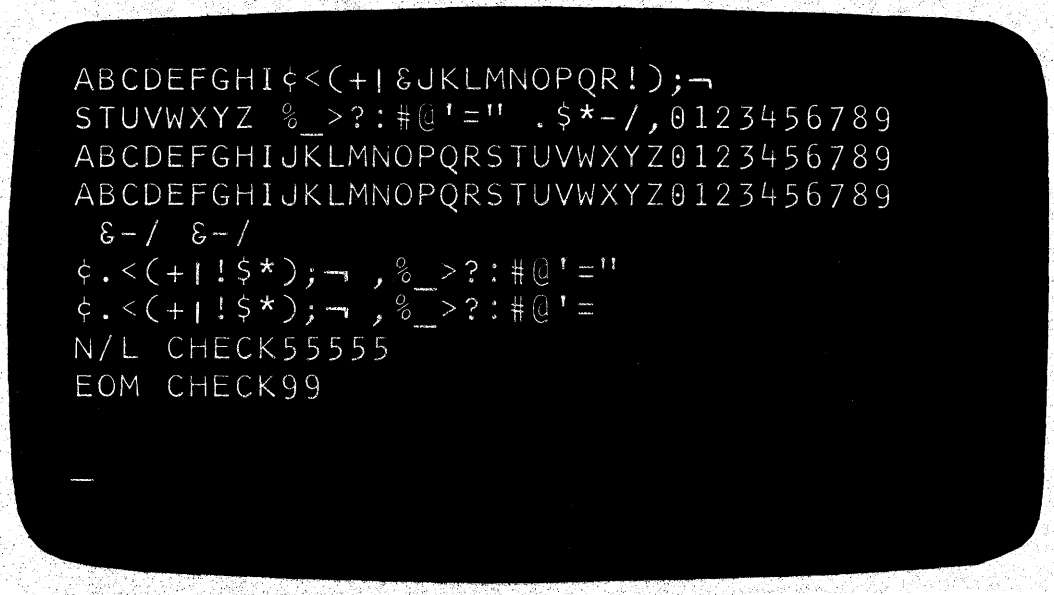
Note: ADR — appears only when pattern is called in from OLTEP.

3277 Model 2 — Attached to 3271, Model 12

Diagram 2-6. Test Pattern 3

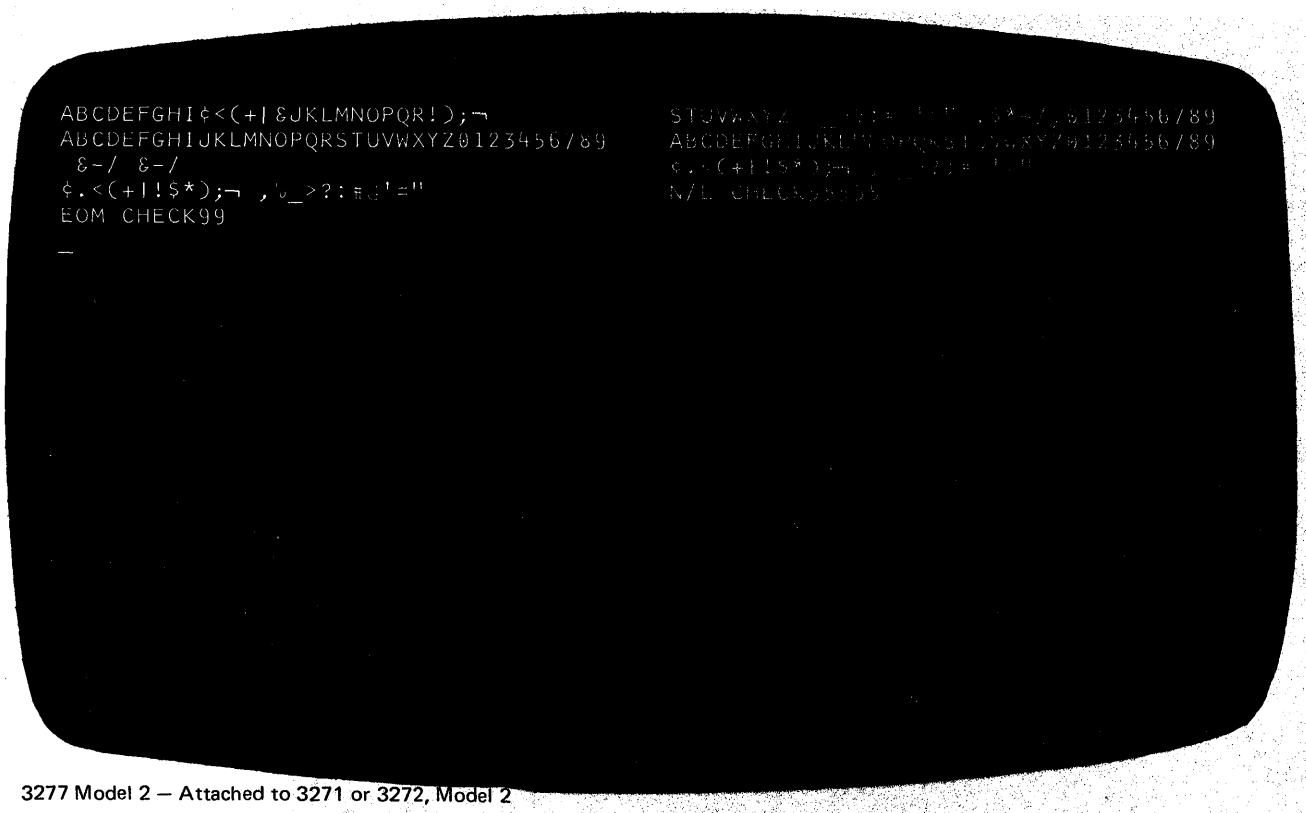


3277 Model 1 — Attached to 3271 or 3272, Model 1 or 2



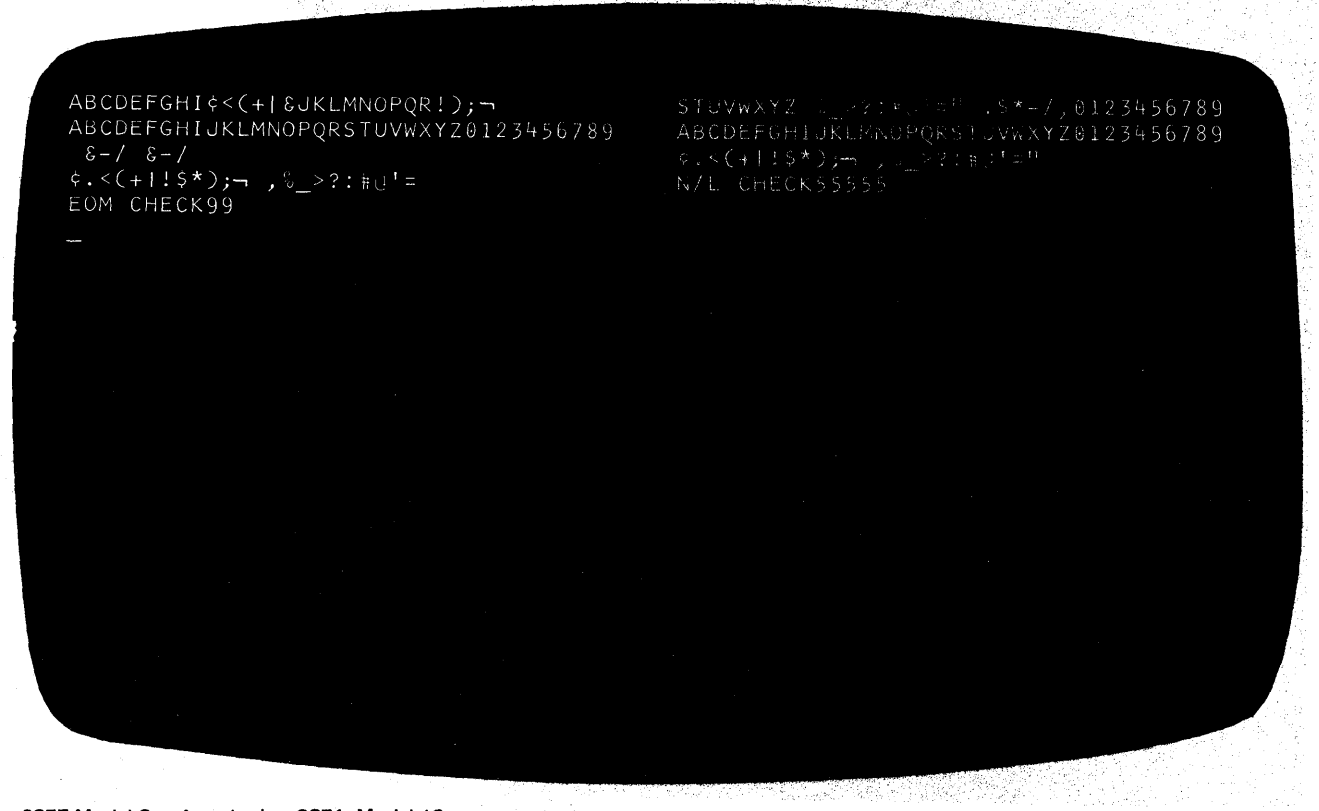
3277 Model 1 — Attached to 3271, Model 12

Diagram 2-7. Test Pattern 5, USA EBCDIC (Sheet 1 of 2)



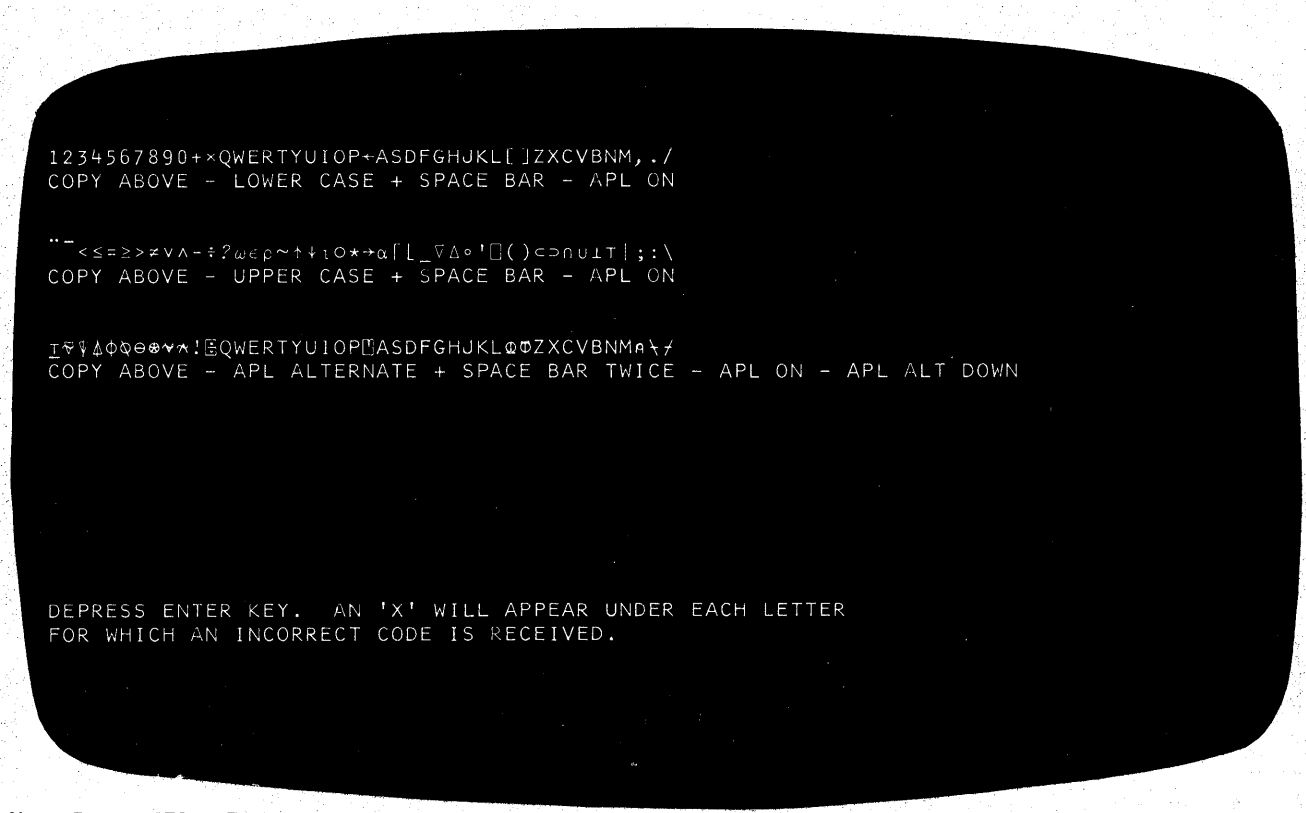
3277 Model 2 — Attached to 3271 or 3272, Model 2

Note: Use Diagram 2-9 to determine unique character replacements when ASCII or WTC languages are used.



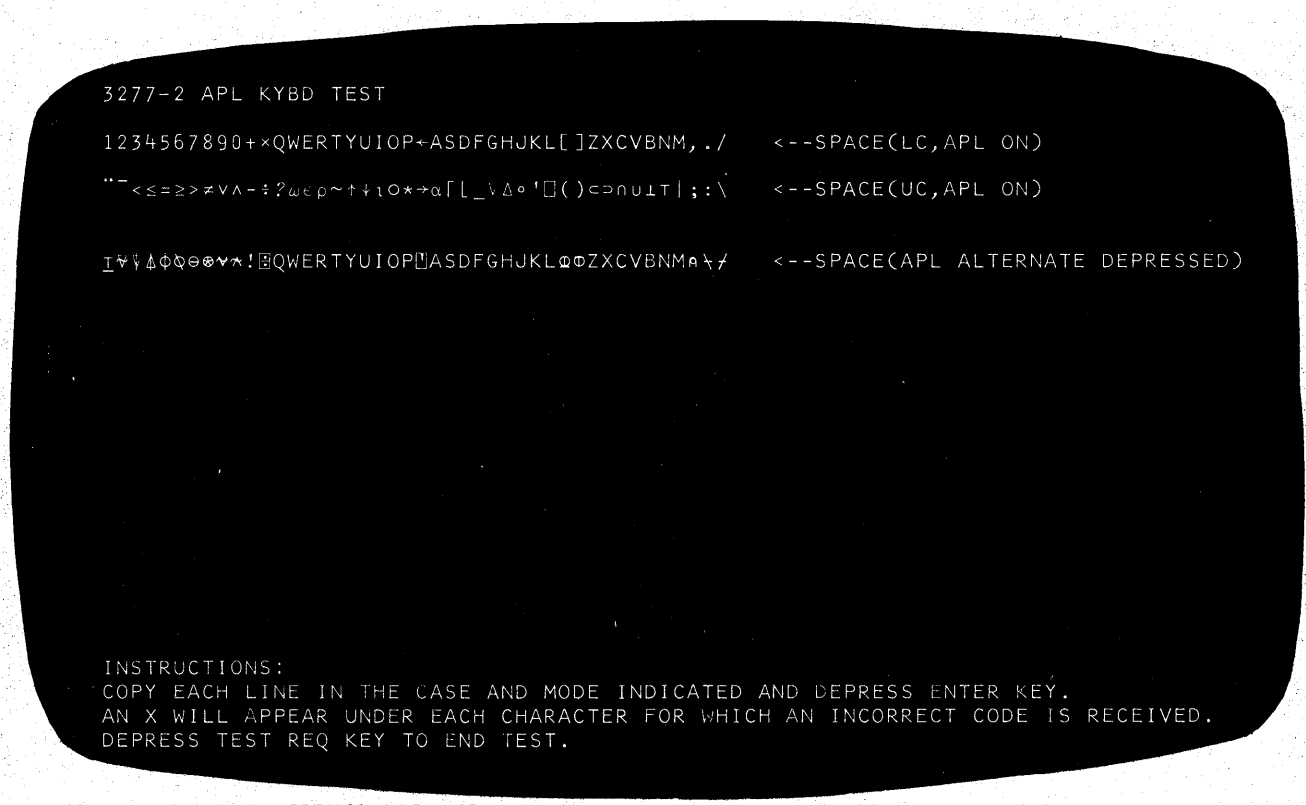
3277 Model 2 — Attached to 3271, Model 12

Diagram 2-7. Test Pattern 5, USA EBCDIC (Sheet 2 of 2)



Note: Depress TEST REQ key to end test.

3277 Model 2 — Attached to 3272, Model 2



3277 Model 2 — Attached to 3271, Model 2 or 12

Diagram 2-8. APL Keyboard Test Pattern

Language	Hex Code/Graphic							
	4A	5A	5B	7B	7C	7F	4F	5F
*USA EBCDIC	¢	!	$	#	@	"	¦	¬
USA ASCII-A	[	]	$	#	@	"	¦	^
USA ASCII-B	[	]	$	#	@	"	¦	¬
Austrian/German	Ö	Ü	Ü	Ä	Ö	Ä	¦	¬
Danish/Norwegian	Ø	Å	Å	Æ	Ø	Æ	¦	¬
Finnish/Swedish	Ö	Å	Å	Ä	Ö	Ä	¦	¬
Portuguese	Ã	Ç	Ç	Õ	Ã	Õ	¦	¬
Spanish	¢	!	P+	Ñ	@	Ñ	¦	¬
United Kingdom	$	!	£	#	@	"	¦	¬

*Belgian, French, and Italian languages use the USA EBCDIC character set.

Diagram 2-9. Character Differences for ASCII and WTC Languages

2.2.2 Requesting RFT Patterns

RFT patterns can be requested for 3277 Display Stations that are attached to a local control unit (3272) or to a remote control unit (3271 Model 1 or 2). Patterns can be requested from one display station to be displayed on another. (RFT patterns cannot be used for 3277 Display Stations attached to a 3274 Control Unit. Refer to Appendix A for procedures for these 3277s.) To display patterns, the controlling CPU must be operating under OS BTAM (Operating System Basic Telecommunications Access Method) or DOS BTAM (Disc Operating System Basic Telecommunications Access Method), and the application program must be set up to accept test requests. The system programmer can verify that the requirements to request RFT patterns are met. The eight test patterns (four EBCDIC and four ASCII) that can be requested by RFTs and their identification numbers are listed in Diagram 2-10.

Test Pattern	ID Number	
	EBCDIC	ASCII
1	23	29
2 (Model 1)	24	30
3 (Model 2)	25	31
5	27	33

Diagram 2-10. Test Pattern ID Numbers

2.2.2.1 Local Display Stations

1. Position the cursor at the top left (character position 0) of an *unformatted* screen. (One way to accomplish this is to press the CLEAR key and then press the RESET key.)
2. From the keyboard, enter the RFT request message in the following format:

   XXYYNCUU

   where:

   XX = The number of the test pattern desired. Use EBCDIC column of Diagram 2-10.

   YY = Any number from 01 to 99. This number specifies the number of times the pattern will be repeated.

   N = The number 3. This identifies the request as coming from a display station attached to a 3272 Control Unit.

   CUU = The three-digit hexadecimal number of the channel (C) and the display station (UU) address to which the pattern is to be sent. *Alphabetic characters in the hexadecimal number must be entered in uppercase.*
3. Press TEST REQ key. INPUT INHIBITED indicator should come on.

4. The desired pattern should appear within 15 seconds. If INPUT INHIBITED indicator stays on and the pattern does not appear, proceed as follows:
   a. Repeat the request while ensuring that steps 1–3 are performed correctly.
   b. Check that the operating system and the BTAM application program are still executing.
   c. Check that the BTAM application program is set up for online test requests. (The customer's system programmer can provide this information.)

2.2.2.2 Remote Display Stations

1. Position the cursor at the top left (character position 0) of an *unformatted* screen. (One way to accomplish this is to press the CLEAR key and then press the RESET key.)
2. From the keyboard, enter the RFT request message in the following format:

   XXYYNMMDD

   where:

   XX = The number of the test pattern desired. Use appropriate column of Diagram 2-10.

   YY = Any number from 01 to 99. This number specifies the number of times the pattern will be repeated.

   N = The number 4. This identifies the request as coming from a display station attached to a 3271 Control Unit.

   MMDD = The selection address characters of the control unit (MM) and the display station (DD) to which the pattern is to be sent. (The release level of the operating system being used determines what characters will be entered. Check with the customer programmer for this information.)
3. Press TEST REQ key. INPUT INHIBITED indicator should come on.
4. The desired pattern should appear within 15 seconds. If INPUT INHIBITED indicator stays on and the pattern does not appear, proceed as follows:
   a. Repeat the request while ensuring that steps 1–3 are performed correctly.
   b. Check that the operating system and the BTAM application program are still executing.
   c. Check that the BTAM application program is set up for online test requests. (The customer's system programmer can provide this information.)

2.2.3 Online Tests (OLTs)

Online tests may be available, at the customer's option, to aid in maintaining 3277 Display Stations. Detailed descriptions and instructions for using OLTs are contained in the diagnostic program binder that is shipped with each control unit. Control unit MLTGs also contain this information. Most OLT routines apply to control units. The following three routines apply to display stations:

1. KEY - This routine handles manually generated interrupts from the keyboard, selector light-pen, and program function keyboard. The results of the interrupts are presented on the display station screen, informing the CE of the success or failure of the interrupt operation. This routine also reads back data entered from the keyboard to check lowercase character codes.
2. MAG - This routine tests the operator identification card reader and identification cards.
3. PAT - This routine displays the test patterns described in paragraph 2.2.1. The test patterns appear in sequence on the CRT after they are initially called in. An explanatory message containing instructions for running the test pattern sequence precedes Test Pattern 1.

3.1 SYMPTOM INDEX USAGE

The Symptom Index lists trouble symptoms that could be encountered on 3277 Display Stations and features. Illustrations that show both correct and incorrect display images are also contained in this section. Use the Symptom Index and illustrations as the first step in a systematic method of resolving display station problems. The index is divided into six major categories:

1. Display malfunctions.
2. Keyboard malfunctions.
3. Selector light-pen malfunctions.
4. Power malfunctions.
5. CPU error indications.
6. Operator identification card reader malfunctions.

Some categories are divided into subcategories, making it easier to relate the trouble experienced to the correct item in the index. *Beginning with 1A1, the first item that most closely describes the display station trouble should be used.* Categories and specific items are identified by a one-, two-, or three-letter/number code (e.g., 1A1, 2G, or 4) in the left column of the index. The code specifies the entry point into the Troubleshooting Diagrams in Section 4.

The right column of the Symptom Index specifies action to take to remedy the display station problem. That column directs the Customer Engineer to a section troubleshooting diagram sheet or specifies a logic card (or cards) to change. When more than one card is listed, isolate the failing card by card swapping from among those specified. Change the failing card and return the others to stock. The right column may also specify an adjustment procedure in Section 5.

Diagrams 3-1 through 3-24 show both correct and some incorrect display images. The symptom list refers to these illustrations to aid in identifying display station symptoms. As an aid to rapid repair, diagrams that show incorrect display images also specify the repair action.

3.2 DEVELOPING SYMPTOMS

Display station malfunctions should be isolated offline unless the trouble occurs only when operating online through the control unit to the host CPU. Failures of this type are listed in Category 5 (CPU Error Indications). Display station operations that require a formatted buffer for failure symptoms to become evident are:

1. Selector light-pen operations.
2. Display intensity control (high intensity and non-display).
3. Protected and numeric field operations.
4. Tab operations.
5. Erase input and erase field operations.

Test Pattern 1 contains fields that test these operations. The test pattern may be loaded from the system as an RFT or OLT. Test tapes can also be used to load the patterns necessary to test these operations. Symptoms that require a formatted buffer are marked with an asterisk (*) in the Symptom Index.

Note: Appendix A contains offline procedures to format the buffer to test the selector light-pen feature on 3277s attached to a 3274 Control Unit.

Offline symptoms should be developed by performing the following test sequence after the I/O signal cable is removed.

1. Turn power on. (Always begin from a power-on reset condition.)
2. Test cursor move keys →, ↑, ↓, ←, →, ↵
3. Test CLEAR key.
4. Enter four or five characters.
5. Press Tab (→) key.
6. Press Backspace (←) four times.
7. Enter four characters.
8. Press Backspace (←) four times.
9. Press INS MODE.
10. Enter four or five characters.
11. Test DEL key.

1 Normal Mode — Go to new line. Text Feature (Code Mode) — Go to new line.

2 Print ⊡ and go to new line.

Stop the test sequence and go to the Symptom Index when the first failure occurs.

Do steps 12, 13, and 14 if the Data Analysis - APL Feature is installed.

12. Press the APL ON/OFF key.
13. Enter four or five characters.
14. While holding the APL ALT key depressed, enter four or five APL alternate shift characters.

Stop the test sequence and go to the Symptom Index when the first failure occurs.

3.3 INTERMITTENT PROBLEMS

Intermittent problems can be caused by excessive ripple on the output voltage of the display station LV power supply, and by missing or improperly connected ground wires on control units and display stations.

Excessive power supply ripple voltage can cause intermittent data checks and I/O errors. To minimize intermittent problems caused by the LV power supply, make the following checks:

1. Check that all power supply capacitor screws are tight.
2. Check that the LV power supply output voltages do not exceed the specified tolerances given in paragraph 5.1.3-1.
3. Check that the LV power supply output ripple voltages do not exceed the following tolerances:

PS Voltage	Tolerance (mv)
+5	200
+8	300

Improper ground connections resulting in ground loops can cause intermittent problems such as: timeouts, "hanging in transmit", failure of "request-to-send" to fall, false status information, data checks with and without unit specify, equipment checks, and intervention required. To minimize intermittent problems caused by improperly connected or missing ground wires, check the ground system, as follows:

1. Check the display station ac power connector for loose or otherwise poor ground connections.
2. Check for missing ground connections at the control unit:
   a. Ensure that power is off at the control unit and the attached display stations, that power cords are plugged into the ac receptacles, and that the coaxial cable is connected at the display station(s) and disconnected at the control unit.
   b. Measure the ac voltage at the control unit, between any D08 pin and frame ground. A reading of 0V is correct. If 50 to 70 volts are present, the ground connection is missing.
3. Check the control unit and display station ground connections as follows:
   a. With power off, and the control unit connected to the CPU (or modem), and the coaxial cable to the display station plugged at the control unit end, measure 0 ohm at the control unit between dc ground and frame ground.
   b. Measure 0 ohm at the display station between the end of the coaxial cable shield and frame ground.
4. Check the control unit and display station for ground loops:
   a. In a remote installation, check that signal ground and frame ground are connected at one location only, either in the external modem or in the modem cable that is connected to the 3271 unit.
   b. In a local installation, check that signal and frame ground are connected at one location only, either in the channel or in the CPU.
   c. Disconnect the channel or modem cable at the control unit and all device cables at the control unit, and check for an infinite resistance reading between control unit signal ground (D08) and frame ground.
   d. With the display station disconnected from the control unit, check for a minimum resistance reading of 7K or 10K ohms between the display station signal and frame grounds.

   Note: Also, if a keyboard is attached, check the keyboard cable for ground loops. Installation of ECA 035 corrects keyboard ground loop problems.

SYMPTOM INDEX

Symptom	Diagram Sheet or Direct Action Repair
Note: Bad or missing green wire grounds on display stations or control units can cause failures ranging from intermittent to catastrophic. Verify proper grounding by using ground checker PN 9900453.	
1. DISPLAY MALFUNCTIONS	
A. No Display:	
1. No visible light or glow on CRT. (Device Check not indicated; no cursor, characters, or indicators displayed.)	Sheet 2
2. Glow only on CRT (Diag 3-9)	Sheet 4
B. Intensity and Focus:	
1. One horizontal line on CRT (Diag 3-10)	Sheet 4
2. Model 1 – Full raster on screen (Diag 3-11) *OR* Model 2 – 24 rows of nine scan lines with space between each row (one row of ten scan lines) (Diag 3-12)	Sheet 5
3. Block displayed in every character position; cursor normal (Diag 3-14).	
a. INPUT INHIBITED lighted	Change card J2.
b. INPUT INHIBITED not lighted	Change card K2.
4. Display too dim or too bright (No control of intensity), or dim and blurred (no effect using display focus control).	Sheet 5
5. Characters out of focus (Diag 3-18)	Sheet 5
*6. Dual-intensity problems or characters displayed that should not	Sheet 6
7. Display erratic (e.g., display flashes, characters move, more than one cursor)	Sheet 6
8. Screen full of lines	Sheet 6
9. Retrace unblanked	Change cards H2, J2, K2.
10. Random data on screen. INPUT INHIBITED lighted	Change card H2.
11. Cursor on left side in all rows	Change card H2.
12. One dot at character location zero cursor position	Change card J2.
C. Display Position and Size:	
1. Horizontal size too large or too small (vertical normal) *OR* Vertical size too large or too small (horizontal normal, Diag 3-8)	Adjust analog card. If out of range of adjustment, change analog card and card J2.
2. Both horizontal and vertical size too large or too small	If less than 1" in either direction, adjust analog card. If more than 1", or if display size erratic, change HV power supply.
3. No space between rows of characters (Model 2 only) (Diag 3-16)	Sheet 7

* Requires a formatted buffer.

Symptom	Diagram Sheet or Direct Action Repair
1. DISPLAY MALFUNCTIONS (Cont)	
C. Display Position and Size: (Cont)	
4. Rows of characters not evenly spaced	Change analog card
5. Display not centered (Diag 3-7)	See centering procedure (5.2.1.5).
6. Display tilted (Diag 3-6)	See yoke adjustment procedure (5.2.1.4)
D. Characters:	
1. No characters displayed, but cursor displayed. (See Symptom 2B4 if keyboard problem only.)	Sheet 7
2. Display out of sync. (Characters may be recognizable but are moving, and more than one cursor is seen. INPUT INHIBITED not lighted.) (Diag 3-15)	Sheet 6
3. Character(s) not formed correctly wherever displayed on screen	Change card K2.*
4. Screen full of quote marks (no Device Check)	Change cards A2, K2.*
a. Quote mark in location 0 and cursor in location 1 after POR	Replug connector inside keyboard.
5. Wrong character displayed from program, keyboard, or POR:	
a. Without Device Check	Change card K2.*
b. With Device Check	Sheet 7
6. Data displayed that should not	Sheet 8
7. Screen full of one character with or without INPUT INHIBITED lighted	Sheet 8
8. Screen slowly fills with character of last keyboard key pressed. INPUT INHIBITED not lighted	Change card A2.
9. Attribute characters displayed	Sheet 8
E. Cursor:	
1. No cursor on screen, but rest of display normal (no Device Check)	Change card K2.*
2. No cursor with INPUT INHIBITED lighted. Cursor cannot be returned to screen by Power On Reset or CLEAR key	Sheet 9
3. Cursor appears normally. INPUT INHIBITED lighted	Sheet 9
4. Cursor under all or most character positions, and Device Check indicated (INPUT INHIBITED lighted) (Diag 3-13)	Sheet 10
5. Cursor under all character positions of one or more lines, but Device Check not indicated (Diag 3-13)	Change card K2.*
6. Cursor not positioned correctly under a character; may be in character area	Change card K2.*
7. Cursor too long or too short	Change card K2.*
8. No cursor, and INPUT INHIBITED not on. Partial cursor appears as each character enters until 80 characters in row appear with partial cursor under each character. Occurs on one row at a time	Change card J2.
9. Screen slowly fills with cursors	Change cards A2, C2, H2.
10. Cursor appears in three or four rows equally spaced on left side of display after POR. Characters may or may not enter and appear at cursor location. Display may blink	Sheet 10
11. No cursor on screen after POR. Characters may enter, but only first scan line of each row displays as character enters. (INPUT INHIBITED not lighted)	Change card J2.

*If the Data Analysis - APL Feature is installed, check the +8V dc at A-A1K2U11.

Symptom	Diagram Sheet or Direct Action Repair
1. DISPLAY MALFUNCTIONS (Cont)	
F. Indicators:	
1. No indicators light. (Characters and cursor normal.)	Sheet 11
*2. One indicator fails to light	Sheet 11
*3. One indicator lit when it should not be	Sheet 9
2. KEYBOARD MALFUNCTIONS	
Note: If card reader feature is installed on failing display station, remove card reader feature logic card at location N2, and move keyboard cable from socket Z4 to socket Z1. If keyboard operates correctly with card removed and cable swapped, change card N2, and return keyboard cable to socket Z4. If keyboard still fails with card removed and cable swapped, select symptom that best describes failure.	
A. All Keys	
1. Keyboard inoperative	Sheet 12
2. Keyboard operation erratic (INPUT INHIBITED on after certain keys.)	Sheet 12
3. Diagonal row of dots appears starting at lower left corner of screen as characters enter. INPUT INHIBITED not lighted	Change card J2.
B. Character Keys:	
1. Wrong character for one key	See keyboard check procedure 5.1.4.
2. Wrong character for more than one key	Sheet 12
3. No characters enter for all keys	Sheet 13
*3a. Correct character enters, but INPUT INHIBITED lights for one or more keys	Sheet 7
4. No character enters for all keys; cursor advances with each key depression. Dots may appear on one line. (INPUT INHIBITED indicator does not light.)	Sheet 13
*5. Alpha characters enter into "numeric only" fields. (Verify that keyboard numeric lock feature is installed. See Diag 6-18.)	Sheet 13
*6. Numeric characters cannot enter in "numeric only" fields	Change card B2.
7. Typamatic failures	See keyboard check procedure 5.1.4.
8. Cursor disappears when character enters	Sheet 14
9. Characters entered not displayed. Cursor move keys work correctly. (INPUT INHIBITED not lighted.)	Change cards A2, B2, G2.

* Requires a formatted buffer.

Symptom	Diagram Sheet or Direct Action Repair
2. KEYBOARD MALFUNCTIONS (Cont)	
C. Cursor Control Key Failures:	
1. Failure of any or all cursor move keys: → ↓ ↑ ↵ ⇥ ← ⇤	Sheet 14
2. Data moves to left when ← key pressed	Change cards C2, H2.
D. Operator Function Key Failures:	
*1. ERASE FIELD	Sheet 18
*2. ERASE INPUT	Sheet 18
3. INS MODE	Sheet 18
3a. INPUT INHIBITED lights when cursor moves from last to first character position	Change card J2.
4. DEL	Sheet 19
5. RESET	Sheet 19
E. Program Access Key Failures:	
1. CLEAR	Sheet 20
2. ENTER, PA1, PA2, PA3, TEST REQ, or PF1–12	Sheet 20
F. Keyboard Assembly	
1. Keyboard Mechanical Failures (includes audible feedback)	Sheet 20
2. Keyboard Electrical Failures	Sheet 21
G. Audible Alarm Failures:	
1. Fails to sound	Sheet 21
2. Sounds when it should not	Change cards G2, H2.
3. SELECTOR LIGHT-PEN MALFUNCTIONS	
*A. Nothing happens when tip switch closed	Sheet 22
*B. Lines appear and remain through all detectable characters with detect attempted	Sheet 22
*C. Lines always appear through all detectable characters, even when pen not used	Sheet 22
*D. Data not entered when selector light-pen initiates entry into system:	
1. INPUT INHIBITED does not light	Change card M2, K2.
2. INPUT INHIBITED lights	Change cards G2, M2.
*E. Selector light-pen action changes verification characters correctly, but INPUT INHIBITED lights	Change card D2.

* Requires a formatted buffer.

Symptom	Diagram Sheet or Direct Action Repair
4. POWER MALFUNCTION	Sheet 23
5. CPU ERROR INDICATIONS	
Note: (Device check is indicated by INPUT INHIBITED light on due to an error condition.)	
A. Device not available	Sheet 26
B. Operator cannot use attention-generating keys and/or selector light-pen successfully	Sheet 26
C. Display station always appears busy to control unit	Sheet 26
D. Control unit cannot write to, or read from, display station correctly. (Random characters may appear after CLEAR key operation.)	Change cards G2, H2, J2.
E. **Error Printouts**	
1. Device Checks (no cursor)	Sheet 9
2. Device Checks (too many cursors)	Sheet 10
*3. Device Checks (parity)	Sheet 7
4. Transmit Checks	Sheet 27
F. **Read Modified (MDT bit) Failure:**	
1. Selector pen changes designator character correctly, but INPUT INHIBITED lights	Change card D2.
2. Selector pen fails to set MDT, and INPUT INHIBITED does not light	Change card M2, K2.
3. Keyboard fails to set MDT	Change cards A2, C2.
G. Programmed audible alarm failure	Sheet 21
H. Keyboard remains disabled after program attempt to enable it	Change card G2.
I. Program erase of unprotected data unsuccessful; erase from keyboard successful	Change card G2.
6. OPERATOR IDENTIFICATION CARD READER MALFUNCTIONS	
A. Cards do not feed through reader	Sheet 27
B. Incorrect number of characters read	Sheet 27
C. Cursor does not move as card feeds through reader	Sheet 28

* Requires a formatted buffer.

See Diagram 2–4 for greater detail of the test pattern data.

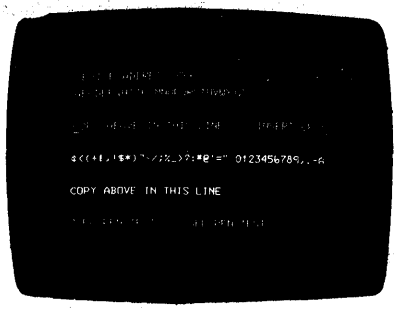


Diagram 3–1. Test Pattern 1, Model 1

See Diagram 2–4 for greater detail of the test pattern data.

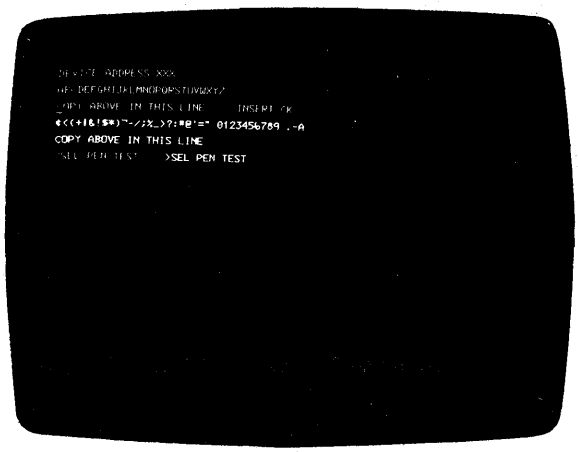


Diagram 3–2. Test Pattern 1, Model 2

See Diagram 2–5 for greater detail of the test pattern data.

Diagram 3–3. Test Pattern 2

See Diagram 2–6 for greater detail of the test pattern data.

Diagram 3–4. Test Pattern 3

Model 1 malfunction produces similar results. (Adjust yoke, 5.2.1.4.)

Diagram 3–5. Yoke Back Too Far on CRT Neck

Model 1 malfunction produces similar results. (Adjust yoke, 5.2.1.4.)

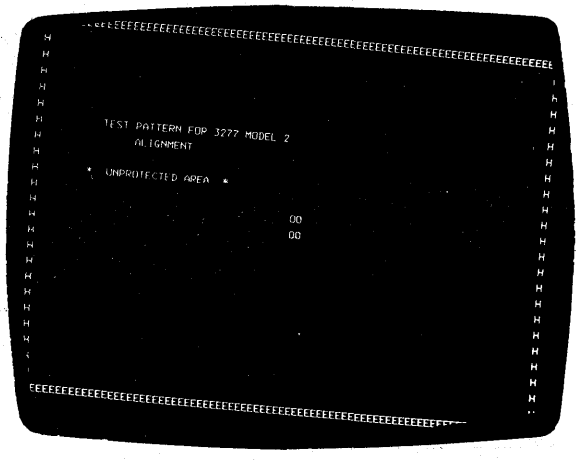


Diagram 3–6. Yoke Tilted

Model 1 malfunction produces similar results. (Adjust centering rings, 5.2.1.5.)

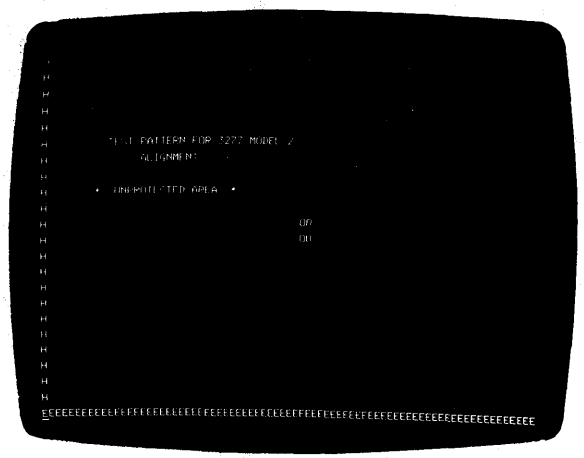


Diagram 3–7. Centering Rings Not Adjusted Properly

Model 1 malfunction produces similar results. (Adjust analog card. Model 1, 5.2.1.6, Model 2, 5.2.1.7.)

Diagram 3–8. Character Height Too Small

(Troubleshoot on Diag 4-1, Sh 4, 1A2.)

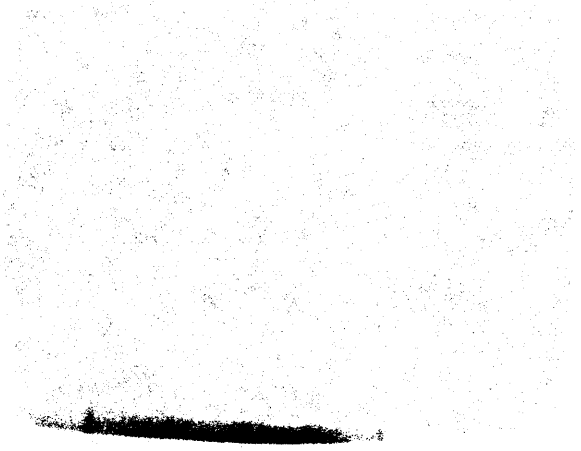


Diagram 3–9. Glow Only on CRT

(Troubleshoot on Diag 4-1, Sh 4, 1B1.)

Diagram 3–10. Single Horizontal Line on CRT

(Troubleshoot on Diag 4-1, Sh 5, 1B2.)

Diagram 3–11. Model 1 Raster

(Troubleshoot on Diag 4-1, Sh 5, 1B2.)

Diagram 3–12. Model 2 Raster

Model 1 malfunction produces similar results. (Troubleshoot on Diag 4-1, Sh 10, 1E4 if INPUT INHIBITED is on. If off change card K2.)

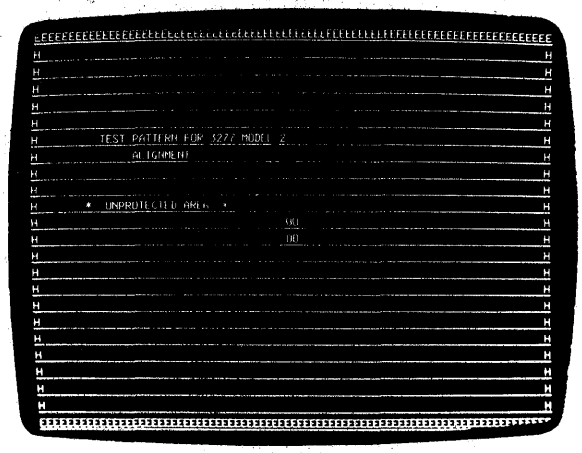


Diagram 3–13. Cursor in Every Row

Model 1 malfunction produces similar results. The density of each row is determined by the number of characters in that row. (Troubleshoot on Diag 4-1, Sh 6 1D2.)

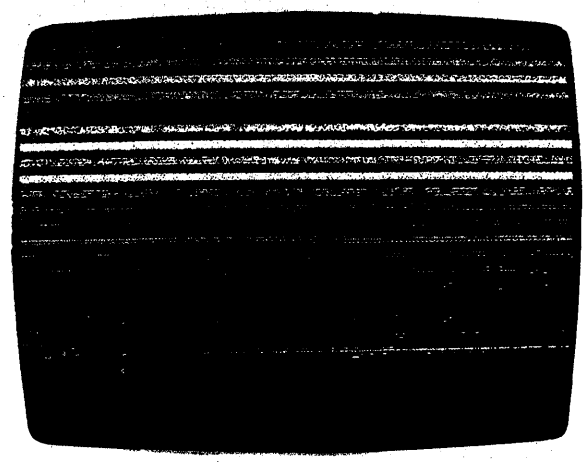


Diagram 3–15. No Horizontal Sync

Model 1 display is same except for size.

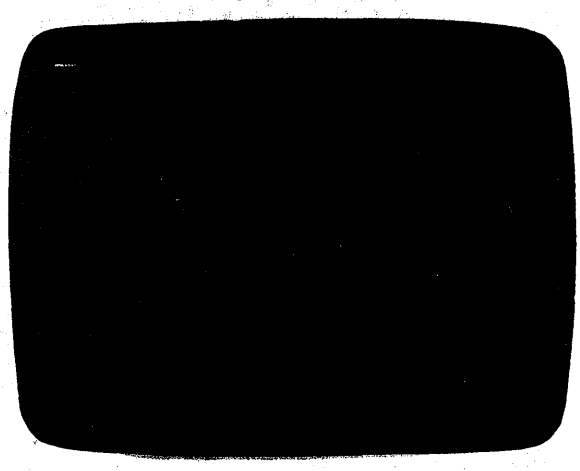


Diagram 3-17. Correct Display after POR

Model 1 malfunction produces similar results. (Change card J2 if INPUT INHIBITED is on. Change card K2 if off.)

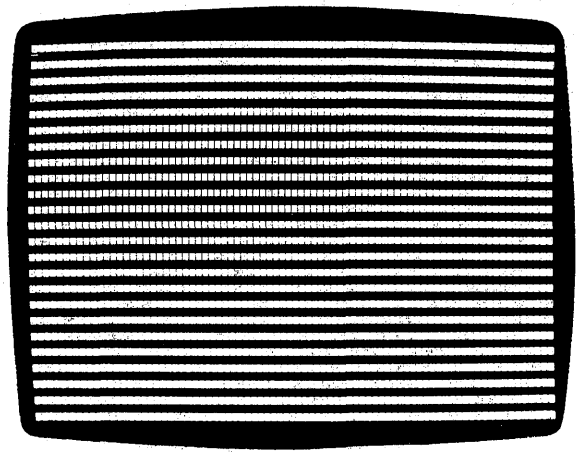


Diagram 3–14. Box in Every Character Position

This failure applies to Model 2 displays only. (Troubleshoot on Diag 4-1, Sh 7, 1C3.)

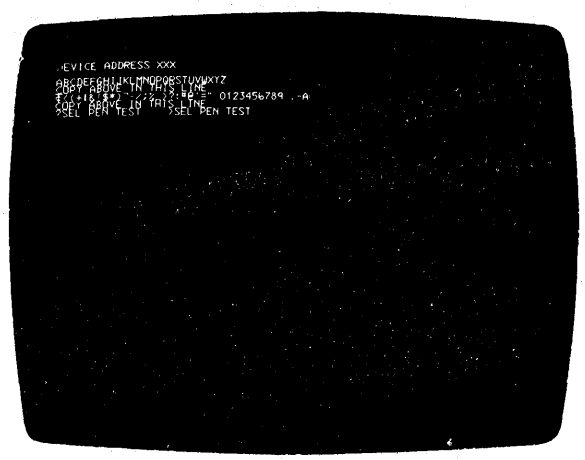


Diagram 3–16. No Interrow Spacing

Model 2 malfunction produces similar results. (Troubleshoot on Diag 4-1, Sh 5, 1B5.)

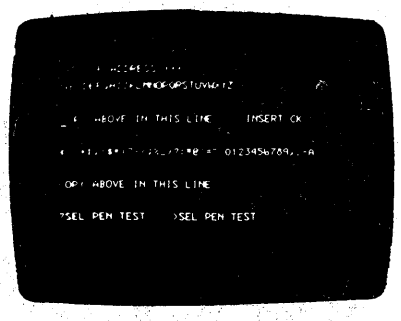


Diagram 3–18. Out of Focus Image

Model 1 malfunction produces similar results. The density of the superimposed characters is determined by the number of characters in the row.

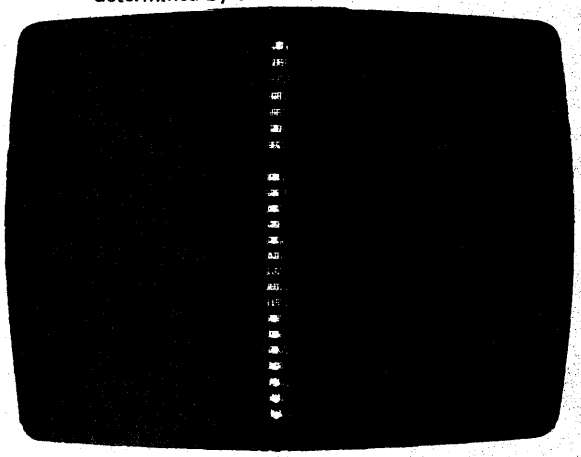


Diagram 3–19. Yoke Horizontal Return Line Open †

Model 1 malfunction produces similar results.

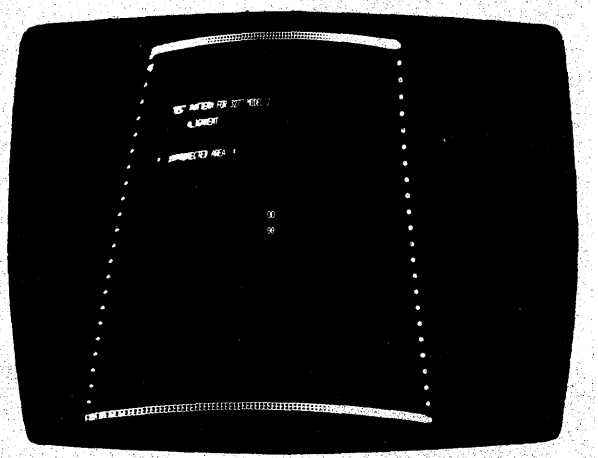


Diagram 3–20. Open in Yoke Horizontal Winding †

Model 1 malfunction produces similar results.

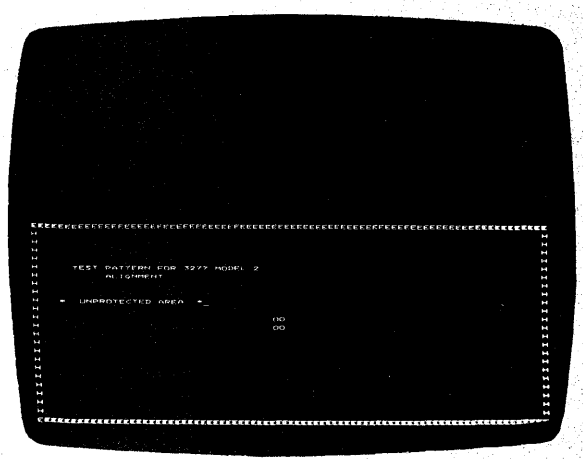


Diagram 3–21. 1/2 Vertical Yoke Open †

Model 1 malfunction produces similar results. The vertical bar appears in every row that has data.

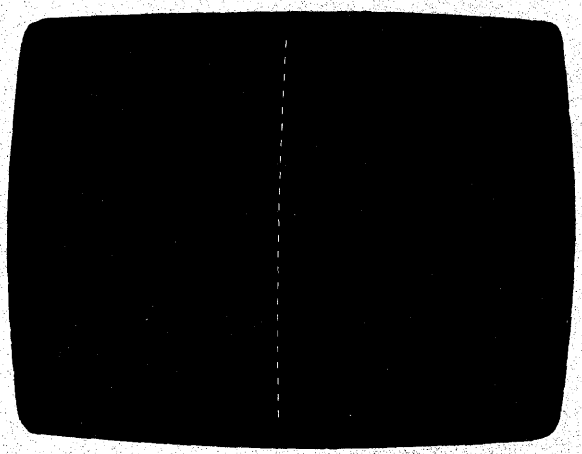


Diagram 3–22. Horizontal Yoke Open †

Model 1 malfunction produces similar results. The pattern displayed is data dependent.

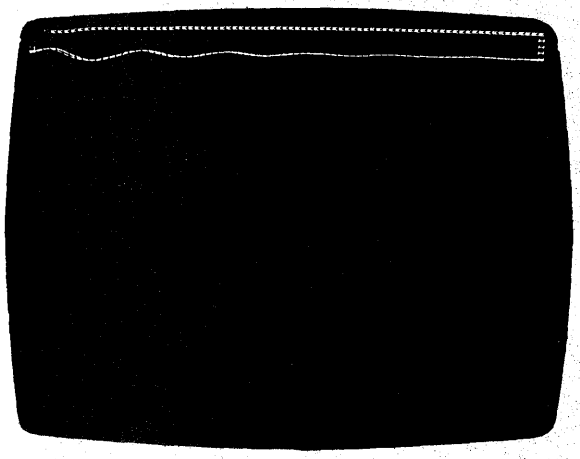


Diagram 3–23. Vertical Yoke Open †

† Connector P1 loose on analog card can cause similar symptom. Check P1 before changing yoke. change analog card if connector and / or yoke do not repair the problem.

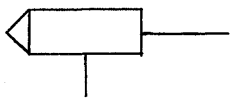
The Troubleshooting Diagrams (29 sheets) in this section should be used as directed by the Symptom Index (Section 3). The diagrams are flowcharts arranged in a sequence that ensures successful trouble resolution in a minimum time. The steps in the flowcharts must be followed in sequence because successive steps depend on the actions and results obtained in preceding steps. Although the sequence may seem illogical and shortcuts may seem apparent, deviation is discouraged to avoid unnecessary duplication of effort and prolonged service calls.

Sheet 1 determines whether the symptom experienced is caused by a display station problem or by a control unit problem. Subsequent flowcharts cover display, keyboard, selector pen, and card reader malfunctions. Additional sheets analyze power troubles and miscellaneous keyboard assembly electrical and mechanical troubles.

Observe good safety habits while working on the display station with power on. High voltage is present at the CRT anode, the yoke assembly, the HV power supply, and the voltage distribution points. Always remove power from the display station when removing or replacing logic cards. This avoids damaging circuitry on that card or other cards feeding it.

The flowcharts use the terms "replace card XX" and "change card XX". "Replace" means to reinstall the same card that was earlier removed; "change" means to install a new card from stock. The old card being changed is the probable cause of the failure.

Two unique symbols are used in the flowcharts. The symbol

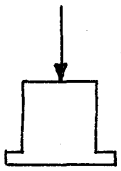


means to probe (with the logic probe) the point designated in the symbol. Seven logic probe conditions can be seen with the older style probe (PN 453652). An output line from the probe symbol specifies one of the seven conditions. If the observed condition is the same as that specified in the flowchart, continue down that part of the flowchart. If the observed result is different from the specified result, use the part of the flowchart labeled "Other". The seven logic probe observations specified in the flowcharts and their definitions are as follows:

1. Red – solid red.
2. Green – solid green.
3. Red Blink – solid green with one (and only one) red blink.
4. Green Blink – solid red with one (and only one) green blink.
5. Pulsing Red – solid green with regular red pulses. (Any frequency of pulses as long as green indicator appears to stay on.)
6. Pulsing Green – solid red with regular green pulses. (Any frequency of pulses as long as red indicator appears to stay on.)
7. Red and Green – approximately equal red and green pulses (any frequency).

The same conditions can be observed using the new GLP (General Logic Probe), PN 453212. The difference from the older-style logic probe is that the GLP uses UP in place of red to indicate a plus level and DOWN in place of green to indicate a minus level. This difference must be kept in mind when troubleshooting with the GLP because the flowcharts in this manual were designed for use with the older-style logic probe.

The card-shaped symbol



appearing at the end of a diagnostic sequence gives the location of the card(s) to be replaced that will repair the problem. It also means to take the following action:

1. Turn power off.
2. Change card(s).
3. Turn power on.
4. Verify that trouble is repaired.
5. Replace covers.
6. Return display station to user.

When more than one card is listed in the symbol, isolate the failing card by card-swapping from among those specified. Change the failing card, and return the others to stock. If changing the specified cards does not repair the problem, check *all* voltages on the A1 board backpanel at these card locations. Use Diagram 6-19 to identify the voltages and voltage pins.

The flowcharts call out certain check, adjustment, and removal procedures. Because of their length and their utility as standalone procedures, they are contained in Section 5. Flowchart references to these procedures appear as three- or four-digit numbers, indicating the paragraphs in Section 5 where the procedures are found.

Check that all basic cards are installed and seated properly before beginning the troubleshooting procedure. Basic cards for Model 1 display stations are C-E and G-K. Model 2 basic cards are C-K. Applicable feature cards should also be installed and seated properly. Diagram 6-17 shows logic board card plugging for display stations with no features (1/2 board); Diagram 6-18 shows card plugging for display stations that have features installed (2/3 board).

The logic probe is used extensively in this section to isolate failing cards. Ensure that the logic probe is operating correctly before troubleshooting. Use the procedure in paragraph 2.1.3.3 to check out the probe.

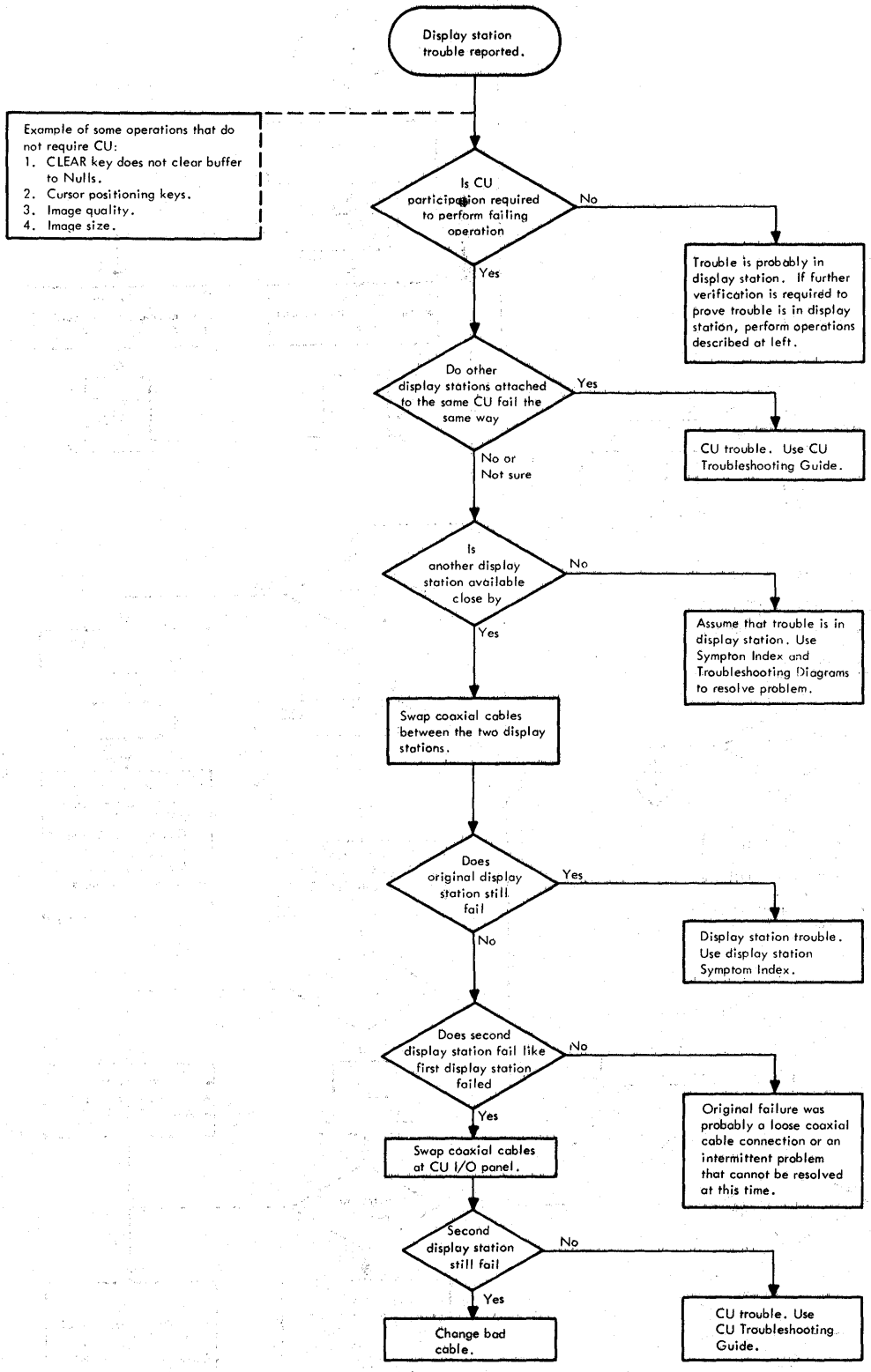


Diagram 4-1. Display Station Troubleshooting Diagram (Sheet 1 of 29)

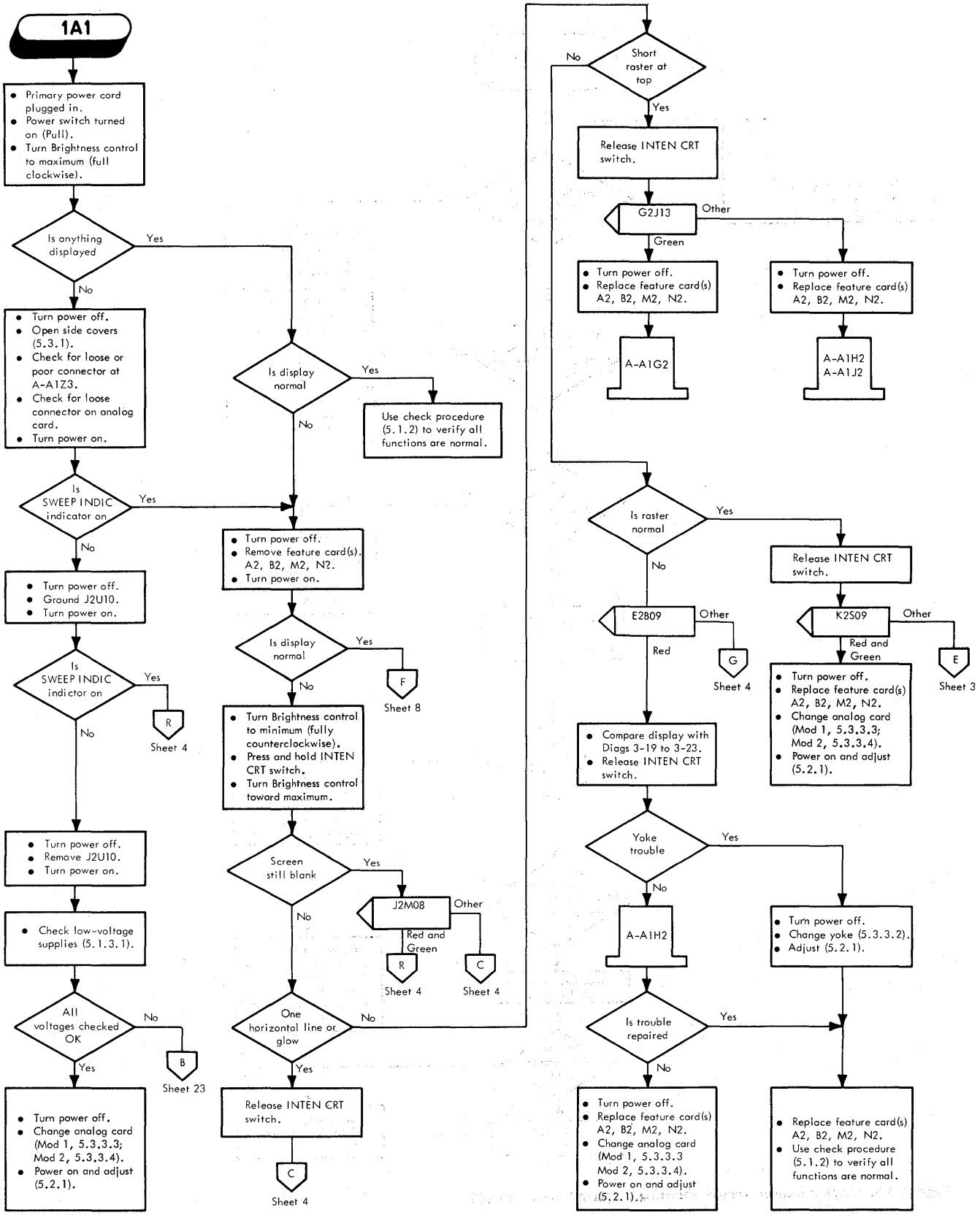


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 2 of 29)

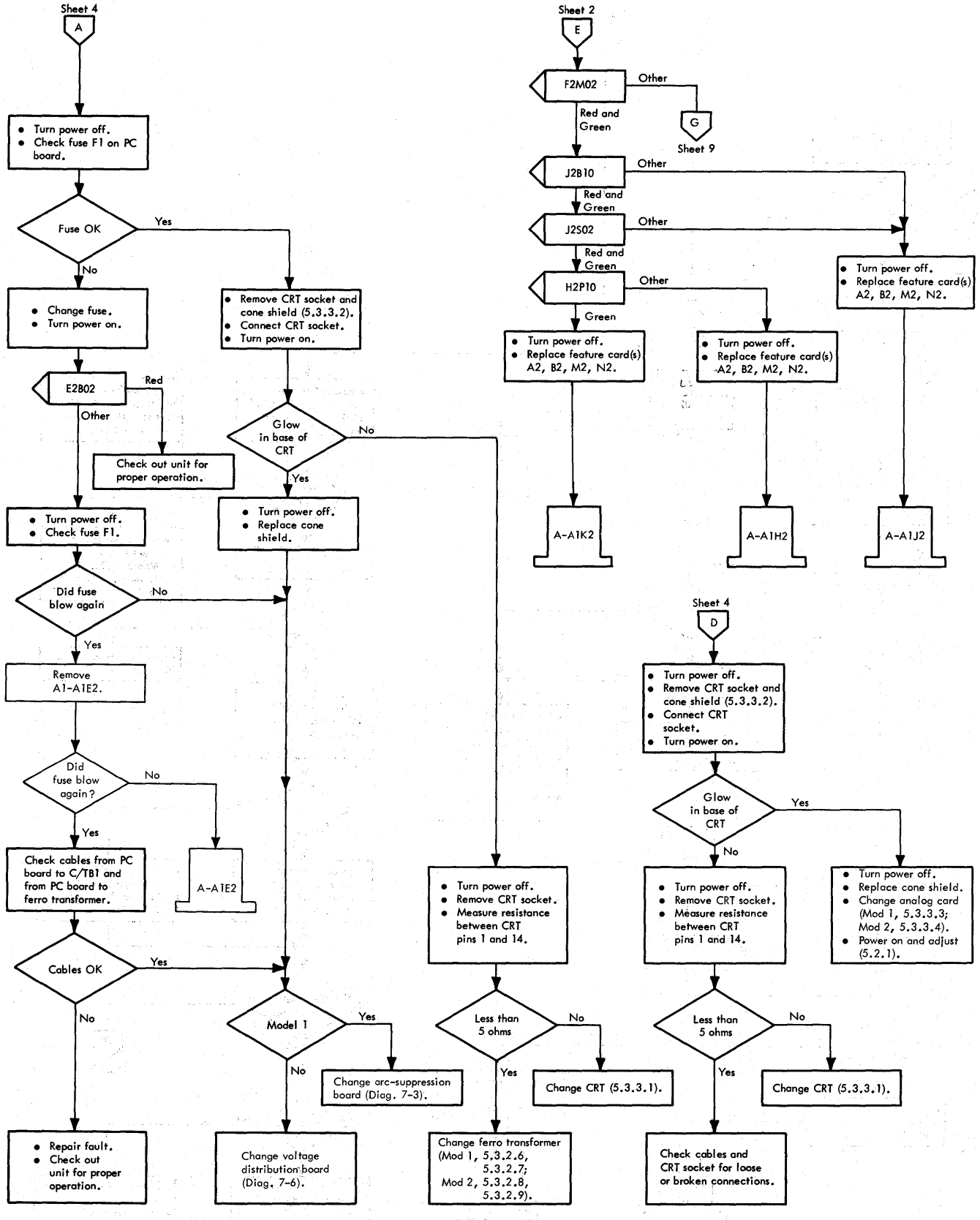


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 3 of 29)

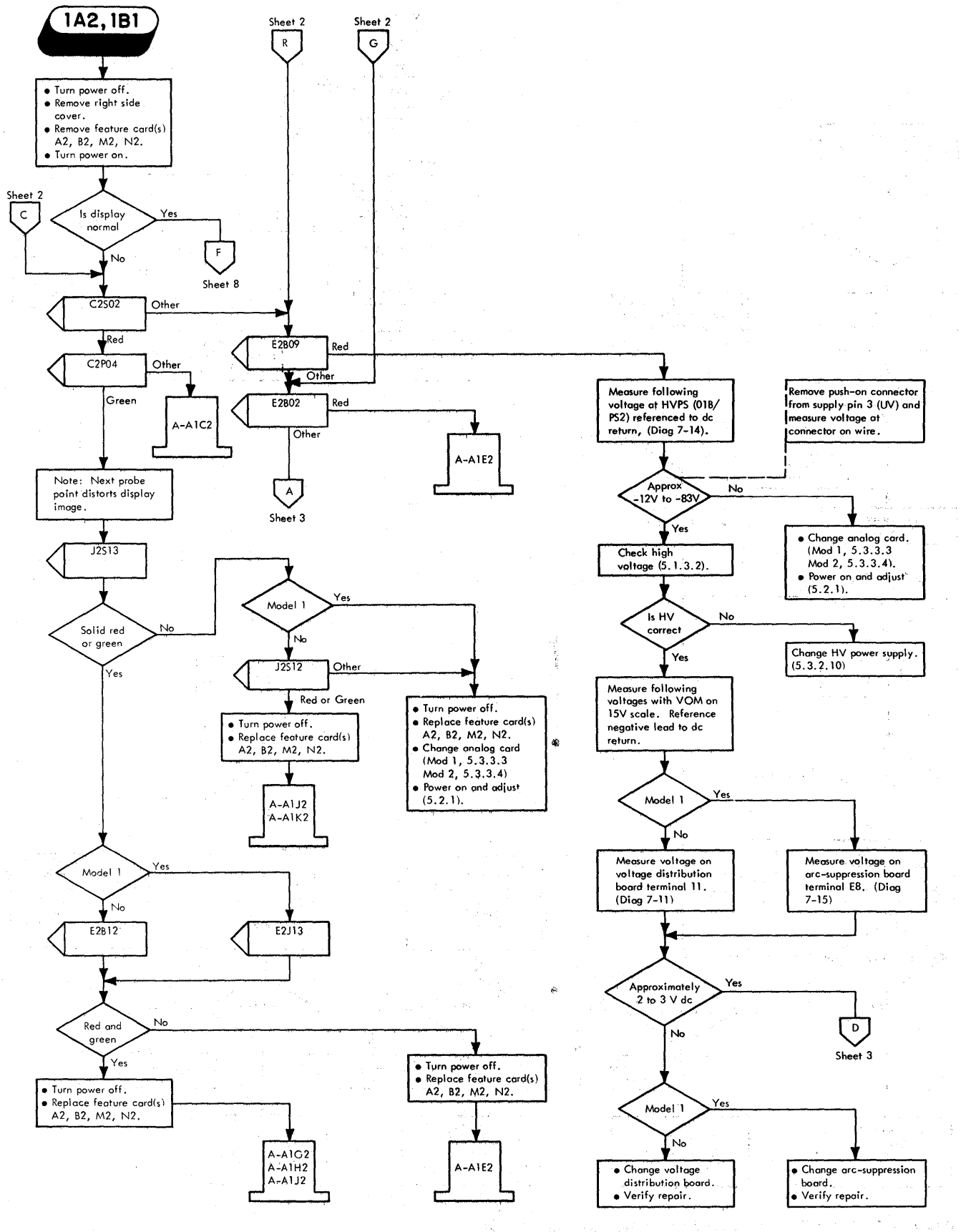


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 4 of 29)

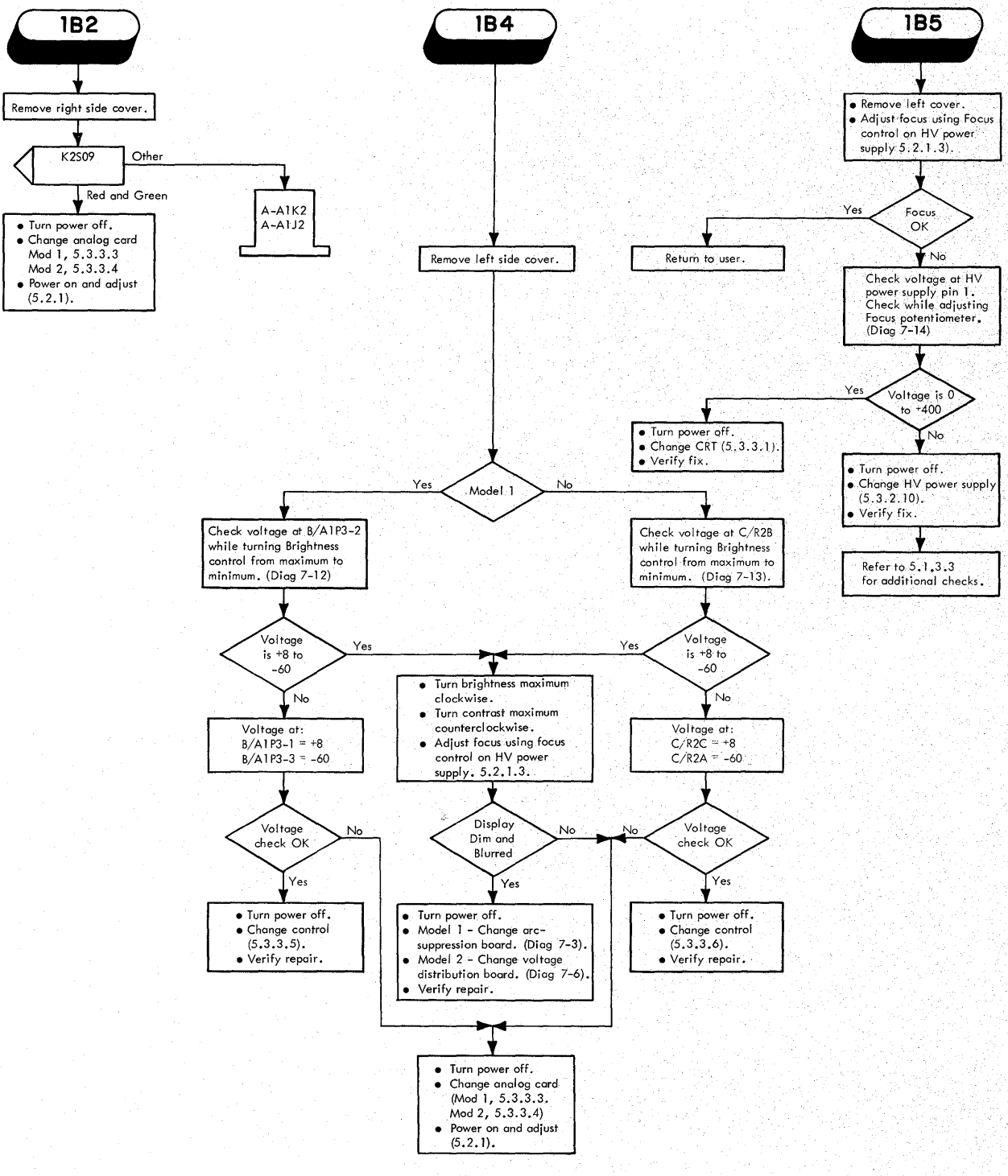


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 5 of 29)

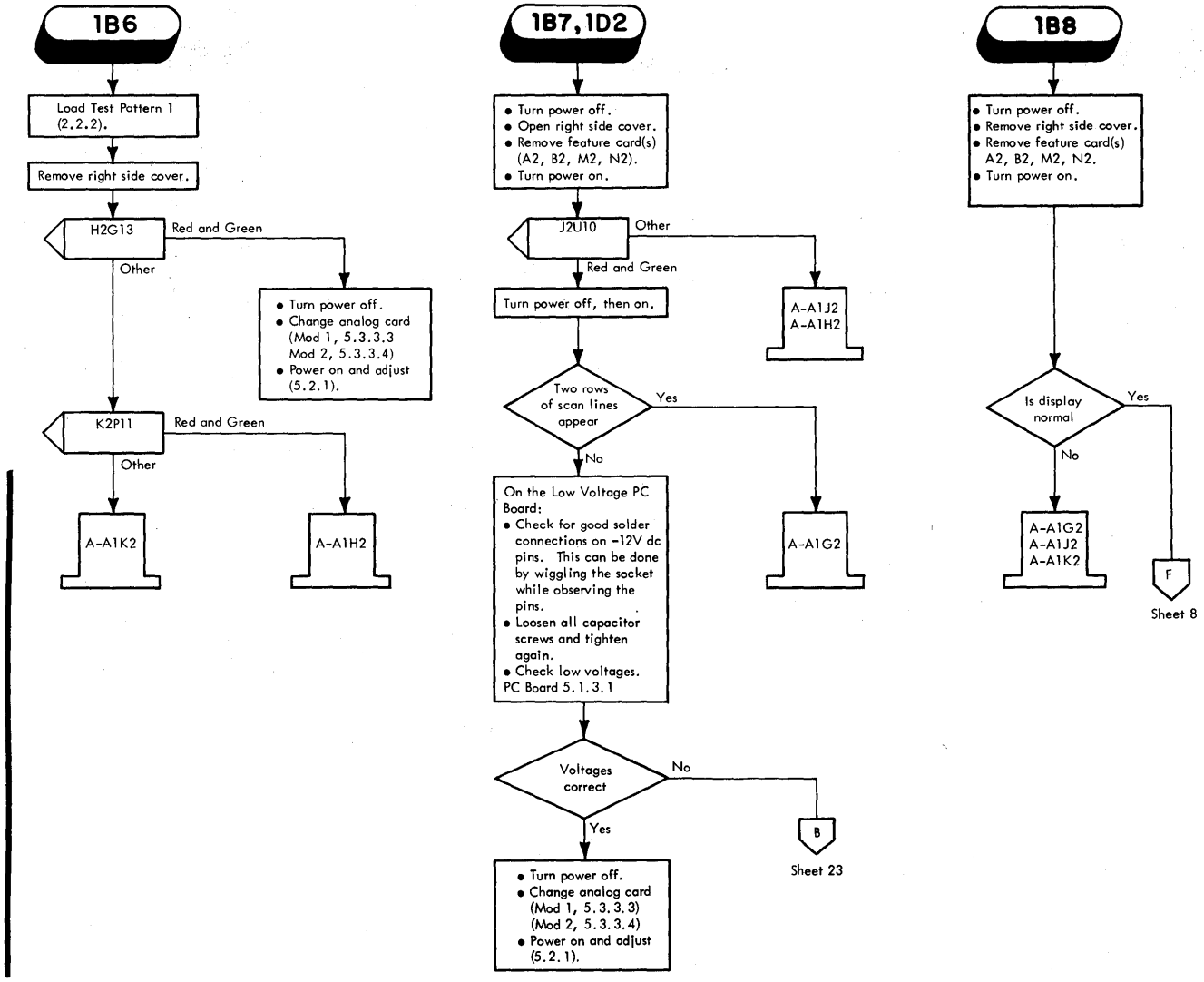
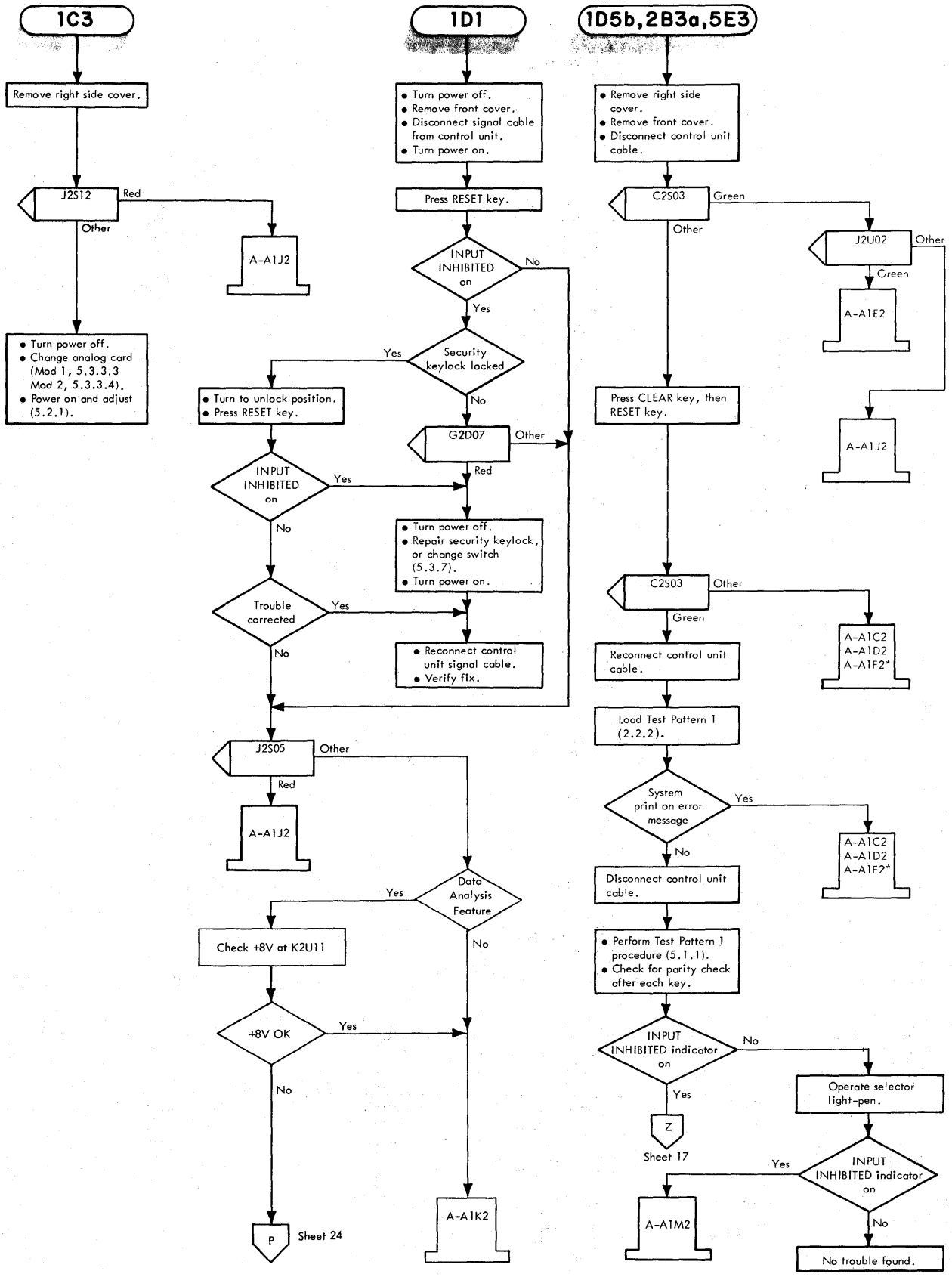


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 6 of 29)



* Model 2 only.

Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 7 of 29)

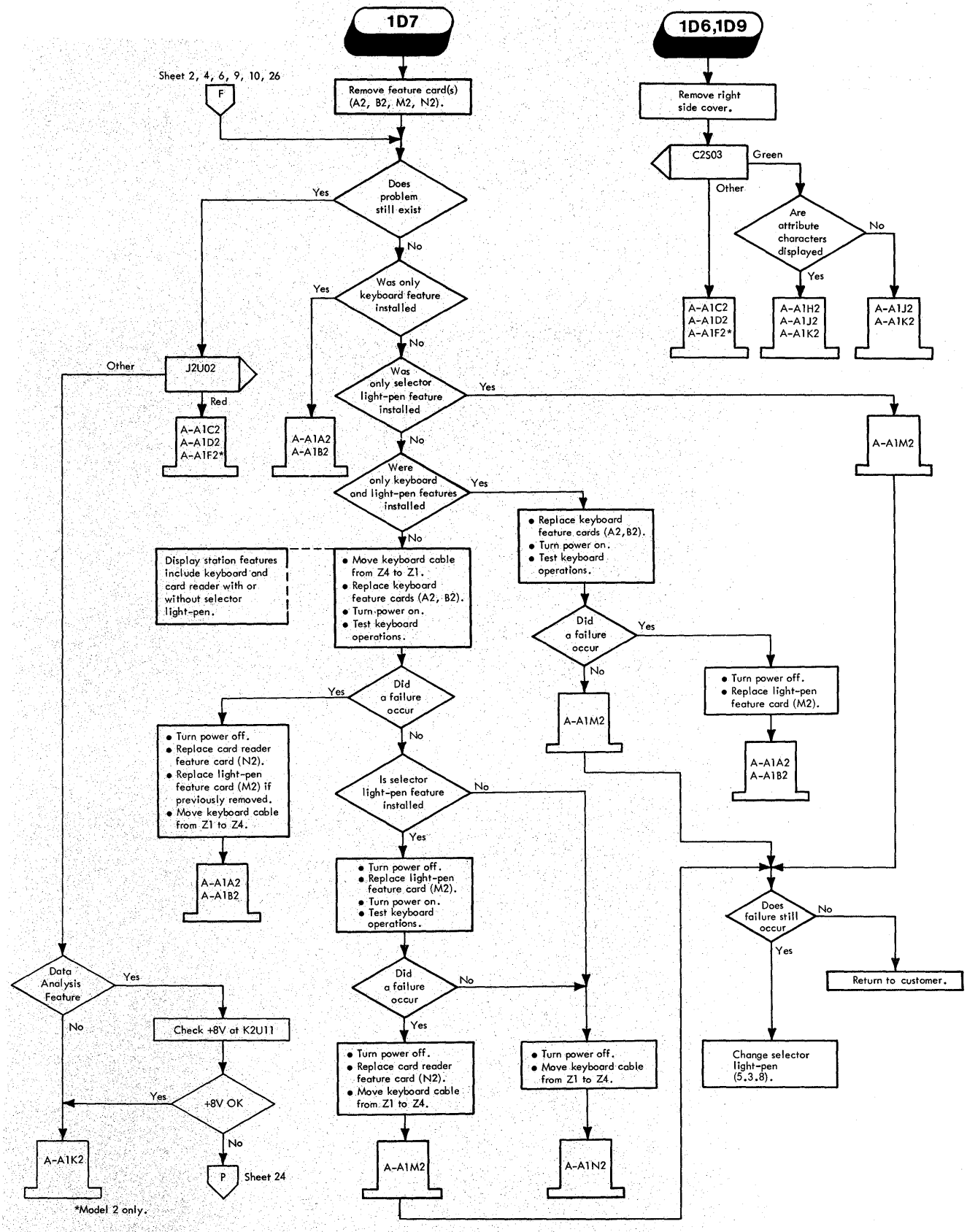


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 8 of 29)

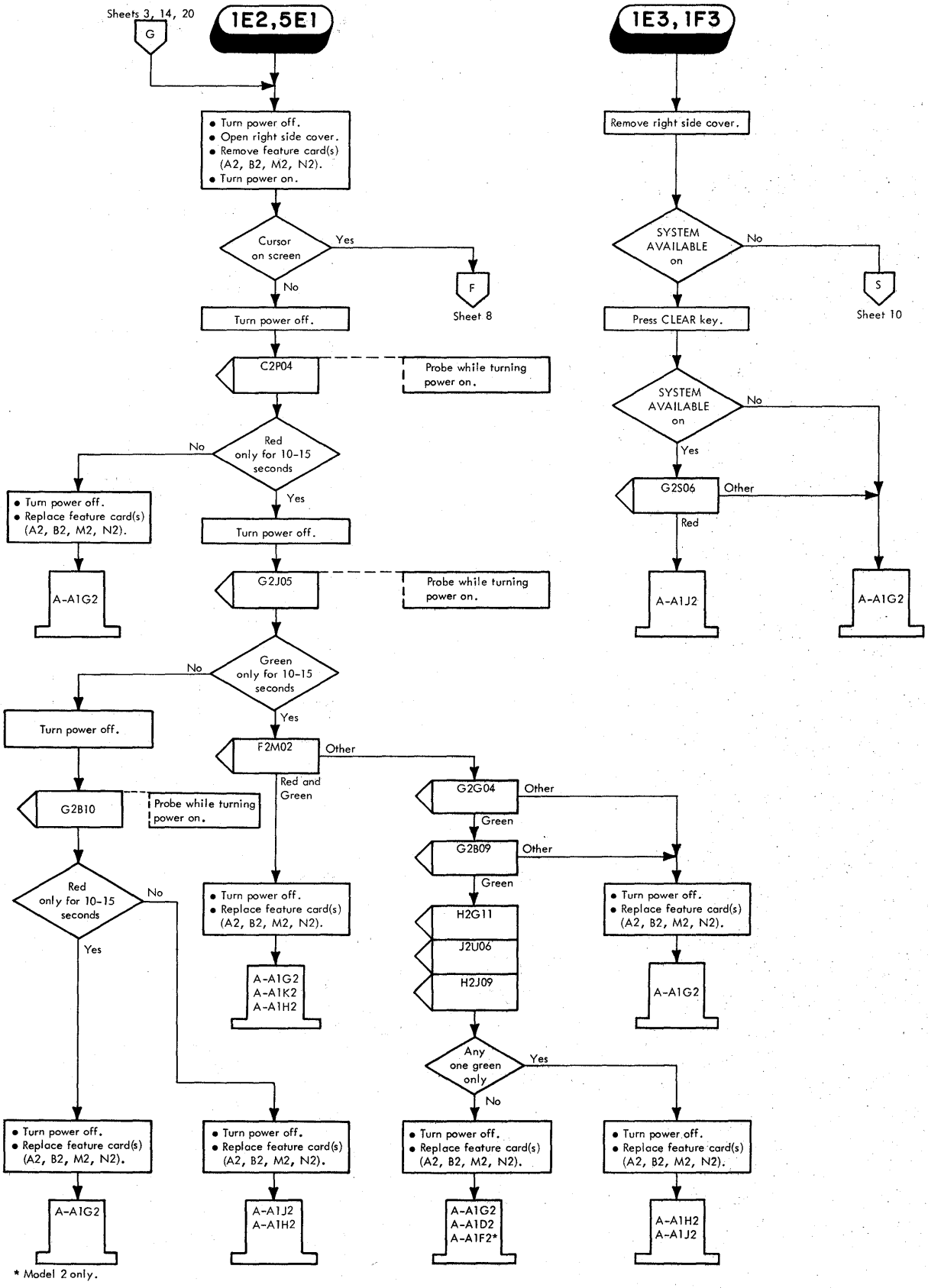
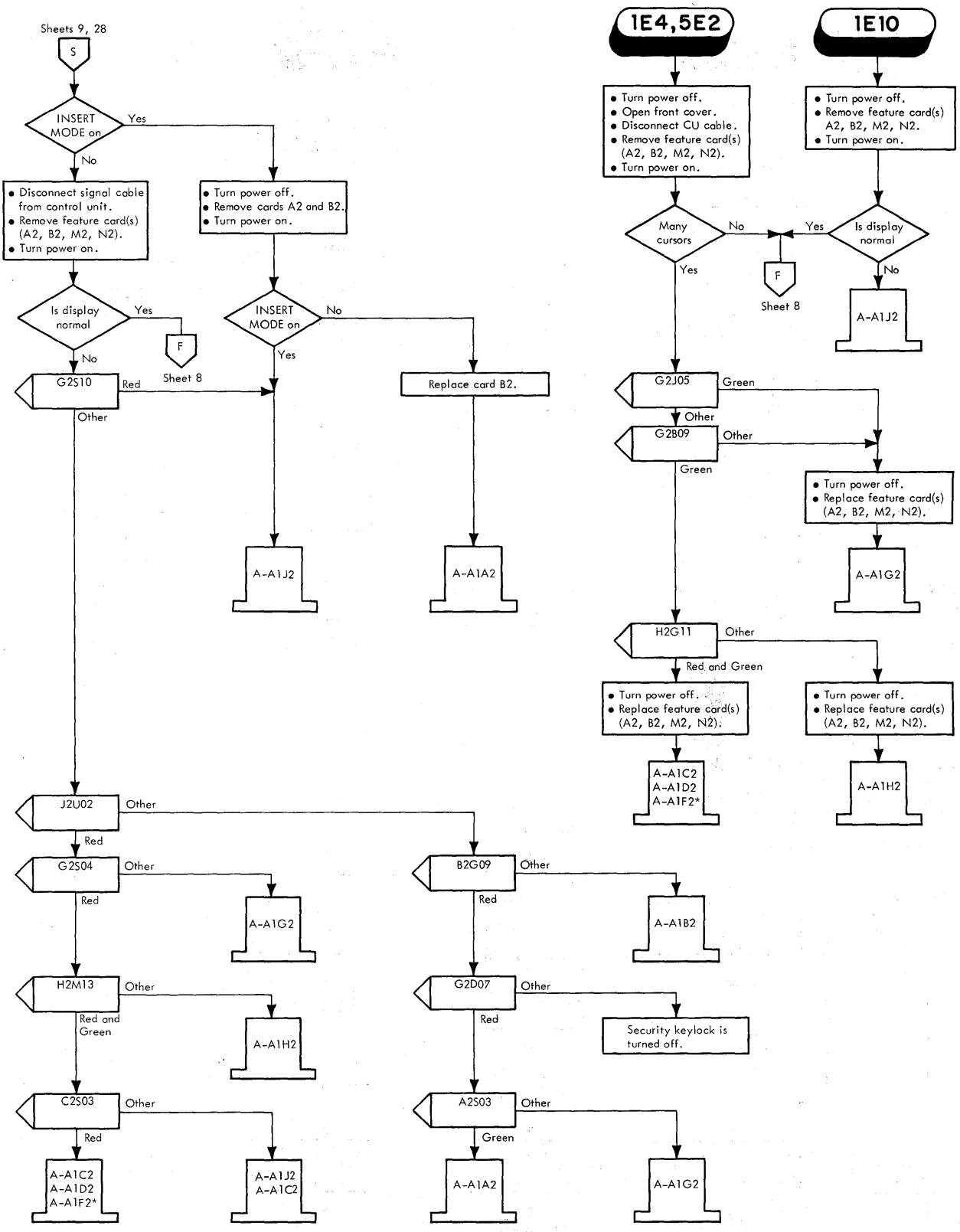


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 9 of 29)



Model 2 Only

Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 10 of 29)

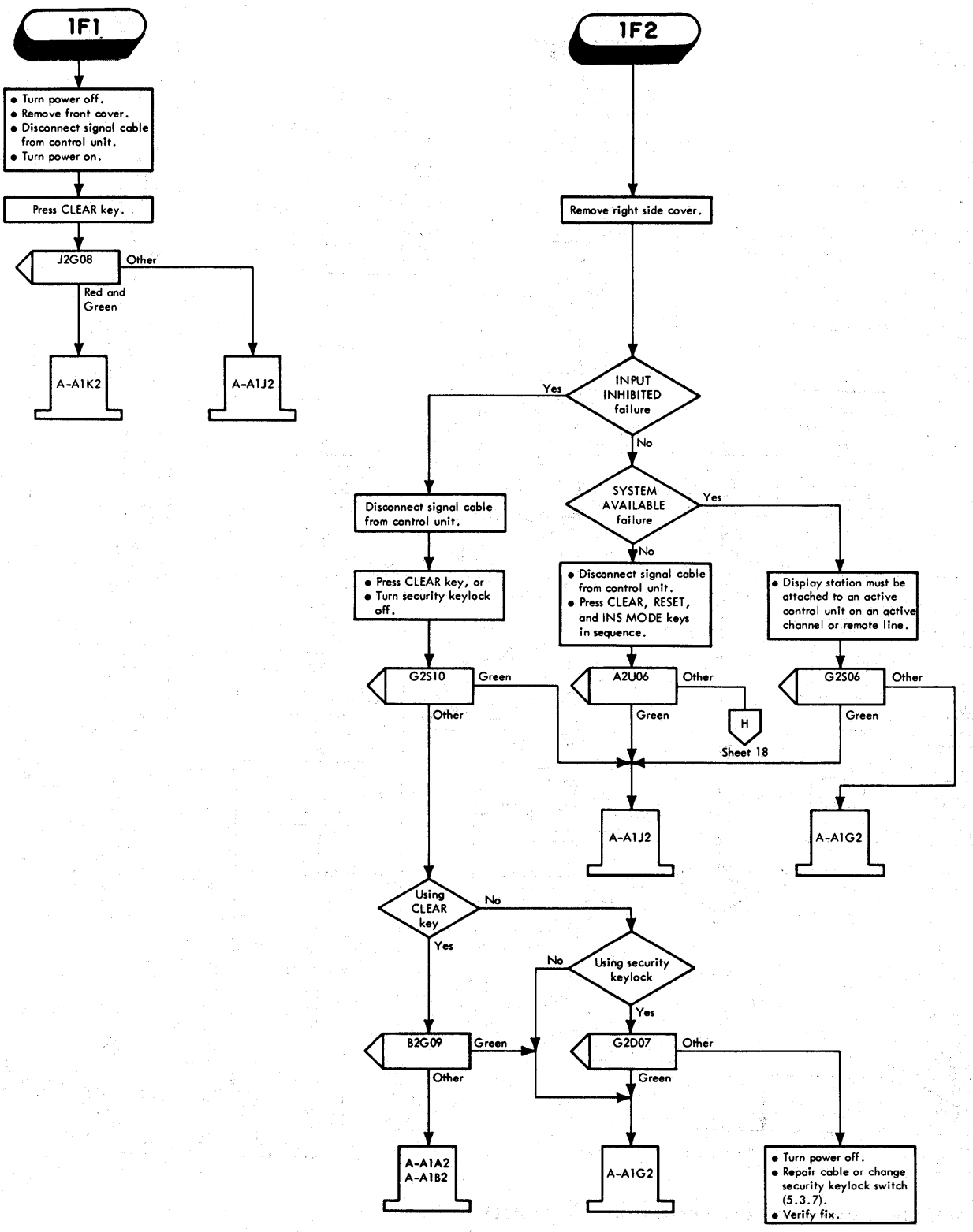


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 11 of 29)

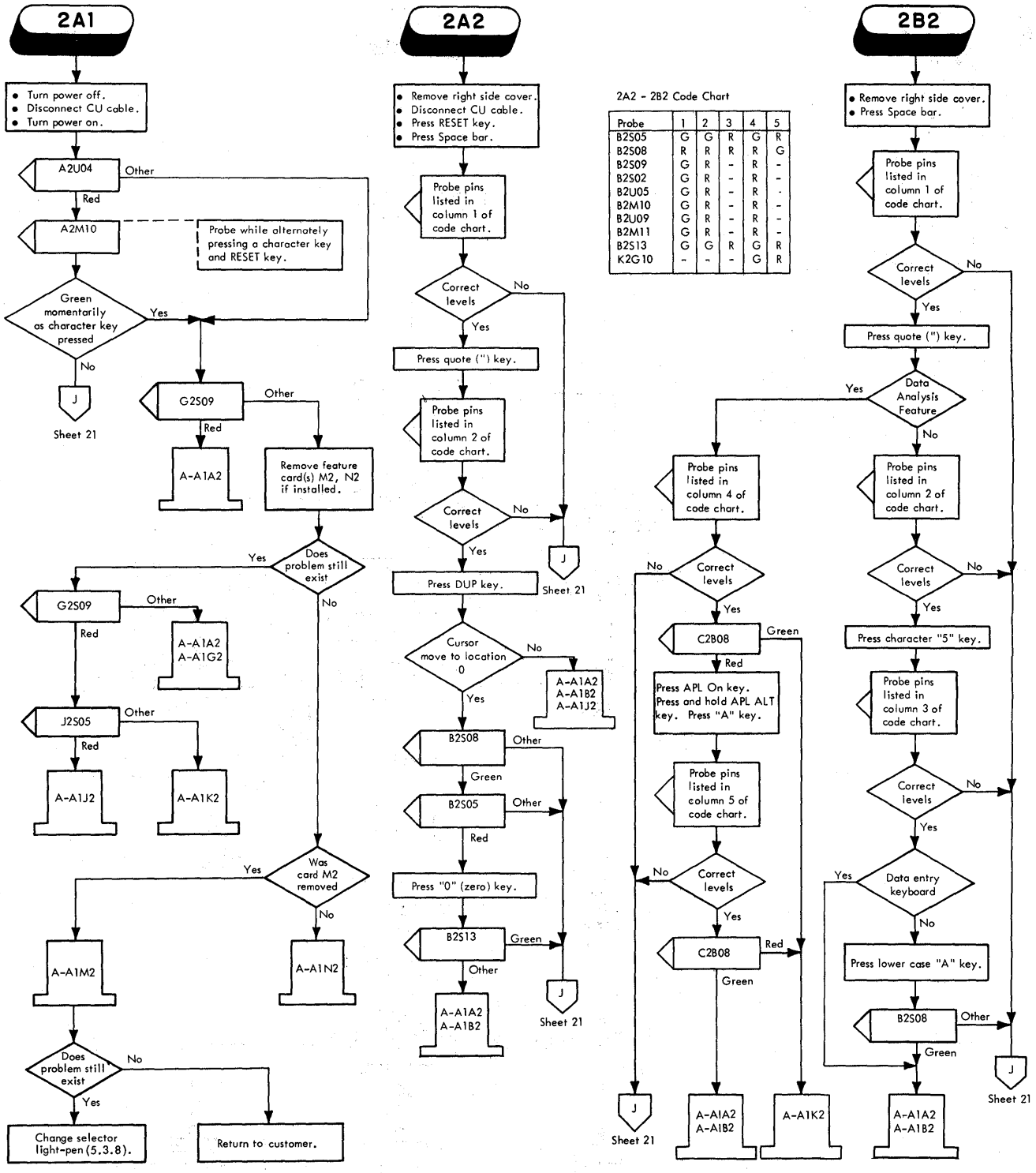


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 12 of 29)

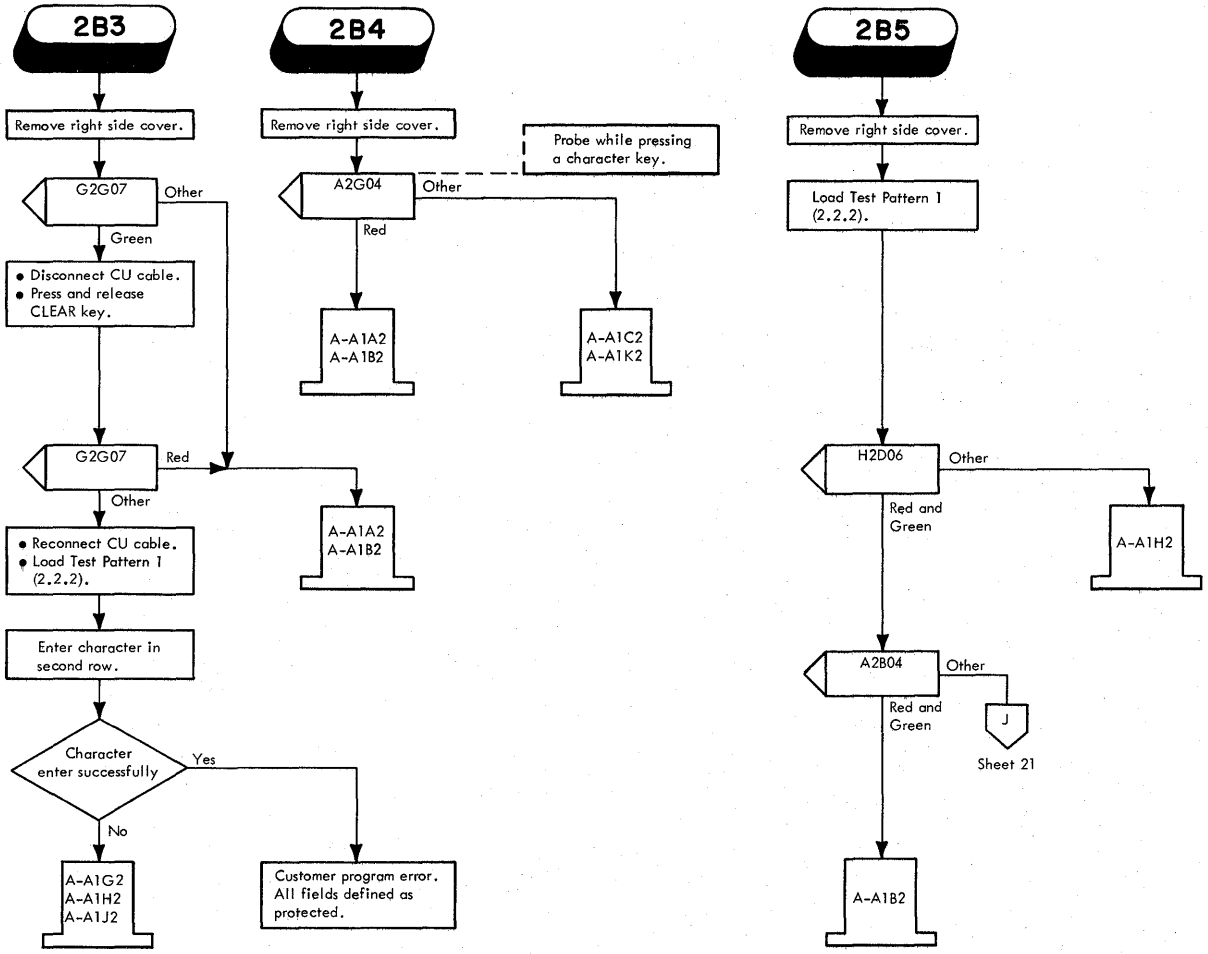


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 13 of 29)

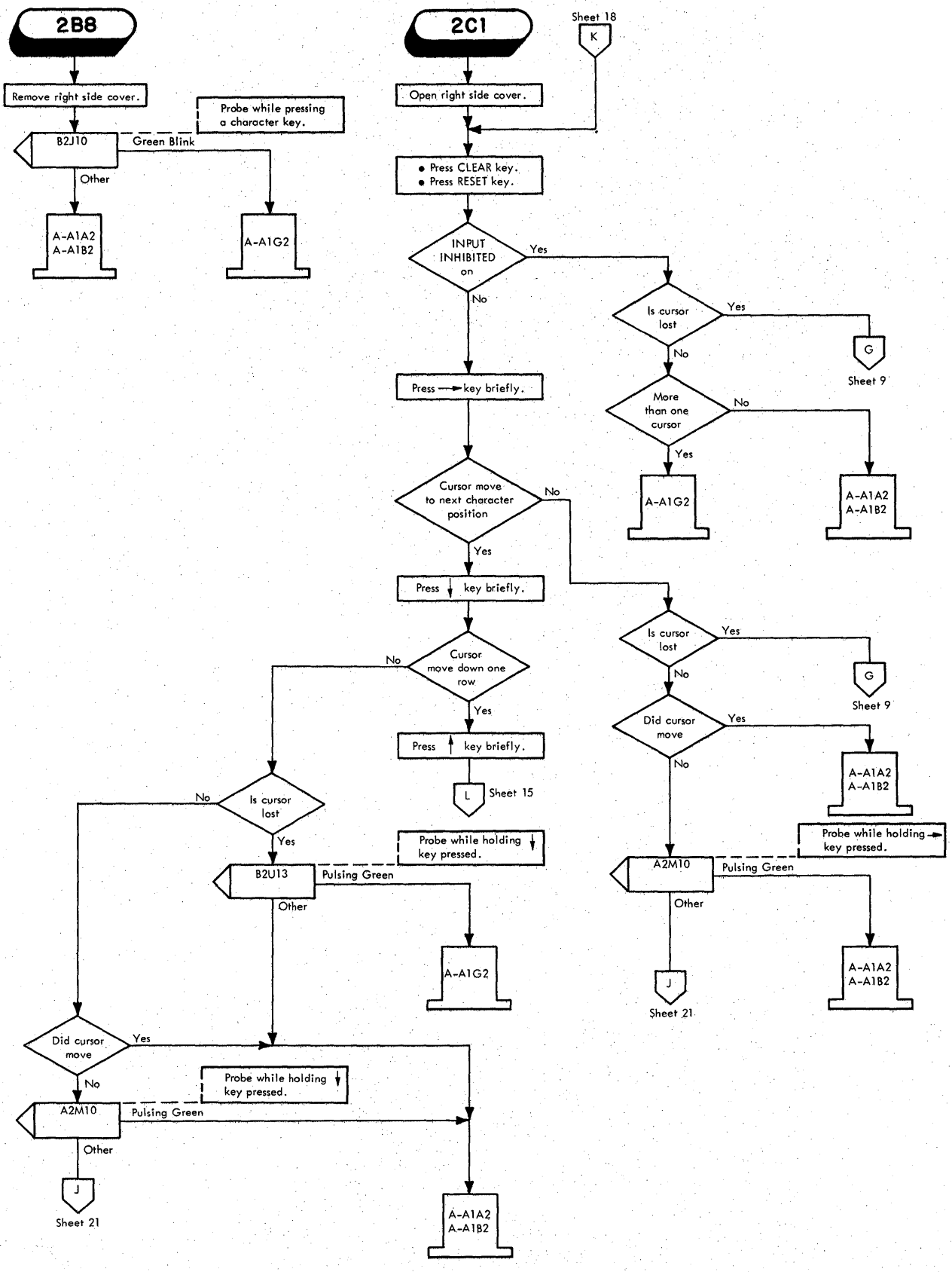


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 14 of 29)

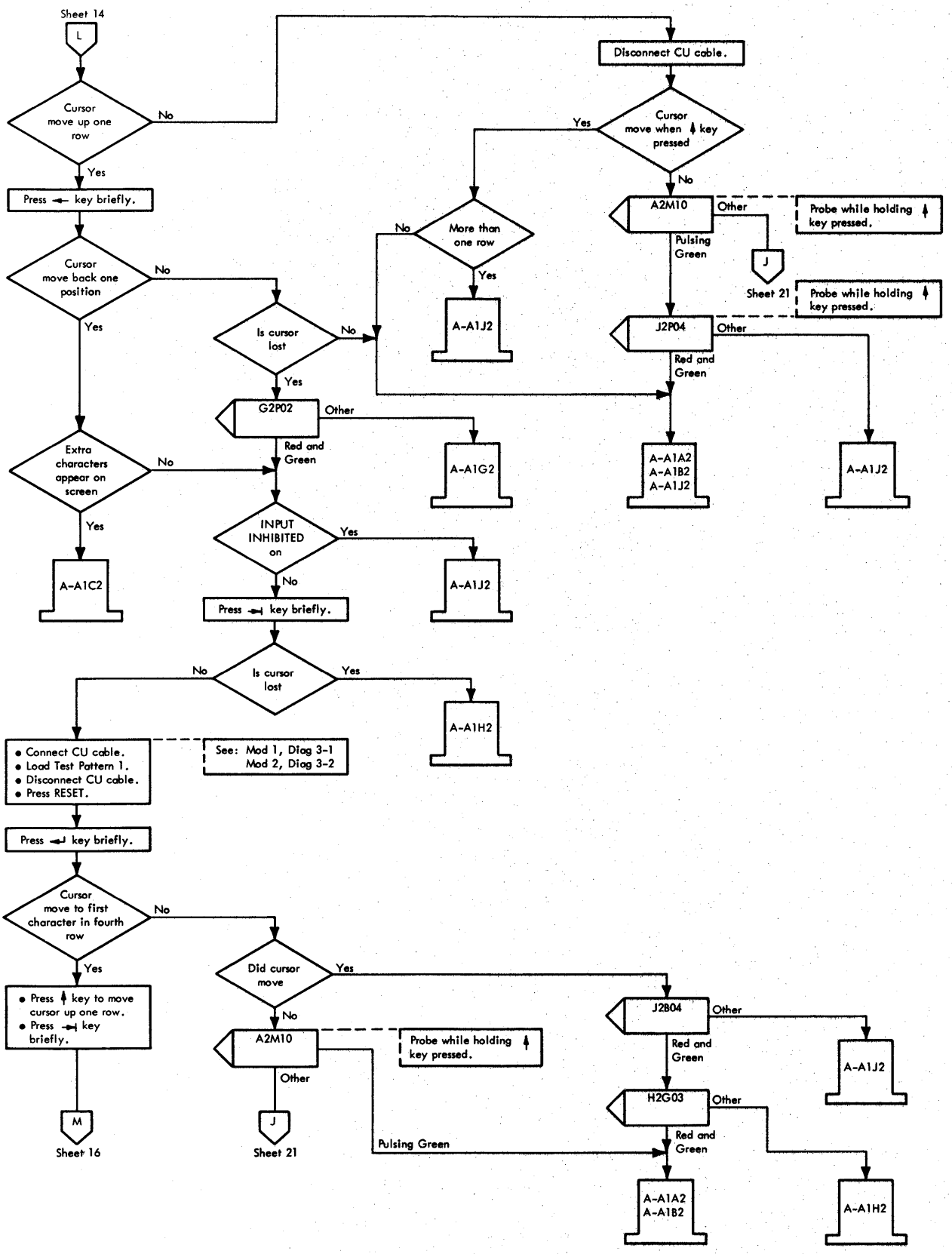


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 15 of 29)

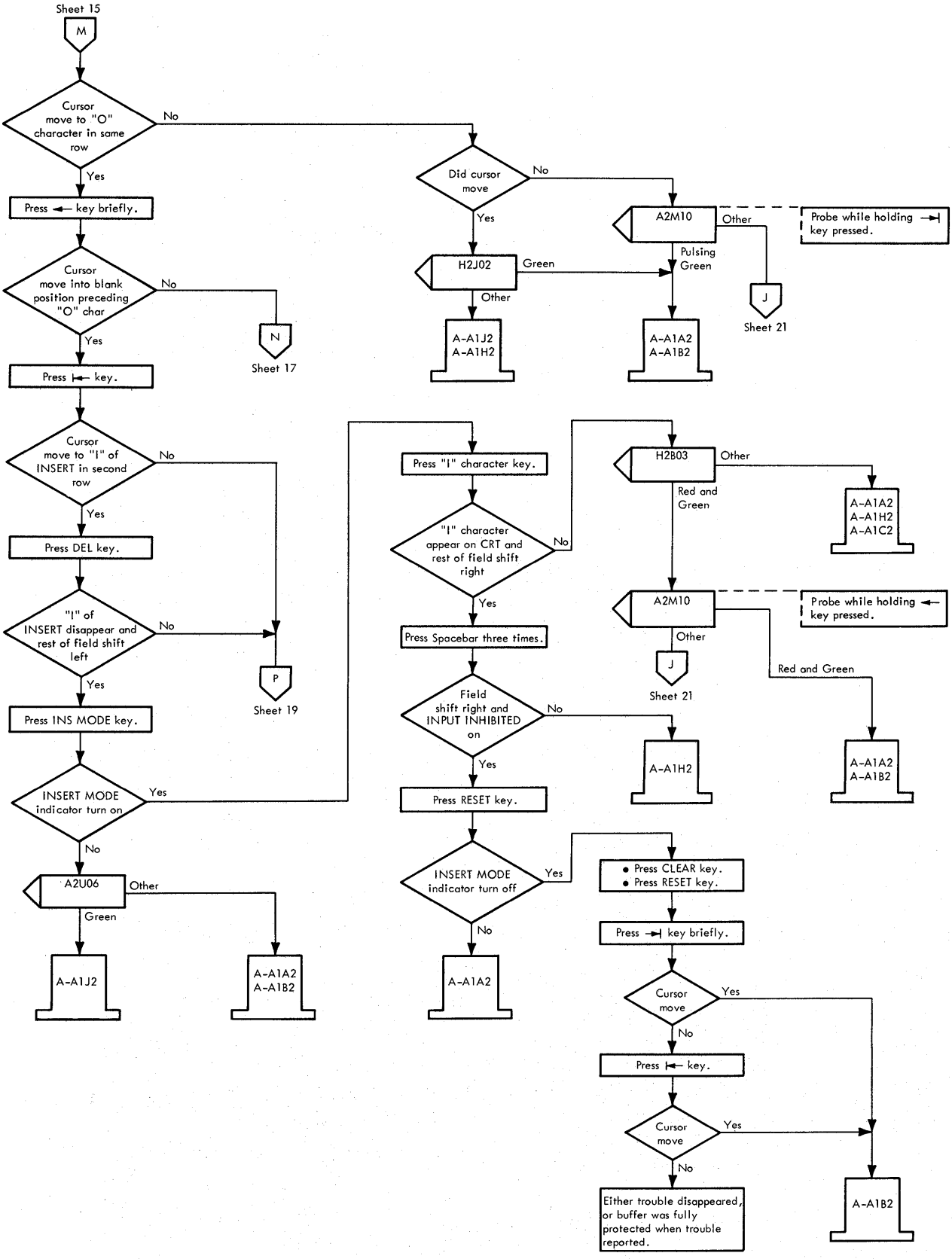


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 16 of 29)

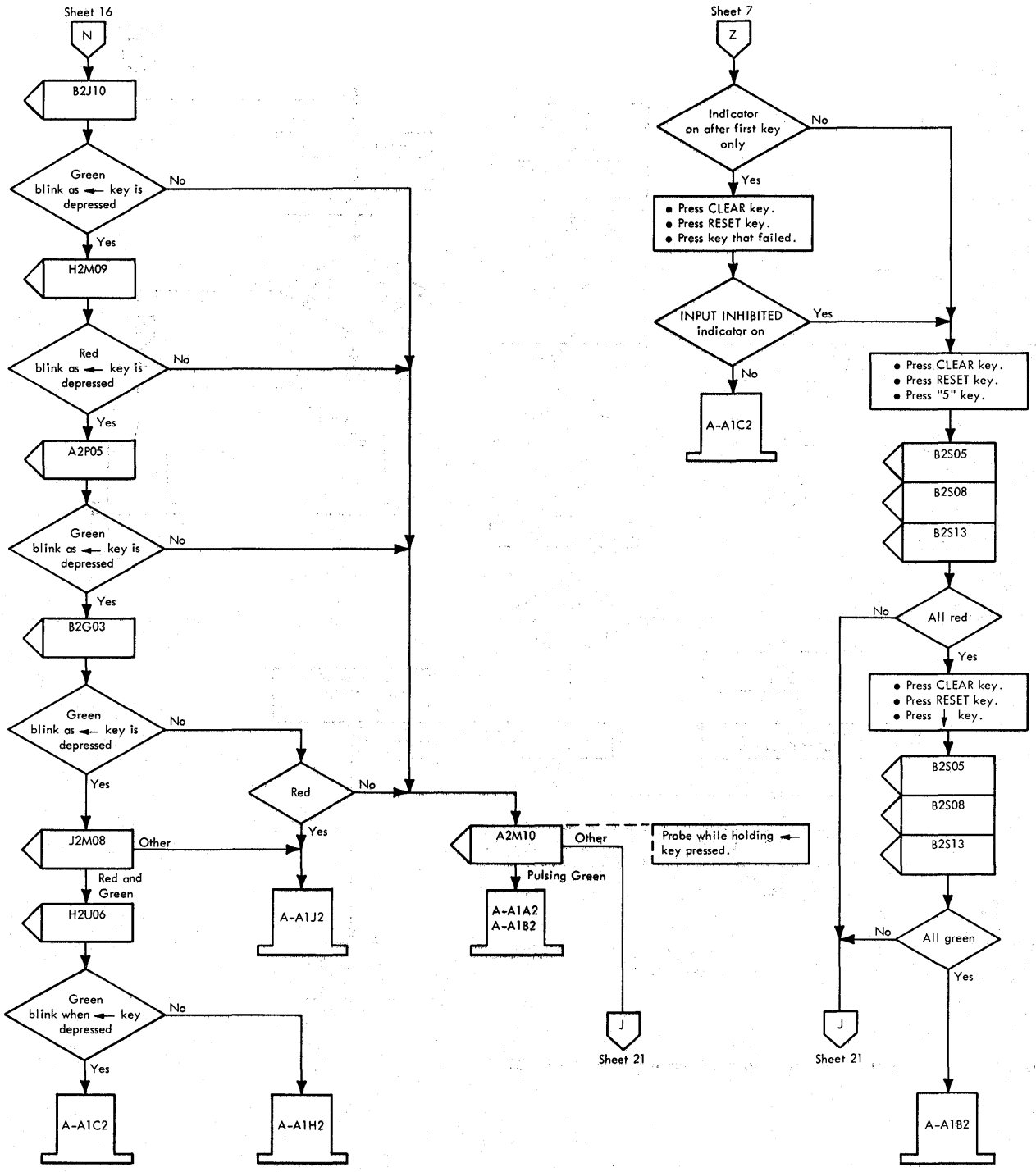


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 17 of 29)

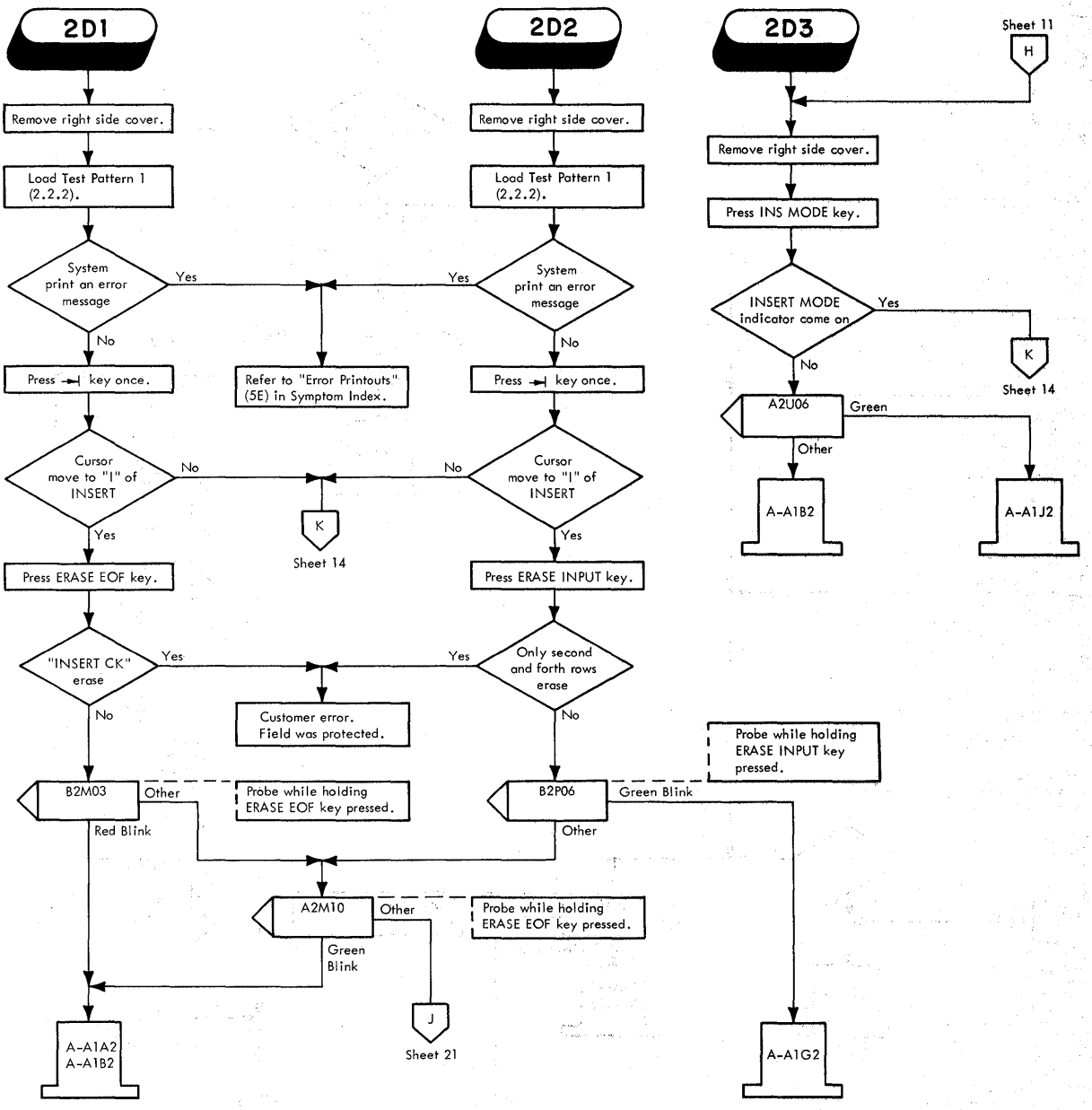


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 18 of 29)

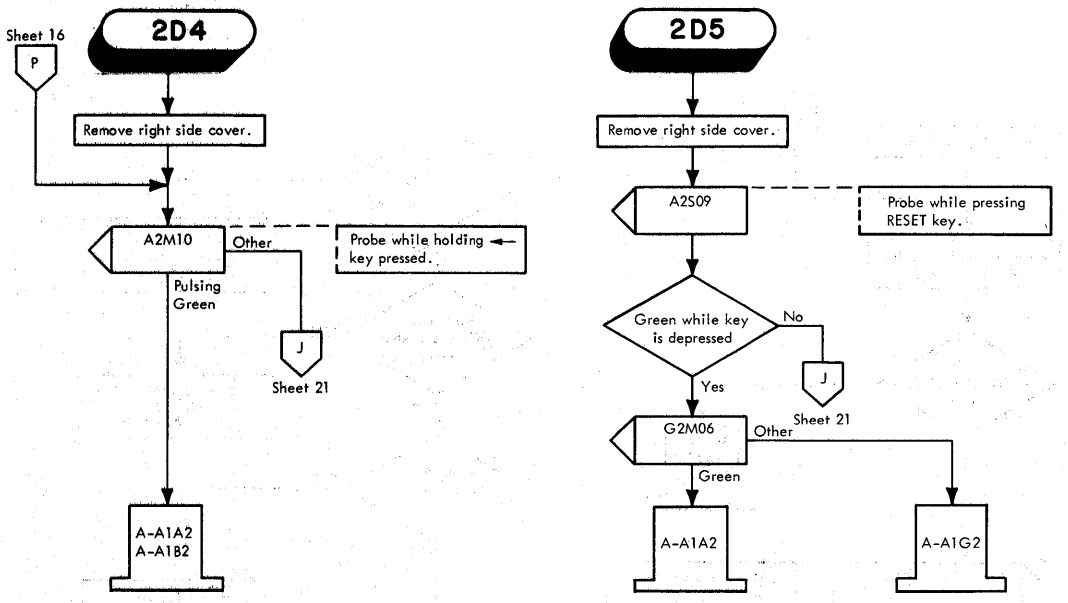


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 19 of 29)

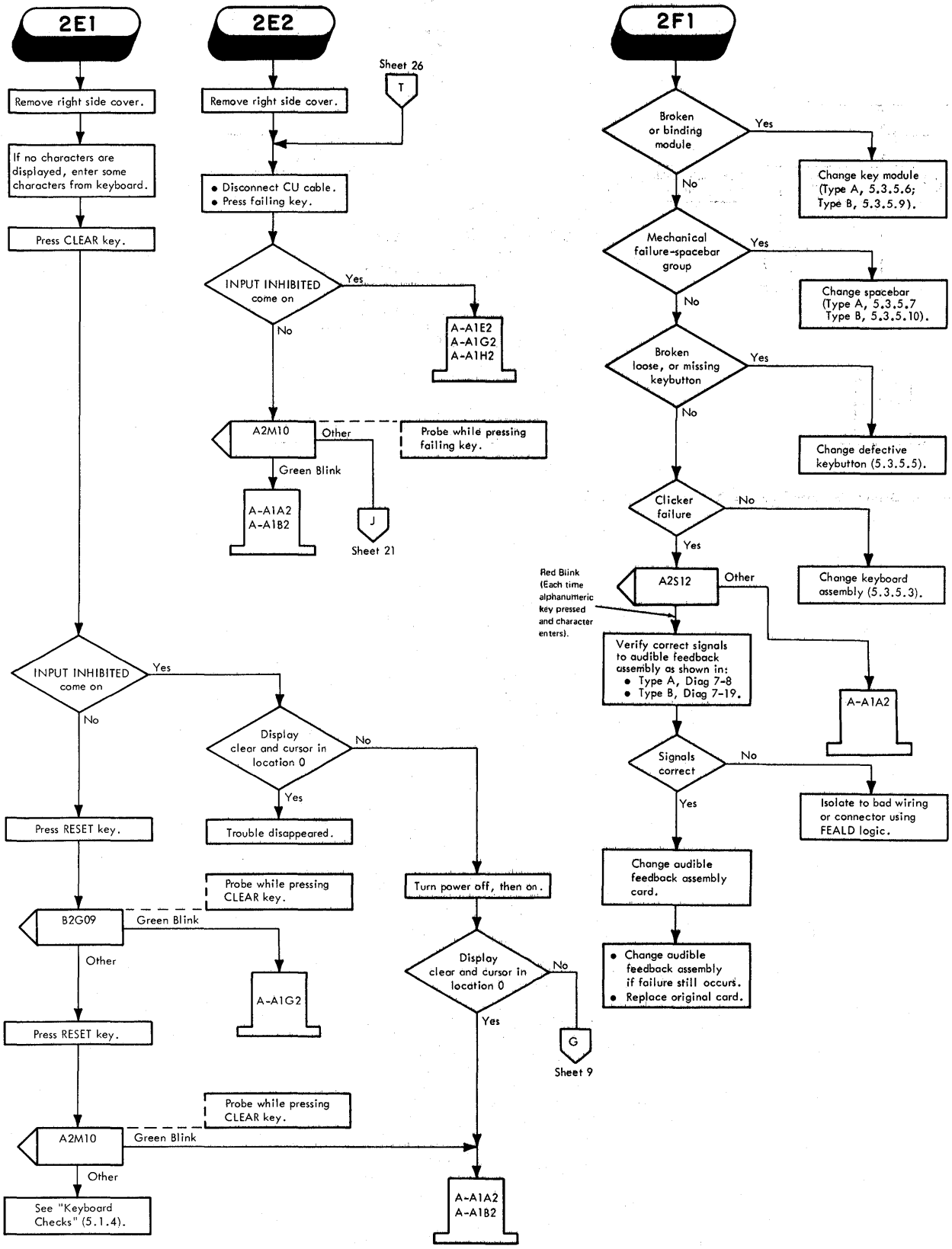


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 20 of 29)

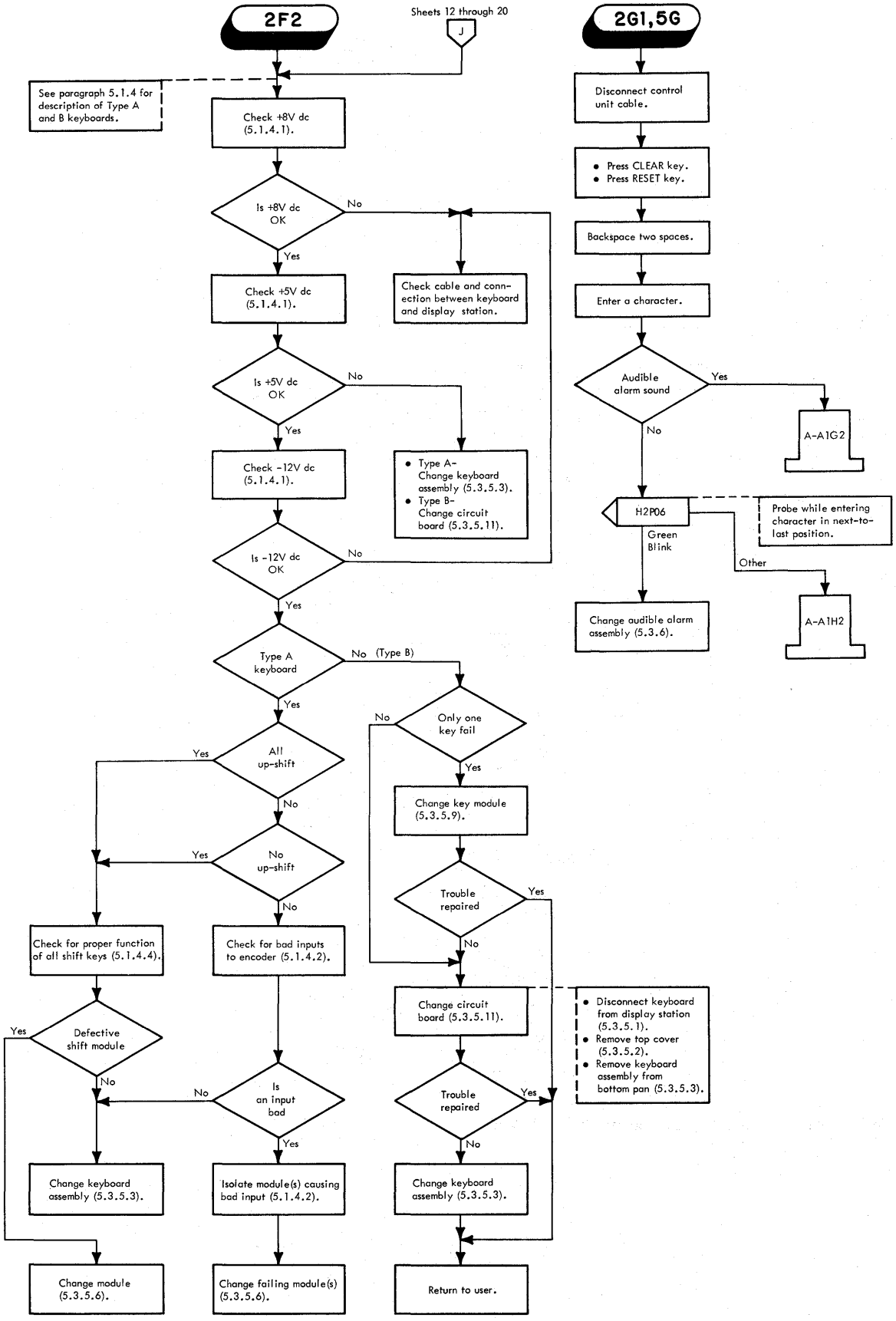


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 21 of 29)

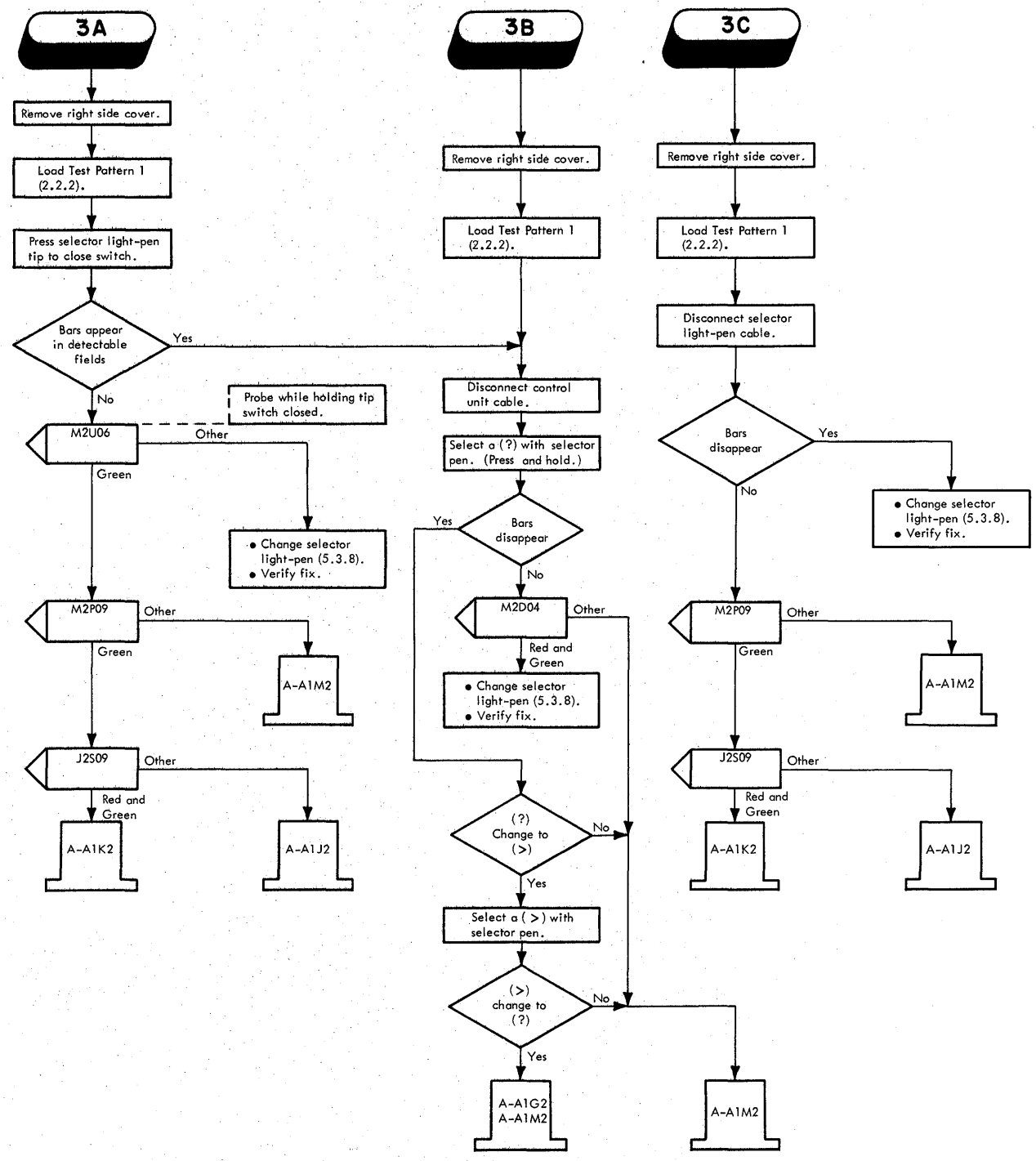


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 22 of 29)

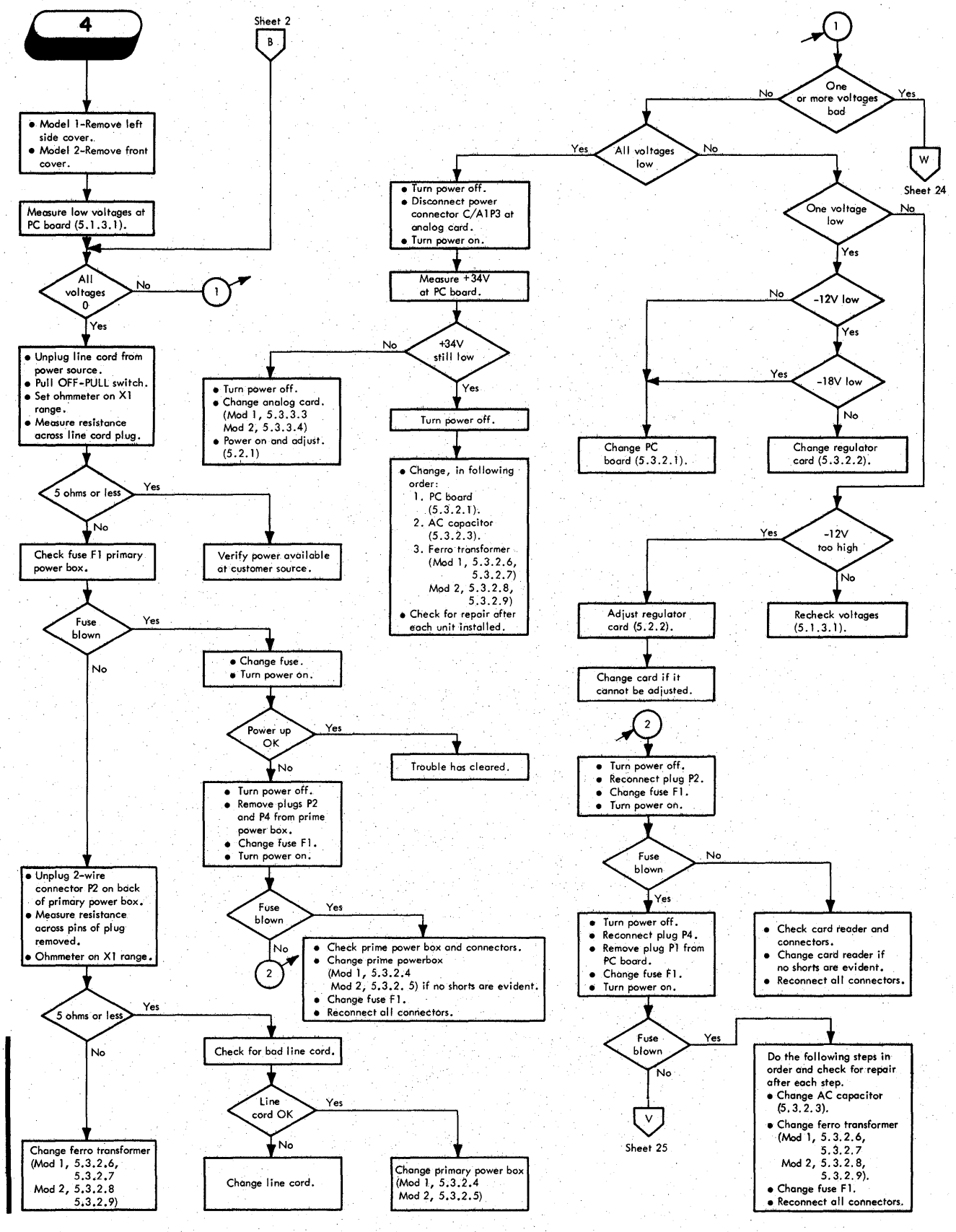


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 23 of 29)

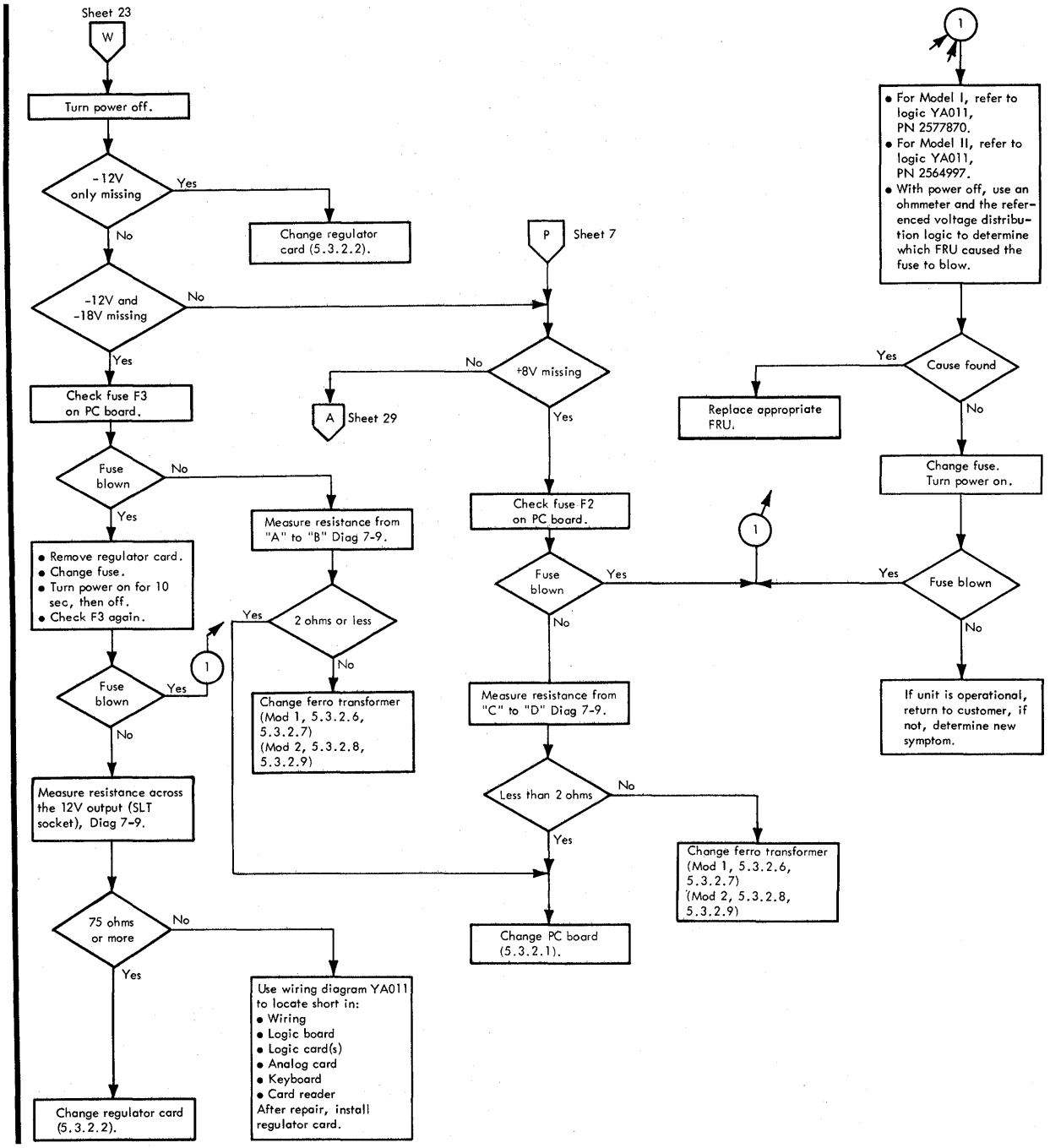


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 24 of 29)

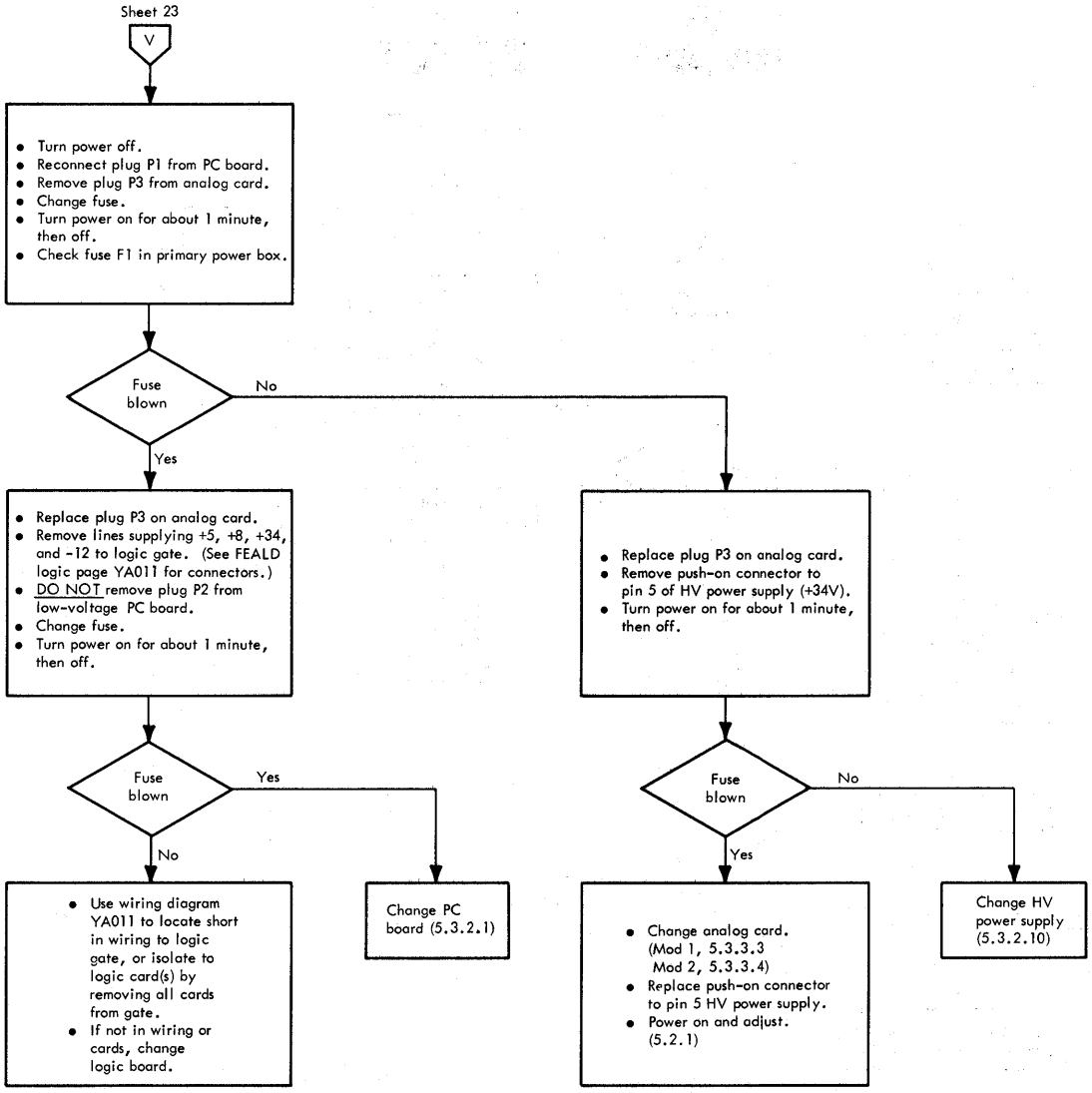


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 25 of 29)

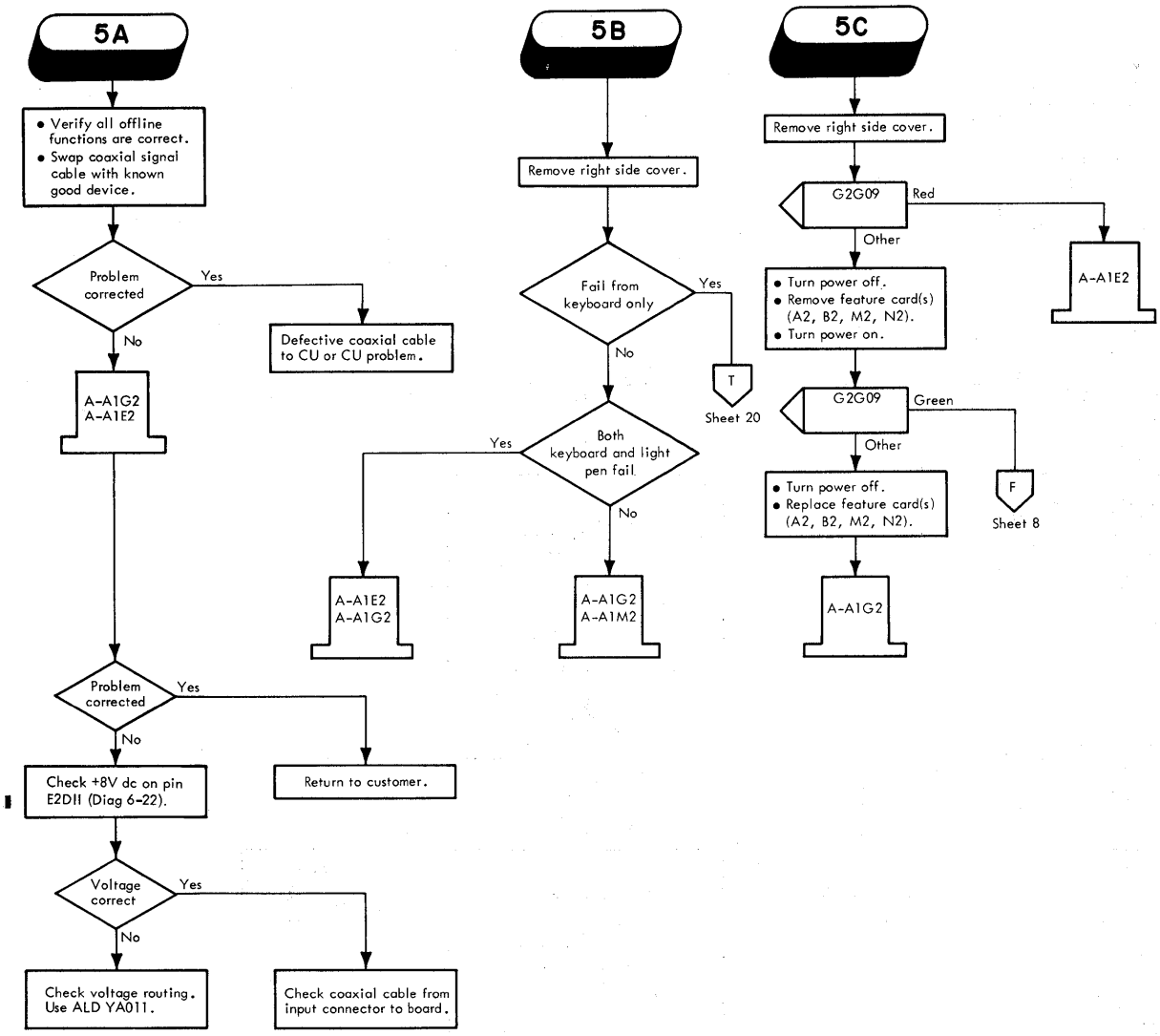


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 26 of 29)

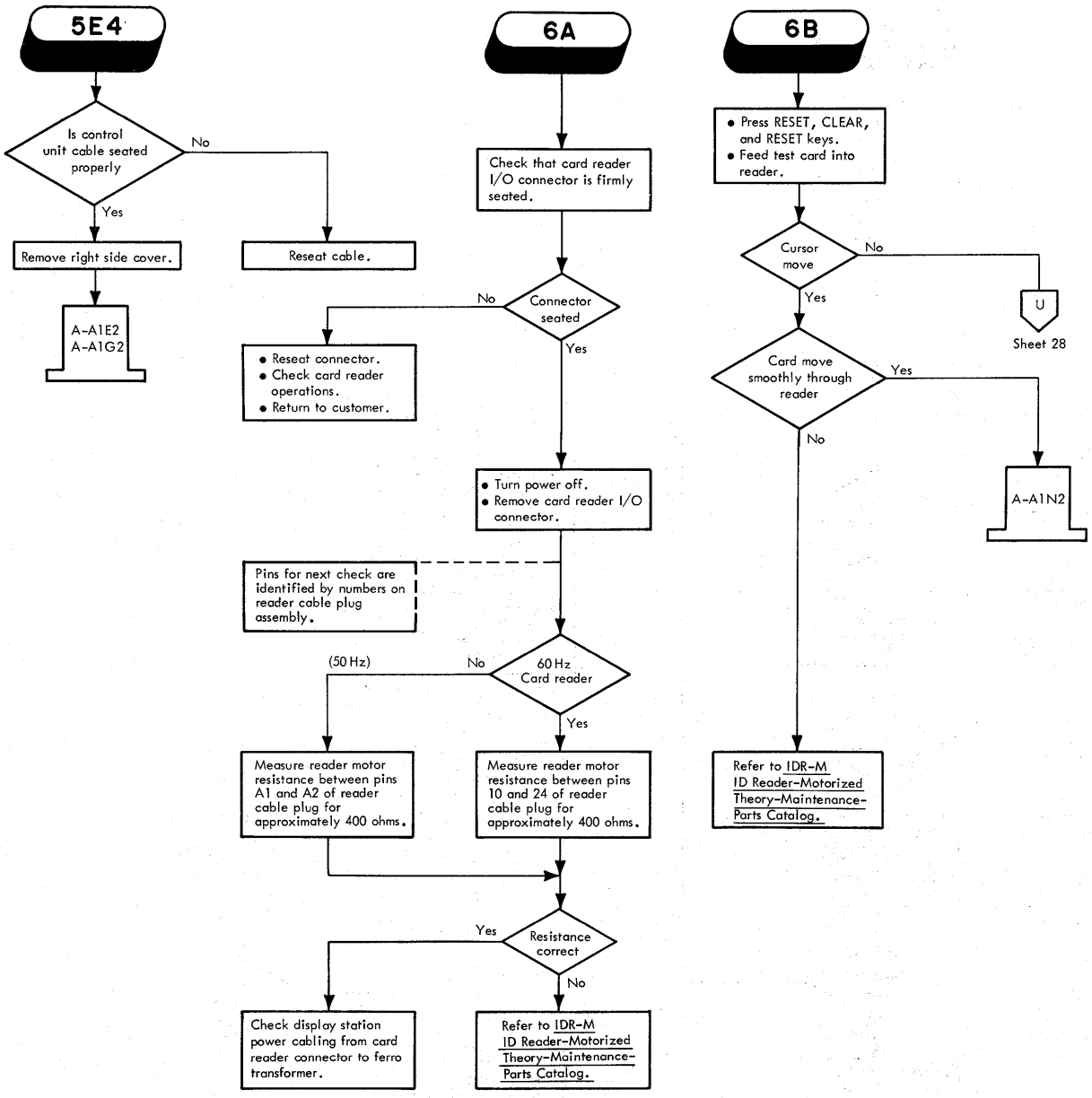


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 27 of 29)

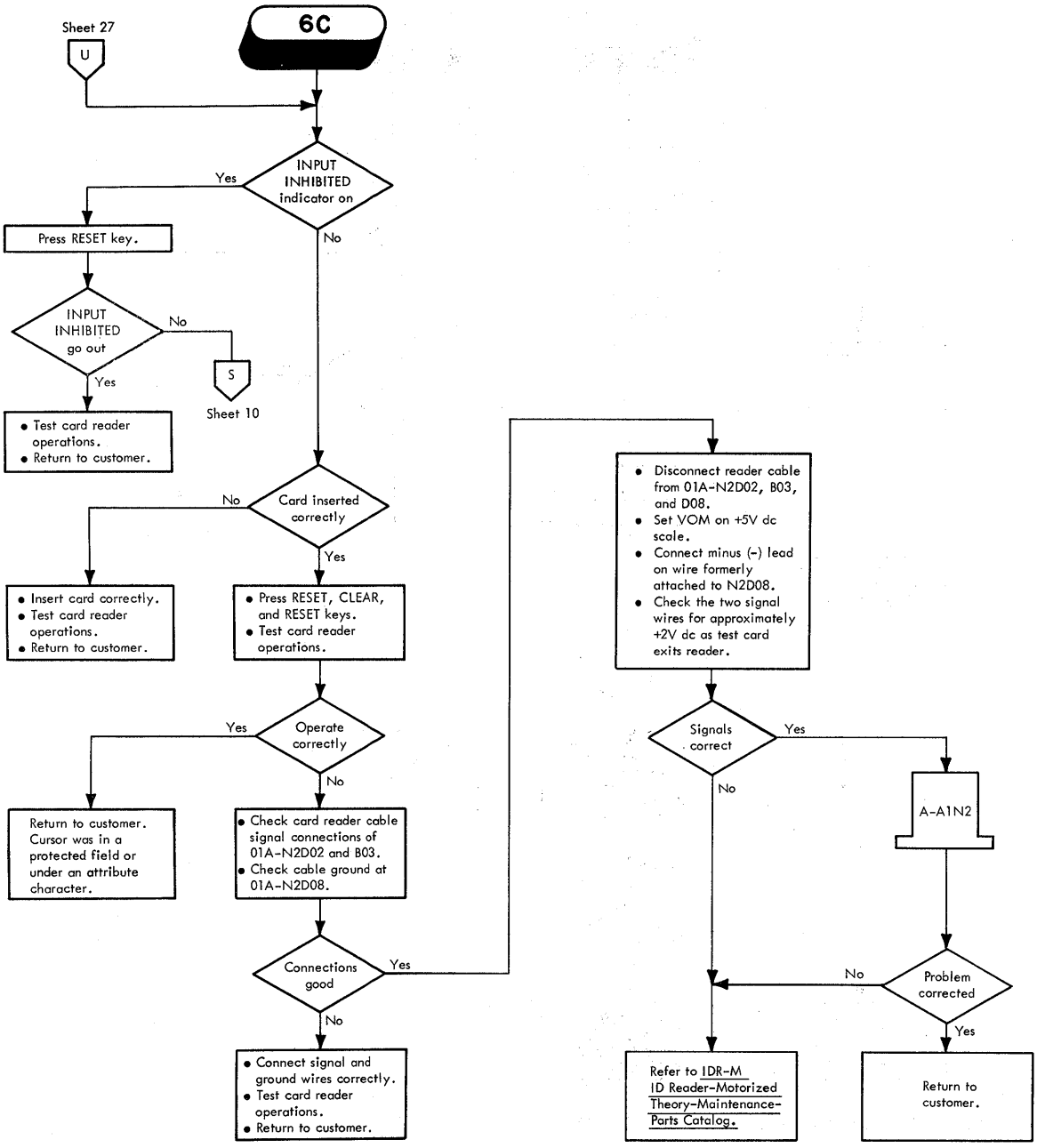


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 28 of 29)

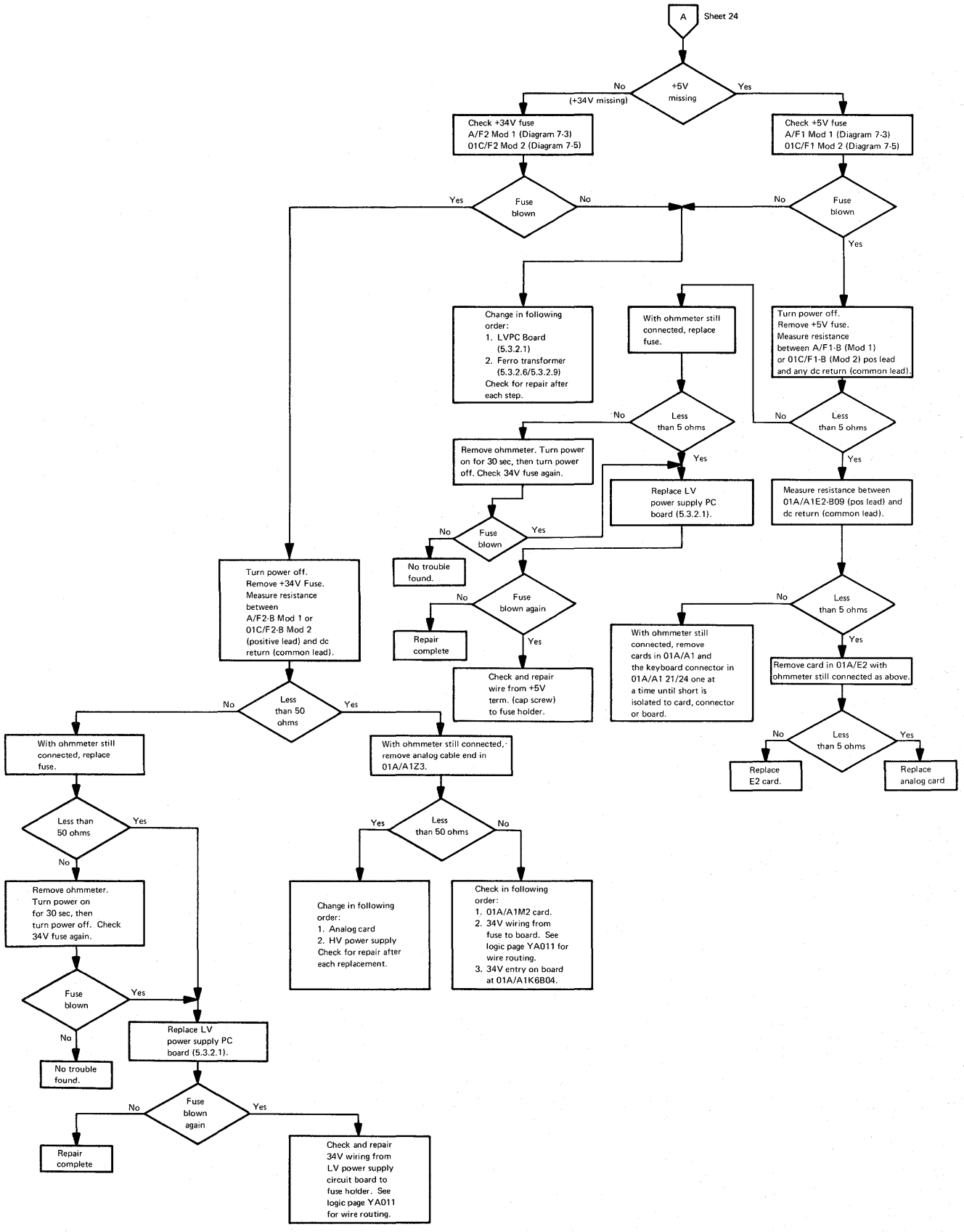


Diagram 4-1. Display Station Troubleshooting Diagrams (Sheet 29 of 29)

This section contains all alignment, adjustment, and removal procedures necessary to maintain IBM 3277 Display Stations. It also contains service checks and checkout procedures to determine whether adjustments are required and to verify the accuracy of any adjustments made.

5.1 CHECKS

5.1.1 Display Station Test Using Test Pattern 1

A comprehensive test of the display station and all attached features is performed by using diagnostic Test Pattern 1 and the procedures described in the following paragraphs. The step-by-step procedures describe the sequence in which the various operations should be performed and the results expected of each operation.

The tests should be performed in the sequence presented, because each test is dependent on data left on the screen from preceding tests. The observations described in paragraph 5.1.1.1 apply to all display stations. Further testing depends on what features are attached to the display station.

If a problem is discovered while performing this operational test, refer to the Symptom Index or the Trouble-shooting Diagrams to resolve the problem.

Note: Test Pattern 1 is not available for 3277 Display Stations attached to a 3274 Control Unit. Therefore, paragraphs 5.1.1.1 through 5.1.1.5 do not apply to these 3277s.

Go to paragraph 5.1.2 for Display Station Operational Test (without Test Pattern 1).

Refer to Appendix A for offline procedures to test the selector light pen on 3277s attached to a 3274.

5.1.1.1 Initialization and Observations

1. Load Test Pattern 1 on display station being checked. (See paragraph 2.2.1 for instructions for loading Test Pattern 1.) SYSTEM AVAILABLE is the only indicator that should be on after pattern is loaded.
2. Take display station offline by removing control unit signal cable. Jack is located at front of display station, under front cover. Do not turn power off while removing cable or Test Pattern 1 will be lost.
3. Compare image on screen with expected image shown in Diagram 2-4. The "NON DISPLAY" field should be blank. Top two rows are displayed in normal intensity, next two rows are displayed in high intensity, and half of last row is displayed in high intensity.
4. Check for only one cursor. Cursor should be in first character position of second row of displayed data.
5. Check quality of displayed image. Image should not be tilted or blurred, and characters should be formed properly with correct inter-row spacing.
6. Vary Brightness control. Set it where high intensity characters have proper brightness.
7. Vary Contrast control. Set it where normal intensity characters contrast with high intensity characters at desired level.

5.1.1.2 Security Keylock Test (Optional Feature)

1. Turn security key off (vertical position). All data should disappear from screen, INPUT INHIBITED indicator should light, and cursor should remain displayed.
2. Turn security key on. Original data should reappear on screen, and INPUT INHIBITED indicator should go out.

5.1.1.3 Tests from Keyboard (Optional Feature)

Press the RESET key. The display image should appear as shown in Diagram 2-4, with the cursor located under the character C in the second row of displayed data. No indicators should be on.

1. Key in the row of alphabetic characters and the one space exactly as they appear in the row above. All characters should enter correctly, and cursor should move under I after Space bar is pressed.
2. Move cursor under C of CK in second row of displayed data, using → (Right) key.
3. Press INS MODE key. INSERT MODE indicator should light.
4. Press A key. Field should now appear ACK.
5. Press FIELD MARK key. (Use B key on Operator Console keyboard.) Field should now appear A; CK (ABCK).
6. Press C key. The data should not change, but the INPUT INHIBITED indicator should come on (in addition to the INSERT MODE indicator, which has remained on.)
7. Press RESET key. Both indicators should go out.
8. Press DEL key. The C should disappear, and the field should now appear A;K (ABK).
9. Press ↵ key (New Line). Cursor should move under C character in fourth row of displayed data.
10. Enter the special characters as they appear in the row above, shifting where required. Cursor should appear under 0 character after last special character enters.
11. Enter the digits 0 through 9 and the characters , . - and A as they appear in the row above. (On Data Entry keyboards, use the , over * and . over $ keys to enter the , and . characters.) The following results should occur:
    a. Typewriter and Operator Console keyboards without numeric lock feature — all characters should enter.

b. Data Entry keyboard without numeric lock feature — characters , . and - enter normally; the A character enters as < symbol.
c. All keyboards with numeric lock feature — characters . and — enter normally; keyboard should lock and INPUT INHIBITED should light when , and A keys are pressed. (Use Reset and → keys to move cursor from those positions.)

12. Check ↑ (Up), ↓ (Down), and ← (Backspace) cursor move keys for proper operation.
13. Check the Typamatic function of the Space bar or any other key with Typamatic capability. Use the first field in the fourth row of displayed data for this step.
14. Move cursor under first character displayed of test message.
15. Press any alphameric key. INPUT INHIBITED indicator should come on, and character should not enter or display because field is designated as a protected data field.
16. Press RESET key. INPUT INHIBITED indicator should go out.
17. Press ENTER key. INPUT INHIBITED indicator should light, and keyboard should lock.
18. Press RESET key. INPUT INHIBITED indicator should go out, and keyboard should unlock.

    Note: The following steps check tab, DUP, and new line functions.

19. Press →| (Tab) key. Cursor should appear under character A in second row of characters.
20. Press DUP key. An asterisk (*) should appear in cursor position, and cursor should move under I of INSERT. (On Operator Console keyboard, use Tab key; cursor should move under I of INSERT, but the asterisk should not appear.)
21. Space one character position. The I should disappear.
22. Press |← (Backtab) key. Cursor should move back one space to where the I was formerly located.
23. Press Tab key. (Use SKIP key on Data Entry keyboards.) The cursor should appear in the first character position of the fourth row of displayed data.

    Note: The following steps test the erase and clear functions.

24. Position cursor under character E in second row of displayed data.
25. Press ERASE EOF key. Characters E through Z should disappear, and cursor should not move.
26. Press ERASE INPUT key. All unprotected data, including keyed-in characters and field that originally appeared as INSERT CK, should disappear from screen.
27. Proceed to paragraph 5.1.1.4 if display station being tested has a selector light-pen attached. If a pen is not attached, press CLEAR key. All characters remaining on screen should disappear, and cursor should reappear in first character position in first row. Press RESET key.
28. Proceed to paragraph 5.1.1.5 if display station has an operator identification card reader attached. If a card reader is not attached, test is completed. Turn power off, and reconnect control unit signal cable.

5.1.1.4 Selector Light-Pen Tests (Optional Feature)

Note: Refer to Appendix A for selector light-pen tests for 3277 Display Stations attached to a 3274 Control Unit.

1. Fire pen on detectable field that has a question mark (?) as its first character. Question mark should change to a greater-than (>) symbol. Remainder of field should not change.
2. Fire pen again on the field. The greater-than symbol should change back to a question mark. Remainder of field should not change.
3. Fire pen on next detectable field that has a greater-than symbol as its first character. The greater-than symbol should change to a question mark. Remainder of field should not change.
4. Fire pen again on same field. Question mark should change back to a greater-than symbol. Remainder of field should not change.
5. Press CLEAR key. All characters on screen should disappear, and cursor should move to character location 0. Press RESET key.
6. Proceed to paragraph 5.1.1.5 if display station being tested has an operator identification card reader attached. If a card reader is not attached, test is completed. Turn power off, and reconnect control unit signal cable.

5.1.1.5 Operator Identification Card Reader Tests (Optional Feature)

1. Key in a few characters on the screen.
2. Return cursor to character position 1. (Do not use CLEAR key.)
3. Read in card reader test card (PN 2143816). The following events should occur:
   a. Keyed-in data disappears from screen.
   b. Cursor moves 40 character positions.
   c. INPUT INHIBITED indicator comes on and stays on.
   If cursor does not move 40 spaces, read-in operation was unsuccessful.
4. Tests are now completed. Turn power off, and reconnect control unit signal cable.

5.1.2 Display Station Operational Test (without Test Pattern 1)

The following test sequence is a quick checkout procedure that can be used as an offline display station reliability test. This procedure tests display station circuitry extensively, but is not as comprehensive as the procedure described in paragraph 5.1.1. It can be used as a quick checkout to verify correct operation after maintenance is performed.

Perform the steps in sequence for most effective results.

1. Turn power off.
2. Take display station offline by removing coaxial signal cable from display station I/O jack. Jack is located at front of display station. Front cover must be removed for access to it.
3. Turn power on. Within 15 seconds, cursor should appear on screen at character location 0. No indicators should be lighted.
4. Press → (Right) key, and hold it down. Cursor should move through each character location in the row. After reaching last character location, cursor should appear in first character location in second row.
5. Exercise ↑ (Up), ↓ (Down), ↵ (New Line), and ← (Left) cursor move keys. Observe that each key performs its operation correctly.
6. Press several alphameric keys in succession. The corresponding characters should display, and cursor should move one space as each new character appears.
7. Key in a complete row of characters. When last character of row enters, cursor should appear in first character position of next row.
8. Press an alphameric key. Character should appear in cursor location, and cursor should advance one space.
9. Exercise both upper and lower shift of all keys. If the 3270 Data Analysis - APL Feature is installed, exercise upper and lower with APL turned off; then upper, lower, and alternate shift with APL turned on. Observe display screen as each key is pressed, checking for proper operation.
10. Exercise Typamatic function of each Typamatic key.
11. Move cursor into last row, and key in several alphameric chararacters.
12. Backspace cursor near middle of group of characters just entered.
13. Press INS MODE key. INSERT MODE indicator should light.
14. Press Space bar enough times to cause characters at right of cursor to move to end of row and wrap around to first row.
15. Press RESET key. INSERT MODE indicator should go out.
16. Delete several characters using DEL key. Character in cursor position should disappear, and characters in same row at right of cursor should move left one character position each time DEL is pressed.
17. Move cursor to middle of a row of characters.
18. Press ERASE EOF key. Characters from cursor position through last position on screen should erase, and cursor should not move.
19. Press ERASE INPUT key. All characters should erase, and cursor should move to location 0.
20. Enter several alphameric characters as in step 6.
21. If display station has the security keylock feature, turn key off. Characters should disappear from screen, INPUT INHIBITED should light, and cursor should remain displayed.
22. Turn security key on. Original data should reappear on screen, and INPUT INHIBITED should go out.
23. Press CLEAR key, then RESET key. All characters should disappear from screen, and cursor should reappear in character location 0.
24. Press Backspace key two times.
25. Press any character key. Audible alarm (feature) should sound when key is pressed if feature is installed.
26. If an operator identification card reader is attached, proceed to step 27. Turn power off, and reconnect control unit signal cable if a card reader is not attached.
27. Press CLEAR key, RESET key, then enter several alphameric characters as in step 6.
28. Return cursor to location 0 using ← (Left) key.
29. Read in card reader test card (PN 2143816).
30. Observe that INPUT INHIBITED indicator comes on, cursor moves 40 spaces, and keyed-in data disappears from screen as card passes through reader.
31. If cursor does not move 40 spaces, read-in operation was unsuccessful.
32. Offline tests are completed. Turn power off, and reconnect control unit signal cable.

5.1.3 Voltage Checks

A ferroresonant transformer (ferro) with a 110V ac primary and multiple secondary taps provides all display station voltages. (World Trade Corporation display stations use a ferro with a tapped primary winding.) The ferro is protected by fuse F1 in series with its primary winding. F1 is located in the prime power box. Display station voltages consist of low dc voltages, high dc voltages, and 6.3V ac CRT filament voltage. These voltages can be checked at the LV printed circuit (PC) board or at Terminal Board 1 (TB1).

Refer to the Symptom Index and Troubleshooting Diagrams if a voltage is incorrect or is missing.

5.1.3.1 Low-Voltage DC Checks

Model 1: For +8V and -12V, measure the low dc voltages at the capacitor screws on the LV printed circuit board. Diagram 7-9 shows the location and the polarity of the capacitor screws. Remove the left side cover for access to the circuit board. For +5V and +34V, measure the voltages at the fuse holders at A/F1-B for +5V and A/F2-B for +34V (Diagram 7-3).

Model 2: For +8V and -12V, measure the low dc voltages through the access holes in the shield that covers the printed circuit board. A line with arrowheads at each end designates the pairs of terminals associated with each voltage. For +5V and +34V, measure the voltages at the fuse holders at 01C/F1-B for +5V and 01C/F2-B for +34V (Diagram 7-5). Diagram 7-10 illustrates the PC board shield.

Remove the front cover for access to the circuit board.

Observe the polarities of the terminals, and probe with the correct test leads to prevent damage to the meter. The following voltages can be measured at the PC board:

+5V ±10% (This voltage is protected by fuse at A/F1 (Model 1) Diagram 7-3 and 01C/F1 (Model 2) Diagram 7-5.)

+8V ±12% (This voltage is protected by fuse F2 on PC board.)

+34V ±10% (This voltage is protected by fuse at A/F2 (Model 1), Diagram 7-3 and 01C/F2 (Model 2), Diagram 7-5.)

-18V (This voltage is fuse-protected by fuse F3 on PC board and is the input to the -12V regulator card. If this voltage is missing, the -12V will also be missing.)

-12V ±4%

5.1.3.2 High-Voltage Check

The only high voltage that should be checked is the +400V dc (which is derived from the HV power supply). If this voltage is correct, the other high voltages for the CRT should also be correct. Because the +400V is a low-current supply, it is impossible to obtain an accurate measurement with the standard voltmeter. Check the arc-suppression circuitry whenever HV troubles occur.

1. Turn power off.
2. Set voltmeter selector switch to a position that will measure up to +400V dc.
3. Connect minus (-) meter lead on any dc return terminal.
4. Connect plus (+) meter lead to HV power supply terminal 2 (Diagram 7-14) by sliding push-on connector back slightly.
5. Turn power on.
6. Check for a meter indication of +400V ±50V dc. (Because this voltage is a low-current supply, it is impossible to measure the +400V dc operating voltage with the IBM meter; therefore, the wide range of ±50V is given.) If voltage is correct, turn power off, remove test leads from terminals, and check the arc-suppression circuitry (paragraph 5.1.3.3). If voltage is incorrect, proceed with steps 7–10.
7. Turn power off.
8. Remove push-on connectors from HV power supply terminals 1 and 2.
9. Turn power on.
10. Check again for +400V ±50V dc on terminal 2. If voltage is correct, turn power off, remove test leads from terminals, reconnect power supply push-on connectors, and check the arc-suppression circuitry (paragraph 5.1.3.3). If voltage is still incorrect, change the HV power supply (paragraph 5.3.2.10).

5.1.3.3 Arc-Suppression Check

A defective arc-suppression circuit may appear as a defective HV power supply or analog card. If excessive trouble is experienced with either of the two assemblies, check the arc-suppression circuitry as listed below. Arc-suppression circuitry is located on the arc-suppression board (Z1, Diagram 7-15) on Model 1 display stations and on the voltage distribution board (TB1, Diagram 7-11) on Model 2 display stations.

Visual Checks:

1. Check for bent, broken, or missing wires.
2. Check for bent capacitor leads that are too close to other components and could cause arcing.
3. Check for broken capacitors or other components showing obvious damage.

Model 1 Resistance Checks:

1. Turn power off.
2. Remove arc-suppression board from its socket.
3. With the CE VOM, check between the following pairs of pins on the arc-suppression board for the resistances specified:

E9 and E13 - 1 Megohm	E7 and E13 - Infinity
E10 and E14 - 1 Megohm	E7 and E14 - Infinity

4. Replace the arc-suppression board if the resistances are not correct.

Model 2 Resistance Checks:

1. Turn power off.
2. Disconnect wires from voltage distribution board terminals 12, 13, 14, and 15.
3. With the CE VOM, check between the following pairs of pins on the voltage distribution board for the resistances specified:

12 and 13 - 1 Megohm	13 and 16 - Infinity
14 and 15 - 1 Megohm	14 and 16 - Infinity

4. Replace voltage distribution board if the resistances are not correct.

If the above checks do not reveal an obvious fault in the arc-suppression circuit and if excessive trouble persists, change the arc-suppression board (Model 1) or the voltage distribution board (Model 2). Return to Diagram 4-1, sheet 4, if the checks were performed as a result of instructions in the troubleshooting diagrams.

5.1.3.4 6.3V AC Check

The CRT filament voltage of 6.3V ac (±10%) is the only ac voltage used in the display station. A quick check to determine if 6.3V ac is present is to look for a glowing filament at the back of the CRT neck, near the tube socket. The CRT cone shield must be removed to see filament (par. 5.3.3.2, steps 1–3). This voltage is protected by fuse F1 located on the LV PC board.

1. Turn power off.
2. Set voltmeter selector switch to a position that will measure 6.3V ac.

3. Remove fuse F1. (Remove shield for access on Model 2 display stations.)
4. Connect a meter lead on each end of fuse holder.
5. Turn power on.
6. Check for a meter indication of 6.3V ac.
7. Turn power off, and remove meter leads from fuse holder.
8. Reinstall fuse and shield (if removed).

5.1.3.5 High-Voltage Power Supply Check

1. Turn power off.
2. Remove HV power supply leads 3 (UV) and 4 (DC return). See Diagram 7-14.
3. Set CE VOM selector switch to RX10 position.
4. Measure resistance between HV power supply pins 3 and 4.
5. Reverse meter leads and measure again.
6. Replace HV power supply (par. 5.3.2.10) if readings in step 4 or 5 indicate a shorted or open condition.

5.1.4 Keyboard Checks

Two different style keyboards may be found on IBM 3277 Display Stations. Both are identical in operation and vary only slightly in external appearance. The rows of keys on Type "A" keyboards have an even slope downward from top to bottom. The rows of keys on Type "B" keyboards are slightly concave. The two types can be distinguished with the keyboard cover removed by observing the location and type of cable connection and the location of the +5V regulator (large transistor on heat sink). The Type A keyboard cable plugs into the rear edge of the printed circuit board, and the regulator is located in the left corner of the circuit board. The Type B keyboard cable plugs into a 24-pin SLT connector which is mounted in the left corner of the circuit board, and the regulator is located in the right corner of the circuit board.

The following paragraphs contain check procedures which can be used to isolate keyboard problems. When the check procedure differs for the different keyboard types (A and B), the differences are noted. Ensure that the correct procedure is used. Keyboard problems can be isolated to one of three possible areas:

1. External to the keyboard.
2. A FRU in the keyboard.
3. The keyboard assembly. (Type A assembly consists of circuit board with key modules; Type B assembly consists of circuit board and electronics assembly with key modules in an all-keys assembly.)

Problems external to the keyboard should be diagnosed as outlined in the Troubleshooting Diagrams. Keyboard FRUs include keybuttons, switch modules, spacebar assembly, support modules (Type A only), circuit board and electronics assembly (Type B only), and the audible response device. Do not attempt to repair any other keyboard units.

While performing the following checks, the keyboard assembly should be visually inspected for shorts or grounds that could cause erratic operation or erroneous results.

A faulty keyboard assembly should be replaced with a good one. A faulty Type A assembly should be returned to the factory if it is less than one year old. The date code is marked on Type A keyboard assemblies by week (01–52) and year.

5.1.4.1 Voltages

Type A Keyboards (See Diagrams 7-7 and 7-8 for Type A keyboard locations):

1. Check for -12V dc between KB1 pins Z(-) and X (ground).
2. Check for +8V dc between KB1 pins V(+) and X (ground).
3. Check for +5V dc across keyboard capacitor C1. This voltage is developed (by the voltage regulator on the keyboard assembly) from the display station +8V dc power supply. Replace the keyboard assembly if the +8V dc is correct and the +5V dc is not correct.

Type B Keyboards (See Diagram 7-19 for Type B keyboard locations):

1. Check for -12V dc between KB1 pin D02 (-) and D08 (ground).
2. Check for +8V dc on one of the voltage regulator terminals (under the circuit board and electronics assembly) and +5V dc on the other terminal. Reference the meter negative (-) lead to test pin D08. Input to the regulator is +8V dc, and the output is +5V dc. Replace circuit board and electronics assembly if the +8V dc is correct and the +5V dc is incorrect. Check KB1 connector and display station power supply if +8V and +5V are incorrect.

5.1.4.2 Key Module and Encoding – Type A Keyboards Only (Diagram 6-19)

Correctly functioning key modules present two active (2.5V dc minimum) input lines to the keyboard assembly encoder. With two and only two active inputs present, the encoder generates the strobe signal and the encoded character output. This procedure checks that the strobe signal is generated properly, and the key modules activate only two inputs to the encoder. Replace the key module if it is found to be defective. Replace the keyboard assembly if the encoder or the printed circuit board is defective.

Strobe check:

1. Set selector switch on volt-ohmmeter to a position that will accurately measure 5V dc.
2. Place minus (-) meter lead on KB1 tab X (ground).
3. Place plus (+) meter lead on KB1 tab R (strobe signal).
4. With no keys pressed, the meter should indicate at least 2.5V. If the meter indicates 0.6V or lower, proceed to step 7.

5. Press and hold one alphameric key. The meter should indicate less than 0.6V. If the meter indicates 2.5V or higher, replace the keyboard assembly.
6. Press and hold two alphameric keys simultaneously. The meter should indicate at least 2.5V. Proceed to paragraph 5.1.4.3 if the preceding results are correct.

0.6V (or lower) with no keys pressed:

7. With meter leads attached as in steps 2 and 3, press two alphameric keys simultaneously. If meter indicates 0.6V or lower, replace keyboard assembly.
8. Probe KB1 pins D, E, F, H, J, K, L, M, and N (bits 0–7 and Parity, Diagram 7-8) with no keys pressed.
9. Note bit configuration of encoded output. With logic probe, a red indication is a 1 bit, and a green indication is a 0 bit. With voltmeter, greater than 2.5V is a 1 bit, and less than 0.6V is a 0 bit.
10. Find code in Diagram 6-7 or 6-14 that corresponds to bit configuration observed in step 9.
11. Check center two lead frame terminals of suspected module for 2.5V or higher. (Keyboard assembly must be removed from bottom pan for this voltage check. See paragraph 5.3.5.3.)
12. Replace defective module if 2.5V or higher is measured on both center terminals in step 11.
13. If only one terminal measures 2.5V or higher and other measures 0.6V or less, recheck steps 8 through 11. If same results are obtained, replace keyboard assembly.
14. Replace keyboard assembly if less than 0.6V is measured in step 11.

5.1.4.3 Output Codes

The unshifted and shifted codes for all keys on both types of keyboards (A or B) can be checked by the following procedure, which uses the logic probe and Diagram 6-7 or 6-14. (Use Diagram 6-8 if the 3270 Data Analysis - APL feature is installed.)

1. Press and release desired key. Hold SHIFT (NUMERIC on data entry keyboards) key down while pressing key if desired character is on top half of keybutton. If APL is installed, hold APL ALT key depressed, in conjunction with character key, to enter APL alternate shift codes when APL is active.
2. Probe pins listed below with logic probe, and note bit configuration observed. A red (UP) indication is a 1 bit, and a green (DOWN) indication is a 0 bit.

Pin (1A1-B2)	Keyboard Bit
S05	0
S08	1
S09	2
S02	3
U05	4
M10	5
U09	6
M11	7
S13	Parity
1A1-K2-G10	8 (APL only)

3. Compare bit configuration observed in step 2 with configuration for desired character shown in Diagram 6-7 or 6-14. Use Diagram 6-8 for APL.

5.1.4.4 Shift Key Modules - Type A Keyboards Only

Two SHIFT keys and the shift LOCK key (NUMERIC and NUM LOCK keys on data entry keyboards) generate an input signal to the keyboard assembly encoder. The encoder generates upshift character codes of the characters appearing on the top half of the keyboard keys. The following procedure isolates a shift module failure.

1. Set volt-ohmmeter selector switch to a position that will accurately measure up to +5V dc.
2. Place minus (-) meter lead on KB1 tab X (ground).
3. Check all three shift keys individually for 2.5V (minimum) on both center leads of the corresponding key module when each key is pressed and for 0.6V (maximum) when key is restored.
4. Replace shift module that fails to generate proper levels on both leads.
5. If shift module generates proper levels, and keyboard generates incorrectly shifted characters (5.1.4.3), replace keyboard assembly.

5.1.4.5 Spacebar Assembly Mechanical Checks

The spacebar assembly and mountings should be checked for easy motion and freedom from binds. The spacebar should depress and return to the restored position without drag or binds. Replace the spacebar assembly if binds, broken mountings, or bent components are discovered. It may not be necessary to replace the spacebar module (actuator) if the problem is mechanical.

5.2 ADJUSTMENTS

Adjustment procedures for the IBM 3277 Display Station should be performed after it is established that all operating voltages are correct. Paragraph 5.1.3 details the voltage checkout procedure.

5.2.1 Display Image Adjustments

A test pattern generated by the diagnostic program provides the display image to be used during image adjustment. Test Pattern 2 is used to adjust the Model 1 display image, and Test Pattern 3 is used to adjust the Model 2 display image. The procedure for displaying the required test pattern is described in paragraph 2.2. If the program-generated test pattern is not used, the test pattern image must be keyed in from the keyboard. Diagrams 2-5 and 2-6 show Test Patterns 2 and 3, respectively.

Adjustments should be performed in the sequence listed. However, if only minor touchup adjustment is required, analog card adjustments can be made separately. Use

Diagrams 7-1 through 7-6 to locate the adjustments specified in the following procedures. The following equipment is required.

Alignment mask:
Model 1 – PN 2577899 (Diagram 2-2)
Model 2 – PN 2565170 (Diagram 2-3)
Screwdriver (small blade)
SLT backpanel jumper

5.2.1.1 Brightness

Note: The Brightness control is the outer knob on the OFF-PUSH switch.

Adjust as follows:
1. With Brightness control fully counterclockwise, no image should be visible.
2. At full clockwise rotation, raster may become visible. Image may bloom and become excessively bright for comfortable viewing if Contrast control (inner knob) is fully counterclockwise.
3. Set Brightness control at point that produces best display image for comfortable viewing.

5.2.1.2 Contrast

Note: Test Pattern 1 or a customer program that contains dual brightness fields must be loaded to properly adjust the Contrast control. The Contrast control is the inner knob on the OFF-PUSH switch.

Adjust as follows:
1. With Contrast control fully counterclockwise, contrast between normal and bright fields should be approximately equal.
2. At full clockwise rotation, contrast should be maximum. Normal brightness characters may disappear from screen if Brightness control (outer knob) is set at a low level.
3. Set Contrast control for comfortable viewing, with desired amount of contrast between normal and bright fields.

5.2.1.3 Focus

Adjust the Focus potentiometer to the point that produces the sharpest display image. Observe closely the characters at the center of the screen and those at the edges of the screen. Set the potentiometer where the best focus over the entire CRT is achieved. The Focus potentiometer is on the HV power supply.

5.2.1.4 Yoke

1. Place proper alignment mask in position against face of CRT.

   Note: Use mask PN 2577899 to adjust Model 1 display stations and mask PN 2565170 to adjust Model 2 display stations. The yoke shield must be on the yoke before making the following adjustments.

2. Short together the three test pins on analog card. Use a clip or bare wire. (Pins are located between CHAR HEIGHT potentiometer and SWEEP INDIC neon.) This jumper disables vertical deflection and produces a single horizontal trace across approximate middle of screen.
3. Loosen yoke clamp and rotate yoke until horizontal trace is parallel to, or coincides with, horizontal lines on alignment mask.
4. Ensure that yoke is firmly seated against CRT bell while maintaining horizontal alignment obtained in step 3.
5. Tighten yoke clamp loosened in step 3.

5.2.1.5 Magnetic Centering Rings

1. Leave vertical deflection grounding jumper (connected in step 2 of paragraph 5.2.1.4) attached and the alignment mask in place for this adjustment.
2. Loosen cone shield retaining screw, rotate cone counterclockwise until locking tabs disengage, and slide cone back 25 to 38 mm (1 to 1-1/2 inches) to expose tabs on centering rings.
3. Using tabs on centering rings, rotate rings until horizontal trace passes through geometric center of screen. (Geometric center is indicated by crossed lines in center of alignment mask. Vertical center is indicated by line B on the Model 1 mask and by line D on the Model 2 mask. Horizontal center is judged by comparing ends of trace to vertical lines at edges of mask.)
4. Reinstall cone shield.
5. Proceed to paragraph 5.2.1.6 (Model 1 analog card adjustments) or to paragraph 5.2.1.7 (Model 2 analog card adjustments).

5.2.1.6 Model 1 Analog Card Adjustments

The procedures described in the following paragraphs apply only to the IBM 3277 Model 1 Display Stations. See paragraph 5.2.1.7 for Model 2 analog card adjustment procedures. These procedures require that the Model 1 alignment mask (PN 2577899) be positioned against the face of the CRT.

Model 1 Horizontal Width: The vertical deflection grounding jumper (connected in step 2 of paragraph 5.2.1.4) should remain attached during this adjustment. Proceed as follows:

1. Adjust Horizontal Width potentiometer so that ends of horizontal trace on screen coincide with vertical lines C and E on alignment mask. When adjusted correctly, trace should be 162.6 ± 1.6 mm (6.4 inches ± 1/16 inch).
2. Check to make sure that horizontal trace still passes through geometric center of CRT (Line B). Readjust centering rings as described in paragraph 5.2.1.5 if it is necessary to move trace back through center of CRT.
3. Remove vertical deflection grounding jumper.

Model 1 Top Margin: Adjust Top Margin potentiometer so that top trace of first character row falls within line A marked on alignment mask.

Model 1 Character Height: Adjust Character Height potentiometer so that bottom trace of characters in last row falls within line D of alignment mask. When adjusted correctly, overall height of display image should be 99.1 mm (3.9 inches).

Model 1 Linearity: After completing the yoke, centering ring, and analog card adjustments, check that 20th and 21st characters on sixth and seventh rows fall within rectangle H at center of alignment mask. Test Pattern 2 provides characters in these four locations. Recheck preceding adjustments if this specification is not met.

5.2.1.7 Model 2 Analog Card Adjustments

The procedures described in the following paragraphs apply to Model 2 display stations only. (See paragraph 5.2.1.6 for the Model 1 analog card adjustment procedures.) The following procedures require that the Model 2 alignment mask (PN 2565170) be in place at the face of the CRT and Test Pattern 3 be displayed.

Model 2 Horizontal Width: The vertical deflection grounding jumper (connected in step 2 of paragraph 5.2.1.4) should remain attached during this adjustment. Proceed as follows:

1. Adjust Horizontal Width potentiometer so that ends of horizontal trace on screen coincide with lines E and G on alignment mask. When adjusted correctly, trace should be 266.7 mm (10.5 inches).
2. Check to make sure that horizontal trace still passes through geometric center of CRT (line D). Readjust centering rings as described in paragraph 5.2.1.5 if it is necessary to move trace back through center of CRT.
3. Remove vertical deflection grounding jumper.

Model 2 Top Margin:

1. Connect a jumper between logic board pin A1J2M03 and ground (any D08 pin). This jumper disables vertical skip circuit, causing inter-row spacing to disappear and display image to gather toward top of screen.
2. Adjust Top Margin potentiometer so that top trace of first character row falls within center of line A (marked on alignment mask).

Model 2 Character Height:

1. Leave vertical skip disabling jumper attached for this adjustment.
2. Adjust Character Height potentiometer so that bottom trace of characters in last row coincides with center of line C on alignment mask. When adjusted correctly, overall height of display image should be 83.8 mm (3.3 inches) from line A to line C.
3. Remove vertical skip disabling jumper. Display image should appear nearly normal, with inter-row spacing. Overall image may be too large or too small.

Model 2 Inter-Row Spacing: Adjust Row Spacing potentiometer so that bottom trace of characters in last row falls within line F on alignment mask. When adjusted correctly, overall height of image should be approximately 203 mm (8.0 inches) from line B to line F.

Model 2 Linearity: After completing yoke, centering ring, and analog card adjustments, check that 40th and 41st characters on 12th and 13th rows fall within rectangle M on alignment mask. Test Pattern 3 provides characters in these four locations. Recheck preceding adjustments if this specification is not met.

5.2.2 -12V Regulator Card

This adjustment should be performed when the -12V regulator card is replaced or when a voltage check shows that -12V is not at its nominal value. Voltage measurements are made on TB1. TB1 is located on the right side frame in Model 1 display stations and is under the left side of the CRT in Model 2 display stations.

1. Set volt-ohmmeter selector switch to a position that will accurately measure 12V dc.
2. Attach meter plus (+) lead to a dc return (-) terminal on TB1.
3. Attach meter minus (-) lead to the -12V terminal on TB1.
4. Adjust potentiometer on -12V regulator card. Use a small screwdriver. Set potentiometer so voltmeter shows 12V.
5. Remove meter leads from TB1.

5.2.3 OFF-PUSH Switch (Model 2 Only)

This adjustment should be made after replacing the prime power box or switch actuator mechanism. Ensure that the upper chassis is seated properly on the lower chassis, the chassis clamps are latched, and power is removed before proceeding. Use Diagram 5-1 to locate the components specified in this adjustment.

1. Loosen the following components:
   a. Front control cable clamp.
   b. Rear control cable clamp.
   c. Control wire setscrew.
   d. Actuator bracket mounting screw.
2. Position control assembly flush with the rear edge of rear control cable clamp.
3. Tighten rear control cable clamp.
4. Adjust actuator mounting bracket (front to rear) to center actuator over power switch plungers.
5. Tighten actuator mounting bracket.
6. Tighten front control cable clamp.

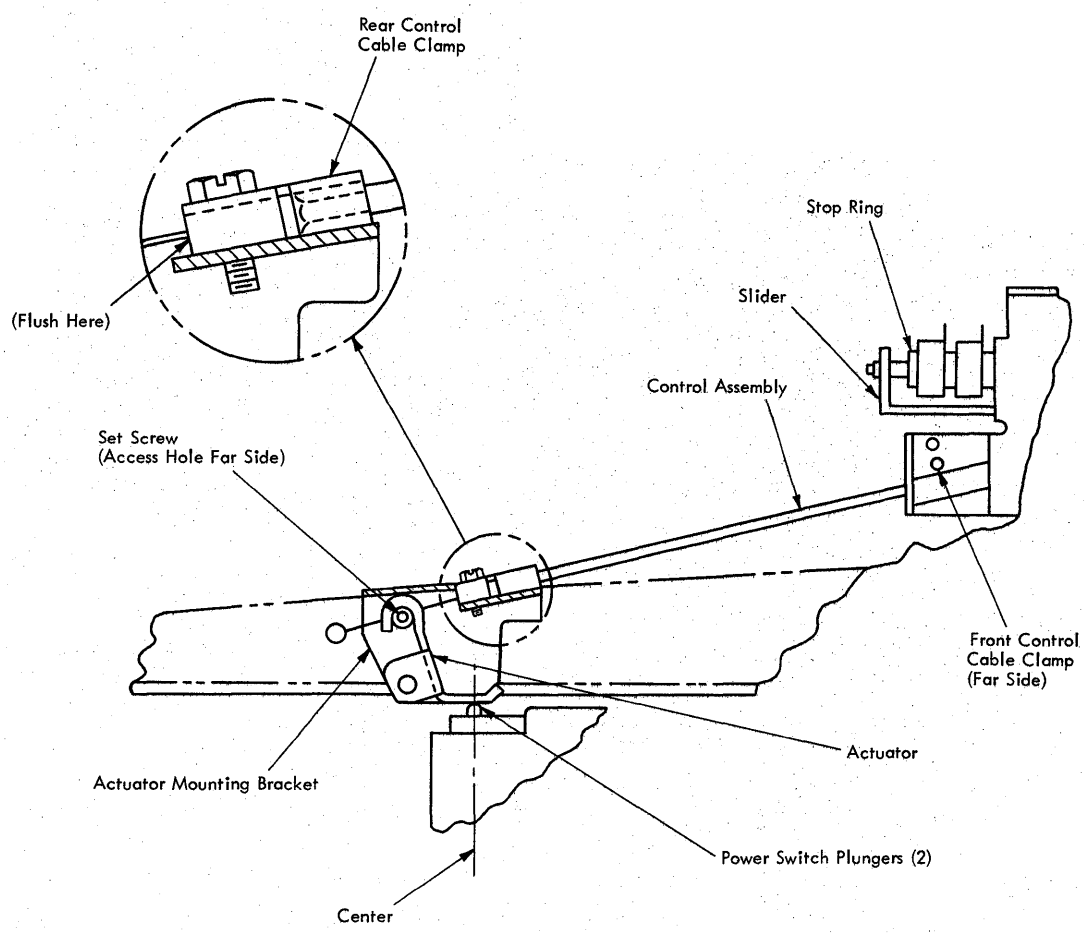


Diagram 5-1. OFF-PUSH Switch Adjustment

7. Pull OFF-PUSH switch fully forward to the on position. Slider should be against the stop ring.
8. Press down and hold actuator so power switch plungers are fully activated.
9. Tighten control wire setscrew. (Avoid overtightening setscrew. Overtightening will cause control wire to bend and prevent proper operation.)
10. Activate OFF-PUSH switch to check that slider remains forward against stop ring with power switch plungers fully depressed. Repeat steps 8 and 9 if these conditions are not met.

5.3 REMOVALS

The following paragraphs describe removal and replacement procedures for IBM 3277 Display Station FRUs. Where the procedure for removing and replacing a unit in the Model 1 display station differs from the procedure used with the Model 2 display station, a separate paragraph describing the unique procedure is presented. All removal and replacement procedures require that the desired unit has been made accessible by the removal of necessary covers and made safe by the removal of power. The top cover can be left on the display station while performing most maintenance procedures. This provides a degree of safety by keeping the CRT covered.

5.3.1 Covers

5.3.1.1 Model 1 Cover Removal

1. Front Cover: Pull out on bottom edge.

   Note: Security key must be removed from lock before removing right-side cover.

2. Side Covers: Insert a stiff card or badge in slot in grillwork at edge of top cover to unlatch side cover.
3. Top/Rear Center Cover: Release the four quick-disconnect fasteners that hold combination top/rear center cover to frame.

5.3.1.2 Model 2 Cover Removal

1. Front Cover: Push down on latch (accessible at center underside of cover). The cover falls away from base assembly at top while pivoting on two guide pins at bottom. Lift cover off guide pins.
2. Side Covers: Security key must be removed from lock before removing right-side cover. Pull frontmost stud (under front of side cover) toward front of display. When stud reaches limit of travel, pivot rear edge of cover slightly away from base and top cover simultaneously. Lift cover clear of display station. WTC side covers use a rear retainer spring that blocks travel of the frontmost stud. Release retainer spring by inserting screwdriver in spring and twisting while pulling on stud.
3. Top Cover: Top cover can be removed only after both side covers are removed. Pull out spring-loaded knobs at lower right and lower left of top cover and pivot up. Pull top cover back slightly to disengage it from guides in CRT bezel. Carefully lift cover off display station.

5.3.2 Power Components

DANGER
All power component removal and replacement procedures must be performed with power turned off and with the power cord removed from the wall or from the input jack at the display station.

5.3.2.1 Low-Voltage Power Supply Assembly

1. (This step applies to Model 2 display stations only.) Remove shield covering printed circuit (PC) board by prying through slot along right edge of shield.
2. Disconnect the two cable connectors plugged into board.
3. Disconnect wiring from +5V screw and +5V return screw (Diagram 7-9).

   Note: For model 1 the wire attached to the +5V return screw is part of an optional change and may or may not be installed.

4. Remove screw holding assembly to frame. (The screw is located in center bottom of PC board bracket.)
5. Slide assembly from machine.
6. Replace in reverse order. If a new assembly is being installed, remove -12V regulator card and replace in new assembly per paragraph 5.3.2.2.

5.3.2.2 -12V Regulator Card

1. Lift plastic retainer, and pull -12V regulator card from socket in same manner as an SMS card is removed from a card socket.
2. Replace card by lifting plastic retainer and sliding card into the SMS socket.
3. Perform -12V regulator card adjustment (paragraph 5.2.2).

5.3.2.3 AC Capacitor

1. Remove rubber boot from top of capacitor, and slide back on wire leads.
2. Holding insulated handle of a screwdriver, short out capacitor terminals with metal shaft of screwdriver to ensure that capacitor is fully discharged.
3. Pull off the two leads from terminals at top of capacitor.
4. Pull capacitor from spring holder.
5. Replace in reverse order.

5.3.2.4 Model 1 Prime Power Box

1. Unplug line cord from line cord jack if it was not previously removed.
2. Unplug two cable connectors plugged into prime power box. (Three cable connectors must be removed if an operator identification card reader is attached on 60-Hz units.)
3. Pull Brightness and Contrast knobs from OFF-PUSH switch.
4. Remove the two screws holding prime power box to frame.
5. Replace in reverse order.
6. If a new prime power box is being installed, Brightness and Contrast knobs from the old box must be installed on the new one.

5.3.2.5 Model 2 Prime Power Box

1. Unplug cable connector plugged into rear of box. (Two cable connectors must be removed if an operator identification card reader is attached on 60-Hz units.)
2. Unplug line cord from line cord jack if it was not previously removed.
3. Remove the two screws holding prime power box to frame.
4. Remove assembly from machine.
5. Replace in reverse order.
6. When replacing box, be sure that the on-off switches protruding from top of box are positioned under switch linkage.
7. Adjust position of box so switch plungers depress to within 1/32" of switch body with OFF-PUSH switch pulled out.

5.3.2.6 Model 1 Ferro Transformer (60 Hz)

1. Unplug ferro transformer cable that plugs into LV power supply printed circuit board.
2. Unplug ferro transformer cable that plugs into prime power box.
3. Remove the two wires from ac capacitor.
4. Remove rear screw that holds transformer to base chassis.
5. Remove front holding screw.
6. Lift transformer clear of the machine.
7. Replace in reverse order.

5.3.2.7 Model 1 Ferro Transformer (50 Hz)

1. Unplug ferro transformer cable that plugs into LV power supply printed circuit board.
2. Remove the two wires from ac capacitor.
3. Refer to Diagram 7-21. Disconnect two wires leading from ferro terminal block (TB1) to prime power box by turning cam screw counterclockwise only. Note where wires were terminated (for later reconnection).
4. If a card reader is attached, disconnect two wires leading from ferro terminal block to card reader I/O connector. Note where wires were terminated (for later reconnection).
5. Remove rear screw that holds transformer to base chassis.
6. Remove front holding screw.
7. Lift transformer clear of machine.
8. Replace in reverse order. When connecting wires to terminal block, cam screw must be turned clockwise.

5.3.2.8 Model 2 Ferro Transformer (60 Hz)

1. Disconnect LV cable connector (J2) between the two chassis.
2. Remove all I/O connectors (keyboard, card reader, I/O).
3. If a card reader is attached, unplug cable from rear of prime power box.
4. If a selector-pen is attached, remove cable from clip at lower right rear of frame.
5. Release the two clamps at sides of chassis that hold upper chassis to base chassis.
6. Release spring catches on rear guides, and slide upper chassis slightly to front to disengage the two rear guides.
7. Lift upper chassis off base chassis, and place upper chassis on a flat surface.
8. Remove ac capacitor per paragraph 5.3.2.3.
9. Remove screw holding ferro cover, and remove cover.
10. Disconnect the two cable connectors leading from ferro transformers.
11. Remove the two screws holding ferro to base chassis.
12. Slide transformer out of housing and clear of chassis.
13. Replace in reverse order.

5.3.2.9 Model 2 Ferro Transformer (50 Hz)

1. Disconnect LV cable connector (J2) between the two chassis.
2. Remove all I/O connectors (keyboard, card reader, I/O).
3. If a card reader is attached, unplug cable plugged in ferro transformer cover.
4. If a selector-pen is attached, remove cable from clip in lower right rear of chassis.
5. Release the two clamps at side of chassis holding upper chassis to base chassis.
6. Release spring catches on rear guides, and slide upper chassis slightly to front to disengage the two rear guides.
7. Lift upper chassis off base chassis, and place upper chassis on a flat surface.
8. Remove ac capacitor per paragraph 5.3.2.3.
9. If a card reader is attached, remove access cover on ferro cover over ferro terminal block (Diagram 7-21), and disconnect two wires leading from terminal block to connector on ferro cover by turning cam screw counterclockwise only. Note where leads were terminaled (for later reinstallation).
10. Remove screw holding ferro cover and remove cover.
11. Disconnect the two wires leading from ferro terminal block to prime power box by turning cam screw counterclockwise only. Note where leads are terminated for later reinstallation.
12. Remove the two screws holding ferro to base chassis.
13. Slide transformer out of housing and clear of chassis.
14. Replace in reverse order. When connecting wires to terminal block, cam screw must be turned clockwise.

5.3.2.10 High-Voltage Power Supply

1. Disconnect anode lead from CRT.
2. Unplug input cable at lower edge of HV assembly. Note where leads are terminated (for later reconnection).
3. Remove mounting screw.
4. Lift power supply clear of machine.
5. Replace in reverse order. Ensure that anode lead is firmly seated in CRT bell.

5.3.2.11 Fuses

1. Determine which fuse is blown.
2. Replace blown fuse with another fuse of same value.
3. Turn power on.
4. Check that fuse does not blow again.

Note: The +8V, -12V, and 6.3V ac fuses are held in fuse clips located on the LV power supply printed-circuit board. Remove plastic shield over the LV power supply board on Model 2 display stations to replace these fuses. The ac line fuse is located in a screw-type fuse holder on the prime power box. The +5V and +34V fuses are located at:

+5V (Model 1): A/F1 +34V (Model 1): A/F2	Diagram 7-3
+5V (Model 2): 01C/F1 +34V (Model 2): 01C/F2	Diagram 7-5

5.3.2.12 Voltage Distribution Board (Model 2 Display Stations Only)

1. Disconnect the LV cable connector (J2) at the top of the LV power supply near the front of the unit (Diagram 7-4).
2. Remove the cable tie that holds the LV cable against the chassis.

3. Unsolder the two wires connected to the +34V fuse at 01C/F2 A and B (Diagram 7-5).
4. Remove retaining screw in the corner of the voltage distribution board; move board toward the power switch and remove from unit (Diagram 7-6).
5. Install the voltage distribution board by reversing the procedure given in steps 1 through 4. When connecting the two wires to the +34V fuse, solder lead No. 4 of the new cable to 01C/F2-A and lead No. 16 to 01C/F2-B.

5.3.3 Analog Components

5.3.3.1 CRT

DANGER
All persons handling a CRT or who are near an exposed CRT under vacuum must wear safety glasses and long-sleeved garments.

The yoke and shield assemblies are removed with the CRT. To remove the CRT from the display station, proceed as follows:

Model 1

1. Disconnect power cord at display station (under front cover).
2. Remove left, right, and top covers (5.3.1.1).
3. Remove mask/bezel assembly by loosening the two captive knurled head screws that hold assembly to frame.
4. Carefully disconnect CRT anode lead. Static charge may be present.
5. Using an insulated jumper wire, momentarily ground CRT anode terminal to discharge static charge.
6. Disconnect yoke cable from analog card, and disconnect ground wire(s) from yoke shield.
7. Remove cone shield from base area of CRT:
   a. Loosen cone shield retaining shoulder screw.
   b. Rotate cone counterclockwise until locking tabs disengage.
   c. Pull cone straight back and clear of CRT neck.
8. Remove socket from base of CRT.
9. Open new CRT carton and place pad on firm surface close to display station so that a safe place is available when old CRT is removed.

CAUTION
The following steps free the CRT from its mounting. The tube weighs about 1.8 kg (4 pounds). Protect and support CRT from excessive pressures that could cause damage to the CRT or other components.

10. Remove top two CRT holding nuts, and remove grounding spring.
11. Loosen the bottom two holding nuts.
12. Connect lifting strap (PN 2565197) to top CRT mounting ears. (It may be necessary to slide CRT off the threaded studs and tilt it forward to attach strap to mounting ears.)
13. Remove bottom two holding nuts.
14. Carefully slide CRT and yoke assembly toward front of display station and clear of unit.
15. Place CRT face down on pad.
16. Note approximate orientation of yoke with reference to CRT.
17. Loosen yoke and shield retaining clamp and carefully slide assembly off CRT neck.
18. Install yoke and shield assembly on new CRT in location noted in step 16.
19. Install new CRT in reverse order, ensuring that CRT grounding spring (step 10) and yoke shield ground wire(s) (step 8) are reconnected.
20. Perform all Model 1 display image adjustments (5.2.1 through 5.2.1.6).

Model 2

1. Disconnect power cord at display station (under front cover).
2. Remove left, right, and top covers (5.3.1.2).
3. Remove Contrast and Brightness control knobs.
4. Mark position of power control actuator assembly on left side rail.
5. Remove the two power control actuator mounting screws. (One screw attaches assembly to side rail; the other attaches to front frame.)
6. Remove power control actuator assembly to expose lower left CRT holding nut.
7. On units with security keylock optional feature:
   a. Mark location of keylock assembly mounting bracket on front frame.
   b. Remove screws holding bracket to frame.
   c. Place keylock assembly aside to expose lower right CRT holding nut.
8. Carefully disconnect CRT anode lead. Static charge may be present.
9. Using an insulated jumper wire, momentarily ground CRT anode terminal to discharge static charge.
10. Disconnect yoke cable from analog card, and disconnect ground wire(s) from yoke shield.
11. Remove socket from base of CRT.
12. Remove cone shield from base area of CRT:
    a. Loosen cone shield retaining shoulder screw.
    b. Rotate cone counterclockwise until locking tabs disengage.
    c. Pull cone straight back and clear of CRT neck.
13. Open new CRT carton and place pad on firm surface close to display station so that a safe place is available when old CRT is removed.

CAUTION
The following steps free the CRT from its mounting. The tube weighs about 7.2 kg (16 pounds). Protect and support CRT from excessive pressures that could cause damage to the CRT or other components.

14. Remove top two CRT holding nuts, and remove grounding spring.
15. Loosen bottom two holding nuts.
16. Connect lifting strap (PN 2565197) to top CRT mounting ears.
17. Remove bottom two holding nuts.
18. Carefully slide CRT and yoke assembly toward rear of display station and clear of unit.
19. Place CRT face down on pad.
20. Note approximate orientation of yoke with reference to CRT.
21. Loosen yoke and shield retaining clamp and carefully slide assembly off CRT neck.
22. Install yoke and shield assembly on new CRT in location noted in step 20.
23. Install new CRT in reverse order, ensuring that CRT grounding spring (step 14) and yoke shield ground wire(s) (step 12) are reconnected.
24. Perform all Model 2 display station image adjustments (5.2.1 through 5.2.1.7).

Note: To dispose of a defective CRT, follow the instructions given in the CRT disposition procedure that is available at the branch office.

5.3.3.2 Yoke and Shields

The yoke and shield assemblies are removed from the CRT neck as a unit. After the assemblies are removed, they can be separated.

Note: Top cover on Model 2 display station must be removed before cone shield can be moved back to observe CRT filament.

1. Disconnect yoke cable from analog card, and disconnect ground wire(s) from yoke shield.
2. Remove socket from base of CRT. (On Model 1 display stations it is necessary to perform step 3 before socket can be removed.)
3. Remove cone shield from base area of CRT:
   a. Loosen shield retaining shoulder screw.
   b. Rotate cone counterclockwise until locking tabs disengage.
   c. Pull cone straight back and clear of CRT neck.
4. Note approximate orientation of yoke with reference to CRT.
5. Loosen yoke and shield retaining clamp and carefully slide assembly off CRT neck.
6. Separate yoke from shield.
7. Replace in reverse order. Position yoke on CRT as noted in step 4. (Yoke cable should be at bottom, and clamp screw should be on left side as viewed from top-front of display station.)
8. Ensure that grounding spring (fingers) on front of yoke is in contact with the conductive coating of the CRT bell by pressing yoke assembly toward face of CRT before tightening clamp screw.
9. Perform all display image adjustments (5.2.1.4 through 5.2.1.7).

5.3.3.3 Model 1 Analog Card

CAUTION
Perform HV power supply check (par. 5.1.3.5) before installing a new analog card. Premature failure of new analog card may result if power supply is defective.

1. Unplug connectors at top of analog card.
2. Loosen the two captive screws passing through analog card and into wire form. (These two screws have large knurled heads and a spacer on them.)
3. Unplug bottom connector.
4. Remove analog card from machine.
5. Remove the two screws and spacers from old analog card.
6. Reassemble screws and spacers in new analog card.
7. Plug in bottom connector.
8. Replace analog card in machine.

   Note: The two open slots in the rear edge of the analog card must fit into the slots in the rear leg of the wire form.

9. Tighten the two captive screws.
10. Plug in two top connectors.
11. Perform analog card adjustments (paragraphs 5.2.1.6 and 5.2.1.7) if a new card is installed or if the adjustments were disturbed.

5.3.3.4 Model 2 Analog Card

CAUTION
Perform HV power supply check (par. 5.1.3.5) before installing a new analog card. Premature failure of new analog card may result if power supply is defective.

1. Open logic gate.
2. Remove the two upper screws supporting analog card shield, and lift off shield.
3. Unplug cables plugged into front of analog card.
4. Remove the two screws holding analog card to base chassis.
5. Remove analog card from support.
6. Unplug rear connector.
7. Replace in reverse order.
8. Perform analog card adjustments (paragraph 5.2.1.7) if a new card is installed or if the adjustments are disturbed.

5.3.3.5 Model 1 Brightness and Contrast Controls

The Brightness and Contrast controls are part of the prime power box on Model 1 display stations. Do not replace these controls; replace prime power box. See paragraph 5.3.2.4 for prime power box replacement procedure.

5.3.3.6 Model 2 Brightness and Contrast Controls

1. Unsolder the three leads on each of the two potentiometers. Note terminals from which wires are removed, for later reinstallation.
2. Pull the two knobs off concentric control shafts.
3. Remove rear-most C clip on slider bracket that retains slider bracket to potentiometer shaft.
4. Pull off large retaining clip that holds potentiometers to mounting bracket.
5. Lift assembly clear of unit from rear.
6. Assemble in reverse order.
7. Turn power on.
8. Check for proper operation of both controls.

5.3.3.7 Power Control Switch

The power control switch is part of the prime power box. If it is necessary to replace the switch, the prime power box must be replaced. See paragraph 5.3.2.4 for the Model 1 prime power box replacement procedure or paragraph 5.3.2.5 for the Model 2 prime power box replacement procedure.

5.3.4 Logic Components

5.3.4.1 Logic Card

1. Turn power off.
2. Pull out on the two handles on plastic card holder to disengage card from board.
3. Pull logic card from socket evenly and perpendicular to logic board.
4. If card is being changed, remove card holder from old card and install it on new card.
5. Place card in socket guides.
6. Push card on logic board pins. Do not bend pins. Make sure card seats firmly, with a snap, in socket.
7. Turn power on.

5.3.4.2 Logic Board

1. Turn power off.
2. Remove all cards from board to be replaced, noting positions.
3. Remove decoupling capacitor from clip, and remove capacitor wires from the two board pins. Note where wires were terminated, for later reinstallation.
4. Remove all cables on pin side of board. Cables are labeled with their pin assignments.
5. Remove plastic bumper (yoke assembly). Check for presence of Keyboard Feature Jumpers (Diag. 6-10). Note terminations.
6. Remove voltage buses from board with cables attached. Note positions for re-installation.
7. Remove all socket-head screws with clamps that hold board to gate.
8. Remove board from machine while unplugging connectors plugged in card side of board.
9. Replace in reverse order. Be extremely careful to replace wires, cables, and connectors on correct board pins and to replace logic cards in proper sockets.
10. Rewire Keyboard Feature Jumpers onto new board if feature was present.

5.3.5 Keyboard Components

This section describes procedures to remove and replace keyboard components. Paragraphs 5.3.5.1 through 5.3.5.5 are common to Type A and Type B keyboard assemblies, paragraphs 5.3.5.6 through 5.3.5.8 apply only to Type A, and paragraphs 5.3.5.9 through 5.3.5.11 apply only to Type B. Ensure that the correct procedure is used. The following equipment may be required:

Keytop puller tool	-	PN 9900373 (preferred), PN 75475, or PN 627953
Isopropyl alcohol	-	PN 2200200 (or IBM tape transport cleaner - PN 453511)
Cloth (lint-free)	-	PN 2108930 (or tissue - PN 2123106)

5.3.5.1 Keyboard from Display Station

1. Turn power off.
2. Remove display station front cover.
3. Disconnect keyboard cable ground strap from chassis.
4. Remove keyboard cable connector from its socket. On Model 2 display stations, I/O cable retainer must be unhooked to release keyboard connector. On Model 1 display stations, nylon cable clamp must be removed.
5. Replace in reverse order.
6. Ensure that all I/O cable connectors are firmly seated in sockets and that ground straps are attached.

5.3.5.2 Keyboard Top Cover

1. Turn keyboard over.
2. Loosen the four captive screws in corners of keyboard bottom pan.
3. Place keyboard upright on a flat surface.
4. Lift top cover off keyboard.
5. Replace in reverse order.

5.3.5.3 Keyboard Assembly from Bottom Pan

1. Disconnect keyboard from display station. (See paragraph 5.3.5.1.)
2. Remove keyboard top cover. (See paragraph 5.3.5.2.)
3. Disconnect keyboard cable connector.
4. Remove the four fasteners that hold keyboard assembly to mounts. (Type A assemblies use nuts; Type B use screws.)
5. Lift keyboard assembly off mounts.
6. Replace in reverse order.
7. Ensure that cable connector is firmly seated.

5.3.5.4 Audible Feedback Assembly

1. Disconnect keyboard from display station. (See paragraph 5.3.5.1.)
2. Remove keyboard top cover. (See paragraph 5.3.5.2.)

Note: The audible feedback device consists of two assemblies. The logic card is removed by pulling it out of its socket. To remove the audible feedback assembly, proceed with steps 3 and 4.

3. Disconnect the two leads from audible feedback assembly at connector positions 8 (white wire) and 9 (blue wire). On assemblies where logic card is mounted horizontally, it is necessary to remove card socket for access to leads.
4. Remove the two screws that hold relay assembly to keyboard bottom pan.
5. Replace in reverse order.

5.3.5.5 Keybutton

A keybutton should be replaced when it deteriorates in appearance or when it fails to remain attached to the key stem. Buttons are removed by sliding the keytop puller tool over the keytop and pulling straight up.

5.3.5.6 Type A Switch Module

Steps 1–3 must be performed in the order listed before removing the switch module.

1. Disconnect keyboard from display station. (See paragraph 5.3.5.1.)
2. Remove keyboard top cover. (See paragraph 5.3.5.2.)
3. Remove keyboard assembly from bottom pan. (See paragraph 5.3.5.3.)
   A. *Switch Module Removal* (Except Spacebar Switch Module):
      1. Record locations of keybuttons in area of switch module (PN 5995542) being replaced. Remove keybutton from faulty module (and from as many others as needed to provide work space).
      2. Take the two small, flat, pointed tools from box containing new module, and slip one down the inside face of each D bracket (retainer) to force brackets away from locking channels on plastic case of old module (Diagram 5-2).
      3. With flat tools in this position, grip shouldered portion of switch module plunger with pliers, and pull switch module straight out.

         CAUTION
         In the next step, do not apply the soldering iron for longer than necessary to flow the solder.

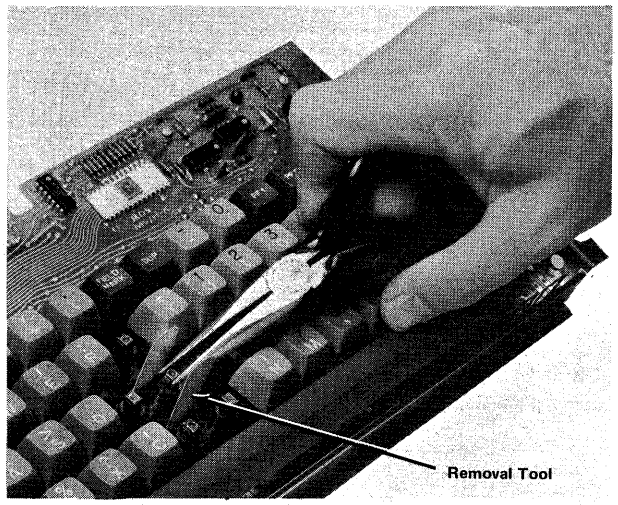


Diagram 5-2. Switch Module Removal (Type A)

4. The black plastic lead frame package is left behind when the plunger assembly is removed. Using solderwick (PN 5151439), unsolder and remove excess solder from the four terminal pads on printed circuit board (Diagram 5-3). Remove lead frame package from printed circuit board (Diagram 5-4).

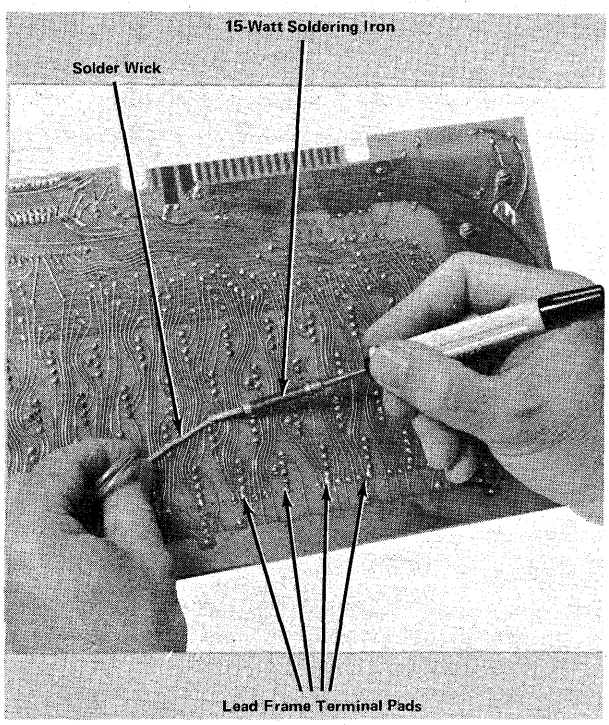


Diagram 5-3. Unsoldering Lead Frame Terminals (Type A)

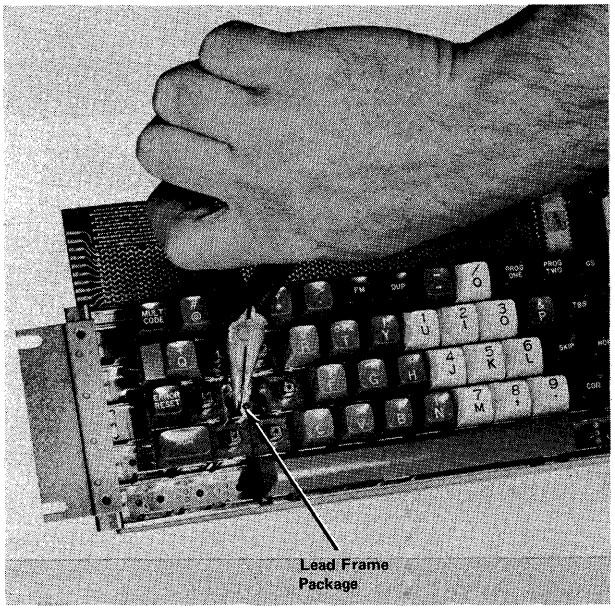


Diagram 5-4. Lead Frame Removal (Type A)

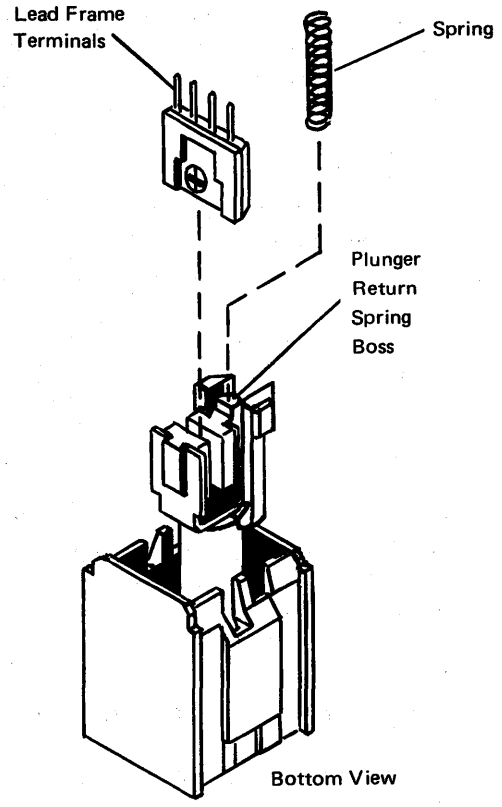


Diagram 5-5. Switch Plunger Return Spring Positioning (Type A)

Note: If the switch mounting frame becomes distorted during removal of the old module, form it back to its normal position. This can be done by squeezing the D brackets together until they will seat firmly against the sides of the new module housing.

B. *Switch Module Replacement:* Do not disassemble replacement module. Lead frame and plunger assemblies are matched during manufacture. Proceed as follows:

1. Check that return spring is firmly seated on spring boss on bottom of plunger of new switch module (Diagram 5-5). If it is not, invert switch module so that lead frame terminals are up. Place spring on boss. Compress and rotate spring until last coil expands around boss. When properly seated, spring should be parallel to long axis of switch module.

   Note: When the plunger return spring is in place, check the lead frame terminals to see that they are not bent and that they are parallel to the long axis of the switch module.

2. Insert module into keyboard switch mounting frame, with orientation arrow on top of module pointed in the same direction as arrows on other modules (Diagram 5-6). As module is inserted, be sure plunger return spring seats on raised boss on bottom of mounting frame and that the four terminals extend through holes in printed-circuit board.

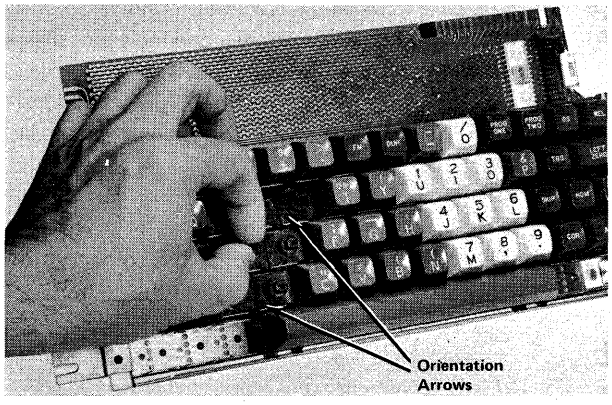


Diagram 5-6. Switch Module Orientation (Type A)

Once new module is in place, check for the following conditions:

- Plunger moves freely.
- Top surface of module is even with those of other modules.
- D brackets on mounting frame lock module firmly in place.

Note: Should it be necessary to remove the new module to correct any of these conditions, be careful not to mar any portion of the plunger, since operation of the module and/or retention of the keybutton would be affected.

CAUTION
In the next step, do not apply soldering iron for longer than necessary to flow the solder.

3. Solder terminals of lead frame. Use a minimum amount of solder.
4. Reassemble keybuttons on switch modules. Check to see that correct keybuttons are returned to correct module positions.
5. Install the assembly on the bottom pan, replace keyboard top cover, and reconnect keyboard to display station.

5.3.5.7 Type A Spacebar Assemblies

Type A spacebar assemblies consist of the spacebar group (PN 5995544) and the spacebar switch module (identical to other switch modules). The spacebar group comprises the spacebar, the torsion bar, and the two spacebar guide modules. Replacement of any spacebar part requires removal of the spacebar and torsion bar. Perform the removals in paragraphs 5.3.5.1 through 5.3.5.3 for access to the keyboard assembly.

A. *Spacebar Removal:*

1. Grasp torsion bar near one end with thumb and forefinger (Diagram 5-7) and flex it upward, snapping it forward out of retaining lugs on spacebar guide module.
2. Swing loose end of torsion bar upward, and disengage it from other spacebar guide module.
3. Lift spacebar straight up out of spacebar guide modules. This exposes spacebar guide modules and spacebar switch module.
4. If spacebar group is to be replaced, remove spacebar guide modules as explained in paragraph 5.3.5.6A, step 2. (See Diagram 5-8). Lift module straight out with thumb and forefinger.
5. If spacebar switch module is to be replaced, remove switch module as described in paragraph 5.3.5.6A, steps 2 through 4.

B. *Spacebar Replacement:*

1. If spacebar switch module is to be replaced, use procedure described in paragraph 5.3.5.6B, steps 1 through 3.
2. If spacebar group is to be replaced, insert new spacebar guide modules into mounting frame; be careful to have torsion bar retaining lugs positioned to the front. Be sure that D brackets lock guide modules firmly in place.
3. Insert spacebar guides in spacebar guide modules, and drop spacebar in place.
4. Holding torsion bar at a suitable angle and position, insert end of torsion bar in the hole in one spacebar guide (Diagram 5-8). At the same time, engage torsion bar with retaining lugs on guide module. Lower torsion bar to horizontal. Flex it as during removal, and insert other end simultaneously into hole in other spacebar guide and into retaining lugs on other guide module.
5. Operate spacebar to see that switch module operates freely and that torsion bar and spacebar guides do not bind.
6. Replace keyboard top cover and reconnect keyboard to display station.

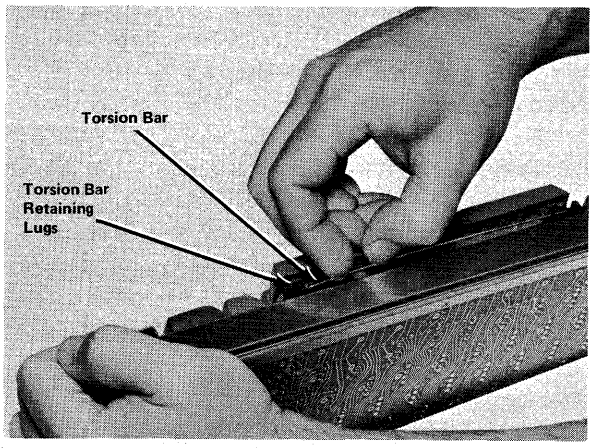


Diagram 5-7. Torsion Bar Removal (Type A)

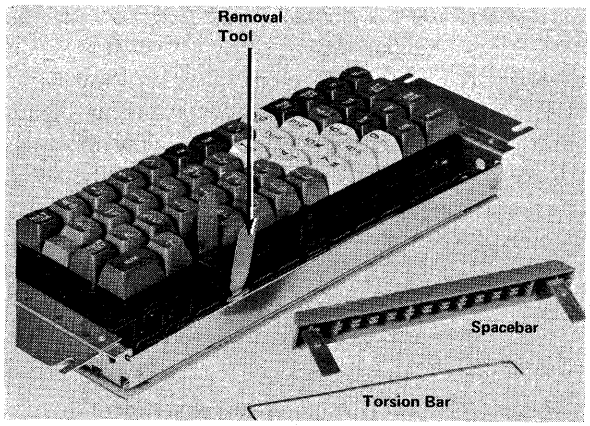


Diagram 5-8. Spacebar Guide Module Removal (Type A)

5.3.5.8 Keybutton Support Modules - Type A Keyboards Only

The longer keybuttons, 1-3/4 and 2-3/4 units long, on Type A keyboard utilize support modules PN 5995543 and PN 5995547, respectively.

A. *Support Module Removal:*

1. Remove keybutton(s) to provide adequate work space.
2. Take the two small, flat, pointed tools from box containing new module, and slip one down inside face of each D bracket (retainer) to force brackets away from locking channels on plastic case of old module.
3. With flat tools in this position, grip shouldered portion of support module plunger with pliers, and pull old module straight out.

B. *Support Module Replacement:*

1. Check that return spring is firmly seated on spring boss on bottom of plunger of new support module. If it is not, invert module, place spring on boss, and compress and rotate spring until last coil expands around boss.
2. Insert new module into keyboard switch mounting frame, with orientation arrow on top of module housing pointed in same direction as arrows on other modules. As module is inserted, be sure plunger return spring seats on raised boss on bottom of mounting frame.

   Once new module is in place, check that plunger moves freely, that top surface of module does not extend above other modules, and that D brackets on mounting frame have locked module firmly in place.
3. Reassemble keybuttons on switch modules. Check that correct keybuttons are returned to correct module positions.

5.3.5.9 Type B Module

Steps 1–3 must be performed in the order listed before removing the module. *Cleanliness is important when working on the keyboard. Any particle between the key module flyplate and the printed circuit board is a potential problem.* Before keyboard disassembly, prepare a smooth, clean work area by wiping contamination away with a lint-free cloth dampened with isopropyl alcohol. Gently tap, brush, and shake the keyboard assembly to remove most loose particles that could get into the PC board and flyplate area during disassembly and reassembly.

1. Disconnect keyboard from display station. (See paragraph 5.3.5.1.)
2. Remove keyboard top cover. (See paragraph 5.3.5.2.)
3. Remove keyboard assembly from bottom pan. (See paragraph 5.3.5.3.)

   A. *Module Removal* (Including Spacebar Module):

   Note: See paragraph 5.3.5.10 for spacebar removal if spacebar module is to be replaced.

1. Ensure that all small particles that might contaminate the keyboard assembly are removed from the work area.
2. Record locations of keybuttons in area of module that is being replaced. Remove keybutton from faulty module and from as many others as may be required to provide enough work space.
3. Place keyboard assembly upside down in the cleaned area, and loosen the screws holding base plate and circuit board to the all-keys assembly (Diagram 5-9). Do not remove the holding screws at this time.
4. Place keyboard assembly right side up, and slide one corner off the work surface edge to expose one holding screw. With fingers, remove holding screw from bottom.
5. Carefully rotate keyboard assembly and remove remaining holding screws, one at a time. Keep the all-keys assembly and PC board together.

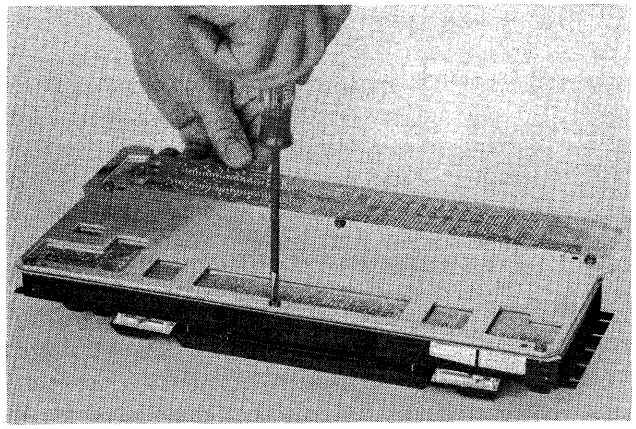


Diagram 5-9. Screw Loosening (Type B)

6. Lift the all-keys assembly from the circuit board, and place the assembly right side up (keybuttons up) in the clean area. Handle the all-keys assembly by the sides (Diagram 5-10). Be careful not to depress any keys while removing assembly, since a flyplate could detach.

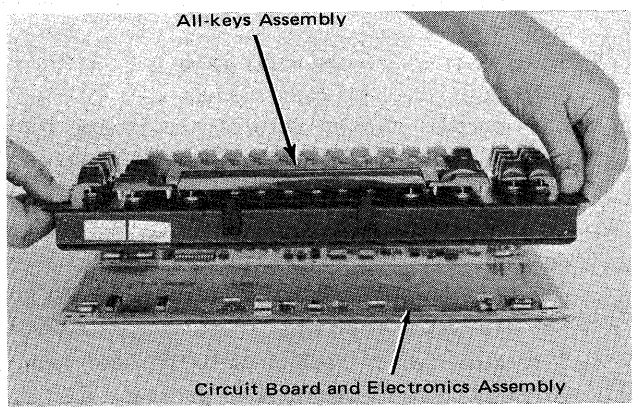


Diagram 5-10. Keyboard Assembly Separation (Type B)

Note: Replace the key module if the flyplate comes off. Do not attempt to repair the module. Repaired modules can cause intermittent failures.

7. Raise the edge of the all-keys assembly nearest the key module to be replaced about 6.4 mm (1/4 inch). Press down on the shoulder of the key module until it snaps out of the retaining plate (Diagram 5-11).
8. Select either removal method, a or b, below, that is most convenient.
   a. Lift the all-keys assembly, leaving behind the defective key module. Place the all-keys assembly rightside up in the clean area.
   b. Lift the all-keys assembly, leaving behind the defective module. Place the all-keys assembly upside down, either on the existing system keyboard mounting hardware and brackets or on prepared supports (such as blocks of wood or standoffs).

B. *Module Replacement:*

1. Observe orientation of the new key module. Ensure that the alignment lug and keystem are in the same position as the rest of the modules in the all-keys assembly.
2. Install new module (PN 1772948) by lowering the all-keys assembly over the new module (if step 8a was used for removal) or by snapping the key module in the retaining plate by hand from the bottom (if step 8b was used for removal).
3. Clean the printed circuit board (Diagram 5-12) and key module flyplates by carefully wiping each with a lint-free cloth dampened with isopropyl alcohol. *Be careful not to dislodge or remove flyplates from key modules.*
4. Align the holding screw holes through base plate, PC board, insulator, and top insulator (if present). Diagram 7-18 shows the correct locations of these components. Lower the all-keys assembly into place.
5. Carefully slide one corner of the keyboard assembly off the work area edge, and install one holding screw finger tight. Rotate keyboard assembly carefully, and install remaining screws finger tight.
6. Turn keyboard assembly upside down, and tighten all holding screws with a screwdriver.
7. Turn keyboard assembly rightside up, and reinstall keybuttons in proper locations.
8. Manually check operation of each key module.
9. With an ohmmeter, check for continuity between the base plate and KB 1 connector pin D08. The two base plate grounding studs (Diagram 5-13) must contact the PC board ground circuit.
10. Install the keyboard assembly on the bottom pan, replace keyboard top cover, and reconnect keyboard to the display station.

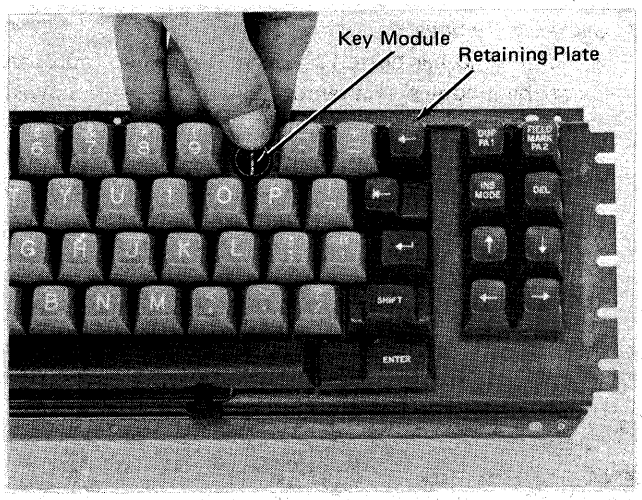


Diagram 5-11. Module Removal (Type B)

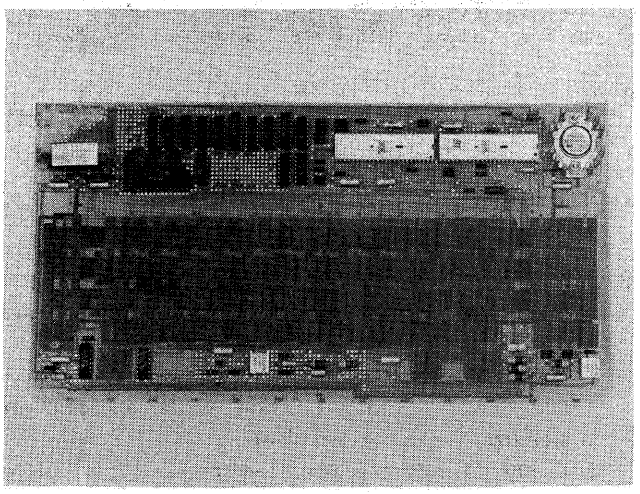


Diagram 5-12. Circuit Board and Electronics Assembly (Type B)

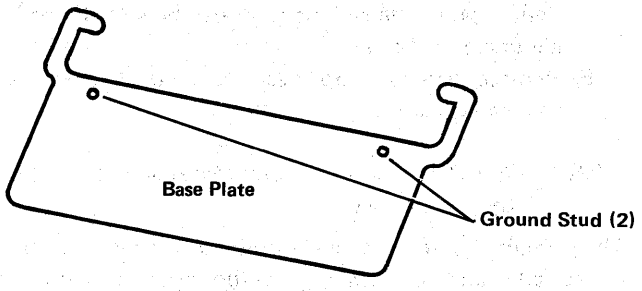


Diagram 5-13. Base Plate Ground Studs (Type B)

5.3.5.10 Type B Spacebar

Perform the removals described in paragraphs 5.3.5.1 through 5.3.5.3 for access to the keyboard assembly.

A. *Spacebar Removal:*

1. Grasp spacebar button at each extreme end (outboard of the modules) and remove by applying even upward force.
2. Pivots can be removed (if required) by prying with the tip of a screwdriver placed in the molded slot in the side of the pivot (Diagram 5-14).

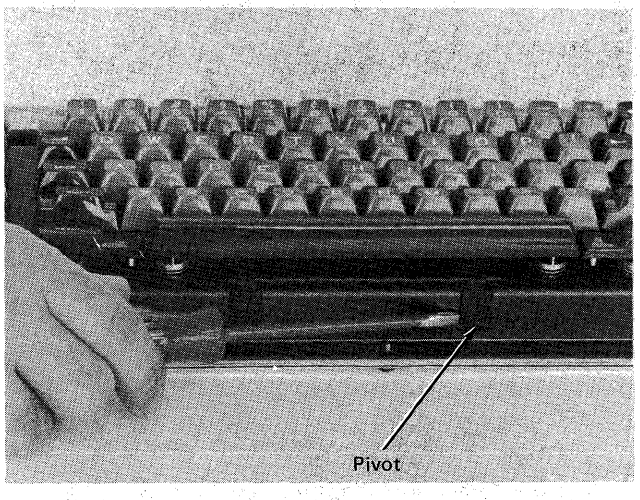


Diagram 5-14. Spacebar Pivot Removal (Type B)

B. *Spacebar Replacement:*

1. Snap any pivots removed in step 2 (above) into mounting frame.
2. Place spacebar button over its respective modules, and lower it into position while engaging the stabilizer bar in the two pivots.
3. Apply downward pressure on spacebar at the points directly over spacebar modules to seat the spacebar button.
4. Check spacebar operation for binds. If binds are present, the most common problem is a slightly bent right module stem. This stem can be straightened to eliminate the bind.
5. Replace keyboard top cover, and reconnect keyboard to display station.

5.3.5.11 Circuit Board and Electronics Assembly - Type B Keyboards Only

The circuit board and electronics assembly is a field-replaceable unit on Type B keyboards. To remove or replace the circuit board and electronics assembly, proceed as follows:

1. Clean the work area and prepare the keyboard. (Use steps 1–3 of paragraph 5.3.5.9.)
2. Disassemble keyboard. (Use steps 3–6 of paragraph 5.3.5.9A.)
3. Reassemble keyboard. (Use steps 2–9 of paragraph 5.3.5.9B.)

5.3.6 Audible Alarm (Optional Feature)

The audible alarm device circuitry is packaged in a small metal box mounted on the base chassis beneath the CRT, inside the front cover. The audible alarm box is mounted vertically on Model 1 display stations and horizontally on Model 2 display stations.

1. Remove front cover.
2. Remove audible alarm box from chassis. Box can be removed from snap fasteners by rocking metal box while pulling away from chassis.
3. Remove circuit board from the metal box.
4. Remove cable wires from audible alarm circuit board with long-nosed pliers or small blade screwdriver.
5. Replace in reverse order. Circuit board is etched with color code of wires to be replaced.

5.3.7 Security Keylock (Optional Feature)

5.3.7.1 Model 1

1. Remove screws that hold keylock assembly to frame.
2. Release cable clamps that route switch assembly cable to logic board.
3. Remove cable leads from connector at socket A1Z3. Note positions from which wires are removed (for later reconnection).
4. Lift switch cable assembly free of machine.
5. Reassemble in reverse order. Make sure that leads removed in step 3 are replaced in proper connector positions and that keylock assembly is aligned with hole in right side cover.

5.3.7.2 Model 2

1. Remove screws that hold keylock assembly to frame.
2. Remove keylock assembly cover.
3. Remove cable leads from switch with pliers or small screwdriver. Note terminals from which leads are removed (for later connection).
4. Remove cable strain relief from hole in switch assembly.
5. Remove cable from keylock assembly.
6. Reassemble in reverse order. Make sure to align keylock assembly with hole in right side cover.

5.3.8 Selector Light Pen (Optional Feature)

5.3.8.1 Model 1

1. Remove screws from base of selector light-pen holder; remove cable.
2. Unplug feature cable from logic board cable socket Y4.
3. Unscrew nylon cable clamp screw that holds cable to center rear of board assembly.
4. Remove screw and retainer that clamps routing cable and ground wire to rear of chassis.
5. Slip cable out of slotted hole at center rear of chassis.
6. Replace in reverse order. Make sure that ground wire is reconnected to chassis, and that cable is positioned in slot so that extra insulation on cable acts as a grommet.
7. Position light-pen cable in pen holder so that distance from holder to cable end of pen is about 762 mm (30 inches).

5.3.8.2 Model 2

1. Remove screws from base of selector light-pen holder; remove cable.
2. Unplug feature cable from logic board cable socket Y4.
3. Release cable from cable clamps that route cable to bottom of chassis.
4. Disconnect ground wire from frame.
5. Slip cable out of slotted hole at bottom, right, rear of chassis.
6. Replace in reverse order. Make sure cable is positioned in cable clamps so that extra insulation on cable acts as a grommet where cable passes through hole in chassis. Make sure that ground wire is reconnected to frame.
7. Position light-pen cable in pen holder so that distance from holder to cable end of pen is approximately 762 mm (30 inches).

5.3.9 Operator Identification Card Reader (Optional Feature)

1. Disconnect card reader cable ground strap from chassis.
2. Remove card reader cable connector from its socket. On Model 1 display stations, nylon cable clamp must be removed. On Model 2 display stations, the I/O cable retainer must be unhooked to release cable connector.
3. Replace in reverse order.
4. Ensure that all I/O cable connectors are firmly seated in sockets and that all ground straps are attached to chassis ground terminal.

5.4 TYPE B KEYBOARD MAINTENANCE AIDS

The Symptom Index in Chapter 3 and the Troubleshooting Diagrams in Chapter 4 isolate Type B keyboard malfunctions. The check and removal procedures presented earlier in this chapter provide detailed instructions for repairing keyboard faults. This section provides miscellaneous maintenance aids to supplement the existing procedures. These aids are not intended to replace the existing procedures, CEMs, or other published data.

5.4.1 Cleaning

The importance of cleanliness when servicing Type B keyboards cannot be overemphasized. Any particle between the key module flyplate and the printed circuit board is a potential problem.

5.4.1.1 Work Area

Before beginning any keyboard disassembly, prepare a smooth, clean work area by wiping contamination away with a lint-free cloth dampened with isopropyl alcohol. Gently tap, brush, and shake the keyboard assembly to remove most loose particles that can get into the PC board and flyplate area during disassembly and reassembly.

5.4.1.2 Keyboard Assembly

Before reassembling the keyboard assembly, the printed circuit board and key module flyplates must be carefully cleaned by wiping each with a lint-free cloth dampened with isopropyl alcohol. Be careful not to dislodge or remove flyplates from key modules while cleaning. Replace, rather than attempt to repair, the key module if the flyplate separates from the module.

5.4.2 Liquid Spills

Some minor liquid spills, such as soft drinks or coffee with sugar, can be removed by first "washing" the PC board and affected flyplates with a lint-free cloth dampened with a mixture of water and mild hand soap. "Rinse" with a water-dampened, lint-free cloth. Finally, clean with lint-free cloth dampened with isopropyl alcohol.

Note: Sticky key modules must be replaced. A severe liquid spill may necessitate replacement of the entire keyboard assembly.

5.4.3 Key Modules

Two types of key modules, the original "black body" module and a new "super slick" white body module, are currently in use on Type B keyboards. Super slick key modules must not be used on keyboards that are attached to 3277 display stations. These modules can cause intermittent errors.

5.4.4 Contamination Shields

Some keyboards have foam strips, foam side insulators, and a 0.038 mm (1.5-mil) protective membrane/shield added to prevent contamination from entering the PC board and flyplate area during customer use. The presence of these shields is a function of the EC level of the keyboard. The shields are shown in Diagram 7-18.

5.4.5 Protective Membrane/Shield

When removing a key module from a keyboard with the protective shield, care must be taken not to puncture the shield when snapping out the defective module.

5.4.6 Ground Check

There should be continuity between the two base plate grounding studs (Diagram 5-13) and the dc ground circuit on the PC board. Grounding can be checked with an ohmmeter connected between the base plate and the ground pin, D08, at the interface signal connector, KB 1.

5.4.7 Ground Loop Isolation

Nonconductive inserts have been added to the base plate holding screws on some keyboard assemblies to isolate the base plate and PC board dc ground from the all-keys assembly. With the keyboard assembly disconnected from the 3277, check to ensure that the base plate and all-keys assembly are not electrically shorted.

5.4.8 Crooked or Loose Keytops

Key module stems can be formed left or right to align a crooked looking keytop. The keystem ears can be widened to tighten loose keytops.

This section contains miscellaneous reference information that can be helpful in maintaining IBM 3277 Display Stations.

6.1 CONTROLS

Controls are divided into two categories: external and internal. External controls are those that are accessible without removing covers. Internal controls are those that are under covers and are accessible to maintenance personnel only. The audible alarm volume control, although located under the front cover, is considered an external control because the display station operator can adjust the volume.

6.1.1 External Controls (Diagram 6-1)

6.1.1.1 OFF-PUSH (Power, Brightness, and Contrast)

The OFF-PUSH switch is a triple-function control that adjusts the display image brightness and contrast. It also controls display station power. Pulling the switch out toward the operator turns display station power on. The overall displayed image is made brighter by rotating the Brightness control (outer knob) clockwise; the image is made dimmer by rotating the knob counterclockwise. The Contrast control (inner knob) is on a concentric shaft with the Brightness control. Rotating the Contrast control clockwise reduces the difference in contrast between high and normal intensity characters; rotating the control counterclockwise increases the difference in contrast.

6.1.1.2 Security Keylock (Optional Feature)

This operator control is a key-operated switch lock. The key must be inserted in the lock and turned on (horizontal position) to enable the display station for operation. The key must remain in the On position to keep the display station enabled. The key cannot be removed from the lock unless it is returned to the Off position.

6.1.1.3 Selector Light-Pen Tip Switch (Optional Feature)

The selector light pen contains a spring-loaded switch in its tip. The switch is used to select detectable fields on the

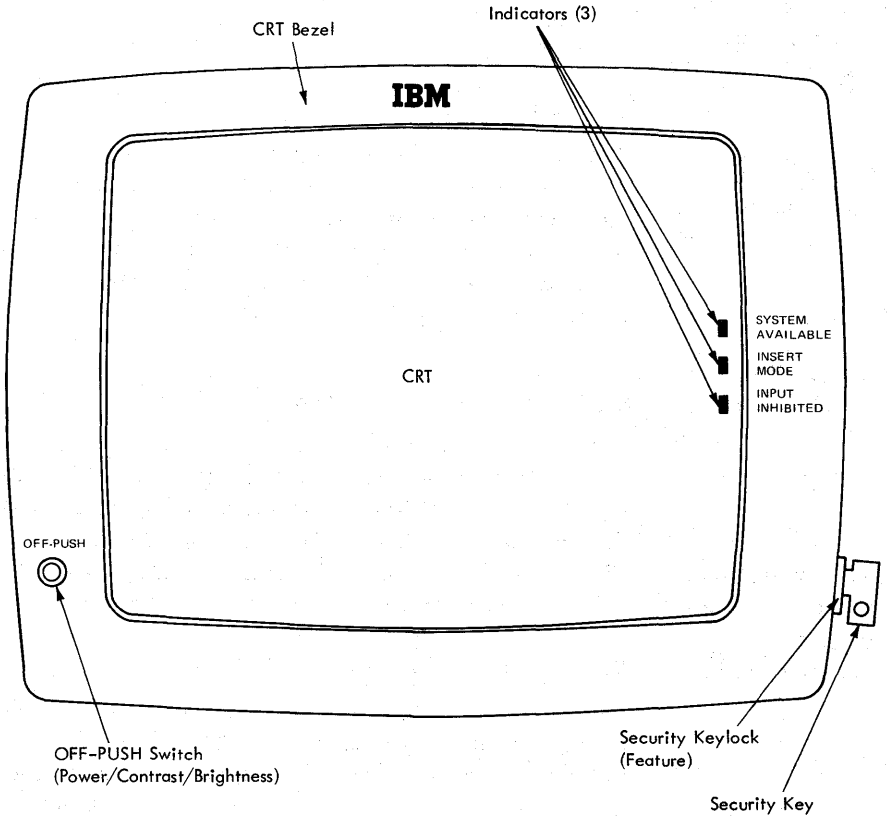


Diagram 6-1. External Controls and Indicators

screen by placing the point of the pen on the desired data field and pushing the barrel of the pen toward the screen. Removing the tip from the screen turns the switch off automatically.

6.1.1.4 Audible Alarm Volume (Optional Feature)

The loudness of the audible tone can be adjusted by the display station operator by turning the audible alarm volume control. The front cover must be lowered for access to the control. On Model 1 display stations, the control protrudes downward from the audible alarm box on the right side of the base chassis. On Model 2 display stations the control protrudes frontward from the audible alarm box on the left side of the upper chassis.

6.1.1.5 Keyboard Audible Response

A knob at the rear of the keyboard bottom plate adjusts the volume of the keyboard audible response device. Volume can be adjusted from off (no click when a key is depressed) to maximum loudness by rotating the knob.

6.1.2 Internal Controls

6.1.2.1 INTEN CRT

This momentary-contact switch is located on the display station analog card. The switch overrides intensity and blanking pulses generated by control logic and causes a complete raster of scan lines to be displayed when pressed.

6.1.2.2 Focus

This control is a screwdriver-adjustable potentiometer located on the HV power supply. Turning the control varies the sharpness of the dots that form the characters on the screen.

6.1.2.3 WIDTH

The WIDTH control is a screwdriver-adjustable potentiometer located on the analog card. Turning this control varies the horizontal dot-to-dot spacing, which alters the total width of the displayed image.

6.1.2.4 CHAR HEIGHT

This control is a screwdriver-adjustable potentiometer located on the analog card. Turning the control varies vertical dot-to-dot spacing of the displayed image. On the Model 1 display station, it determines the overall height of the displayed image.

6.1.2.5 ROW SPACING (Model 2 Display Stations Only)

This control is a screwdriver-adjustable potentiometer located on the analog card. Turning the control varies spacing between character rows and, thus, determines the overall height of the displayed image. The ROW SPACING control is not used in Model 1 display stations.

6.1.2.6 TOP MARGIN

This control is a screwdriver-adjustable potentiometer located on the analog card. The control sets the top reference line on the CRT, from which all other vertical image adjustments are made. Once the control is set, the reference line remains stationary during other vertical character and image adjustments.

6.1.2.7 Image Tilt

The deflection yoke, mounted on the CRT neck, is used to tilt the entire displayed image. Rotating the yoke adjusts the image for squareness with the edges of the CRT bezel.

6.1.2.8 Magnetic Centering Rings

The magnetic centering rings are mounted on the CRT neck, directly behind the deflection yoke. The centering rings are rotated to position the displayed image about the geometric center of the CRT.

6.1.2.9 -12V Supply

This control is a screwdriver-adjustable potentiometer located on the -12V regulator card. Turning the control sets the voltage output of the -12V power supply.

6.2 INDICATORS

Display indicators, like controls, are divided into two categories: external and internal. External indicators are those that can be seen without removing any machine covers. To observe internal indicators, covers must be removed. Internal indicators are accessible only to maintenance personnel.

6.2.1 External Indicators (Diagram 6-1)

The three external indicators on 3277 Display Stations are displayed as small boxes (blips) generated by analog circuitry. They are displayed at the right edge of the CRT. Each indicator has its function identified by a label on the CRT bezel, adjacent to the indicator. The brightness of the indicators is controlled by the Brightness control.

6.2.1.1 SYSTEM AVAILABLE Indicator

This indicator is displayed at character row 4 on Model 1 display stations and at character row 10 on Model 2 display stations. In remote system configurations, the indicator signifies that the carrier is on and that the transmission control unit (TCU) is online when lighted. In local system

configurations, the indicator being on signifies that the channel 'operational out' tag line is active.

6.2.1.2 INSERT MODE Indicator

This indicator is displayed at character row 6 on Model 1 display stations and at character row 12 on Model 2 display stations. The indicator lights when the INSERT MODE key on the keyboard is pressed. It signifies that the display station is in the Insert mode of operation. The indicator remains on, and the display station remains in Insert mode until the RESET key is pressed.

6.2.1.3 INPUT INHIBITED Indicator

This indicator is displayed at character row 8 on Model 1 display stations and at character row 14 on Model 2 display stations. The lighted indicator signifies that manual input to the display station from the keyboard, selector light pen, and Operator Identification Card Reader is blocked. The indicator is extinguished by program control or by pressing the RESET key. When the security keylock is off, this indicator lights.

6.2.2 Internal Indicator (SWEEP INDIC)

The SWEEP INDIC indicator is a neon bulb mounted on the display station analog card. The lighted indicator signifies that the horizontal deflection circuits are operating.

6.2.3 Arc-Suppression Neon

The arc-suppression neon is located on the arc-suppression board in Model 1 display stations and on the voltage distribution board in Model 2 display stations. It is not an indicator and will never be seen lighted. The two elements of the neon bulb are connected between dc ground (RET) and the display station frame ground. The neon acts as a momentary short circuit whenever the difference in potential between its two elements would have exceeded approximately 90V. The difference in potential is occasionally generated by the inherent characteristic of a cathode-ray tube to arc. Arcing causes transients in the return path of the tube. Restricting potentials to 90V to ground protects display station circuitry from possible damage.

6.3 KEYBOARDS (Optional Feature)

Four keyboards are used with 3277 Display Stations. Keyboards of the same type are interchangeable among display stations having keyboard adapter circuitry installed. EBCDIC is the basic code used on all keyboards.

6.3.1 Types of Keyboards

6.3.1.1 Typewriter Keyboard

The typewriter keyboard uses a standard typewriter key layout of 66 keys. An additional 12 Program Function keys may be incorporated in the standard typewriter keyboard. Diagram 6-2 illustrates the typewriter keyboard.

6.3.1.2 Operator Console Keyboard

The operator console keyboard uses an IBM 1052-7 type key layout with an additional 12 Program Function keys. Diagram 6-4 illustrates the operator console keyboard.

6.3.1.3 Data Entry Keyboards

The two data entry keyboards use 66 keys, consisting of 36 alphameric keys and 30 control keys. Diagram 6-5 illustrates the two data entry keyboards.

6.3.2 EBCDIC Keyboard Codes

The EBCDIC code is the standard code used with all 3270 system keyboards. Diagram 6-7, Sheet 1, shows the keyboard codes for the typewriter and operator console keyboards. Characters (and functions) are shown in the Graphics column as they appear on typewriter keyboard keytops. The operator console keyboard key layout is similar. Sheet 2 shows the EBCDIC code arrangement used on the data entry keyboard(s). Diagrams 6-14 and 6-15 show the codes for unique ASCII and WTC language characters.

6.4 ASCII OPTIONS

ASCII* character generator and keyboard options may be present on 3277 Display Stations. ASCII options are available only in the United States and Canada. The following paragraphs describe the characteristics of these options.

6.4.1 ASCII Character Generators (Optional Features)

Two ASCII character generator options allow the ASCII code set to be displayed. The ASCII code set includes the symbols [,], \ , and ^ which are not used in the 3277 EBCDIC code set. ASCII option A uses the symbols | and ¬, while option B substitutes the symbols ! and ^ respectively. Each option requires a different character

*ASCII American National Standard Code for Information Interchange, X3.4-1968.

generator logic card in location K2. Maintenance of the display station is not affected by the presence of the ASCII option; however, if logic card K2 must be changed, the same type number card must be used.

6.4.2 ASCII Keyboards (Optional Features)

Two ASCII typewriter keyboards can be attached to the 3277 Display Station. They are similar to EBCDIC typewriter keyboards described in paragraph 6.3.1.1, except unique ASCII characters are included on some keytops. PF keys 1–12 are included in the 78-key version. ASCII keyboards are serviced like EBCDIC keyboards, and operationally they are the same. Unique logic cards are not used, but ASCII character generator option A or B must be installed to enter and display the unique ASCII characters. Option A provides the 64 ASCII character set including the symbols | (logical or) and ¬ (logical not). Option B provides the 64 ASCII character set but substitutes ! (exclamation point) for logical or and ^ (circumflex) for logical not.

6.5 APL OPTIONS

The 3270 Data Analysis - APL Feature expands the number of different characters and symbols that can be entered and displayed by the 3277 Display Station, Model 2. A five-shift APL keyboard (Diagram 6-3) and a new line buffer and character generator card (Diagrams 6-16, 6-20, and 6-21) provide these expanded capabilities.

The number of data codes necessary to represent the entire character set available with the 3270 Data Analysis - APL Feature is larger than the number of possible data codes on a standard 3277. (Only seven data bits can be stored in each character position of the buffers in standard machines.) The 3270 Data Analysis - APL Feature increases the number of possible data codes by using the control bit as an 8th data bit for some characters. Attribute recognition circuits have been modified to distinguish true attribute characters from those data characters that have the control bit on.

On 3277 Display Stations with the 3270 Data Analysis - APL Feature installed, a character will be recognized to be a true attribute if:

The Control Bit = 1
AND Bit 1 = 1
AND Bit 6 = 0

Any other condition of these particular bits will be decoded as data.

6.5.1 Line Buffer and Character Generator Card

The line buffer and character generator card used with the 3270 Data Analysis - APL Feature is capable of storing and displaying all standard characters, in addition to symbols commonly associated with APL. This includes a full uppercase and lowercase typewriter character set, APL symbols, an uppercase underscored alphabet, and certain overstruck symbols. This card also contains the circuitry that distinguishes true attribute characters from those data characters that have the control bit on.

6.5.2 APL Keyboard

The APL keyboard is similar to the standard 3277 typewriter keyboard, but has been expanded to provide five shifts instead of two. One backspace key has been replaced with the APL ON/OFF key, and the BACKTAB key has been modified to provide the alternate shift function when APL is turned on.

The five shifts available from the 3277 APL keyboard are:

1. Lower (APL off)	Lowercase alphabet, numeric, and special characters.
2. Upper (APL off)	Uppercase alphabet and special characters.
3. Lower (APL on)	Uppercase alphabet, numeric, and special characters.
4. Upper (APL on)	APL symbols and special characters.
5. Alternate (APL on)	Uppercase underscored alphabet and APL overstruck characters.

See Diagram 6-3 for a layout of the APL keyboard.

The keyboard is initially reset to lower shift (APL off) by power-on-reset. APL is turned on by a single depression of the APL ON/OFF key, and will remain on until this key is pressed again or until a power off-on sequence is performed. Upper and lower shift entry is controlled by the SHIFT key, regardless of whether APL is turned on or off. Alternate shift entry is possible only when APL is turned on. To enter alternate shift characters, the APL ALT key must be held down while striking the desired character key. The APL ALT key reverts to its original function (backtab) when APL is turned off.

The APL keyboard generates a 9-bit parity code for each character. The added bit (bit 8) is stored in the control bit position of the buffers. Refer to Diagrams 6-8 through 6-12 for specific character codes. Diagram 7-20 contains APL keyboard pin and terminal locations.

6.5.3 Text Keyboard

The Text Keyboard is similar to the standard 3277 typewriter keyboard, but has been expanded to provide five shifts. The backspace in the top row of keys has been replaced with the ALT ON/OFF key, and the Test Req key, the leftmost key in the bottom row, has been replaced with the CODE key. The ALT ON/OFF and CODE keys provide the additional three shifts. The ALTERNATE mode indicator is located on the keyboard cover just above the ALT ON/OFF key.

The five shifts that are available from the 3277 Text keyboard are:

1. Lower (ALT off): Lowercase alphabet, numeric, and special characters.
2. Upper (ALT off): Uppercase alphabet and special characters.
3. Lower (ALT on): Uppercase alphabet, numeric, and special characters.
4. Upper (ALT on): Alternate symbols and special characters.
5. Code Key: Special characters on front of keys.

See Diagram 6-6 for TEXT keyboard layout.

When power is turned on, the keyboard will be in lowercase standard shift. Alternate shift is turned on by a single depression of the ALT ON/OFF key, and it will remain on until the key is pressed again. Upper and lower shift are controlled by the shift key, regardless of the ALT ON/OFF key status. CODE shift can be active with Alternate mode ON or OFF. To enter CODE shift characters, the CODE must be held depressed while striking the desired character key.

The text keyboard generates a 9-bit odd parity code for each character. The added bit (bit 8) is stored in the control bit position of the buffers. Refer to Diagrams 6-9 and 6-13 for specific character codes. Diagram 7-21 contains pin and terminal locations.

6.6 REFERENCE DIAGRAMS

Diagrams 6-16 through 6-23 contain reference data that can be helpful in maintaining IBM 3277 Display Stations. Diagram 6-16 lists all logic cards used in the display station and describes the function of each card. All logic card I/O pins used as probe points in the troubleshooting diagrams (Section 4) are listed in Diagram 6-17. ALD references are also listed. Logic board jumpering data for the various keyboard feature options is included in Diagram 6-18. Diagram 6-19 shows how characters are encoded in the keyboard assembly. Diagrams 6-20 and 6-21 show logic card plugging for the one-half and two-thirds boards, respectively. Logic board pin identification data is given in Diagram 6-22. Display station data flow is shown in Diagram 6-23, a fold-out page located at the back of this manual.

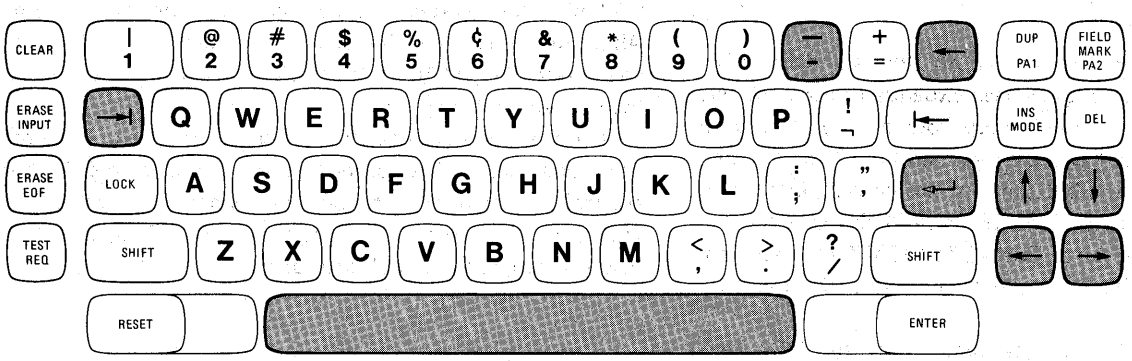
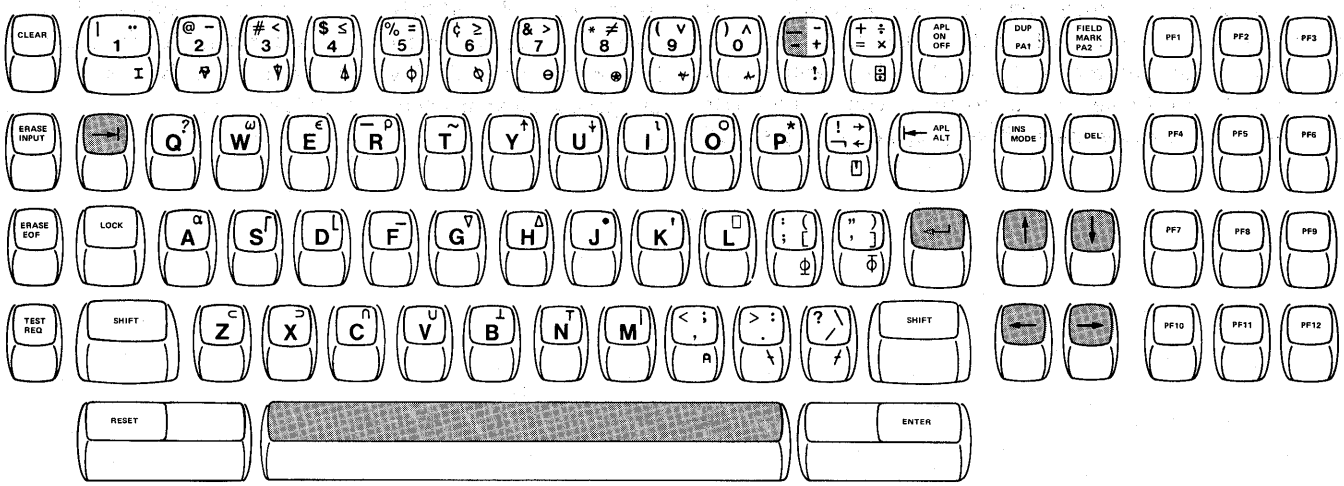


Diagram 6-2. Typewriter Keyboard



Notes:

1. A through Z are invoked by depressing APL ALT and A through Z.
2. ↵ Invokes △ when APL ALT is depressed (△ is not shown on the front surface of the ↵ key).

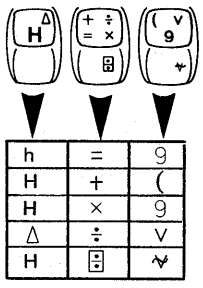


Diagram 6-3. APL Keyboard – US

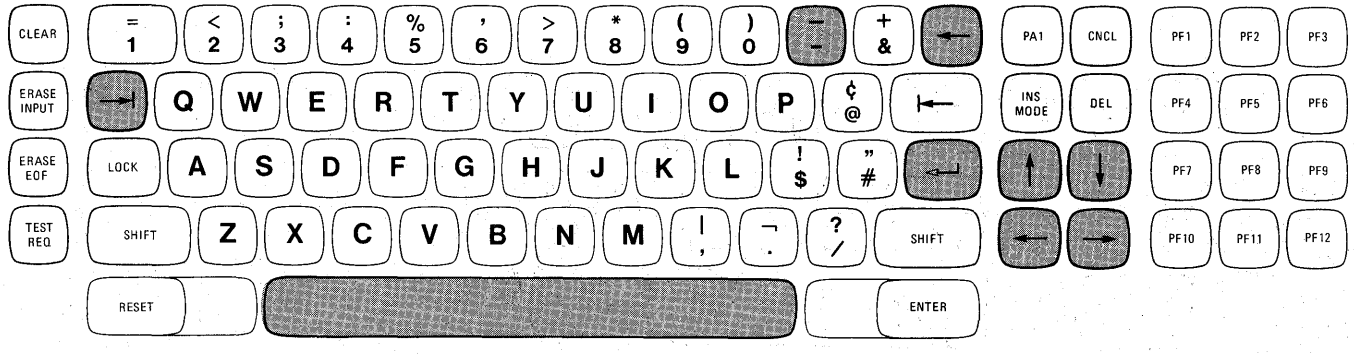
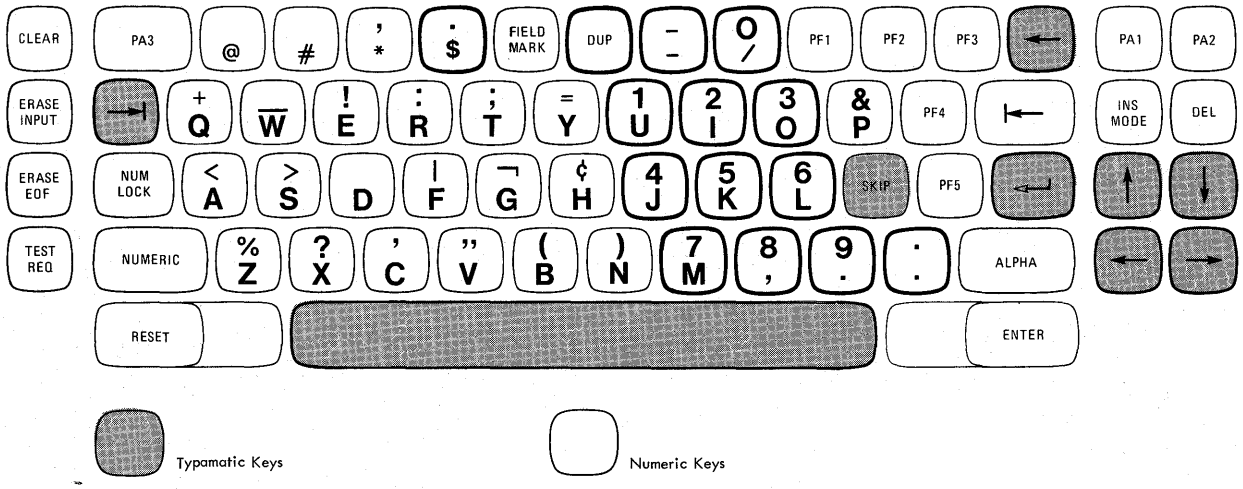


Diagram 6-4. Operator Console Keyboard

Data Entry Keyboard – Keypunch Layout



Data Entry Keyboard

Diagram 6-5. Data Entry Keyboards

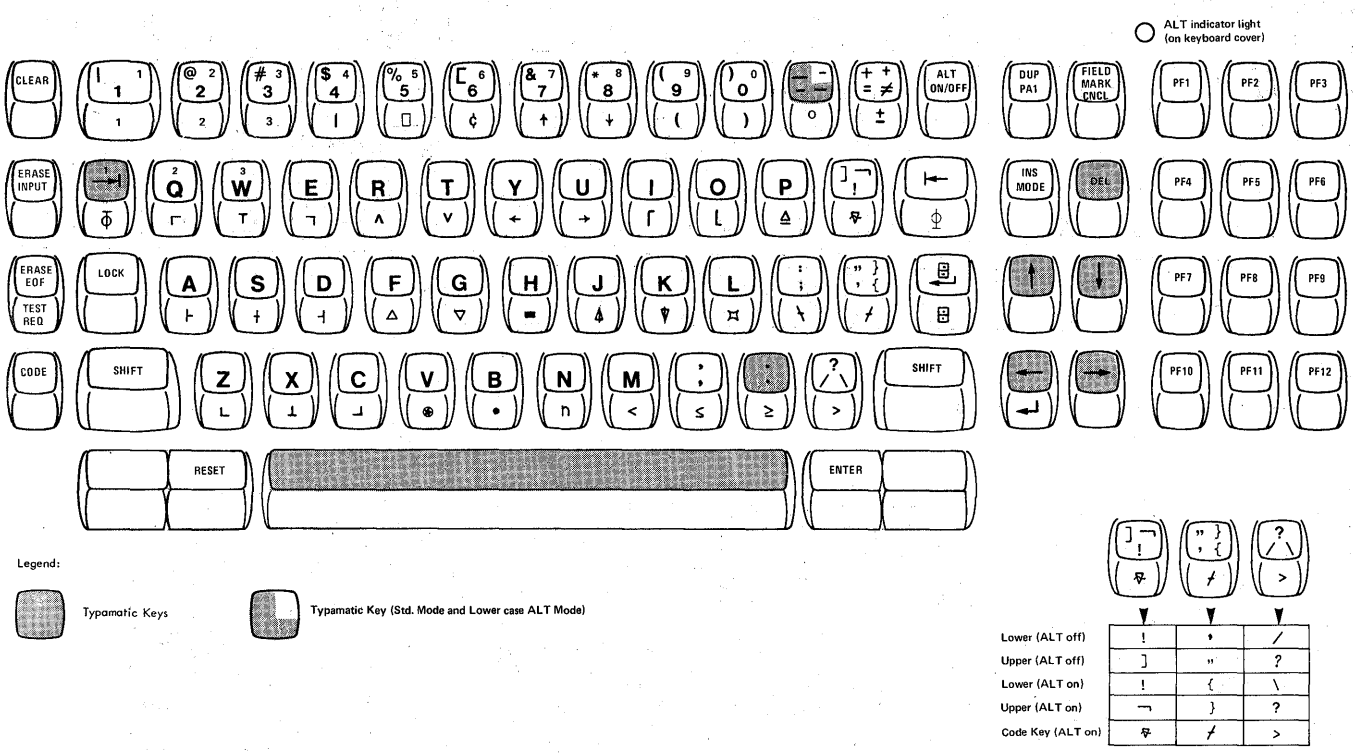


Diagram 6-6. Text Feature Keyboard

Typewriter and Operator Console Keyboard Codes

Graphic U	Graphic L	Upper Shift 0 1 2 3 4 5 6 7 P *	Lower Shift 0 1 2 3 4 5 6 7 P *
ERASE INPUT		0 0 0 1 0 1 1 1 1	0 0 0 1 0 1 1 1 1
ERASE EOF		0 0 0 1 0 1 1 0 0	0 0 0 1 0 1 1 0 0
RESET			
DUP	PA1	1 0 0 1 1 1 0 0 1	0 0 1 0 1 1 0 0 0
CLEAR		0 0 1 0 1 1 0 1 1	0 0 1 0 1 1 0 1 1
INS MODE		0 0 0 1 0 0 0 1 1	0 0 0 1 0 0 0 1 1
DEL		0 0 0 1 0 0 0 0 0	0 0 0 1 0 0 0 0 0
TEST REQ		0 0 1 1 0 0 0 0 1	0 0 1 1 0 0 0 0 1
FIELD MARK	PA2	1 0 0 1 1 1 1 0 0	0 0 1 0 1 1 1 0 1
ENTER		0 0 1 1 1 1 0 1 0	0 0 1 1 1 1 0 1 0
Space		0 1 0 0 0 0 0 0 0 *	0 1 0 0 0 0 0 0 0 *
↵		0 0 0 1 0 1 0 1 0 *	0 0 0 1 0 1 0 1 0 *
↑		0 0 0 1 1 0 0 0 1 *	0 0 0 1 1 0 0 0 1 *
↓		0 0 0 1 1 0 0 1 0 *	0 0 0 1 1 0 0 1 0 *
→		0 0 0 1 1 0 1 0 0 *	0 0 0 1 1 0 1 0 0 *
← (2 Keys)		0 0 0 1 1 0 1 1 1 *	0 0 0 1 1 0 1 1 1 *
⇥		0 0 0 1 0 0 1 1 0 *	0 0 0 1 0 0 1 1 0 *
⇤		0 0 0 1 0 1 0 0 1	0 0 0 1 0 1 0 0 1
|	1	0 1 0 0 1 1 1 1 0	1 1 1 1 0 0 0 1 0
@	2	0 1 1 1 1 1 1 0 0 0	1 1 1 1 1 0 0 1 0 0
#	3	0 1 1 1 1 1 0 1 1 1	1 1 1 1 1 0 0 1 1 1
$	4	0 1 0 1 1 0 1 1 0	1 1 1 1 0 1 0 0 0
%	5	0 1 1 0 1 1 0 0 1	1 1 1 1 0 1 0 1 1
¢	6	0 1 0 0 1 0 1 0 0	1 1 1 1 0 1 1 0 1
&	7	0 1 0 1 0 0 0 0 1	1 1 1 1 0 1 1 1 0
*	8	0 1 0 1 1 1 0 0 1	1 1 1 1 1 0 0 0 0
(	9	0 1 0 0 1 1 0 1 1	1 1 1 1 1 0 0 1 1
)	0	0 1 0 1 1 1 0 1 0	1 1 1 1 0 0 0 0 1
_	-	0 1 1 0 1 1 0 1 0 *	0 1 1 0 0 0 0 0 1 *
+	=	0 1 0 0 1 1 1 0 1	0 1 1 1 1 1 1 0 1
Q	Q	1 1 0 1 1 0 0 0 1	1 0 0 1 1 0 0 0 0
W	W	1 1 1 0 0 1 1 0 0	1 0 1 0 0 1 1 0 1
E	E	1 1 0 0 0 1 0 1 1	1 0 0 0 0 1 0 1 0
R	R	1 1 0 1 1 0 0 1 0	1 0 0 1 1 0 0 1 1
T	T	1 1 1 0 0 0 1 1 0	1 0 1 0 0 0 1 1 1
Y	Y	1 1 1 0 1 0 0 0 1	1 0 1 0 1 0 0 0 0
U	U	1 1 1 0 0 1 0 0 1	1 0 1 0 0 1 0 0 0
I	I	1 1 0 0 1 0 0 1 1	1 0 0 0 1 0 0 1 0
O	O	1 1 0 1 0 1 1 0 0	1 0 0 1 0 1 1 0 1
P	P	1 1 0 1 0 1 1 1 1	1 0 0 1 0 1 1 1 0
!	¬	0 1 0 1 1 0 1 0 1	0 1 0 1 1 1 1 1 1
A	A	1 1 0 0 0 0 0 1 0	1 0 0 0 0 0 0 1 1
S	S	1 1 1 0 0 0 1 0 1	1 0 1 0 0 0 1 0 0
D	D	1 1 0 0 0 1 0 0 0	1 0 0 0 0 1 0 0 1
F	F	1 1 0 0 0 1 1 0 1	1 0 0 0 0 1 1 0 0
G	G	1 1 0 0 0 1 1 1 0	1 0 0 0 0 1 1 1 1
H	H	1 1 0 0 1 0 0 0 0	1 0 0 0 1 0 0 0 1
J	J	1 1 0 1 0 0 0 1 1	1 0 0 1 0 0 0 1 0
K	K	1 1 0 1 0 0 1 0 1	1 0 0 1 0 0 1 0 0
L	L	1 1 0 1 0 0 1 1 0	1 0 0 1 0 0 1 1 1
:	;	0 1 1 1 1 1 0 1 0 0	0 1 0 1 1 1 1 1 0 0
"	'	0 1 1 1 1 1 1 1 1 0	0 1 1 1 1 1 0 1 1
Z	Z	1 1 1 0 1 0 0 1 0	1 0 1 0 1 0 0 1 1
X	X	1 1 1 0 0 1 1 1 1	1 0 1 0 0 1 1 1 0
C	C	1 1 0 0 0 0 1 1 1	1 0 0 0 0 0 1 1 0
V	V	1 1 1 0 0 1 0 1 0	1 0 1 0 0 1 0 1 1
B	B	1 1 0 0 0 0 1 0 0	1 0 0 0 0 0 1 0 1
N	N	1 1 0 1 0 1 0 1 0	1 0 0 1 0 1 0 1 1
M	M	1 1 0 1 0 1 0 0 1	1 0 0 1 0 1 0 0 0
<	,	0 1 0 0 1 1 0 0 0	0 1 1 0 1 0 1 1 0
>	.	0 1 1 0 1 1 1 0 0	0 1 0 0 1 0 1 1 1
?	/	0 1 1 0 1 1 1 1 1	0 1 1 0 0 0 0 1 0
PF1		0 0 1 1 0 0 0 1 0	0 0 1 1 0 0 0 1 0
PF2		0 0 1 1 0 0 1 0 0	0 0 1 1 0 0 1 0 0
PF3		0 0 1 1 0 0 1 1 1	0 0 1 1 0 0 1 1 1
PF4		0 0 1 1 0 1 0 0 0	0 0 1 1 0 1 0 0 0
PF5		0 0 1 1 0 1 0 1 1	0 0 1 1 0 1 0 1 1
PF6		0 0 1 1 0 1 1 0 1	0 0 1 1 0 1 1 0 1
PF7		0 0 1 1 0 1 1 1 0	0 0 1 1 0 1 1 1 0
PF8		0 0 1 1 1 0 0 0 0	0 0 1 1 1 0 0 0 0
PF9		0 0 1 1 1 0 0 1 1	0 0 1 1 1 0 0 1 1
PF10		0 0 1 1 1 0 1 0 1	0 0 1 1 1 0 1 0 1
PF11		0 0 1 1 1 0 1 1 0	0 0 1 1 1 0 1 1 0
PF12		0 0 1 1 1 1 0 0 1	0 0 1 1 1 1 0 0 1

*Typamatic Key

Notes: 1. Typewriter Keyboard button layout used. Character codes are same on both keyboards.

2. Use Diagram 6-15 to determine the codes for unique ASCII and WTC language characters.

Diagram 6-7. USA EBCDIC Keyboard Codes (Sheet 1 of 2)

Data Entry Keyboard Codes

Graphic U	Graphic L	Upper Shift 0 1 2 3 4 5 6 7 P *	Lower Shift 0 1 2 3 4 5 6 7 P *
ERASE INPUT		0 0 0 1 0 1 1 1 1	0 0 0 1 0 1 1 1 1
ERASE EOF		0 0 0 1 0 1 1 0 0	0 0 0 1 0 1 1 0 0
RESET			
PA1		0 0 1 0 1 1 0 0 0	0 0 1 0 1 1 0 0 0
CLEAR		0 0 1 0 1 1 0 1 1	0 0 1 0 1 1 0 1 1
INS MODE		0 0 0 1 0 0 0 1 1	0 0 0 1 0 0 0 1 1
DEL		0 0 0 1 0 0 0 0 0	0 0 0 1 0 0 0 0 0
TEST REQ		0 0 1 1 0 0 0 0 1	0 0 1 1 0 0 0 0 1
PA2		0 0 1 0 1 1 1 0 1	0 0 1 0 1 1 1 0 1
ENTER		0 0 1 1 1 1 1 0 1 0	0 0 1 1 1 1 1 0 1 0
Space		0 1 0 0 0 0 0 0 0 *	0 1 0 0 0 0 0 0 0 *
SKIP		0 0 0 1 0 0 1 1 0 *	0 0 0 1 0 0 1 1 0 *
DUP		1 0 0 1 1 1 0 0 1	1 0 0 1 1 1 0 0 1
↵		0 0 0 1 0 1 0 1 0 *	0 0 0 1 0 1 0 1 0 *
↑		0 0 0 1 1 0 0 0 1 *	0 0 0 1 1 0 0 0 1 *
↓		0 0 0 1 1 0 0 1 0 *	0 0 0 1 1 0 0 1 0 *
→		0 0 0 1 1 0 1 0 0 *	0 0 0 1 1 0 1 0 0 *
← (2 Keys)		0 0 0 1 1 0 1 1 1 *	0 0 0 1 1 0 1 1 1 *
⇥		0 0 0 1 0 0 1 1 0 *	0 0 0 1 0 0 1 1 0 *
⇤		0 0 0 1 0 1 0 0 1	0 0 0 1 0 1 0 0 1
PA3		0 0 1 0 1 0 1 1 1	0 0 1 0 1 0 1 1 1
	@	0 1 0 0 0 0 0 0 0	0 1 1 1 1 1 1 0 0 0
	#	0 1 0 0 0 0 0 0 0	0 1 1 1 1 1 0 1 1 1
,	*	0 1 1 0 1 0 1 1 0	0 1 0 1 1 1 0 0 1
.	$	0 1 0 0 1 0 1 1 1	0 1 0 1 1 0 1 1 0
0	/	1 1 1 1 0 0 0 0 1	0 1 1 0 0 0 0 1 0
+	Q	0 1 0 0 1 1 1 0 1	1 1 0 1 1 0 0 0 1
–	W	0 1 1 0 1 1 0 1 0	1 1 1 0 0 1 1 0 0
!	E	0 1 0 1 1 0 1 0 1	1 1 0 0 0 1 0 1 1
:	R	0 1 1 1 1 0 1 0 0	1 1 0 1 1 0 0 1 0
;	T	0 1 0 1 1 1 1 0 0	1 1 1 0 0 0 1 1 0
=	Y	0 1 1 1 1 1 1 0 1	1 1 1 0 1 0 0 0 1
1	U	1 1 1 1 0 0 0 1 0	1 1 1 0 0 1 0 0 1
2	I	1 1 1 1 0 0 1 0 0	1 1 0 0 1 0 0 1 1
3	O	1 1 1 1 0 0 1 1 1	1 1 0 1 0 1 1 0 0
&	P	0 1 0 1 0 0 0 0 1	1 1 0 1 0 1 1 1 1
<	A	0 1 0 0 1 1 0 0 0	1 1 0 0 0 0 0 1 0
>	S	0 1 1 0 1 1 1 0 0	1 1 1 0 0 0 1 0 1
	D	0 1 0 0 0 0 0 0 0	1 1 0 0 0 1 0 0 0
|	F	0 1 0 0 1 1 1 1 0	1 1 0 0 0 1 1 0 1
¬	G	0 1 0 1 1 1 1 1 1	1 1 0 0 0 1 1 1 0
¢	H	0 1 0 0 1 0 1 0 0	1 1 0 0 1 0 0 0 0
4	J	1 1 1 1 0 1 0 0 0	1 1 0 1 0 0 0 1 1
5	K	1 1 1 1 0 1 0 1 1	1 1 0 1 0 0 1 0 1
6	L	1 1 1 1 0 1 1 0 1	1 1 0 1 0 0 1 1 0
%	Z	0 1 1 0 1 1 0 0 1	1 1 1 0 1 0 0 1 0
?	X	0 1 1 0 1 1 1 1 1	1 1 1 0 0 1 1 1 1
'	C	0 1 1 1 1 1 1 0 1	1 1 0 0 0 0 1 1 1
"	V	0 1 1 1 1 1 1 1 0	1 1 1 0 0 1 0 1 0
(	B	0 1 0 0 1 1 0 1 1	1 1 0 0 0 0 1 0 0
)	N	0 1 0 1 1 1 0 1 0	1 1 0 1 0 1 0 1 0
7	M	1 1 1 1 0 1 1 1 0	1 1 0 1 0 1 0 0 1
8	,	1 1 1 1 1 0 0 0 0	0 1 1 0 1 0 1 1 0
9	.	1 1 1 1 1 0 0 1 1	0 1 0 0 1 0 1 1 1
.	.	0 1 0 0 1 0 1 1 1	0 1 0 0 1 0 1 1 1
-	-	0 1 1 0 0 0 0 0 1	0 1 1 0 0 0 0 0 1
PF1		0 0 1 1 0 0 0 1 0	0 0 1 1 0 0 0 1 0
PF2		0 0 1 1 0 0 1 0 0	0 0 1 1 0 0 1 0 0
PF3		0 0 1 1 0 0 1 1 1	0 0 1 1 0 0 1 1 1
PF4		0 0 1 1 0 1 0 0 0	0 0 1 1 0 1 0 0 0
PF5		0 0 1 1 0 1 0 1 1	0 0 1 1 0 1 0 1 1
FIELD MARK		1 0 0 1 1 1 1 1 0 0	1 0 0 1 1 1 1 1 0 0

*Typamatic key

Note: Use Diagram 6-14 to determine the codes for unique WTC language characters.

Diagram 6-7. USA EBCDIC Keyboard Codes (Sheet 2 of 2)

APL Typewriter Keyboard Codes – APL Off

Graphic		Upper Shift	Lower Shift
Upper	Lower	0 1 2 3 4 5 6 7 8 P *	0 1 2 3 4 5 6 7 8 P *
ERASE INPUT		0 0 0 1 0 1 1 1 0 1	0 0 0 1 0 1 1 1 0 1
ERASE EOF		0 0 0 1 0 1 1 0 0 0	0 0 0 1 0 1 1 0 0 0
RESET			
DUP	PA1	1 0 0 1 1 1 0 0 0 1	0 0 1 0 1 1 0 0 0 0
CLEAR		0 0 1 0 1 1 0 1 0 1	0 0 1 0 1 1 0 1 0 1
INS MODE		0 0 0 1 0 0 0 1 0 1	0 0 0 1 0 0 0 1 0 1
DEL		0 0 0 1 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0 0
TEST REQ		0 0 1 1 0 0 0 0 0 1	0 0 1 1 0 0 0 0 0 1
FIELD MARK	PA2	1 0 0 1 1 1 1 0 0 0	0 0 1 0 1 1 1 0 0 1
ENTER		0 0 1 1 1 1 0 1 0 0	0 0 1 1 1 1 0 1 0 0
Space		0 1 0 0 0 0 0 0 0 0 *	0 1 0 0 0 0 0 0 0 0 *
↵		0 0 0 1 0 1 0 1 0 0 *	0 0 0 1 0 1 0 1 0 0 *
↑		0 0 0 1 1 0 0 0 0 1 *	0 0 0 1 1 0 0 0 0 1 *
↓		0 0 0 1 1 0 0 1 0 0 *	0 0 0 1 1 0 0 1 0 0 *
→		0 0 0 1 1 0 1 0 0 0 *	0 0 0 1 1 0 1 0 0 0 *
←		0 0 0 1 1 0 1 1 0 1 *	0 0 0 1 1 0 1 1 0 1 *
⇥		0 0 0 1 0 0 1 1 0 0 *	0 0 0 1 0 0 1 1 0 0 *
⇤		0 0 0 1 0 1 0 0 0 1	0 0 0 1 0 1 0 0 0 1
|	1	0 1 0 0 1 1 1 1 0 0	1 1 1 1 0 0 0 1 0 0
@	2	0 1 1 1 1 1 0 0 0 0	1 1 1 1 0 0 1 0 0 0
#	3	0 1 1 1 1 0 1 1 0 1	1 1 1 1 0 0 1 1 0 1
$	4	0 1 0 1 1 0 1 1 0 0	1 1 1 1 0 1 0 0 0 0
%	5	0 1 1 0 1 1 0 0 0 1	1 1 1 1 0 1 0 1 0 1
¢	6	0 1 0 0 1 0 1 0 0 0	1 1 1 1 0 1 1 0 0 1
&	7	0 1 0 1 0 0 0 0 0 1	1 1 1 1 0 1 1 1 0 0
*	8	0 1 0 1 1 1 0 0 0 1	1 1 1 1 1 0 0 0 0 0
(	9	0 1 0 0 1 1 0 1 0 1	1 1 1 1 1 0 0 1 0 1
)	0	0 1 0 1 1 1 0 1 0 0	1 1 1 1 0 0 0 0 0 1
–	-	0 1 1 0 1 1 0 1 0 0 *	0 1 1 0 0 0 0 0 0 1 *
+	=	0 1 0 0 1 1 1 0 0 1	0 1 1 1 1 1 1 0 0 1
Q	Q	1 1 0 1 1 0 0 0 0 1	1 0 0 1 1 0 0 0 0 0
W	W	1 1 1 0 0 1 1 0 0 0	1 0 1 0 0 1 1 0 0 1
E	E	1 1 0 0 0 1 0 1 0 1	1 0 0 0 0 1 0 1 0 0
R	R	1 1 0 1 1 0 0 1 0 0	1 0 0 1 1 0 0 1 0 1
T	T	1 1 1 0 0 0 1 1 0 0	1 0 1 0 0 0 1 1 0 1
Y	Y	1 1 1 0 1 0 0 0 0 1	1 0 1 0 1 0 0 0 0 0
U	U	1 1 1 0 0 1 0 0 0 1	1 0 1 0 0 1 0 0 0 0
I	I	1 1 0 0 1 0 0 1 0 1	1 0 0 0 1 0 0 1 0 0
O	O	1 1 0 1 0 1 1 0 0 0	1 0 0 1 0 1 1 0 0 1
P	P	1 1 0 1 0 1 1 1 0 1	1 0 0 1 0 1 1 1 0 0
[	⌜	0 1 0 1 1 0 1 0 0 1	0 1 0 1 1 1 1 1 0 1
A	A	1 1 0 0 0 0 0 1 0 0	1 0 0 0 0 0 0 1 0 1
S	S	1 1 1 0 0 0 1 0 0 1	1 0 1 0 0 0 1 0 0 0
D	D	1 1 0 0 0 1 0 0 0 0	1 0 0 0 0 1 0 0 0 1
F	F	1 1 0 0 0 1 1 0 0 1	1 0 0 0 0 1 1 0 0 0
G	G	1 1 0 0 0 1 1 1 0 0	1 0 0 0 0 1 1 1 0 1
H	H	1 1 0 0 1 0 0 0 0 0	1 0 0 0 1 0 0 0 0 1
J	J	1 1 0 1 0 0 0 1 0 1	1 0 0 1 0 0 0 1 0 0
K	K	1 1 0 1 0 0 1 0 0 1	1 0 0 1 0 0 1 0 0 0
L	L	1 1 0 1 0 0 1 1 0 0	1 0 0 1 0 0 1 1 0 1
;	:	0 1 1 1 1 0 1 0 0 0	0 1 0 1 1 1 1 0 0 1
'	'	0 1 1 1 1 1 1 1 0 0	0 1 1 1 1 1 1 0 1 0 1
Z	Z	1 1 1 0 1 0 0 1 0 0	1 0 1 0 1 0 0 1 0 1
X	X	1 1 1 0 0 1 1 1 0 1	1 0 1 0 0 1 1 1 0 0
C	C	1 1 0 0 0 0 0 1 1 0 1	1 0 0 0 0 0 0 1 1 0 0
V	V	1 1 1 0 0 1 0 1 0 0	1 0 1 0 0 1 0 1 0 1
B	B	1 1 0 0 0 0 1 0 0 0	1 0 0 0 0 0 1 0 0 1
N	N	1 1 0 1 0 1 0 1 0 0	1 0 0 1 0 1 0 1 0 1
M	M	1 1 0 1 0 1 0 0 0 1	1 0 0 1 0 1 0 0 0 0
<	,	0 1 0 0 1 1 0 0 0 1	0 1 1 0 1 0 1 1 0 0
>	.	0 1 1 0 1 1 1 0 0 0	0 1 0 0 1 0 1 1 0 1
?	/	0 1 1 0 1 1 1 1 0 1	0 1 1 0 0 0 0 1 0 0
PF1		0 0 1 1 0 0 0 1 0 0	0 0 1 1 0 0 0 1 0 0
PF2		0 0 1 1 0 0 1 0 0 0	0 0 1 1 0 0 1 0 0 0
PF3		0 0 1 1 0 0 1 1 0 1	0 0 1 1 0 0 1 1 0 1
PF4		0 0 1 1 0 1 0 0 0 0	0 0 1 1 0 1 0 0 0 0
PF5		0 0 1 1 0 1 0 1 0 1	0 0 1 1 0 1 0 1 0 1
PF6		0 0 1 1 0 1 1 0 0 1	0 0 1 1 0 1 1 0 0 1
PF7		0 0 1 1 0 1 1 1 0 0	0 0 1 1 0 1 1 1 0 0
PF8		0 0 1 1 1 0 0 0 0 0	0 0 1 1 1 0 0 0 0 0
PF9		0 0 1 1 1 0 0 1 0 1	0 0 1 1 1 0 0 1 0 1
PF10		0 0 1 1 1 0 1 0 0 1	0 0 1 1 1 0 1 0 0 1
PF11		0 0 1 1 1 0 1 1 0 0	0 0 1 1 1 0 1 1 0 0
PF12		0 0 1 1 1 1 1 0 0 0 1	0 0 1 1 1 1 1 0 0 0 1

*Typamatic Key

Diagram 6-8. APL Modified EBCDIC Keyboard Codes (Sheet 1 of 2)

APL Typewriter Keyboard Codes – APL ON

Upper	Graphic Lower	Alternate	0 1 2 3 4 5 6 7 8 P	0 1 2 3 4 5 6 7 8 P	0 1 2 3 4 5 6 7 8 P
ERASE INPUT			0 0 0 1 0 1 1 1 0 1	0 0 0 1 0 1 1 1 0 1	
ERASE EOF			0 0 0 1 0 1 1 0 0 0	0 0 0 1 0 1 1 0 0 0	
RESET					
DUP	PA1		1 0 0 1 1 1 0 0 0 1	0 0 1 0 1 1 0 0 0 0	
CLEAR			0 0 1 0 1 1 0 1 0 1	0 0 1 0 1 1 0 1 0 1	
INS MODE			0 0 0 1 0 0 0 1 0 1	0 0 0 1 0 0 0 1 0 1	
DEL			0 0 0 1 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0 0	
TEST REQ			0 0 1 1 0 0 0 0 0 1	0 0 1 1 0 0 0 0 0 1	
FIELD MARK	PA2		1 0 0 1 1 1 1 0 0 0	0 0 1 0 1 1 1 0 0 1	
ENTER			0 0 1 1 1 1 0 1 0 0	0 0 1 1 1 1 0 1 0 0	
Space			0 1 0 0 0 0 0 0 0 0*	0 1 0 0 0 0 0 0 0 0	
↵		⍙	0 0 0 1 0 1 0 1 0 0*	0 0 0 1 0 1 0 1 0 0	1 1 1 1 0 0 1 1 1 0
↑			0 0 0 1 1 0 0 0 0 1*	0 0 0 1 1 0 0 0 0 1	
↓			0 0 0 1 1 0 0 1 0 0*	0 0 0 1 1 0 0 1 0 0	
→			0 0 0 1 1 0 1 0 0 0*	0 0 0 1 1 0 1 0 0 0	
←			0 0 0 1 1 0 1 1 0 1*	0 0 0 1 1 0 1 1 0 1	
→|			0 0 0 1 0 0 1 1 0 0*	0 0 0 1 0 0 1 1 0 0	
APL ALT					
¨	1	⍑	1 1 0 0 0 0 1 1 1 0	1 1 1 1 0 0 0 1 0 0	1 1 0 1 0 0 1 0 1 0
¯	2	⍒	1 0 1 0 0 0 0 0 0 1	1 1 1 1 0 0 1 0 0 0	1 1 0 0 0 1 1 0 1 0
<	3	⍋	0 1 0 0 1 1 0 0 0 0	1 1 1 1 0 0 1 1 0 1	1 1 0 1 0 1 1 0 1 1
≤	4	⍙	1 0 0 0 1 1 0 0 0 0	1 1 1 1 0 1 0 0 0 0	1 1 0 1 0 1 1 1 1 0
=	5	⌽	0 1 1 1 1 1 1 0 0 1	1 1 1 1 0 1 0 1 0 1	0 1 0 0 1 1 1 0 1 0
≥	6	⍉	1 0 1 0 1 1 1 0 0 0	1 1 1 1 0 1 1 0 0 1	0 1 0 0 1 1 1 1 1 1
>	7	⊖	0 1 1 0 1 1 1 0 0 0	1 1 1 1 0 1 1 1 0 0	1 1 1 0 0 0 1 0 1 0
≠	8	⍟	1 0 1 1 1 1 1 0 0 1	1 1 1 1 1 0 0 0 0 0	1 1 0 0 0 1 1 1 1 1
∨	9	⍱	0 1 1 0 1 0 1 1 1 1	1 1 1 1 1 0 0 1 0 1	0 1 0 0 1 0 1 1 1 0
∧	0	⍲	0 1 1 0 1 0 1 0 1 0	1 1 1 1 0 0 0 0 0 1	0 1 0 0 1 0 1 0 1 1
-	+	!	0 1 1 0 0 0 0 0 0 1	0 1 0 0 1 1 1 0 0 1	1 1 0 1 0 0 1 1 1 1
÷	×	⍞	1 0 1 1 1 0 0 0 0 1	1 0 1 1 0 1 1 0 0 0	1 1 1 0 0 0 1 1 1 1
?	Q	⍬	0 1 1 0 1 1 1 1 0 1	1 1 0 1 1 0 0 0 0 1	1 0 0 1 1 0 0 0 1 1
⍵	W	⍹	1 0 1 1 0 1 0 0 0 1	1 1 1 0 0 1 1 0 0 0	1 0 1 0 0 1 1 0 1 0
∈	E	⍷	1 0 1 1 0 0 0 1 0 1	1 1 0 0 0 1 0 1 0 1	1 0 0 0 0 1 0 1 1 1
⍴	R	⍴	1 0 1 1 0 0 1 1 0 0	1 1 0 1 1 0 0 1 0 0	1 0 0 1 1 0 0 1 1 0
~	T	⍨	0 1 1 1 1 0 1 1 1 0	1 1 1 0 0 0 1 1 0 0	1 0 1 0 0 0 1 1 1 0
↑	Y	⍸	1 0 0 0 1 0 1 0 0 0	1 1 1 0 1 0 0 0 0 1	1 0 1 0 1 0 0 0 1 1
↓	U	⍳	1 1 0 0 0 0 1 0 1 1	1 1 1 0 0 1 0 0 0 1	1 0 1 0 0 1 0 0 1 1
⍳	I	⍸	1 0 1 1 0 0 1 0 0 1	1 1 0 0 1 0 0 1 0 1	1 0 0 0 1 0 0 1 1 1
○	O	⍥	1 0 0 1 1 1 0 1 0 0	1 1 0 1 0 1 1 0 0 0	1 0 0 1 0 1 1 0 1 0
*	P	⍣	0 1 0 1 1 1 0 0 0 1	1 1 0 1 0 1 1 1 0 1	1 0 0 1 0 1 1 1 1 1
→	←	⍗	1 0 0 0 1 1 1 1 0 0	1 0 1 0 1 1 1 1 0 1	0 1 0 1 1 0 1 0 1 0
⍺	A	⍶	1 0 1 1 0 0 0 0 0 0	1 1 0 0 0 0 0 1 0 0	1 0 0 0 0 0 0 1 1 0
⌈	S	⍵	1 0 0 0 1 1 0 1 0 1	1 1 1 0 0 0 1 0 0 1	1 0 1 0 0 0 1 0 1 1
⌊	D	⍫	1 0 0 0 1 1 1 0 0 1	1 1 0 0 0 1 0 0 0 0	1 0 0 0 0 1 0 0 1 0
_	F	⍒	0 1 1 0 1 1 0 1 0 0	1 1 0 0 0 1 1 0 0 1	1 0 0 0 0 1 1 0 1 1
∇	G	⍋	1 0 1 1 1 0 1 0 0 0	1 1 0 0 0 1 1 1 0 0	1 0 0 0 0 1 1 1 1 0
∆	H	⍙	1 0 1 1 1 0 1 1 0 1	1 1 0 0 1 0 0 0 0 0	1 0 0 0 1 0 0 0 1 0
∘	J	⍤	1 0 1 0 1 1 1 1 0 1	1 1 0 1 0 0 0 1 0 1	1 0 0 1 0 0 0 1 1 1
'	K	⌸	0 1 1 1 1 1 1 0 1 0 1	1 1 0 1 0 0 1 0 0 1	1 0 0 1 0 0 1 0 1 1
⎕	L	⌷	1 0 0 1 0 0 0 0 0 1	1 1 0 1 0 0 1 1 0 0	1 0 0 1 0 0 1 1 1 0
(	[	⍱	0 1 0 0 1 1 0 1 0 1	1 0 1 0 1 1 1 0 1 0 0	1 1 1 0 0 1 1 1 1 0
)	]	⍲	0 1 0 1 1 1 0 1 0 0	1 0 1 1 1 1 0 1 0 1	1 1 1 0 0 1 1 0 1 1
⊂	Z	⍂	1 0 0 1 1 0 1 1 0 0	1 1 1 0 1 0 0 1 0 0	1 0 1 0 1 0 0 1 1 0
⊃	X	⍀	1 0 0 1 1 0 1 0 0 1	1 1 1 0 0 1 1 1 0 1	1 0 1 0 0 1 1 1 1 1
∩	C	⍁	1 0 1 0 1 0 1 0 0 1	1 1 0 0 0 0 1 1 0 1	1 0 0 0 0 0 1 1 1 1
∪	V	⍄	1 0 1 0 1 0 1 1 0 0	1 1 1 0 0 1 0 1 0 0	1 0 1 0 0 1 0 1 1 0
⊥	B	⍃	1 0 1 0 1 1 0 0 0 1	1 1 0 0 0 0 1 0 0 0	1 0 0 0 0 0 1 0 1 0
T	N	⍅	1 0 1 1 1 1 1 0 0 0	1 1 0 1 0 1 0 1 0 0	1 0 0 1 0 1 0 1 1 0
|	M	⍆	1 0 1 1 1 1 1 1 0 0	1 1 0 1 0 1 0 0 0 1	1 0 0 1 0 1 0 0 1 1
;	,	⍪	0 1 0 1 1 1 1 0 0 0	0 1 1 0 1 0 1 1 0 0	0 1 0 1 1 0 1 1 1 1
:	.	⍎	0 1 1 1 1 1 0 1 0 0	0 1 0 0 1 0 1 1 0 1	0 1 0 1 1 1 1 1 1 0
\	/	⍕	1 0 1 1 0 1 1 1 0 1	0 1 1 0 0 0 0 1 0 0	0 1 0 1 1 1 1 0 1 1
PF1			0 0 1 1 0 0 0 1 0 0	0 0 1 1 0 0 0 1 0 0	
PF2			0 0 1 1 0 0 1 0 0 0	0 0 1 1 0 0 1 0 0 0	
PF3			0 0 1 1 0 0 1 1 0 1	0 0 1 1 0 0 1 1 0 1	
PF4			0 0 1 1 0 1 0 0 0 0	0 0 1 1 0 1 0 0 0 0	
PF5			0 0 1 1 0 1 0 1 0 1	0 0 1 1 0 1 0 1 0 1	
PF6			0 0 1 1 0 1 1 0 0 1	0 0 1 1 0 1 1 0 0 1	
PF7			0 0 1 1 0 1 1 1 0 0	0 0 1 1 0 1 1 1 0 0	
PF8			0 0 1 1 1 0 0 0 0 0	0 0 1 1 1 0 0 0 0 0	
PF9			0 0 1 1 1 0 0 1 0 1	0 0 1 1 1 0 0 1 0 1	
PF10			0 0 1 1 1 0 1 0 0 1	0 0 1 1 1 0 1 0 0 1	
PF11			0 0 1 1 1 0 1 1 0 0	0 0 1 1 1 0 1 1 0 0	
PF12			0 0 1 1 1 1 0 0 0 1	0 0 1 1 1 1 0 0 0 1	

*Typamatic Key

Diagram 6-8. APL Modified EBCDIC Keyboard Codes (Sheet 2 of 2)

Text Typewriter Keyboard Codes - Alternate OFF

Graphic		Upper Shift	Lower Shift
Upper	Lower	0 1 2 3 4 5 6 7 8 P *	0 1 2 3 4 5 6 7 8 P *
ERASE INPUT		0 0 0 1 0 1 1 1 0 1	0 0 0 1 0 1 1 1 0 1
ERASE EOF		0 0 0 1 0 1 1 0 0 0	0 0 0 1 0 1 1 0 0 0
RESET			
DUP	PA1	1 0 0 1 1 1 0 0 0 1	0 0 1 0 1 1 0 0 0 0
CLEAR		0 0 1 0 1 1 0 1 0 1	0 0 1 0 1 1 0 1 0 1
INS MODE		0 0 0 1 0 0 0 1 0 1	0 0 0 1 0 0 0 1 0 1
DEL		0 0 0 1 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0 0
TEST REQ		0 0 1 1 0 0 0 0 0 1	0 0 1 1 0 0 0 0 0 1
FIELD MARK	PA2	1 0 0 1 1 1 1 0 0 0	0 0 1 0 1 1 1 0 0 1
ENTER		0 0 1 1 1 1 0 1 0 0	0 0 1 1 1 1 0 1 0 0
Space		0 1 0 0 0 0 0 0 0 0 *	0 1 0 0 0 0 0 0 0 0 *
↵⠿	↵⠿	0 0 0 1 0 1 0 1 0 0	0 0 0 1 0 1 0 1 0 0
↑		0 0 0 1 1 0 0 0 0 1 *	0 0 0 1 1 0 0 0 0 1 *
↓		0 0 0 1 1 0 0 1 0 0 *	0 0 0 1 1 0 0 1 0 0 *
→		0 0 0 1 1 0 1 0 0 0 *	0 0 0 1 1 0 1 0 0 0 *
←		0 0 0 1 1 0 1 1 0 1 *	0 0 0 1 1 0 1 1 0 1 *
⇥		0 0 0 1 0 0 1 1 0 0 *	0 0 0 1 0 0 1 1 0 0 *
⇤		0 0 0 1 0 1 0 0 0 1	0 0 0 1 0 1 0 0 0 1
|	1	0 1 0 0 1 1 1 1 0 0	1 1 1 1 0 0 0 1 0 0
@	2	0 1 1 1 1 1 0 0 0 0	1 1 1 1 0 0 1 0 0 0
#	3	0 1 1 1 1 0 1 1 0 1	1 1 1 1 0 0 1 1 0 1
$	4	0 1 0 1 1 0 1 1 0 0	1 1 1 1 0 1 0 0 0 0
%	5	0 1 1 0 1 1 0 0 0 1	1 1 1 1 0 1 0 1 0 1
¢	6	1 0 1 0 1 1 0 1 0 0	1 1 1 1 0 1 1 0 0 1
&	7	0 1 0 1 0 0 0 0 0 1	1 1 1 1 0 1 1 1 0 0
.	8	0 1 0 1 1 1 0 0 0 1	1 1 1 1 1 0 0 0 0 0
(	9	0 1 0 0 1 1 0 1 0 1	1 1 1 1 1 0 0 1 0 1
)	0	0 1 0 1 1 1 0 1 0 0	1 1 1 1 0 0 0 0 0 1
–	-	0 1 1 0 1 1 0 1 0 0 *	0 1 1 0 0 0 0 0 0 1 *
+	=	0 1 0 0 1 1 1 1 0 1	0 1 1 1 1 1 1 1 0 1
Q	Q	1 1 0 1 1 0 0 0 0 1	1 0 0 1 1 0 0 0 0 0
W	W	1 1 1 0 0 1 1 0 0 0	1 0 1 0 0 1 1 0 0 1
E	E	1 1 0 0 0 1 0 1 0 1	1 0 0 0 0 1 0 1 0 0
R	R	1 1 0 1 1 0 0 1 0 0	1 0 0 1 1 0 0 1 0 1
T	T	1 1 1 0 0 0 1 1 0 0	1 0 1 0 0 0 1 1 0 1
Y	Y	1 1 1 0 1 0 0 0 0 1	1 0 1 0 1 0 0 0 0 0
U	U	1 1 1 0 0 1 0 0 0 1	1 0 1 0 0 1 0 0 0 0
I	I	1 1 0 0 1 0 0 1 0 1	1 0 0 0 1 0 0 1 0 0
O	O	1 1 0 1 0 1 1 0 0 0	1 0 0 1 0 1 1 0 0 1
P	P	1 1 0 1 0 1 1 1 0 1	1 0 0 1 0 1 1 1 0 0
]	!	1 0 1 1 1 1 0 1 0 1	0 1 0 1 1 0 1 0 0 1
A	A	1 1 0 0 0 0 0 1 0 0	1 0 0 0 0 0 0 1 0 1
S	S	1 1 1 0 0 0 1 0 0 1	1 0 1 0 0 0 1 0 0 0
D	D	1 1 0 0 0 1 0 0 0 0	1 0 0 0 0 1 0 0 0 1
F	F	1 1 0 0 0 1 1 0 0 1	1 0 0 0 0 1 1 0 0 0
G	G	1 1 0 0 0 1 1 1 0 0	1 0 0 0 0 1 1 1 0 1
H	H	1 1 0 0 1 0 0 0 0 0	1 0 0 0 1 0 0 0 0 1
J	J	1 1 0 1 0 0 0 1 0 1	1 0 0 1 0 0 0 1 0 0
K	K	1 1 0 1 0 0 1 0 0 1	1 0 0 1 0 0 1 0 0 0
L	L	1 1 0 1 0 0 1 1 0 0	1 0 0 1 0 0 1 1 0 1
:	:	0 1 1 1 1 0 1 0 0 0	0 1 0 1 1 1 1 0 0 1
"	'	0 1 1 1 1 1 1 1 0 0	0 1 1 1 1 1 1 0 1 0
Z	Z	1 1 1 0 1 0 0 1 0 0	1 0 1 0 1 0 0 1 0 1
X	X	1 1 1 0 0 1 1 1 0 1	1 0 1 0 0 1 1 1 0 0
C	C	1 1 0 0 0 0 1 1 0 1	1 0 0 0 0 0 1 1 0 0
V	V	1 1 1 0 0 1 0 1 0 0	1 0 1 0 0 1 0 1 0 1
B	B	1 1 0 0 0 0 1 0 0 0	1 0 0 0 0 0 1 0 0 1
N	N	1 1 0 1 0 1 0 1 0 0	1 0 0 1 0 1 0 1 0 1
M	M	1 1 0 1 0 1 0 0 0 1	1 0 0 1 0 1 0 0 0 0
;	,	0 1 1 0 1 0 1 1 0 0	0 1 1 0 1 0 1 1 0 0
.	.	0 1 0 0 1 0 1 1 0 1	0 1 0 0 1 0 1 1 0 1
?	/	0 1 1 0 1 1 1 1 0 1	0 1 1 0 0 0 0 1 0 0
PF1		0 0 1 1 0 0 0 1 0 0	0 0 1 1 0 0 0 1 0 0
PF2		0 0 1 1 0 0 1 0 0 0	0 0 1 1 0 0 1 0 0 0
PF3		0 0 1 1 0 0 1 1 0 1	0 0 1 1 0 0 1 1 0 1
PF4		0 0 1 1 0 1 0 0 0 0	0 0 1 1 0 1 0 0 0 0
PF5		0 0 1 1 0 1 0 1 0 1	0 0 1 1 0 1 0 1 0 1
PF6		0 0 1 1 0 1 1 0 0 1	0 0 1 1 0 1 1 0 0 1
PF7		0 0 1 1 0 1 1 1 0 0	0 0 1 1 0 1 1 1 0 0
PF8		0 0 1 1 1 0 0 0 0 0	0 0 1 1 1 0 0 0 0 0
PF9		0 0 1 1 1 0 0 1 0 1	0 0 1 1 1 0 0 1 0 1
PF10		0 0 1 1 1 0 1 0 0 1	0 0 1 1 1 0 1 0 0 1
PF11		0 0 1 1 1 0 1 1 0 0	0 0 1 1 1 0 1 1 0 0
PF12		0 0 1 1 1 1 0 0 0 1	0 0 1 1 1 1 0 0 0 1

* Typamatic Key

Diagram 6-9. Text Keyboard Codes (EBCDIC) (Sheet 1 of 2)

Text Typewriter Keyboard Codes - Alternate ON

Graphic			Upper	Lower	Code
Upper	Lower	Code	0 1 2 3 4 5 6 7 8 P	0 1 2 3 4 5 6 7 8 P	0 1 2 3 4 5 6 7 8 P
ERASE INPUT			0 0 0 1 0 1 1 1 0 1	0 0 0 1 0 1 1 1 0 1	
ERASE EOF			0 0 0 1 0 1 1 0 0 0	0 0 0 1 0 1 1 0 0 0	
RESET					
DUP	PA1		1 0 0 1 1 1 0 0 0 1	0 0 1 0 1 1 0 0 0 0	
CLEAR			0 0 1 0 1 1 1 0 1 0 1	0 0 1 0 1 1 1 0 1 0 1	
INS MODE			0 0 0 1 0 0 0 1 0 1	0 0 0 1 0 0 0 1 0 1	
DEL			0 0 0 1 0 0 0 0 0 0 0*	0 0 0 1 0 0 0 0 0 0 0*	
TEST REQ			0 0 1 1 0 0 0 0 0 1	0 0 1 1 0 0 0 0 0 1	
FIELD MARK	PA2		1 0 0 1 1 1 1 0 0 0	0 0 1 0 1 1 1 0 0 1	
ENTER			0 0 1 1 1 1 0 1 0 0	0 0 1 1 1 1 0 1 0 0	
Space			0 1 0 0 0 0 0 0 0 0 0*	0 1 0 0 0 0 0 0 0 0 0*	
↵ ⣿	↵ ⣿	⣿	0 0 0 1 0 1 0 1 0 0	0 0 0 1 0 1 0 1 0 0	1 1 1 0 0 0 1 1 0 0
↑			0 0 0 1 1 0 0 0 0 1*	0 0 0 1 1 0 0 0 0 1*	
↓			0 0 0 1 1 0 0 1 0 0*	0 0 0 1 1 0 0 1 0 0*	
→			0 0 0 1 1 0 1 0 0 0*	0 0 0 1 1 0 1 0 0 0*	
←		↵	0 0 0 1 1 0 1 1 0 1*	0 0 0 1 1 0 1 1 0 1*	0 0 0 1 0 1 0 1 0 0
⇥		⇥	0 0 0 1 0 0 1 1 0 0*	0 0 0 1 0 0 1 1 0 0*	1 1 1 0 0 1 1 0 1 1
⇤		⇤	0 0 0 1 0 1 0 0 0 1	0 0 0 1 0 1 0 0 0 1	1 1 1 0 0 1 1 1 1 0
ALT					
1	1	1	1 0 1 1 0 0 0 1 1 0	1 1 1 1 0 0 0 1 0 0	1 0 0 0 1 0 1 0 1 1
2	2	2	1 0 1 1 0 0 1 0 1 0	1 1 1 1 0 0 1 0 0 0	1 0 0 1 1 0 1 0 1 0
3	3	3	1 0 1 1 0 0 1 1 1 1	1 1 1 1 0 0 1 1 0 1	1 0 1 0 1 0 1 0 1 0
4	4	—	1 0 1 1 0 1 0 0 1 0	1 1 1 1 0 1 0 0 0 0	0 1 0 0 1 1 1 1 0 1
5	5	⬚	1 0 1 1 0 1 0 1 1 1	1 1 1 1 0 1 0 1 0 1	1 0 0 1 0 0 0 0 0 1
6	6	¢	1 0 1 1 0 1 1 0 1 1	1 1 1 1 0 1 1 0 0 1	0 1 0 0 1 0 1 0 0 0
7	7	↑	1 0 1 1 0 1 1 1 1 0	1 1 1 1 0 1 1 1 0 0	1 0 0 0 1 0 1 0 0 0
8	8	↓	1 0 1 1 1 0 0 0 1 0	1 1 1 1 1 0 0 0 0 0	1 1 0 0 0 0 1 0 1 1
9	9	(	1 0 1 1 1 0 0 1 1 1	1 1 1 1 1 0 0 1 0 1	1 0 0 0 1 1 0 1 1 0
0	0	)	1 0 1 1 0 0 0 0 1 1	1 1 1 1 0 0 0 0 0 1	1 0 0 1 1 1 0 1 1 0
–	–	0	1 0 0 0 1 1 0 0 1 1	1 0 1 1 1 1 1 1 1 1*	1 0 1 0 0 0 0 1 1 1
+	≠	±	1 0 0 0 1 1 1 0 1 0	1 0 1 1 1 1 1 0 0 1	1 0 0 1 1 1 1 0 1 1
Q	Q	⌜	1 1 0 1 1 0 0 0 0 1	1 0 0 1 1 0 0 0 0 0	1 0 1 0 1 1 0 0 1 0
W	W	⊤	1 1 1 0 0 1 1 0 0 0	1 0 1 0 0 1 1 0 0 1	1 0 1 1 1 1 0 1 1 0
E	E	⌝	1 1 0 0 0 1 0 1 0 1	1 0 0 0 0 1 0 1 0 0	1 0 1 1 1 1 0 0 1 1
R	R	∧	1 1 0 1 1 0 0 1 0 0	1 0 0 1 1 0 0 1 0 1	0 1 1 0 1 0 1 0 1 0
T	T	∨	1 1 1 0 0 0 1 1 0 0	1 0 1 0 0 0 1 1 0 1	0 1 1 0 1 0 1 1 1 1
Y	Y	←	1 1 1 0 1 0 0 0 0 1	1 0 1 0 1 0 0 0 0 0	1 0 0 1 1 1 1 1 0 1
U	U	→	1 1 1 0 0 1 0 0 0 1	1 0 1 0 0 1 0 0 0 0	1 0 0 0 1 1 1 1 0 0
I	I	⌈	1 1 0 0 1 0 0 1 0 1	1 0 0 0 1 0 0 1 0 0	1 0 0 0 1 1 0 1 0 1
O	O	⌊	1 1 0 1 0 1 1 0 0 0	1 0 0 1 0 1 1 0 0 1	1 0 0 0 1 1 1 0 0 1
P	P	⌂	1 1 0 1 0 1 1 1 0 1	1 0 0 1 0 1 1 1 0 0	1 1 1 1 0 0 1 1 1 0
¬	!	⍱	0 1 0 1 1 1 1 1 0 1	0 1 0 1 1 0 1 0 0 1	1 1 0 0 0 1 1 0 1 0
A	A	⊢	1 1 0 0 0 0 0 1 0 0	1 0 0 0 0 0 0 1 0 1	1 0 1 0 1 1 0 1 1 1
S	S	⊣	1 1 1 0 0 0 1 0 0 1	1 0 1 0 0 0 1 0 0 0	1 0 0 0 1 1 1 1 1 1
D	D	⊥	1 1 0 0 0 1 0 0 0 0	1 0 0 0 0 1 0 0 0 1	1 0 1 0 1 1 1 0 1 1
F	F	△	1 1 0 0 0 1 1 0 0 1	1 0 0 0 0 1 1 0 0 0	1 0 1 1 1 0 1 1 0 1
G	G	▽	1 1 0 0 0 1 1 1 0 0	1 0 0 0 0 1 1 1 0 1	1 0 1 1 1 0 1 0 0 0
H	H	∎	1 1 0 0 1 0 0 0 0 0	1 0 0 0 1 0 0 0 0 1	0 1 1 1 1 1 1 0 0 1
J	J	∆	1 1 0 1 0 0 0 1 0 1	1 0 0 1 0 0 0 1 0 0	1 0 1 1 0 1 1 1 1 0
K	K	∇	1 1 0 1 0 0 1 0 0 1	1 0 0 1 0 0 1 0 0 0	1 0 1 1 0 1 1 0 1 1
L	L	¤	1 1 0 1 0 0 1 1 0 0	1 0 0 1 0 0 1 1 0 1	1 0 0 1 1 0 1 1 1 1
:	:	≮	0 1 1 1 1 0 1 0 0 0	0 1 0 1 1 1 1 0 0 1	0 1 0 1 1 1 1 1 1 0
}	{	≯	1 0 0 1 0 0 0 0 1 0	1 0 1 0 0 0 0 0 1 0	0 1 0 1 1 1 1 0 1 1
Z	Z	⌞	1 1 1 0 1 0 0 1 0 0	1 0 1 0 1 0 0 1 0 1	1 0 1 0 1 0 1 1 1 1
X	X	⊥	1 1 1 0 0 1 1 1 0 1	1 0 1 0 0 1 1 1 0 0	1 0 1 1 1 1 1 0 1 0
C	C	⌋	1 1 0 0 0 0 1 1 0 1	1 0 0 0 0 0 1 1 0 0	1 0 1 1 1 0 1 1 1 0
V	V	⊛	1 1 1 0 0 1 0 1 0 0	1 0 1 0 0 1 0 1 0 1	1 1 0 0 0 1 1 1 1 1
B	B	·	1 1 0 0 0 0 1 0 0 0	1 0 0 0 0 0 1 0 0 1	1 0 1 0 1 1 1 1 1 0
N	N	n	1 1 0 1 0 1 0 1 0 0	1 0 0 1 0 1 0 1 0 1	1 0 1 1 1 0 1 0 1 1
M	M	≤	1 1 0 1 0 1 0 0 0 1	1 0 0 1 0 1 0 0 0 0	0 1 0 0 1 1 0 0 0 0
,	,	≥	0 1 1 0 1 0 1 1 0 0*	0 1 1 0 1 0 1 1 0 0*	1 0 0 0 1 1 0 0 0 0
.	.	∨	0 1 0 0 1 0 1 1 0 1	0 1 0 0 1 0 1 1 0 1	1 0 1 0 1 1 1 0 0 0
?	\	∨	0 1 1 0 1 1 1 1 0 1	0 1 1 0 1 1 1 1 0 1	0 1 1 0 1 1 1 0 0 0
PF1			0 0 1 1 0 0 0 1 0 0	0 0 1 1 0 0 0 1 0 0	
PF2			0 0 1 1 0 0 1 0 0 0	0 0 1 1 0 0 1 0 0 0	
PF3			0 0 1 1 0 0 1 1 0 1	0 0 1 1 0 0 1 1 0 1	
PF4			0 0 1 1 0 1 0 0 0 0	0 0 1 1 0 1 0 0 0 0	
PF5			0 0 1 1 0 1 0 1 0 1	0 0 1 1 0 1 0 1 0 1	
PF6			0 0 1 1 0 1 1 0 0 1	0 0 1 1 0 1 1 0 0 1	
PF7			0 0 1 1 0 1 1 1 0 0	0 0 1 1 0 1 1 1 0 0	
PF8			0 0 1 1 1 0 0 0 0 0	0 0 1 1 1 0 0 0 0 0	
PF9			0 0 1 1 1 0 0 1 0 1	0 0 1 1 1 0 0 1 0 1	
PF10	·		0 0 1 1 1 0 1 0 0 1	0 0 1 1 1 0 1 0 0 1	
PF11			0 0 1 1 1 0 1 1 0 0	0 0 1 1 1 0 1 1 0 0	
PF12			0 0 1 1 1 1 0 0 0 1	0 0 1 1 1 1 0 0 0 1	

* Typamatic Key

Diagram 6-9. Text Keyboard Codes (EBCDIC) (Sheet 2 of 2)

Second Hex Char.		CONTROL BIT = 0 (KEYBOARD BIT 8 = 0)																First Hex Char
		00				01				10				11				Bits 0, 1
	Hex 1	00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11	Bits 2, 3
Bits 4567		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	Hex 0
0000	0		DEL		TEST REQ	SP	&	-									0	
0001	1		INS MODE		PF 1			/		a	j			A	J		1	
0010	2				PF 2					b	k	s		B	K	S	2	
0011	3		→|		PF 3					c	l	t		C	L	T	3	
0100	4		|←		PF 4					d	m	u		D	M	U	4	
0101	5		↵		PF 5					e	n	v		E	N	V	5	
0110	6		ERASE EOF		PF 6					f	o	w		F	O	W	6	
0111	7		ERASE INP		PF 7					g	p	x		G	P	X	7	
1000	8		↑		PF 8					h	q	y		H	Q	Y	8	
1001	9		↓		PF 9					i	r	z		I	R	Z	9	
1010	A		→		PF 10	¢	!		:			<						
1011	B		←		PF 11		$	,	#									
1100	C			PA 1	PF 12	<	*	%	@		DUP							
1101	D			CLEAR	ENT	(	)	_	'									
1110	E			PA 2		+	;	>	=		FM							
1111	F					|	¬	?	"									

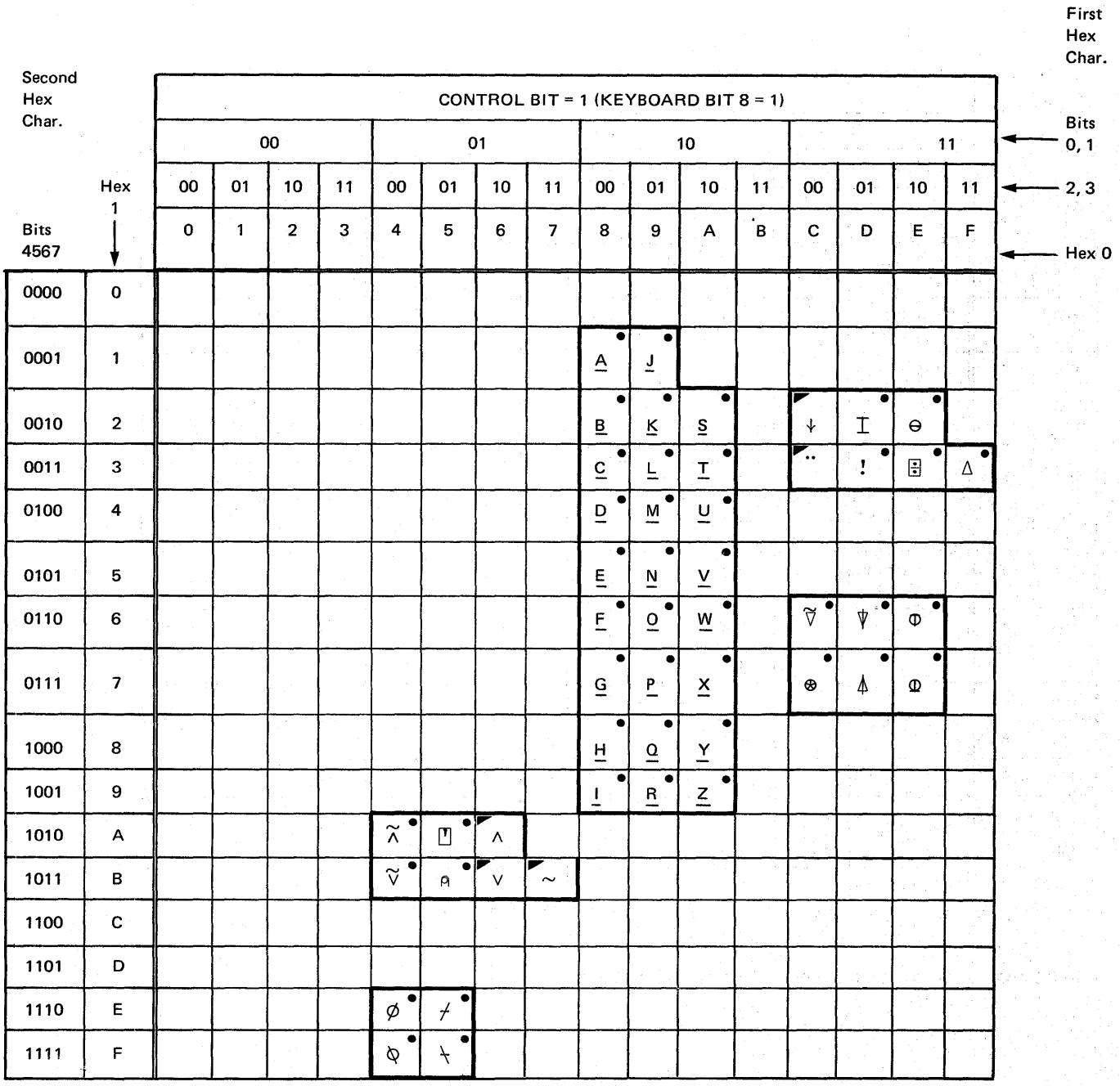
Note: The 66-key APL keyboard does *not* include codes 31 through 3C (PF 1 through PF 12).

Diagram 6-10. 3277 APL Keyboard Codes with APL Turned Off

Second Hex Char / Bits 4567	Hex 1	CONTROL BIT = 0 (KEYBOARD BIT 8 = 0)																First Hex Char
		00				01				10				11				← Bits 0, 1
		00	01	10	11	00	01	10	11	00	01	10	11	00	01	10	11	← 2, 3
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	← Hex 0
0000	0		DEL		TEST REQ	SP		–			□	¯	α				0	
0001	1		INS MODE		PF 1			/					∈	A	J		1	
0010	2				PF 2								⍳	B	K	S	2	
0011	3		⇥		PF 3								⍴	C	L	T	3	
0100	4		APL ALT		PF 4								⍵	D	M	U	4	
0101	5		↤		PF 5									E	N	V	5	
0110	6		ERASE EOF		PF 6								×	F	O	W	6	
0111	7		ERASE INP		PF 7								\	G	P	X	7	
1000	8		↑		PF 8								÷	H	Q	Y	8	
1001	9		↓		PF 9									I	R	Z	9	
1010	A		→		PF 10				:	↑	⊃	∩	∇					
1011	B		←		PF 11	.		,			⊂	∪	∆					
1100	C			PA 1	PF 12	<	*			≤	DUP	⊥	T					
1101	D			CLEAR	ENT	(	)	_	'	⌈	○	[	]					
1110	E			PA 2		+	;	>	=	⌊	FM	≥	≠					
1111	F							?		→	←	∘	|					

Notes: The 66-key APL keyboard does *not* include codes 31 through 3C (PF 1 through PF 12).
Graphic ⍙ associated with code 1-F3 *not* shown on key; see Diagram 6-3.
◤ denotes uppercase only.
■ denotes lowercase only.
● denotes alternate case only.

Diagram 6-11. 3277 APL Keyboard Codes with APL Turned On (Sheet 1 of 2)



Notes: The 66-key APL keyboard does *not* include codes 31 through 3C (PF 1 through PF 12).
Graphic $\underline{\Delta}$ associated with code 1-F3 *not* shown on key; see Diagram 6-3.

- ◤ denotes uppercase only.
- ■ denotes lowercase only.
- ● denotes alternate case only.

Diagram 6-11. 3277 APL Keyboard Codes with APL Turned On (Sheet 2 of 2)

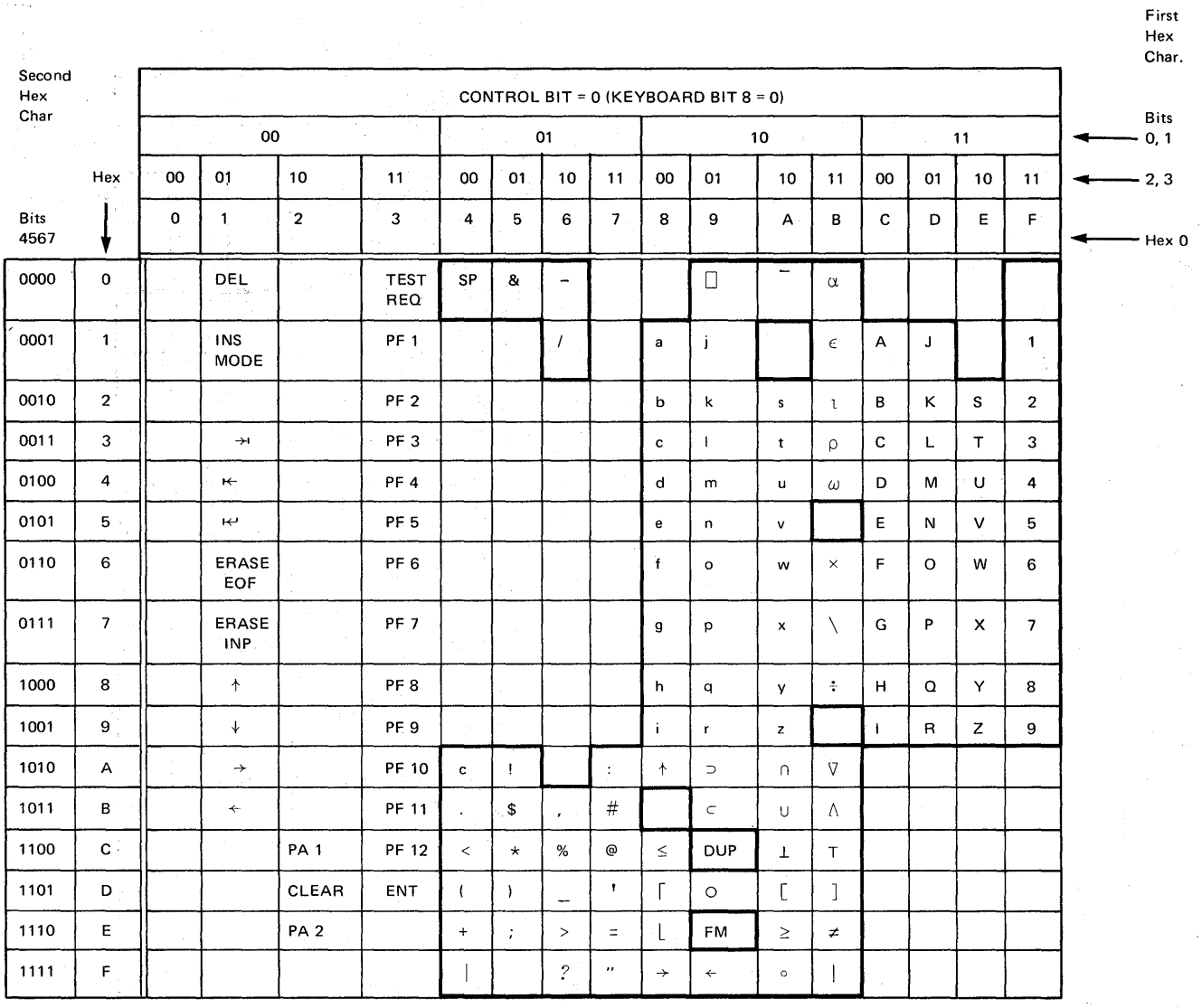
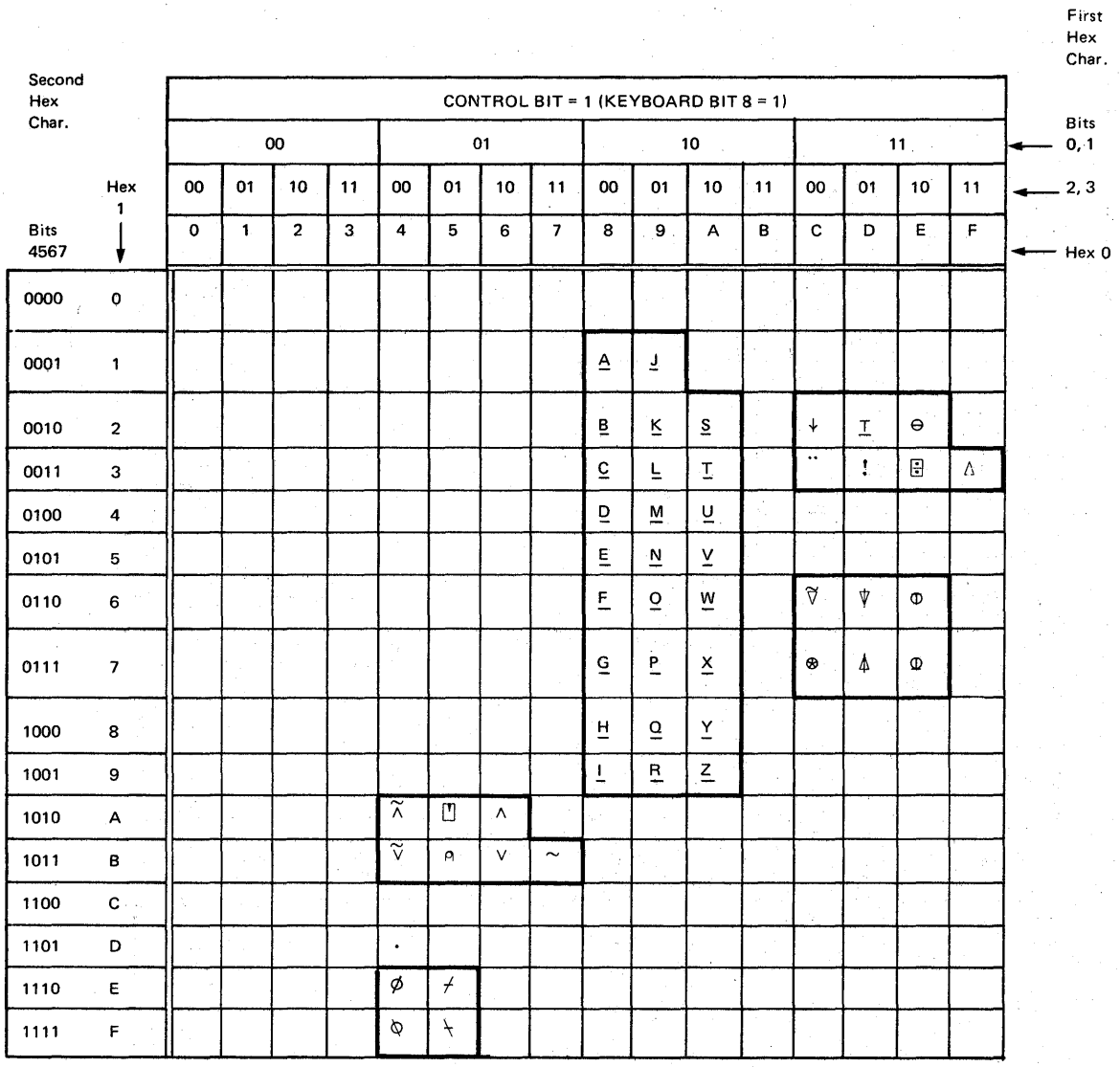
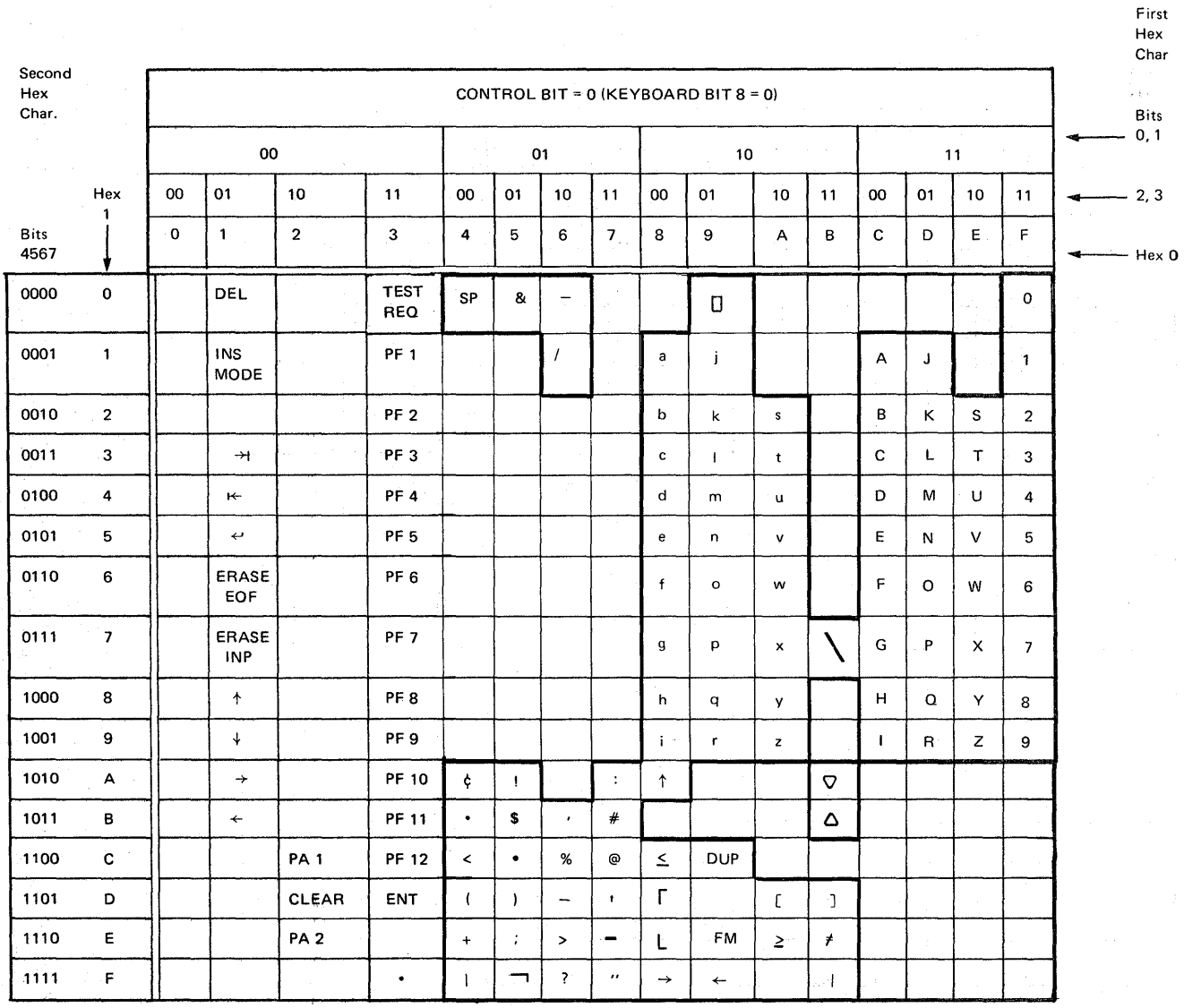


Diagram 6-12. 3277 APL Keyboard Codes – US EBCDIC (Sheet 1 of 2)



Notes: The 66-key typewriter keyboard does *not* include codes 31 through 3C (PF 1 through PF 12).
Graphic $\underline{\Delta}$ associated with code 1-Hex F3 *not* shown on key; see Diagram 6-3.

Diagram 6-12. 3277 APL Keyboard Codes – US EBCDIC (Sheet 2 of 2)



Note: The 66-key APL keyboard does *not* include codes 31 through 3C (PF 1 through PF 12).

Diagram 6-13. Text Feature Keyboard Codes – US EBCDIC (Sheet 1 of 2)

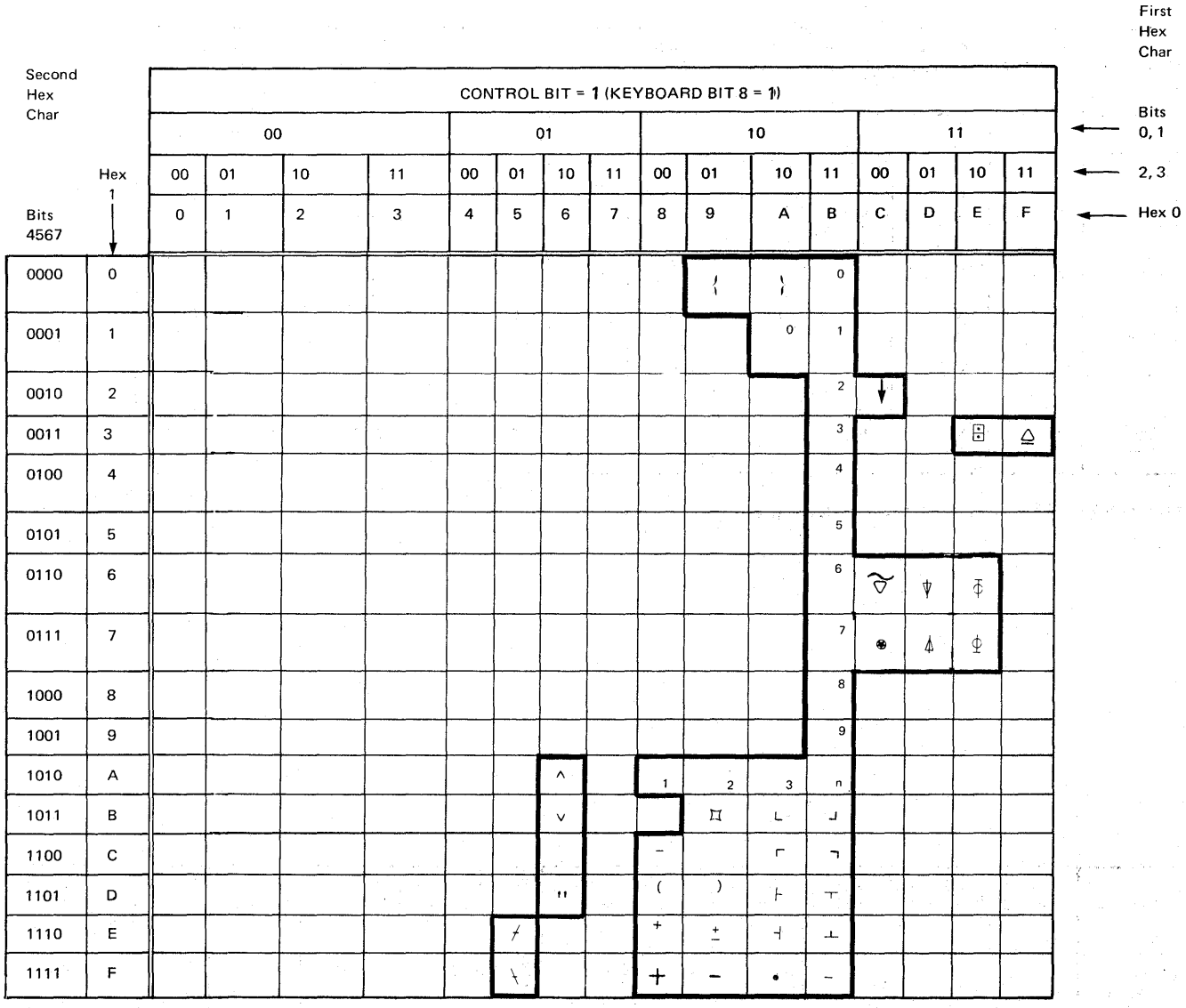


Diagram 6-13. Text Feature Keyboard Codes – US EBCDIC (Sheet 2 of 2)

Language	USA EBCDIC	Austrian/ German	Belgian/ French	Danish/ Norwegian	Finnish/ Swedish	Italian	Portuguese	Spanish	United Kingdom	Keyboard Code 0 1 2 3 4 5 6 7 P
Key	$	Ü	$	Å	Å	$	Ç	Pts	£	0 1 0 1 1 0 1 1 0
Graphic	$	Ü	$	Å	Å	$	Ç	Pt	£	
Key	#	Ä	#	Æ	Ä	#	Õ	Ñ	#	0 1 1 1 1 0 1 1 1
Graphic	#	Ä	#	Æ	A	#	Õ	Ñ	#	
Key	@	Ö	@	Ø	Ö	@	Ã	@	@	0 1 1 1 1 1 0 0 0
Graphic	@	Ö	@	Ø	Ö	@	Ã	@	@	
Key	!	X5A	!	X5A	X5A	!	X5A	!	!	0 1 0 1 1 0 1 0 1
Graphic	!	Ü	!	Å	Å	!	Ç	!	!	
Key	"	X7F	"	X7F	X7F	"	X7F	Ñ	"	0 1 1 1 1 1 1 1 0
Graphic	"	Ä	"	Æ	Ä	"	Õ	Ñ	"	
Key	¢	X4A	¢	X5A	X4A	¢	X4A	¢	$	0 1 0 0 1 0 1 0 0
Graphic	¢	Ö	¢	Ø	Ö	¢	Ã	¢	$	

Diagram 6-14. WTC Language Keyboard Codes (Data Entry Keyboard)

Language	USA EBCDIC	USA ASCII-A	USA ASCII-B	Austrian/ German	Belgian/ French	Danish/ Norwegian	Finnish/ Swedish	Italian	Portuguese	Spanish	United Kingdom	Keyboard Code 0 1 2 3 4 5 6 7 P
Key	$	$	$	Ü (Shift)	$	Å (Shift)	Å (Shift)	$	Ç (Shift)	Pts	£	0 1 0 1 1 0 1 1 0
Graphic	$	$	$	Ü	$	Å	Å	$	Ç	Pt	£	
Key	#	#	#	Ä (Shift)	#	Æ (Shift)	Ä (Shift)	#	Õ (Shift)	Ñ (Shift)	#	0 1 1 1 1 0 1 1 1
Graphic	#	#	#	Ä	#	Æ	Ä	#	Õ	Ñ	#	
Key	@	@	@	Ö (Shift)	@	Ø (Shift)	Ö (Shift)	@	Ã (Shift)	@	@	0 1 1 1 1 1 0 0 0
Graphic	@	@	@	Ö	@	Ø	Ö	@	Ã	@	@	
Key	!	]	]	Ü	!	Å	Å	!	Ç	!	!	0 1 0 1 1 0 1 0 1
Graphic	!	]	]	Ü	!	Å	Å	!	Ç	!	!	
Key	"	"	"	Ä	"	Æ	Ä	"	Õ	Ñ	"	0 1 1 1 1 1 1 1 0
Graphic	"	"	"	Ä	"	Æ	Ä	"	Õ	Ñ	"	
Key	¢	[	[	Ö	¢	Ø	Ö	¢	Ã	¢	$	0 1 0 0 1 0 1 0 0
Graphic	¢	[	[	Ö	¢	Ø	Ö	¢	Ã	¢	$	
Key	¦	¦	!	¦	¦	¦	¦	¦	¦	¦	¦	0 1 0 0 1 1 1 1 0
Graphic	¦	¦	!	¦	¦	¦	¦	¦	¦	¦	¦	
Key	¬	¬	^	¬	¬	¬	¬	¬	¬	¬	¬	0 1 0 1 1 1 1 1 1
Graphic	¬	¬	^	¬	¬	¬	¬	¬	¬	¬	¬	
Key				X6A								0 1 1 0 1 0 1 0 1
Graphic				(None)								

Diagram 6-15. ASCII and WTC Language Keyboard Codes (Typewriter Keyboard)

Location and Name	Type	Logic Page Reference	Function or Major Units	Significant I/O Signals Input	Output
*A2 Keyboard Controls – 2	9072	KM111–161	Tests for modified characters and protected data. Contains keyboard operation latches, control latches, and MDT latch.	Keybd Strobe; Keybd Reset; CU Busy; Index; I/O Unlock Keybd; Allow Char Load.	KB lock; FF Enable; Ld KB to Fets; Char Rdy Decode; MDT Load Bit 7.
*B2 Keyboard Controls – 1	9069	KM011–071	Contains KB decoder, Tab controls, Cursor Controls, and Insert/Delete Controls.	KB Bits 1–7, and P; Alpha Shift; Numeric Shift; KB Strobe.	KB Op Decoder outputs; Char Edit; Csr Edit; Op Complete; Insert Bit 9; Csr Move; Keybd Bits 1–7.
C2 I/O Gating and Parity	9066	MG011–061	Contains message buffer register and parity check circuits, late register, attribute register, and gating circuitry for line buffer and message buffer.	CR Bits 0–9; SR Bits 3–11; KB Bits 1–7; Fets Out Bits 0–9; Load I/O Data; Load Message Buffer.	FQ Ser in Bits 0–9; Mesg Bfr Bits 1–9; Attb Reg Bits 2–6; P Chk Bfr.
D2 (Model 1) 480 Storage and Gate	9057	MB011–061	Model 1 – Contains 480-character message buffer and gates.	FQ Ser in Bits 0–9; Serial Shift Gt; Shift Fets.	Fets Out Bits 0–9.
D2 (Model 2) 960 Storage and Gate	9065	MB011–061	Model 2 - Contains 960-character message buffer and gates.		TQ Ser in Bits 0–9.
E2 SERDES and Special Circuits	L514	KA111–121	Contains line driver and line receiver, I/O serializer/ deserializer (SERDES) and gates, oscillator, and 5V relay switch.	Data to Control Unit; Data to Driver Receiver; Mesg Bfr Bits 1–9; Keyb bits 3–7; Data.	Data to Control Unit; Data from Driver Receiver; SR Bits 1–12; Osc.
F2 960 Storage and Gate	9065	MB111–161	Model 1 – Not used. Model 2 – Contains 960 character message buffer and gates.	Third Quarter Serial in Bits 0–9 (from card D2); Shift Fets.	Fets Out Bits 0–9.
G2 I/O Control	9068	KA011–081	Contains operation decoder, I/O gating controls, status register, SERDES controls, and cursor positioning controls.	Osc, End Screen; Fets Out Bit 7–8; SR Bits 1–12; Data from Driver Receiver; Attention inputs.	Stop Clock; Index; Sound Alarm; Write Latch; System Ready Latch; Control Word 1 and 2; Clock; Data; Input Data; Device Busy; Read Sync; Xmit Check; Read Out Shift; Data to Driver Receiver; CU Busy; Input Inhibited; Load I/O Data; Protected Bfr.

*Optional feature cards

Diagram 6-16. Logic Card Data (Sheet 1 of 2)

Location and Name	Type	Logic Page Reference	Function or Major Units	Significant I/O Signals Input	Output
H2 Clock and Step Control	9071	KF011–071	Contains dot counter, character counter, buffer shifting controls, and buffer attribute register.	Osc; Read Out Shift; Set I/O Fast Shift; Load Late Reg; Last Line.	Interface Op Step Retrace Ctr; Dot 1–8; Char 0; Next to Last Char; Last Char; Char Ctr All Ones; Fast Shift Latch; Unformatted Display; Normal Gates; High Intensity, Non Disp Blank; Unprotected Char; Numeric Field.
J2 Display Control	9067	KF111–181	Contains retrace counter, line counter, row counter, analog controls, and controls to display indicators.	Step Retrace Ctr; Retrace Blank; Lines 0–9; Csr Line; Input Inhibited; System Ready; Insert Mode.	Set Blank for Retrace; First 9 Lines; Ld LB Gates; Shift Line Buff; Ld Atb Reg from Fets; Step Row Ctr; Horiz Sync; Blank CRT at Video Output; Row 0; Row 1; Last Row; End Screen; Unblank; Shift Fets; Vertical Retrace; Bump Display; Serial Shift GT.
K2 Line Buffer and Character Generator	9058 (M1) 9070 (M2)	MC011–091	Contains gates to line buffer, ROS register, line buffer, ROS character generator, and data serializer for analog.	Fets Out Bits 2–9; Shift Line Buff; Blank CRT at Video Output; Unblank Ind; Lines 0–8.	Pre ROS Bits 2, 3, and 7; Bits 4, 5, 6, and 8 from Line Buffer; Non Display or Hi Inten; Video Data Out.
L2 (Not Used)					
*M2 LP Control	9088	KT011–061	Contains selector light-pen interface and control circuitry.	I/O Busy; Bits 4, 5, 6, and 8 from Line Buffer; Pre ROS bits 2, 3, and 7.	Bit 7 and LB and MB; LP Busy; LP Aid Bits 3, 4, 5, and 6.
*N2 Card Reader	2229	KR011–071	Contains magnetic card reader interface and control circuitry.	CR Data; Keybd Bits 0–7; Keybd Parity Bit.	Strobe; Bits 0–7; Pty; Gate Keyboard.

*Optional feature cards

Diagram 6-16. Logic Card Data (Sheet 2 of 2)

Card	Pin	ALD	Signal Name
A-A2	B04	KM141	+ DE Up Shift
	G04	KM111	- Ld KB to Fets
	*M10	KM141	- Keybd Strobe
	P05	KM131	- Load Late Reg Gt
	S03	KM141	- Keybd Lock
	*S09	KM141	- Keybd Reset
	S12	KM141	+ KB Tune
	U04	KM141	+ FF Enable
	U06	KM121	- Insert Mode
A-B2	G03	KM041	- Fill Hole
	G09	KM021	- KB Attn Lock KB
	J10	KM041	- Clr Norm Gt Lth
	M03	KM031	+ Erase Fld 6
	*M10	KM031	+ Keybd Bit 5
	*M11	KM031	+ Keybd Bit 7
	P06	KM031	- Set EAU Lth 7
	*S02	KM031	+ Keybd Bit 3
	*S05	KM031	+ Keybd Bit 0
	*S08	KM031	+ Keybd Bit 1
	*S09	KM031	+ Keybd Bit 2
	*S13	KM021	+ Keybd Parity Bit
	*U05	KM031	+ Keybd Bit 4
	*U09	KM031	+ Keybd Bit 6
	U13	KM011	- Insert Csr Bit 9
A-C2	P04	MG051	+ POR
	*S02	MG051	- POR
	S03	MG041	+ P Chk Bfr
A-E2	*B02	KA111	+ Relay Coil
	B09	KA111	+ Switched 5V
	B12	KA121	+ 2.385 MHz Osc
	J13	KA121	+ 4.770 MHz Osc
A-F2	M02	MB141	+ Fets Out Bit 9
A-G2	B09	KA081	+ Insert Null
	*B10	KA071	- Clr Insert Csr Latch
	*D07	KA061	- Security Key
	G04	KA081	+ Delete Csr Bit 9
	G07	KA071	- Protected Bfr
	G09	KA061	- Device Busy Status Dot
	J05	KA081	- Insert Cursor Norm
	J13	KA071	- Set I/O Fast Shift
	M06	KA061	+ CU Busy
	P02	KA021	+ Index
	S04	KA031	- Delete MDT Bit 7
	S06	KA031	- Syst Rdy Lth Set
	S09	KA071	- Op in Process
	S10	KA061	- Input Inhibit

Card	Pin	ALD	Signal Name
A-H2	B03	KF071	+ Null Bet Cur and End
	D06	KF071	+ Numeric Field
	D13	KF021	- Dot 6
	G03	KF071	+ Unprotected Char
	G11	KF041	- Shift Fets
	G13	KF061	+ High Intensity
	J02	KF051	+ Unformatted Disp Lth
	J09	KF051	+ Normal Gates
	M09	KF051	+ Fast Shift Latch
	M13	KF031	- Char All Ones
	P06	KF031	- Next To Last Char
	P10	KF021	+ Blank For First Frame
	U06	KF021	- Late Reg Strobe
A-J2	B04	KF131	- Cond Fets Bit 8
	B10	KF131	+ Ld LB Gates
	G08	KF161	- Unblank Ind
	M08	KF151	- End Screen
	P04	KF181	+ Up Line
	S02	KF151	+ Last Row
	S05	KF141	+ Blank CRT at Video Output
	S09	KF141	- Force Unblank Line
	S12	KF171	- Bump Display
	S13	KF171	+ Vertical Retrace
	U02	KF141	+ Dev Check
	U10	KF141	+ Horiz Sync
A-K2	P11	MC081	+ Non Dis Or Hi Inten
	S09	MC091	+ Video Data Out
A-M2	*D04	KT041	- LP Strike
	P09	KT051	- Draw Bars
	*U06	KT051	- LP Sw Closed

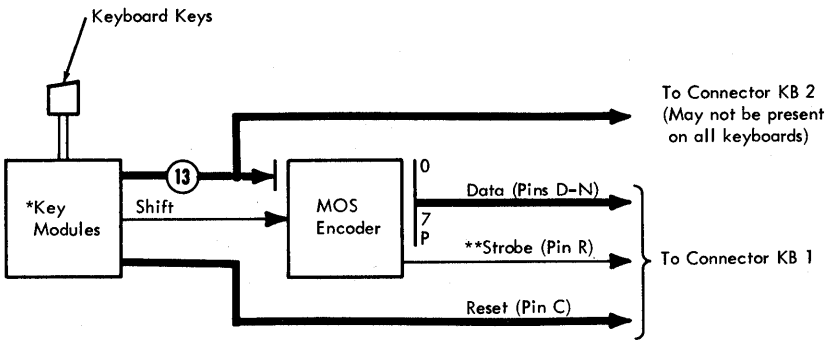
*Input pins

Diagram 6-17. Probe Pin Data

Feature Name	Feature Number	Jumper
Typewriter and Operator Console Keyboards	4630, 4632, 4633, 2955	Add wire: *A2B06 to A2D08
Data Entry Keyboards	4631, 2973	Remove wire: A2B06 to A2D08
Keyboard Numeric Lock (USA English, UK English, Finnish, and Swedish)	4690	Add wire: B4B12 to B4D08 Remove wire (if installed): B5B03 to B5D08
Keyboard Numeric Lock (Austrian, Belgian, Danish, French, German, Italian, Norwegian, Portuguese, and Spanish)	4690	Add wires: B4B12 to B4D08 B5B03 to B5D08

*Do not add this wire if display station is at EC 717946 or higher.

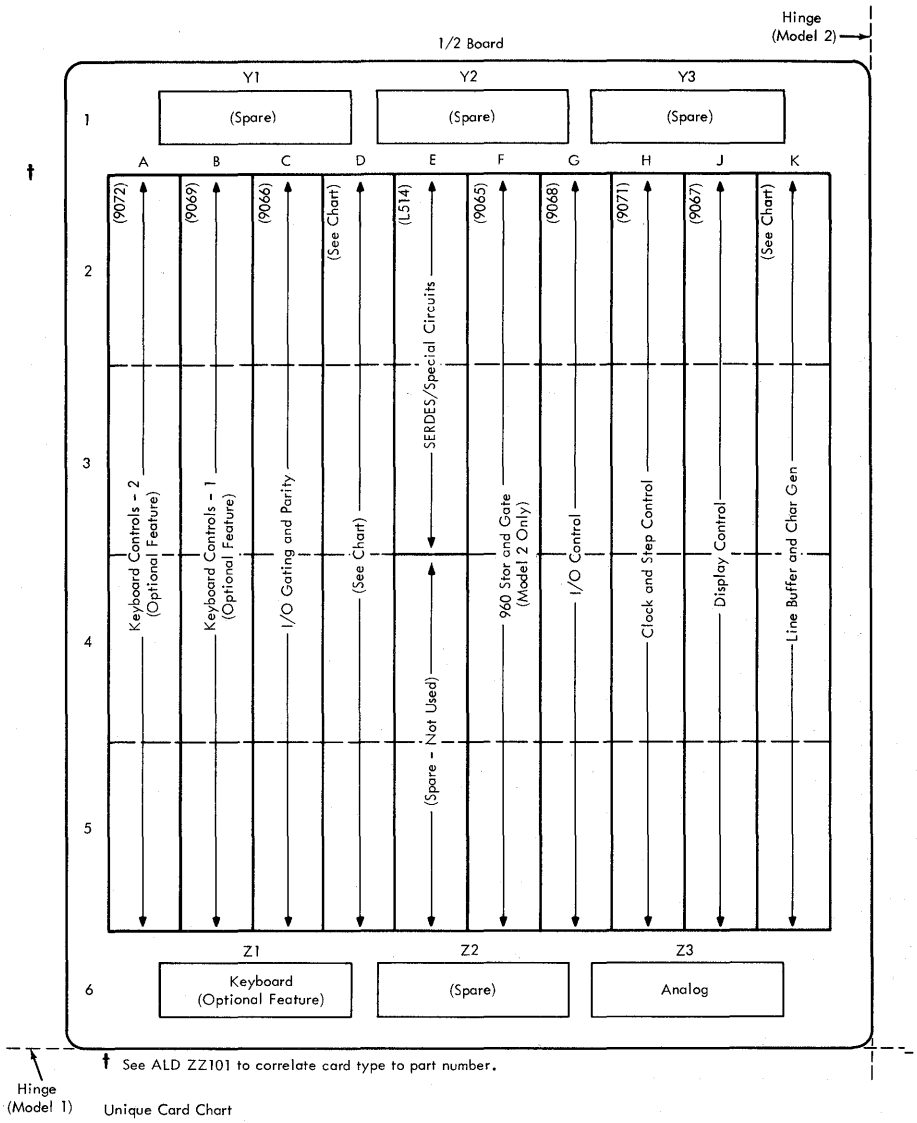
Diagram 6-18. Keyboard Feature Jumpers



*Each key module (except RESET and the shift keys) generates two active inputs to the encoder.

**The strobe signal is active when two and only two active inputs are present at the encoder.

Diagram 6-19. Type A Keyboard Encoding



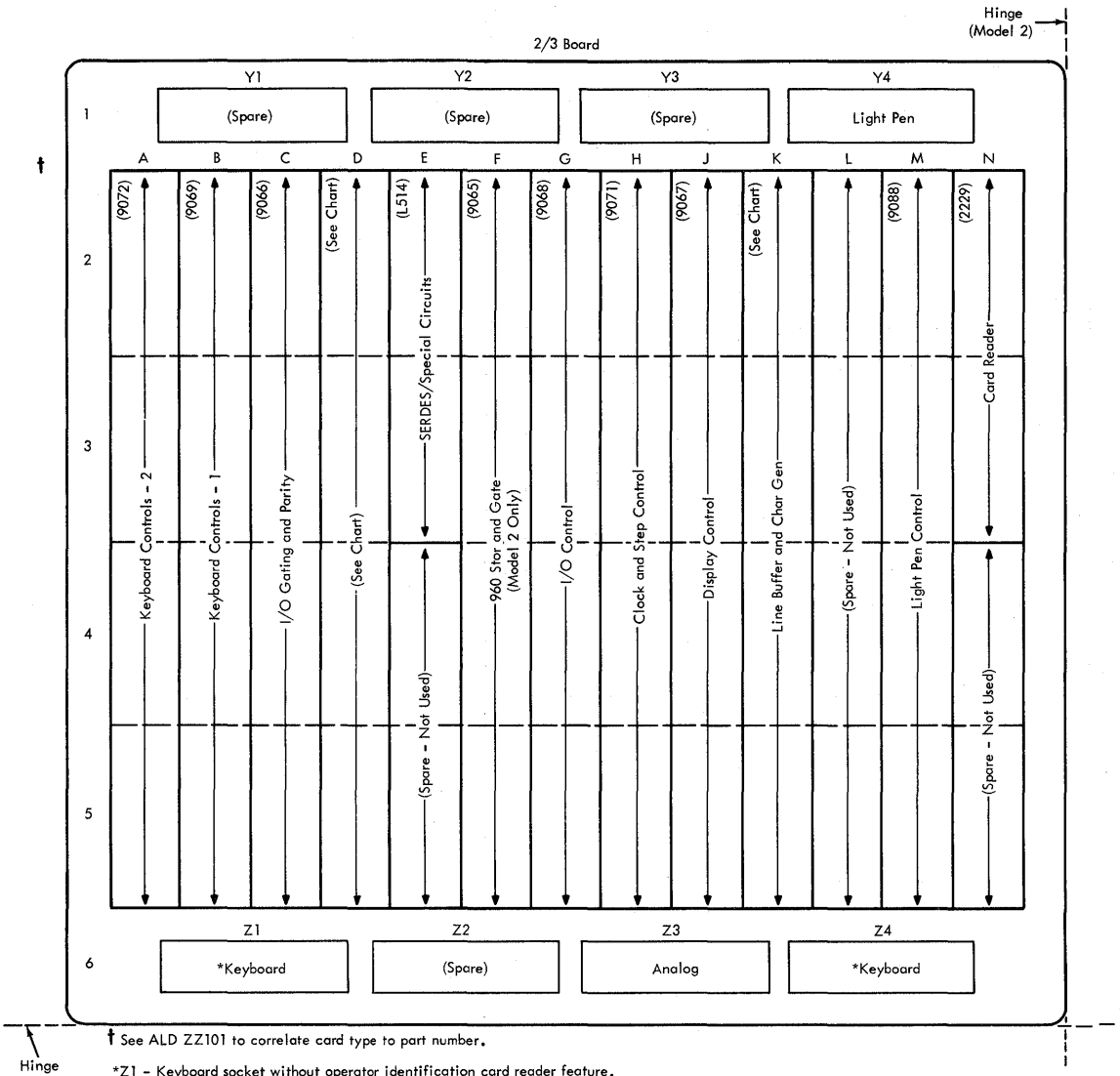
† See ALD ZZ101 to correlate card type to part number.

Unique Card Chart

Location	Model	Language	Name	Type
D2	1	All	480 Stor and Gate	9057
D2	2	All	960 Stor and Gate	9065
F2	1	All	Spare - Not Used	-
F2	2	All	960 Stor and Gate	9065
K2	1	US English EBCDIC	Line Buffer and Char Gen	9058
K2	1	US English ASCII-A	Line Buffer and Char Gen	9103
K2	1	US English ASCII-B	Line Buffer and Char Gen	9104
K2	1	UK English	Line Buffer and Char Gen	9102
K2	1	German	Line Buffer and Char Gen	9101
K2	1	Swedish/Finnish	Line Buffer and Char Gen	W068
K2	1	Norwegian/Danish	Line Buffer and Char Gen	W069
K2	1	Spanish	Line Buffer and Char Gen	W070
K2	1	Portuguese	Line Buffer and Char Gen	W072
K2	2	US English EBCDIC	Line Buffer and Char Gen	9070
K2	2	US English ASCII-A	Line Buffer and Char Gen	9098
K2	2	US English ASCII-B	Line Buffer and Char Gen	9099
K2	2	UK English	Line Buffer and Char Gen	9097
K2	2	German	Line Buffer and Char Gen	9096
K2	2	Swedish/Finnish	Line Buffer and Char Gen	W075
K2	2	Norwegian/Danish	Line Buffer and Char Gen	W076
K2	2	Spanish	Line Buffer and Char Gen	W077
K2	2	Portuguese	Line Buffer and Char Gen	W079
K2	2 (APL)	US English EBCDIC	Line Buffer and Char Gen	AG28

(Languages not listed use USA EBCDIC card types.)

Diagram 6-20. Board Layout by Card Function — Without Features (Card Side View)



† See ALD ZZ101 to correlate card type to part number.

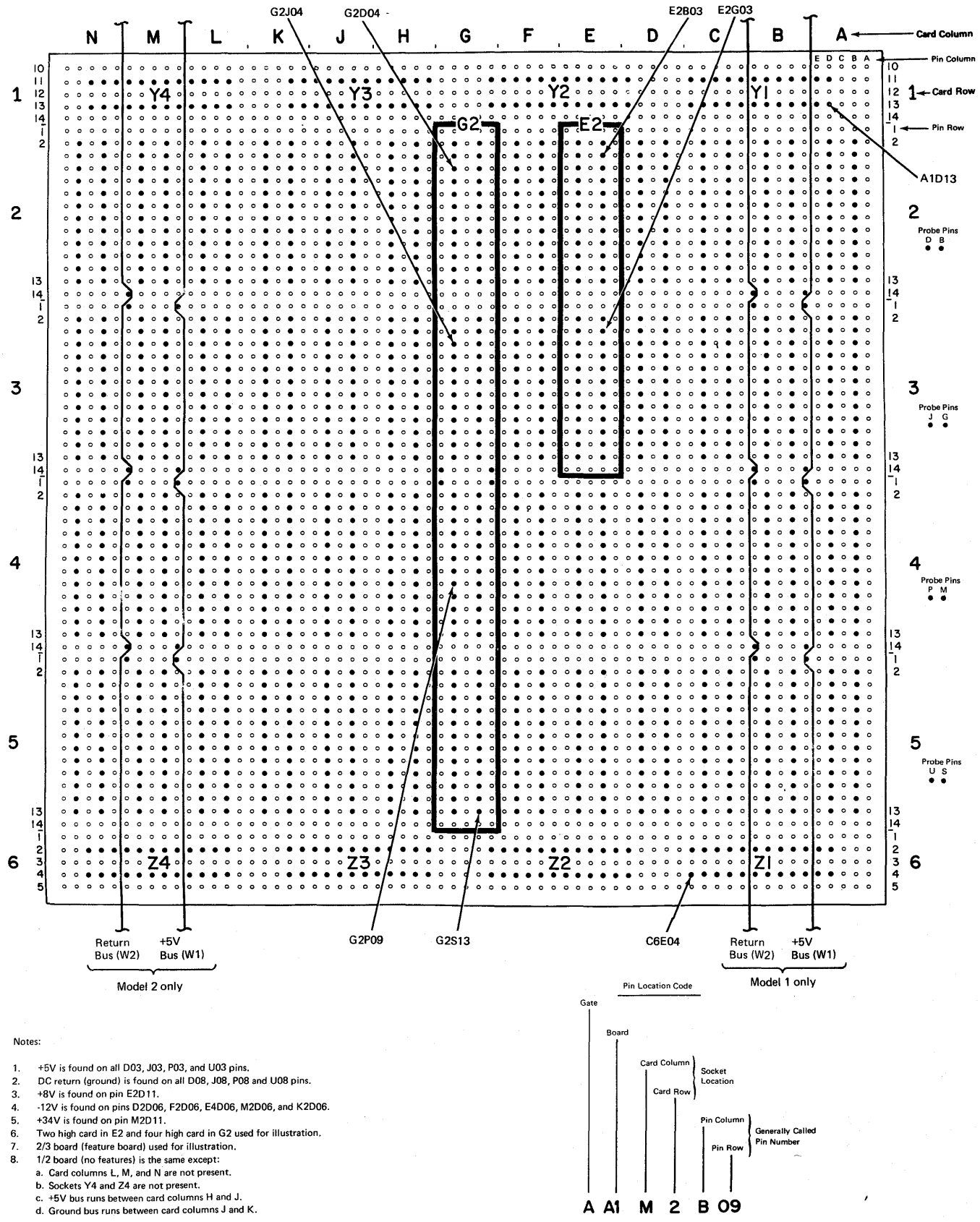
*Z1 - Keyboard socket without operator identification card reader feature.
Z4 - Keyboard socket with operator identification card reader feature.

Unique Card Chart

Location	Model	Language	Name	Type
D2	1	All	480 Stor and Gate	9057
D2	2	All	960 Stor and Gate	9065
F2	1	All	Spare - Not Used	-
F2	2	All	960 Stor and Gate	9065
K2	1	US English EBCDIC	Line Buffer and Char Gen	9058
K2	1	US English ASCII-A	Line Buffer and Char Gen	9103
K2	1	US English ASCII-B	Line Buffer and Char Gen	9104
K2	1	UK English	Line Buffer and Char Gen	9102
K2	1	German	Line Buffer and Char Gen	9101
K2	1	Swedish/Finnish	Line Buffer and Char Gen	W068
K2	1	Norwegian/Danish	Line Buffer and Char Gen	W069
K2	1	Spanish	Line Buffer and Char Gen	W070
K2	1	Portuguese	Line Buffer and Char Gen	W072
K2	2	US English EBCDIC	Line Buffer and Char Gen	9070
K2	2	US English ASCII-A	Line Buffer and Char Gen	9098
K2	2	US English ASCII-B	Line Buffer and Char Gen	9099
K2	2	UK English	Line Buffer and Char Gen	9097
K2	2	German	Line Buffer and Char Gen	9096
K2	2	Swedish/Finnish	Line Buffer and Char Gen	W075
K2	2	Norwegian/Danish	Line Buffer and Char Gen	W076
K2	2	Spanish	Line Buffer and Char Gen	W077
K2	2	Portuguese	Line Buffer and Char Gen	W079
K2	2(APL)	US English EBCDIC	Line Buffer and Char Gen	AG28

(Languages not listed use USA EBCDIC card types.)

Diagram 6-21. Board Layout by Card Function — With Features (Card Side View)



Notes:

1. +5V is found on all D03, J03, P03, and U03 pins.
2. DC return (ground) is found on all D08, J08, P08 and U08 pins.
3. +8V is found on pin E2D11.
4. -12V is found on pins D2D06, F2D06, E4D06, M2D06, and K2D06.
5. +34V is found on pin M2D11.
6. Two high card in E2 and four high card in G2 used for illustration.
7. 2/3 board (feature board) used for illustration.
8. 1/2 board (no features) is the same except:
   a. Card columns L, M, and N are not present.
   b. Sockets Y4 and Z4 are not present.
   c. +5V bus runs between card columns H and J.
   d. Ground bus runs between card columns J and K.

Diagram 6-22. Board Layout Pin Identification Data (Pin Side View)

Photographs and drawings are provided in this section to aid in locating field-replaceable units, adjustable components, and voltage measurement points.

Diagrams 7-1 through 7-6 show Model 1 and Model 2 component locations. Type A keyboard locations are shown in Diagrams 7-7 and 7-8. Voltage component locations and test points are shown in Diagrams 7-9 through 7-15. Diagram 7-16 shows component locations on both the old and new analog cards. Type B keyboard locations are shown in Diagrams 7-17 through 7-20.

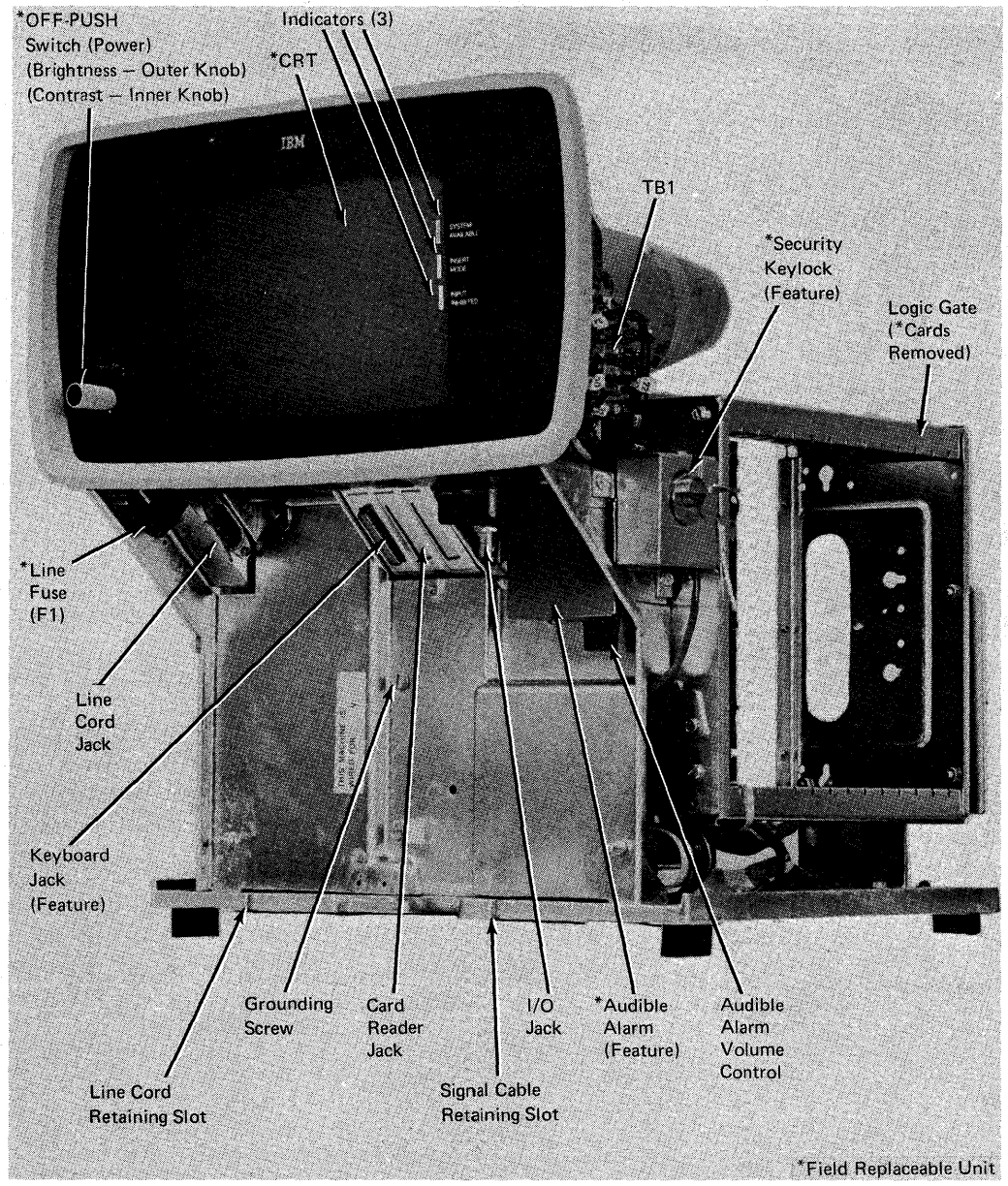


Diagram 7-1. Model 1 Locations, Front View

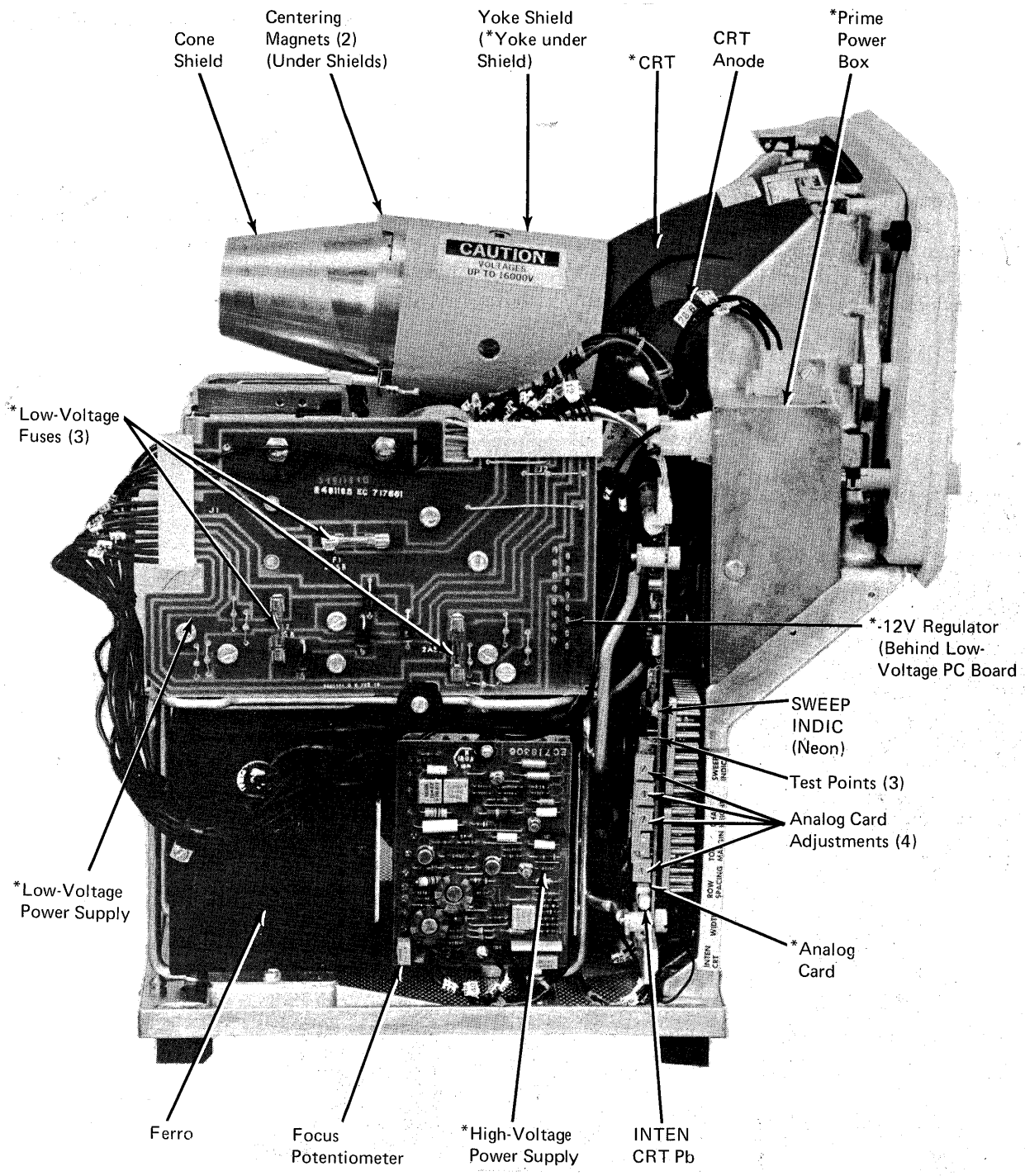


Diagram 7-2. Model 1 Locations, Left-Side View

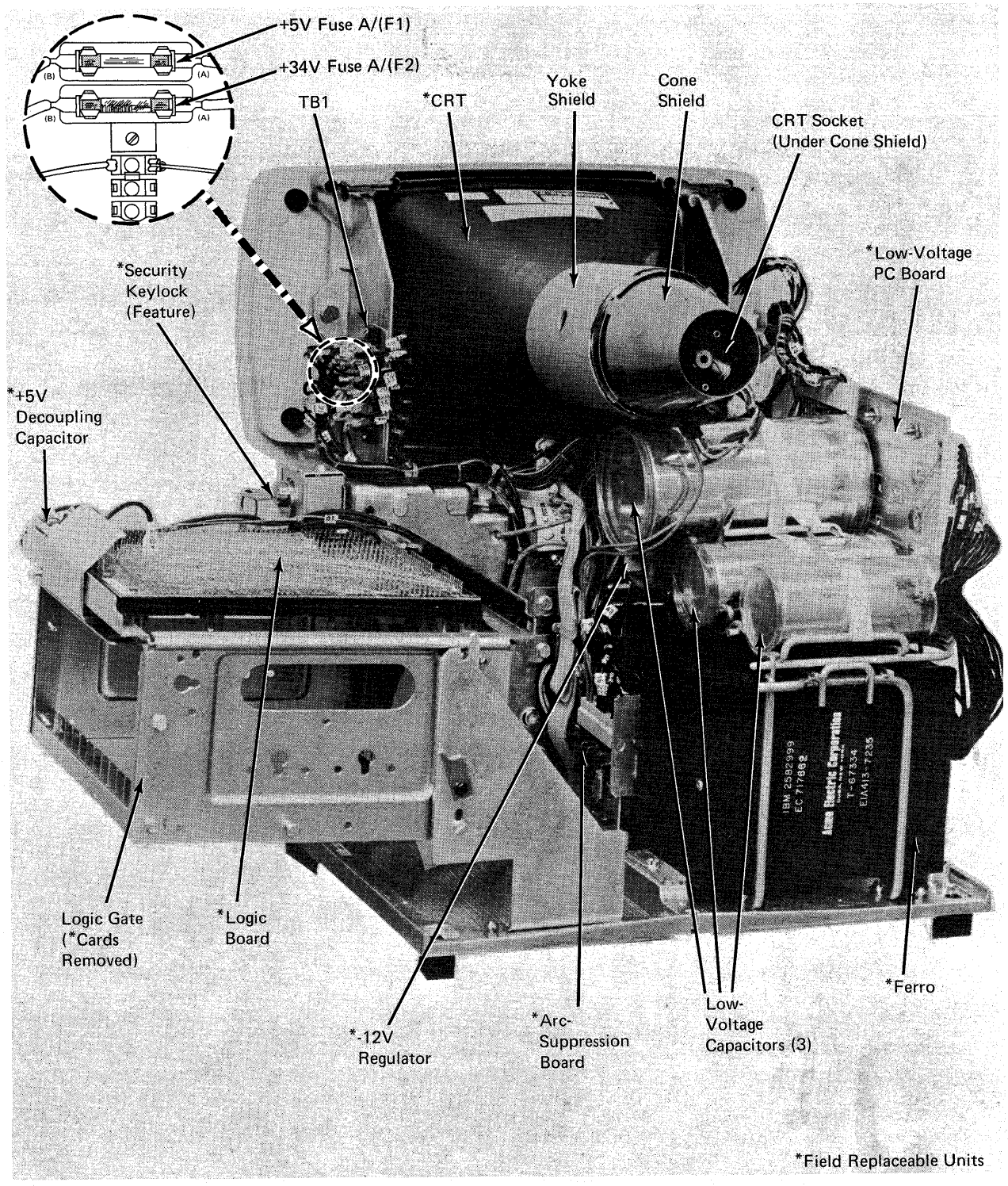


Diagram 7-3. Model 1 Locations, Rear View

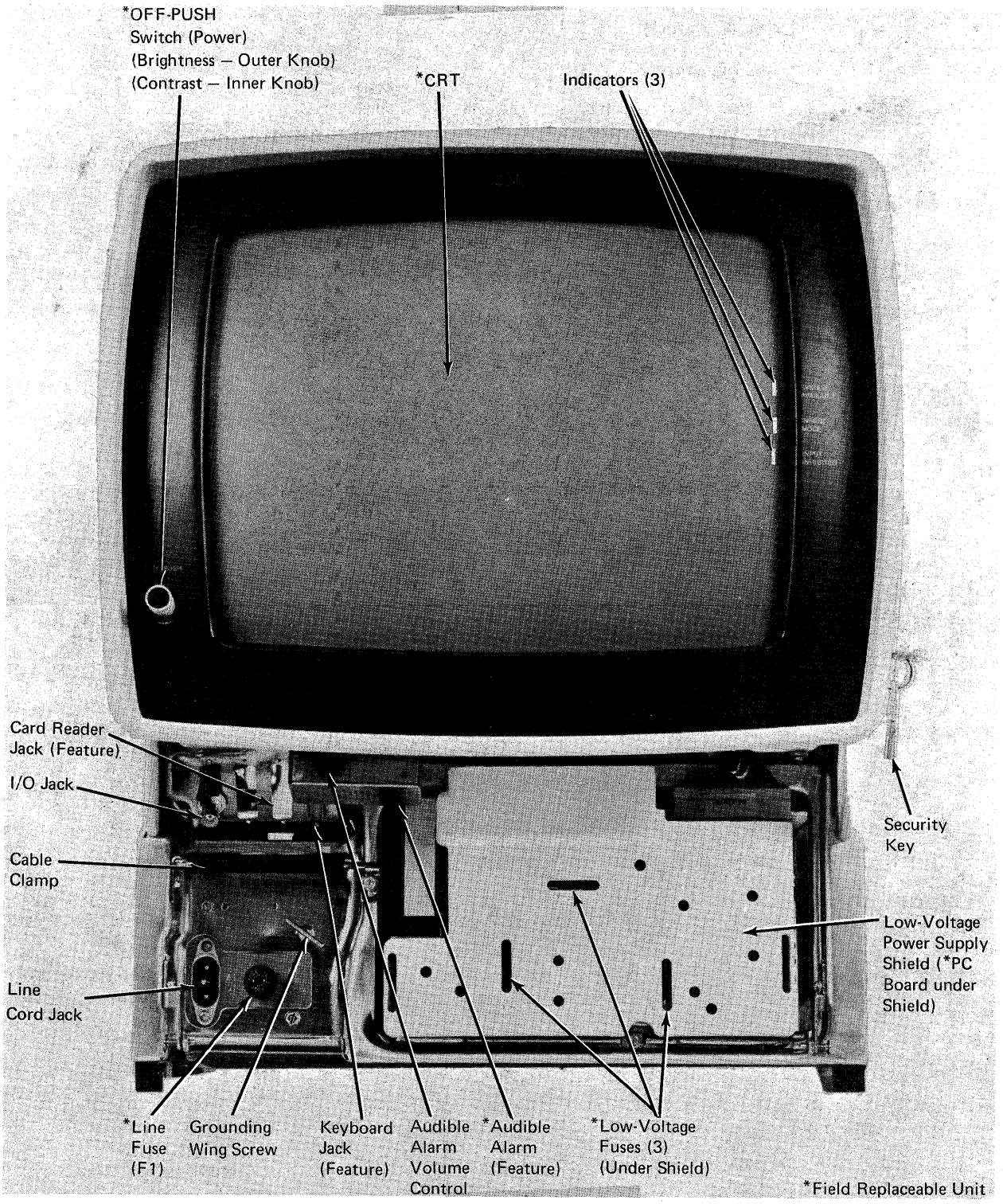


Diagram 7-4. Model 2 Locations, Front View

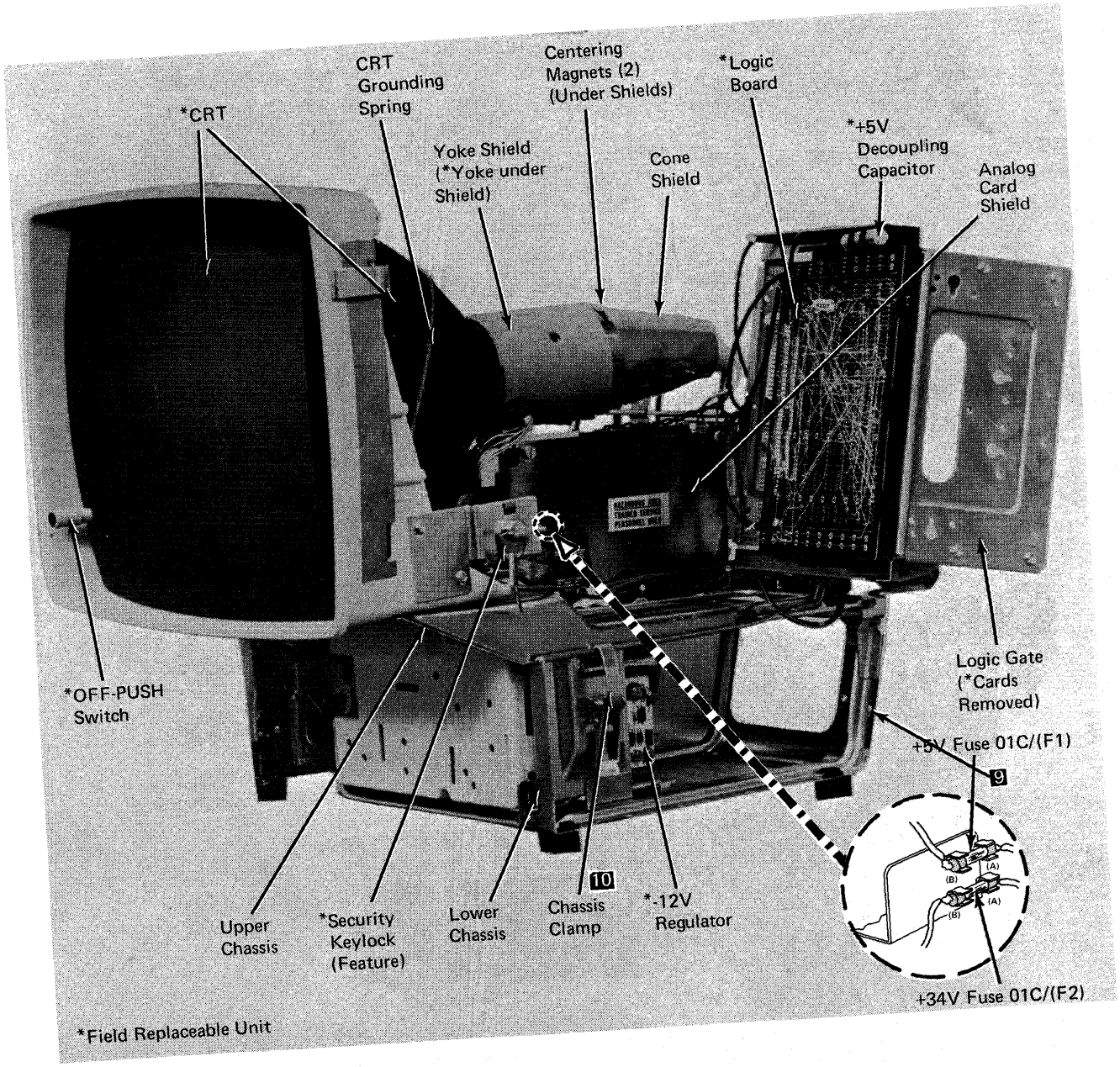


Diagram 7-5. Model 2 Locations, Right-Side View

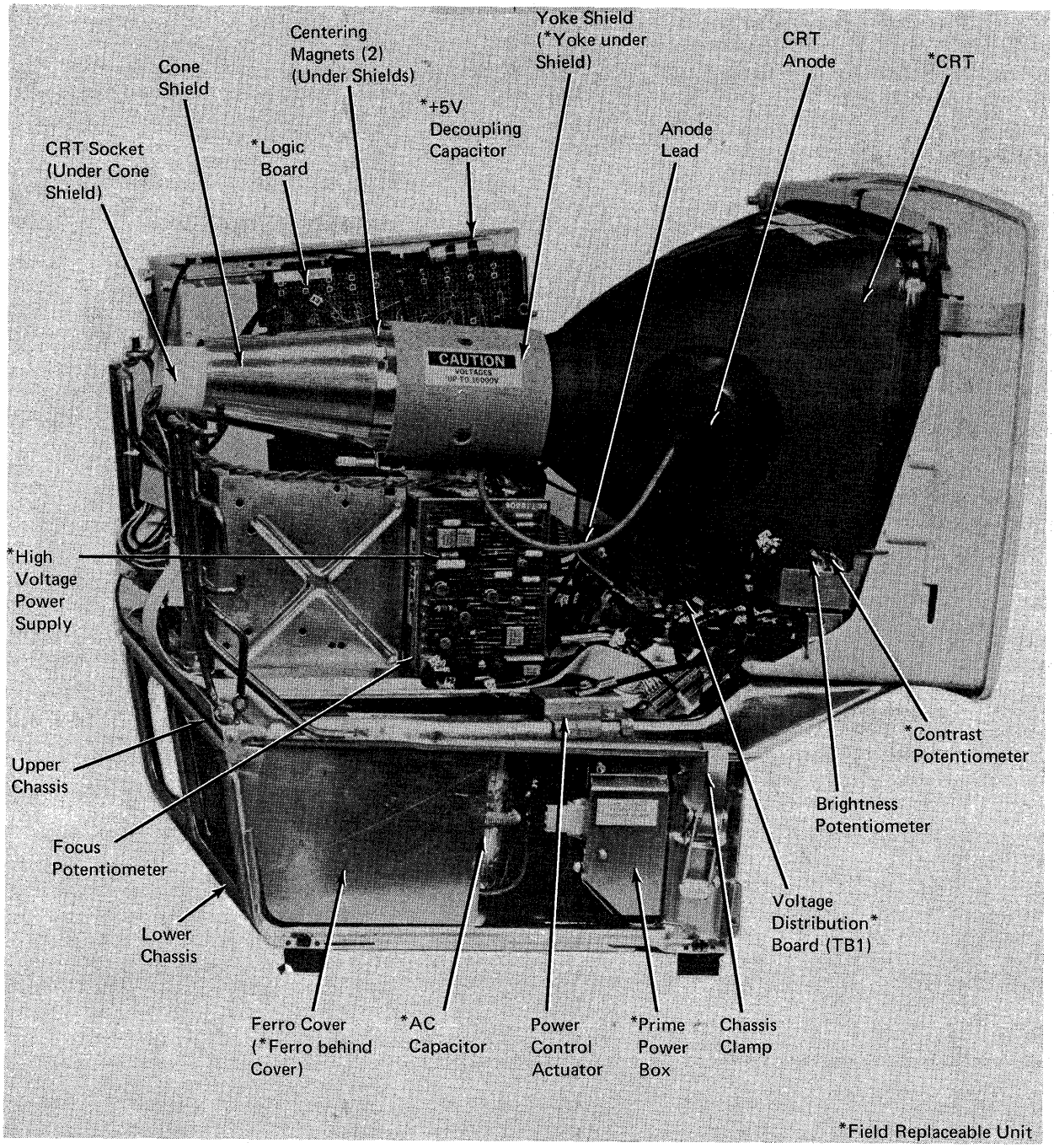


Diagram 7-6. Model 2 Locations, Left-Side View

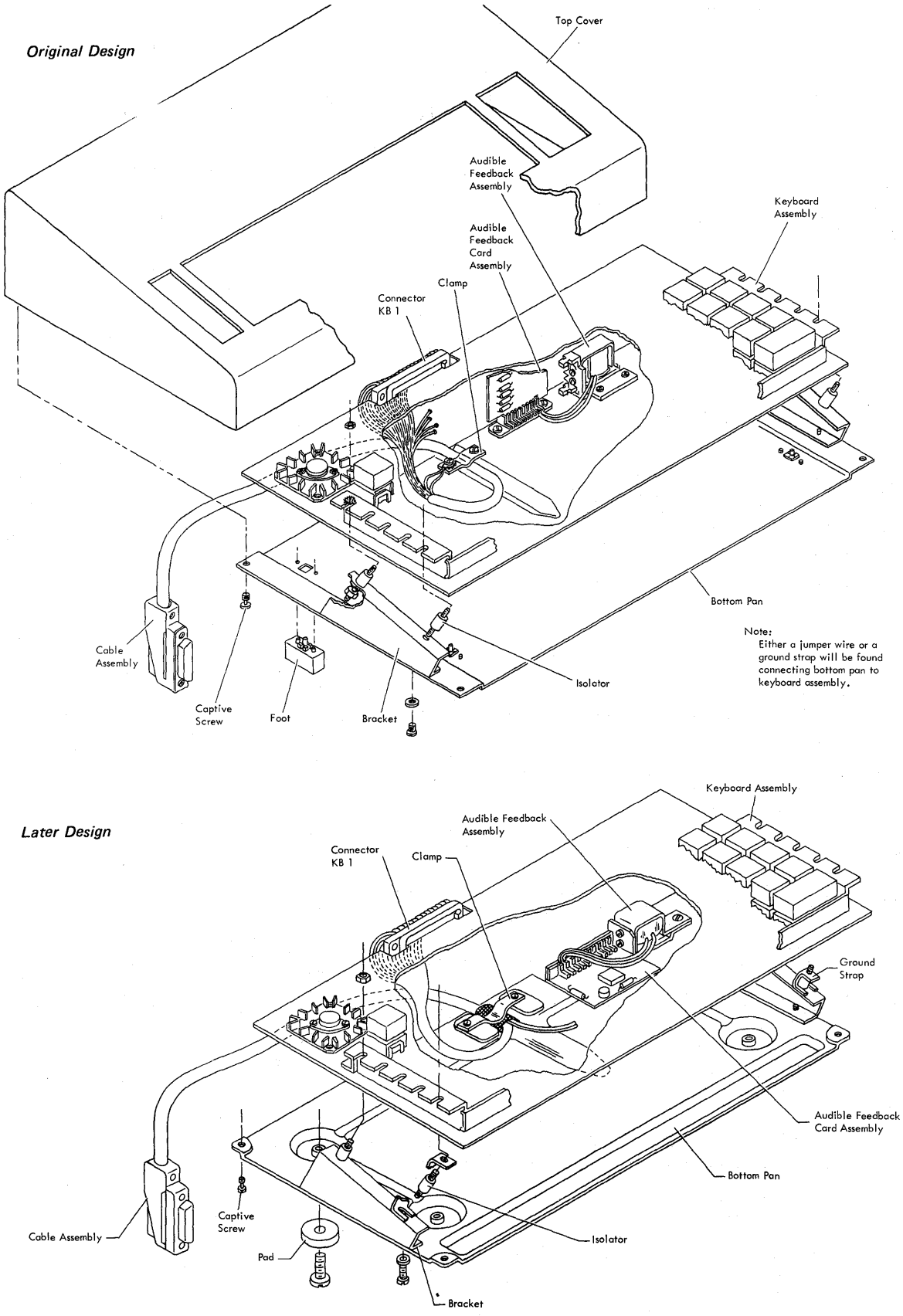
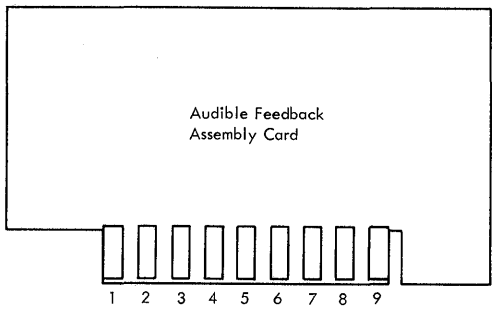


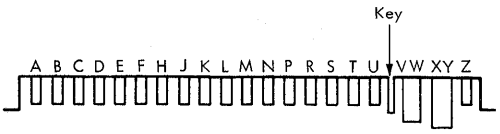
Diagram 7-7. Type A Keyboard Locations



Audible Feedback Card Pin	From/To	Function
1	* I/O Conn 10	Input Signal
2	* I/O Conn 25	+8V
3	* I/O Conn 12	Return
4	* I/O Conn 13 and KB1 Z	-12V
5	Not Used	
6	Not Used	
7	Not Used	
8	Audible Feedback Assy (White wire)	Return
9	Audible Feedback Assy (Blue wire)	-12V

* At Display Station

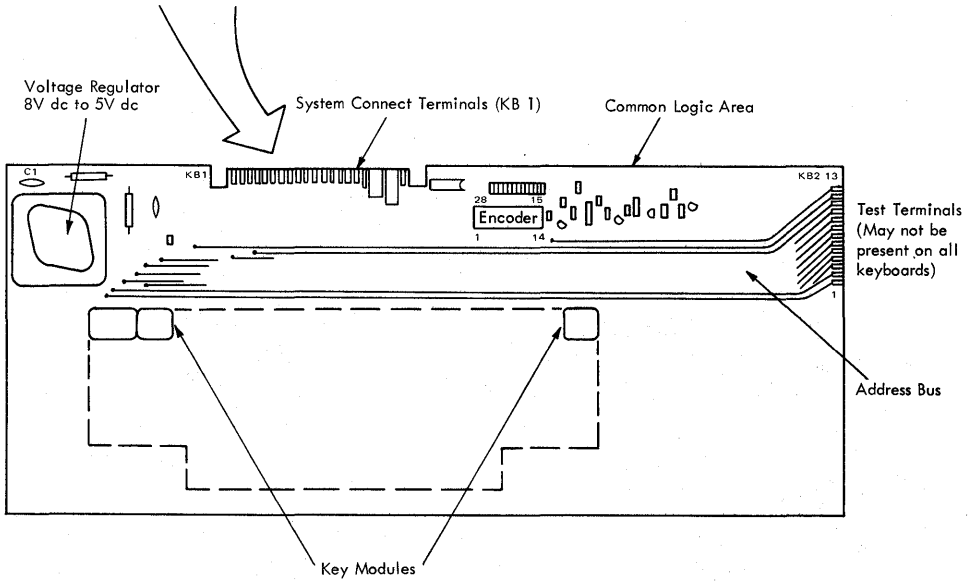
Blowup of KB1



Keyboard Signals

I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
1	D	Bit 0
2	E	Bit 1
3	F	Bit 2
4	H	Bit 3
5	J	Bit 4
6	L	Bit 6
7	M	Bit 7
8	N	Parity Bit
9	R	Strobe
10	-	Audible Feedback Signal
11	X and Y	Gnd (0V dc)
12	-	Audible Feedback Return
13	Z	-12V dc

I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
14	T	Alpha
15	U	DE Up Shift
16	S	Numeric
17	P	Flip-Flop Enable
18	K	Bit 5
19	A	Spare
20	Not Used	Not Used
21	Not Used	Not Used
22	C	Reset
23	B	Spare
24	V and W	+8V dc
25	-	Audible Feedback +8V dc



Top View

Diagram 7-8. Type A Keyboard Pin Assembly and Terminal Location

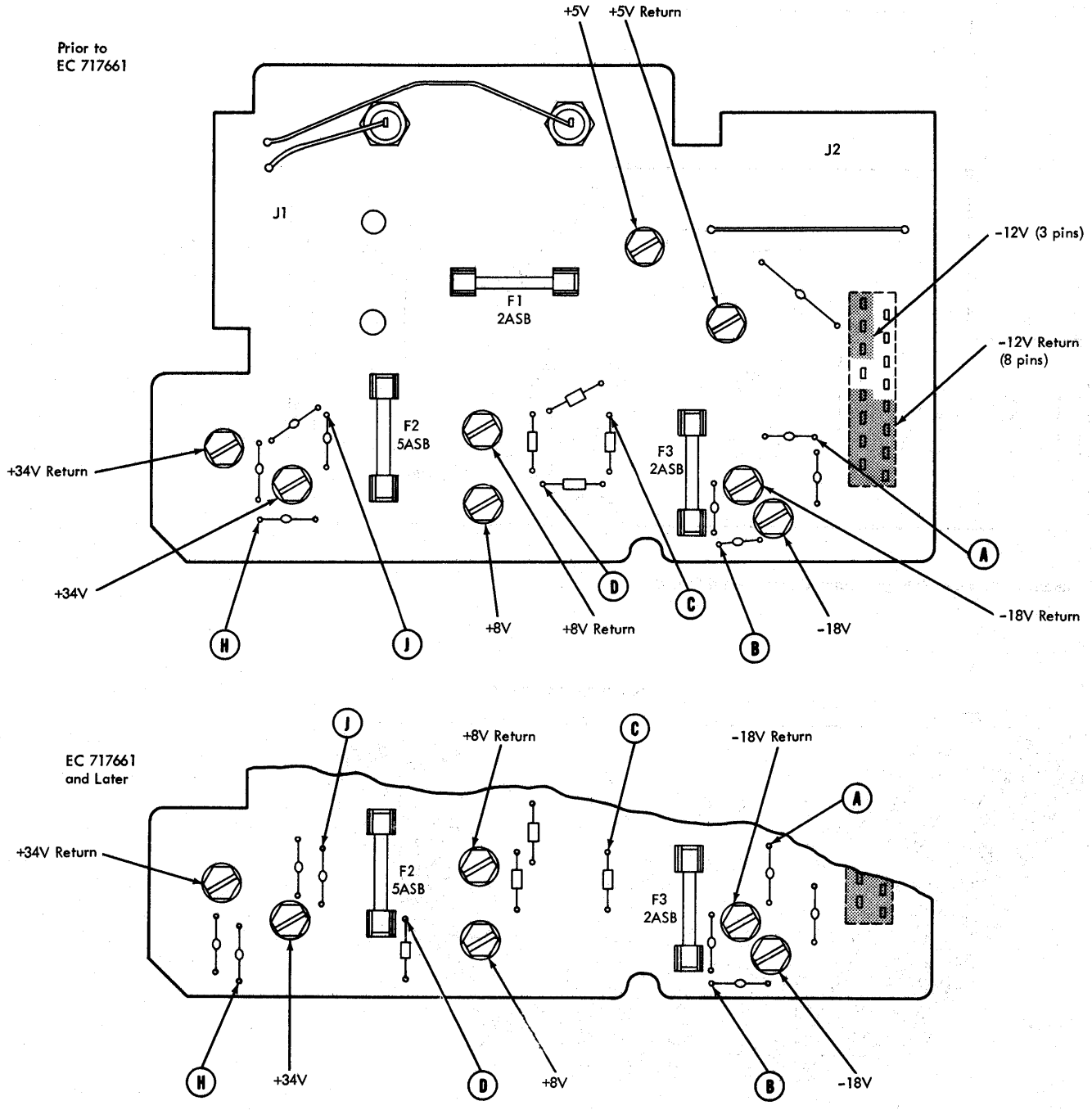


Diagram 7-9. Low-Voltage Printed Circuit Board

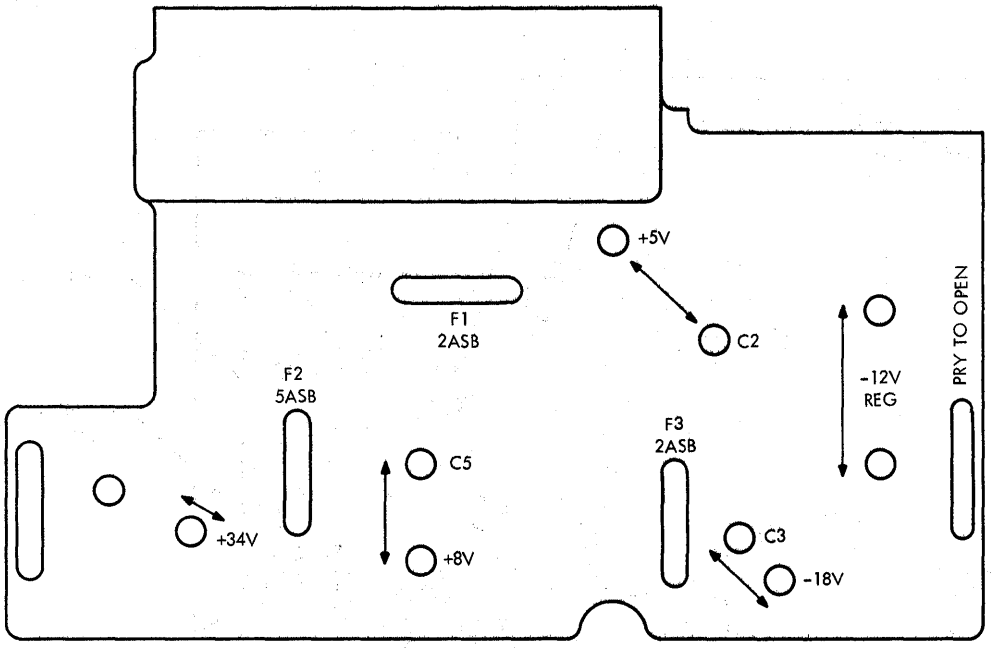


Diagram 7-10. Low-Voltage Printed Circuit Board Shield

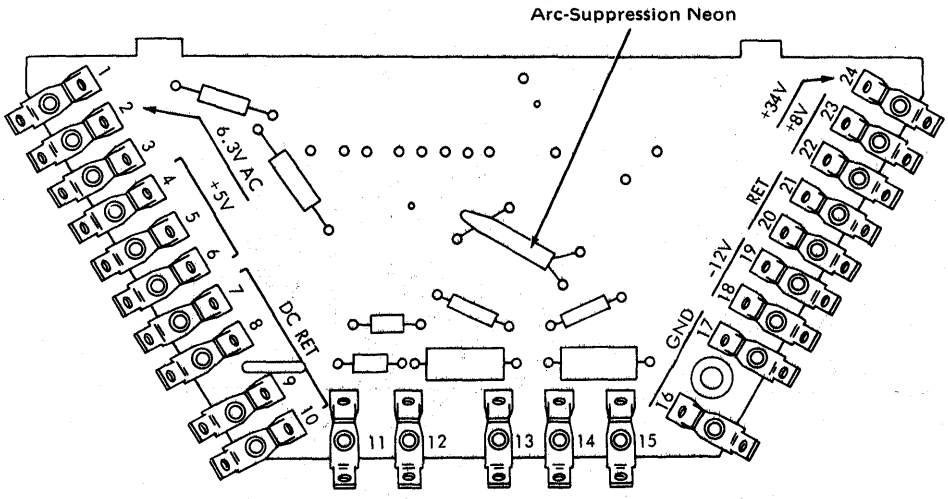
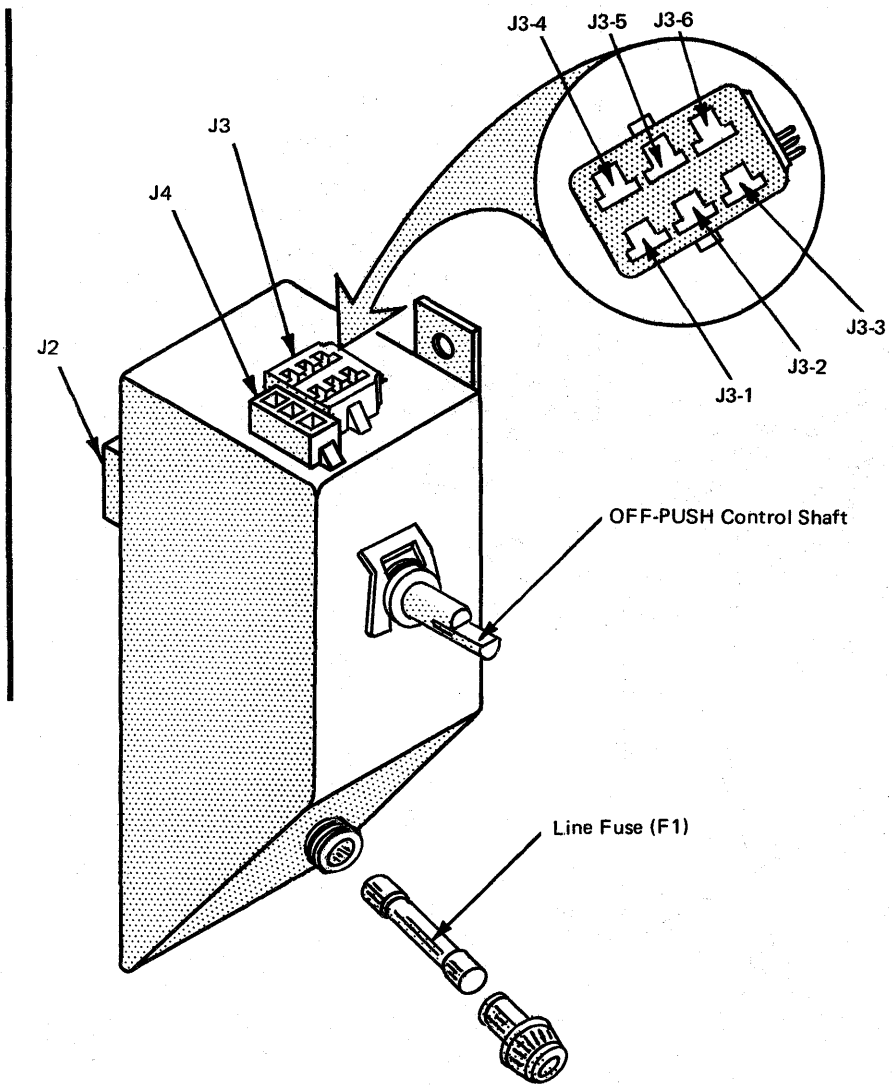


Diagram 7-11. Model 2 Voltage Distribution Board



Notes:
1. "J" denotes jack "P" denotes plug.
2. See 3277 ALDs, page ZZ011, for detailed diagram.

Diagram 7-12. Model 1 Prime Power Box

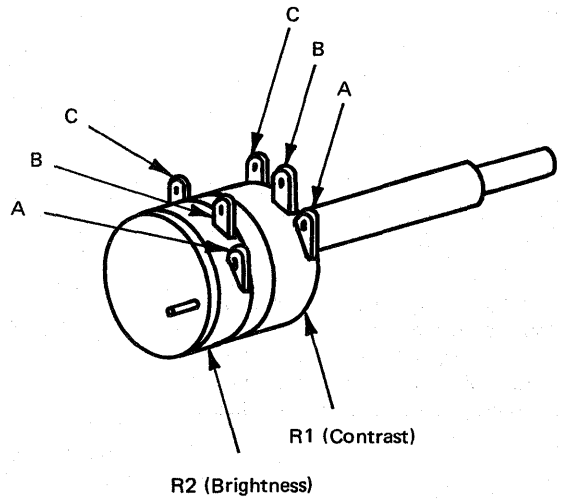


Diagram 7-13. Brightness and Contrast Control Terminals

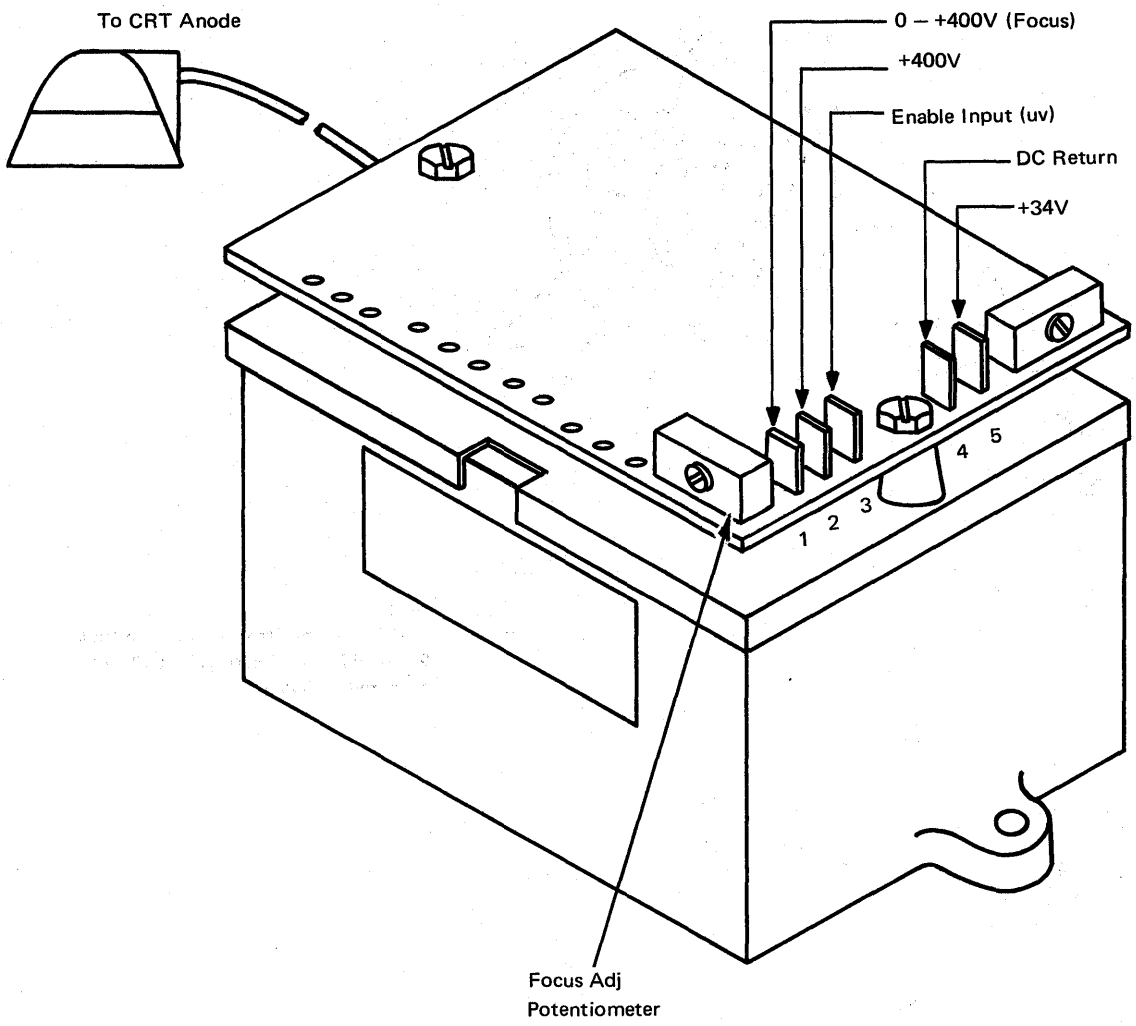
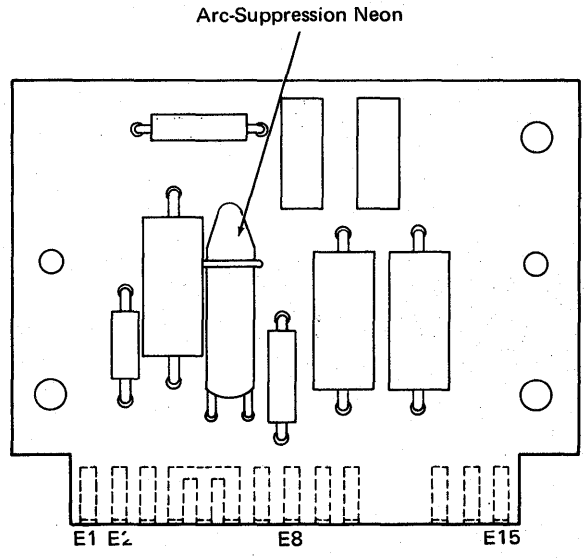


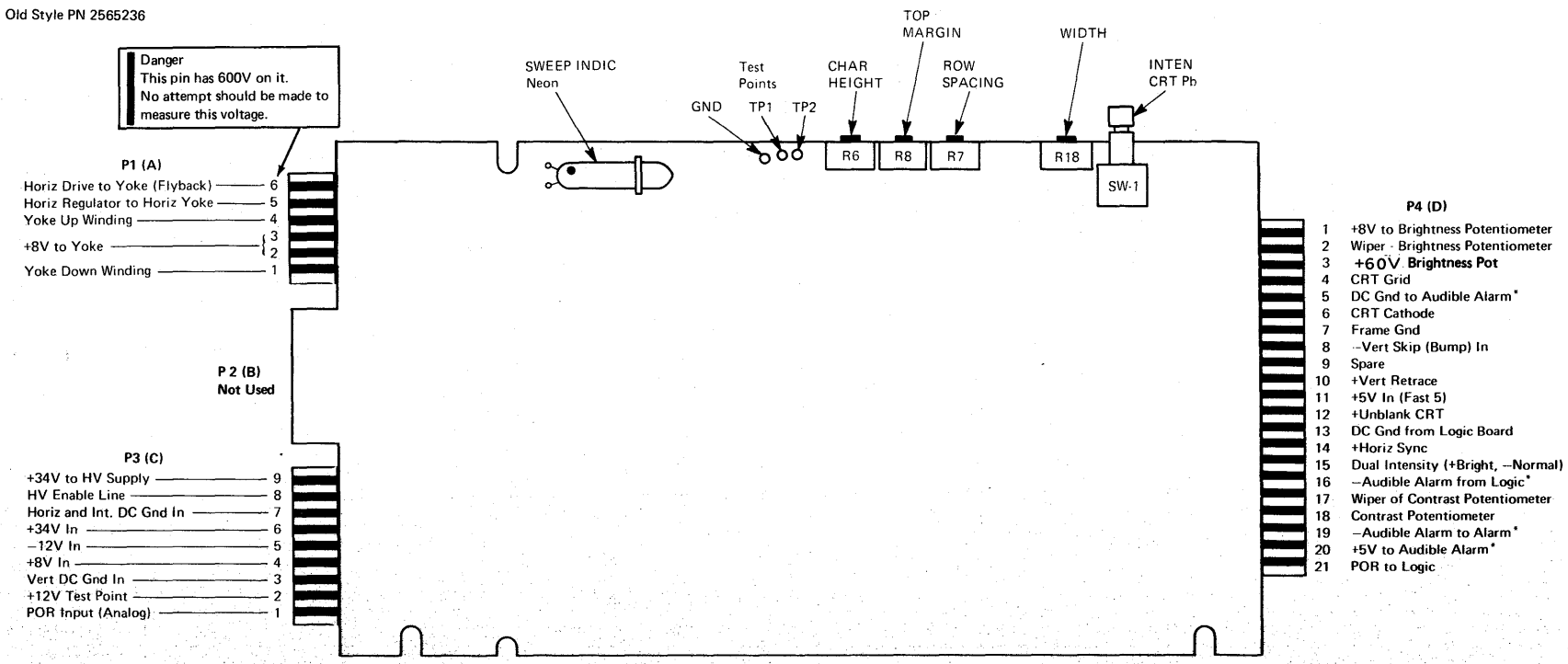
Diagram 7-14. High-Voltage Power Supply



Notes:

1. Connector pins on reverse side of board.
2. Component layout may differ from illustration, depending on part number and EC level; however, connector pins are numbered the same on all variations.

Diagram 7-15. Model 1 Arc-Suppression Board



Note: When PN 2565236 is replaced by PN 2565080 or PN 2568924, a jumper, PN 2577848 (3277 Model 1) or PN 2568928 (3277 Model 2) must be added from P4 pin 7 to frame ground.

* = Feature

Diagram 7-16. Analog Card (Sheet 1 of 2)

New Style PN2565080 and PN2568924

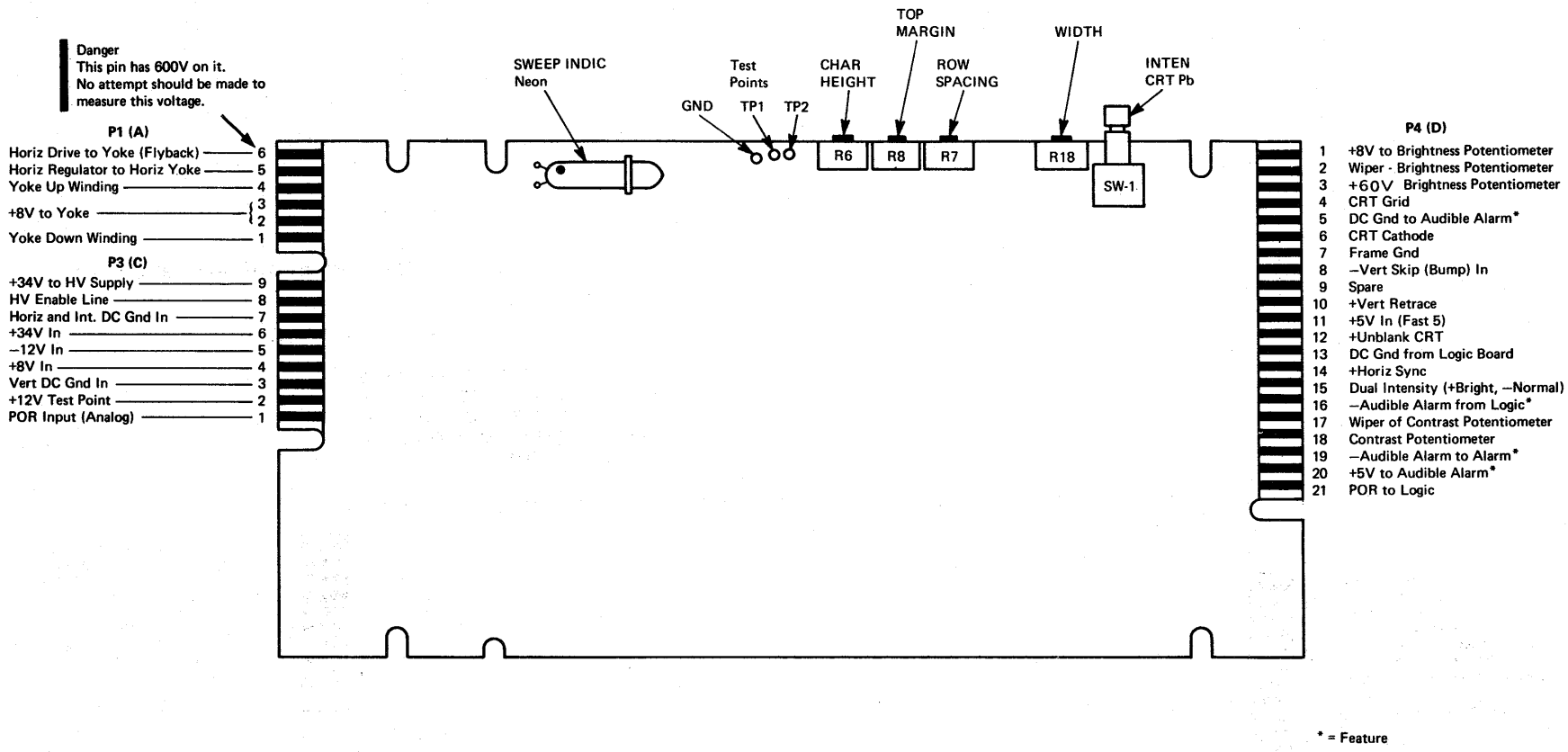


Diagram 7-16. Analog Card (Sheet 2 of 2)

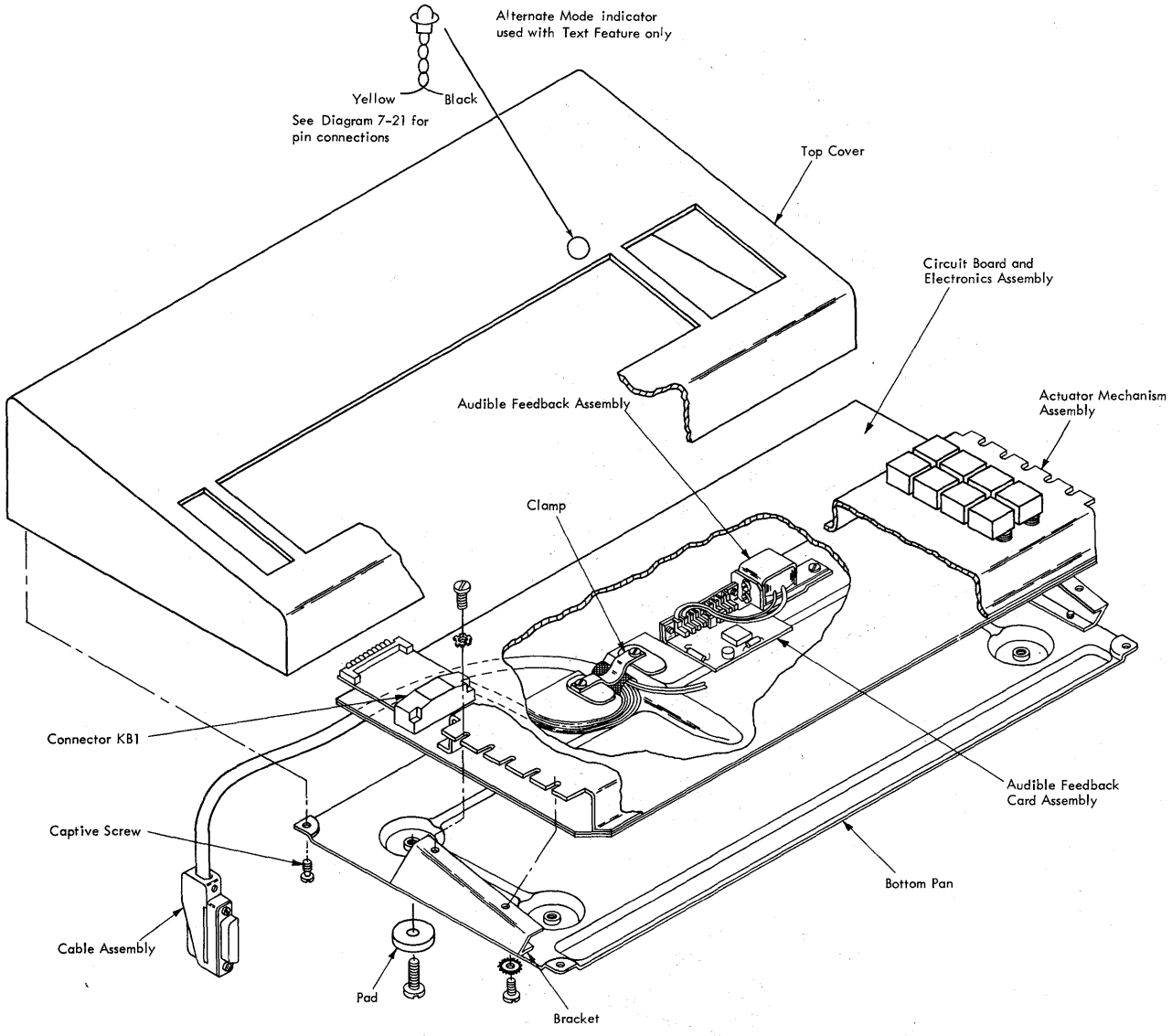


Diagram 7-17. Type B Keyboard Locations

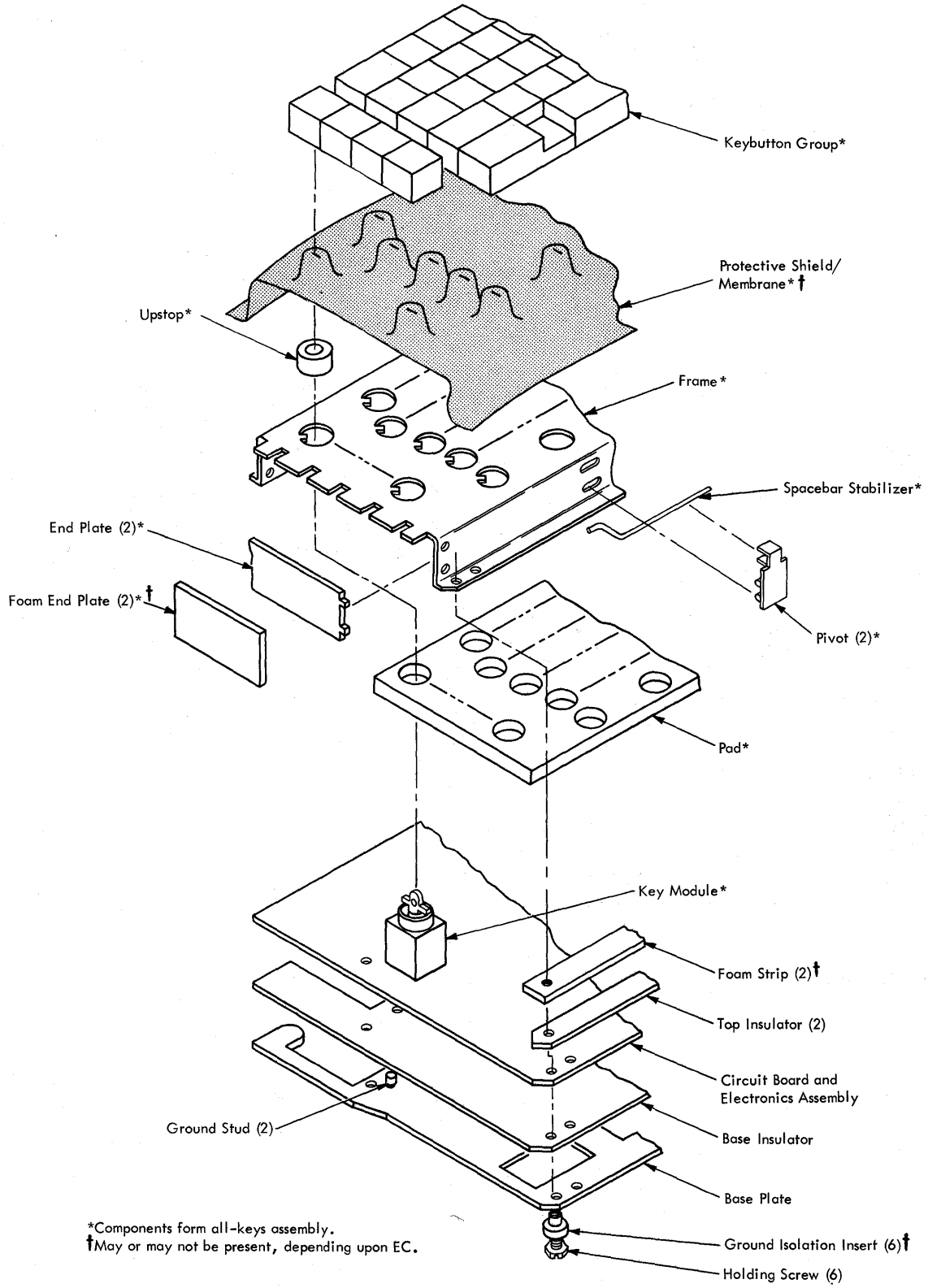
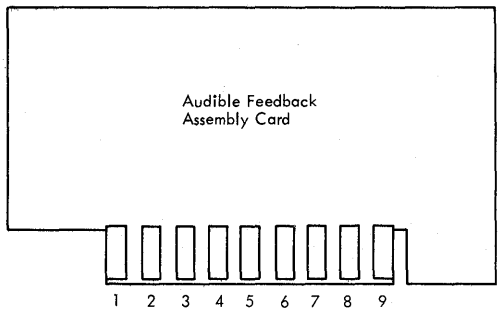


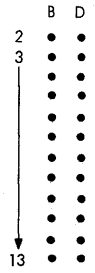
Diagram 7-18. Type B Keyboard Assembly



Audible Feedback Card Pin	From/To	Function
1	* I/O Conn 10	Input Signal
2	* I/O Conn 25	+8V
3	* I/O Conn 12	Return
4	* I/O Conn 13 and KB1 D02	-12V
5	Not Used	
6	Not Used	
7	Not Used	
8	Audible Feedback Assy (White wire)	Return
9	Audible Feedback Assy (Blue wire)	-12V

* At Display Station.

KB1 Test Points



Keyboard Signals

I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
1	B05	Bit 0
2	B06	Bit 1
3	D13	Bit 2
4	B08	Bit 3
5	B09	Bit 4
6	B13	Bit 6
7	B12	Bit 7
8	B04	Parity Bit
9	B02	Strobe
10	D10	Audible Feedback Signal
11	D08	Gnd (0V dc)
12	-	Audible Feedback Return
13	D02	-12V dc

I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
14	D05	* Alpha Shift
15	D04	** DE Up Shift
16	D06	* Numeric Shift
17	D11	KB Lockout
18	B10	Bit 5
19	D07	Spare
20	Not Used	Not Used
21	Not Used	Not Used
22	D12	Reset
23	B11	Spare
24	D03	+8V dc
25	-	Audible Feedback +8V dc

*Ground on Typewriter Keyboard
**Not used on Typewriter Keyboard

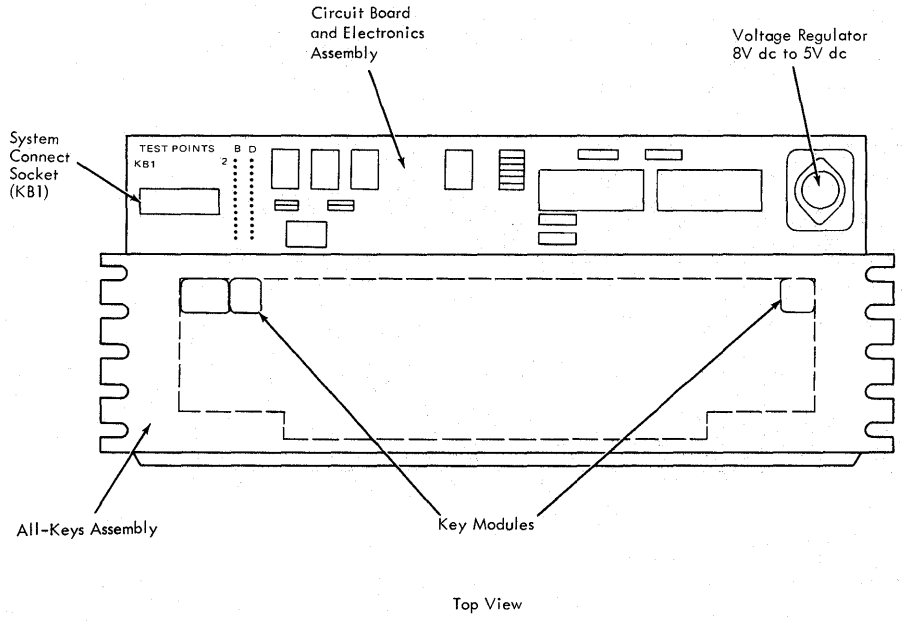
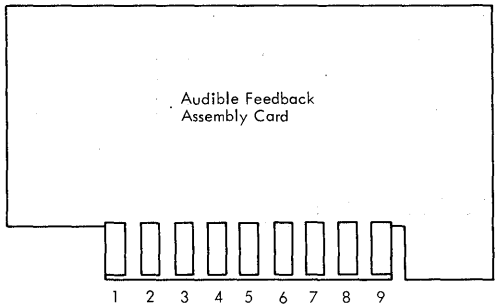
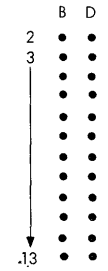


Diagram 7-19. Type B Keyboard Assembly Pin and Terminal Locations



Audible Feedback Card Pin	From/To	Function
1	* I/O Conn 10	Input Signal
2	* I/O Conn 25	+8V
3	* I/O Conn 12	Return
4	* I/O Conn 13 and KB1 D02	-12V
5	Not Used	
6	Not Used	
7	Not Used	
8	Audible Feedback Assy (White wire)	Return
9	Audible Feedback Assy (Blue wire)	-12V

* At Display Station.

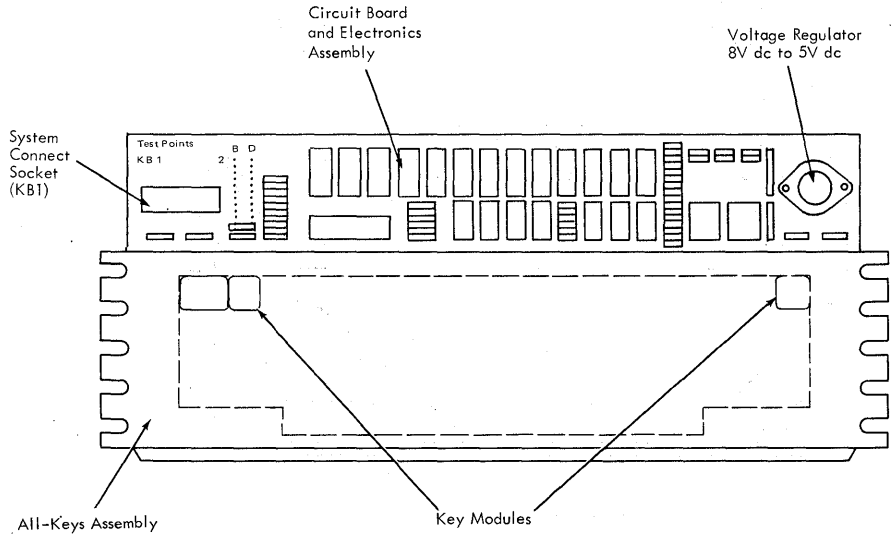


Keyboard Signals

I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
1	B05	Bit 0
2	B06	Bit 1
3	D13	Bit 2
4	B08	Bit 3
5	B09	Bit 4
6	B13	Bit 6
7	B12	Bit 7
8	B04	Parity Bit
9	B02	Strobe
10	D10	Audible Feedback Signal
11	D08	Gnd (0V dc)
12	-	Audible Feedback Return
13	D02	-12V dc

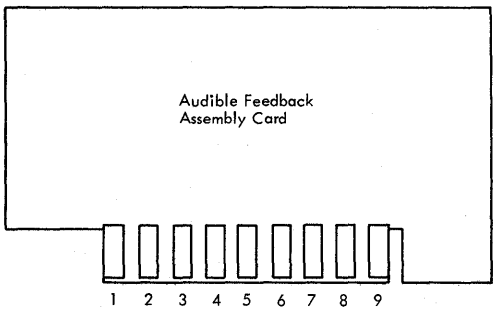
I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
14	D05	* Alpha Shift
15	D04	** DE Up Shift
16	D06	* Numeric Shift
17	D11	KB Lockout
18	B10	Bit 5
19	D07	Spare
20	Not Used	Not Used
21	Not Used	Not Used
22	D12	Reset
23	B11	Bit 8
24	D03	+8V dc
25	-	Audible Feedback +8V dc

*Ground on Typewriter Keyboard
**Not used on Typewriter Keyboard



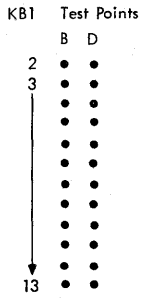
Top View

Diagram 7-20. Type B Keyboard Assembly Pin and Terminal Locations (Data Analysis – APL Feature)



Audible Feedback Card Pin	From/To	Function
1	* I/O Conn 10	Input Signal
2	* I/O Conn 25	+8V
3	* I/O Conn 12	Return
4	* I/O Conn 13 and KB1 D02	-12V
5	Not Used	
6	Not Used	
7	Not Used	
8	Audible Feedback Assy (White wire)	Return
9	Audible Feedback Assy (Blue wire)	-12V

* At Display Station.

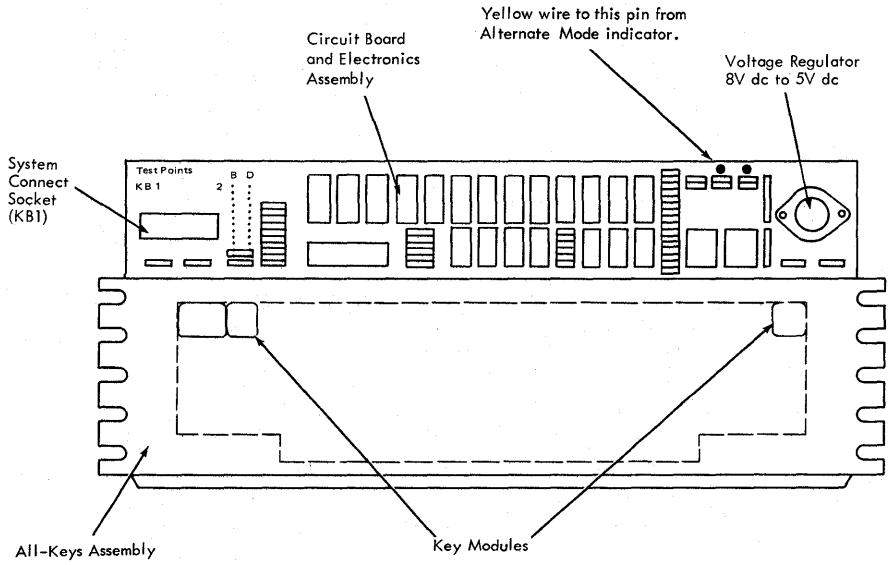


Keyboard Signals

I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
1	B05	Bit 0
2	B06	Bit 1
3	D13	Bit 2
4	B08	Bit 3
5	B09	Bit 4
6	B13	Bit 6
7	B12	Bit 7
8	B04	Parity Bit
9	B02	Strobe
10	D10	Audible Feedback Signal
11	D08	Gnd (0V dc)
12	-	Audible Feedback Return
13	D02	-12V dc

I/O Conn at Display Station	KB1 Conn at Keyboard	Signal
14	D05	* Alpha Shift
15	D04	** DE Up Shift
16	D06	* Numeric Shift
17	D11	KB Lockout
18	B10	Bit 5
19	D07	Spare
20	Not Used	Not Used
21	Not Used	Not Used
22	D12	Reset
23	B11	Bit 8
24	D03	+8V dc
25	-	Audible Feedback +8V dc

*Ground on Typewriter Keyboard
**Not used on Typewriter Keyboard



Top View

Diagram 7-21. Type B Keyboard Assembly Pin and Terminal Locations (Text Feature)

8.1 GENERAL

Carefully inspect the display station for any obvious damage as soon as it arrives on site. Check that all items listed in the bills of material are received. It is extremely important that power-source line voltage is correct and that primary power connections in the display station are correct before power is applied to the unit. Do not turn power on until the following checks are performed.

8.2 INSTALLATION

Check with the customer, and place display station in the location designated by him. If it is necessary to move a display station, observe good safety procedures.

DANGER
The 3277 Model 2 Display Station weighs about 40 kg (90 pounds). Two men should be used to move this unit. Separate the upper chassis from the lower chassis before trying to move the Model 2 display station alone. (See paragraph 5.3.2.8, steps 1–7, to separate the two chassis.)

8.2.1 Line Voltage Check

Domestic (USA) models use 115V ac (±10%), 60-Hz, single-phase line voltage. No internal adjustments are required for domestic display stations.

Important Note: A grounded power source must be used.

World Trade models use 100, 110, 123.5, 220, 235V ac, 50-Hz, single-phase, or 100V ac, 60-Hz single-phase line voltage. Check that the connections on the ferro terminal block, TB1, agree with the line voltage provided. Diagram 8-1 shows the 50-Hz TB1.

8.2.2 Feature Installation

Connect all features supplied with the display station. Proceed to paragraph 8.2.3 if no features are to be attached.

8.2.2.1 Keyboard Installation

1. Remove front cover.
2. Plug keyboard cable connector into keyboard jack. Diagrams 7-1 and 7-4 show location of cable jacks for Model 1 and Model 2 display stations, respectively.
3. Secure cable by attaching Model 1 nylon cable clamp or by hooking Model 2 I/O cable retainer. (Model 2 cable

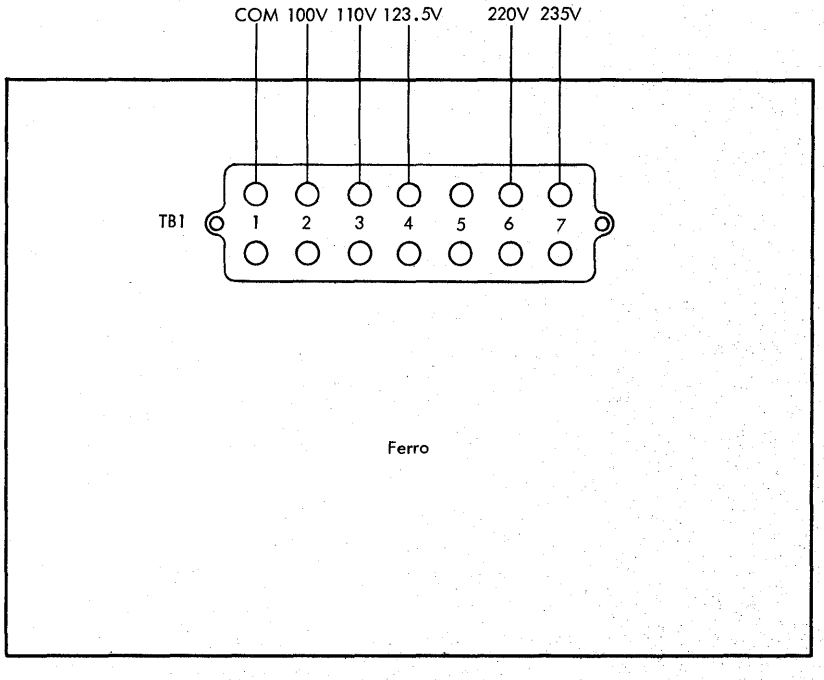


Diagram 8-1. 50-Hz Ferro TB-1

retainer may have to be repositioned to maintain a snug connector fit.)
4. Connect cable ground strap to the chassis.

8.2.2.2 Selector Light-Pen Installation

1. Place pen holder next to display station.
2. Insert pen in pen holder.

8.2.2.3 Operator Identification Card Reader Installation

1. Remove front cover.
2. Plug reader cable connector into reader jack. (Diagrams 7-1 and 7-4 show cable socket locations for Model 1 and Model 2 display stations, respectively.)
3. Secure cable by attaching nylon cable clamp (Model 1) or by hooking the cable retainer (Model 2).
4. Connect cable ground strap to chassis.
5. Attach correct WTC language feature label over English language label if applicable.

8.2.3 Prepower-On Checks

1. Remove front cover if it was not previously removed to install feature(s).
2. Plug line cord into display station chassis jack.
3. Open side covers.
4. Inspect for loose cords in logic gate and for loose cable connections.

8.2.4 Power-On Checks

1. Plug line cord into power source, and pull out OFF-PUSH switch.
2. Perform the display station operational test described in paragraph 5.1.2, beginning at step 3.
3. Refer to Section 3 (Symptom Index) if a malfunction occurs during power-on check procedure.
4. Refer to paragraph 5.2 if any adjustments are required during power-on check.
5. Connect control unit signal cable.
6. Replace all covers previously removed except front cover.

8.2.5 Hexadecimal Address Label

1. On front cover, locate a point 76.2 mm (3 inches) up from bottom edge and 12.7 mm (1/2 inch) in from left edge.
2. Attach label to cover, parallel to bottom edge, with lower-left corner of label on the point located in step 1.
3. Replace front cover.

Appendix A. Offline Selector Light-Pen Test

This appendix contains offline procedures for formatting the buffer and for testing the selector light-pen feature. The procedures are used for 3277 Display Stations attached to 3274 Control Units.

1. Take the display station offline by removing the signal cable at the display station.
2. Press the CLEAR key, then the RESET key.
3. Move the cursor four positions to the right using the cursor move keys (do not use the space bar).
4. Type in >SEL PEN/UNPROT.
5. Move cursor four additional positions to the right using the cursor move keys (do not use the space bar).
6. Type in ?SEL PEN/PROT.
7. Move cursor to the next row using the cursor move keys.
8. Move cursor four positions to the right using the cursor move keys (do not use the space bar).
9. Press space bar and type SEL PEN/UNPROT.
10. Move cursor six positions to the right using the cursor move keys.
11. Type in NUM/UNPROT.
12. On board 01A A1, install jumpers from C2S03 to ground and from C2B08 to ground.
13. Cursor should now be located one position after the NUM/PROT field. Type in a space (i.e., press the space bar).
14. Using the cursor move keys only, move the cursor backward to the first position to the left of the NUM/UNPROT field.
15. Type in the character & (will not be displayed).
16. Using the cursor move keys only, move the cursor backward to two positions to the left of the third SEL PEN field (SEL PEN/UNPROT).
17. Type in the letter D (will not be displayed).
18. Move the cursor backward to the left of the ? using the cursor move keys.
19. Type in the letter Y (will not be displayed).
20. Move cursor to the left of the > using the cursor move keys.
21. Type in the letter D (will not be displayed).
22. Remove the jumper from C2B08 to ground.

The screen is now formatted as follows:

>SEL PEN/UNPROT field is normal intensity, selector pen detectable, and unprotected.

?SEL PEN/PROT field is high intensity, selector pen detectable, and protected.

SEL PEN/UNPROT field is normal intensity, selector pen detectable, and unprotected with a 'space' as the designator character.

NUM/UNPROT field is numeric, unprotected, and nonselector pen detectable.

Field from the NUM/UNPROT to the end of screen is unprotected, alphameric, normal intensity, and non-selector pen detectable.

If the selector light-pen feature is installed, detection of the > should change the designator character to a ? and vice-versa in either the first or second selector pen fields.

A successful detect on the third selector pen field (SEL PEN/UNPROT) will cause the Input Inhibited indicator to turn on. Press the RESET key to turn off the Input Inhibit condition.

Attempted keyboard entry into the high intensity field will cause the Input Inhibited indicator to turn on. Press the RESET key to turn off the Input Inhibit condition.

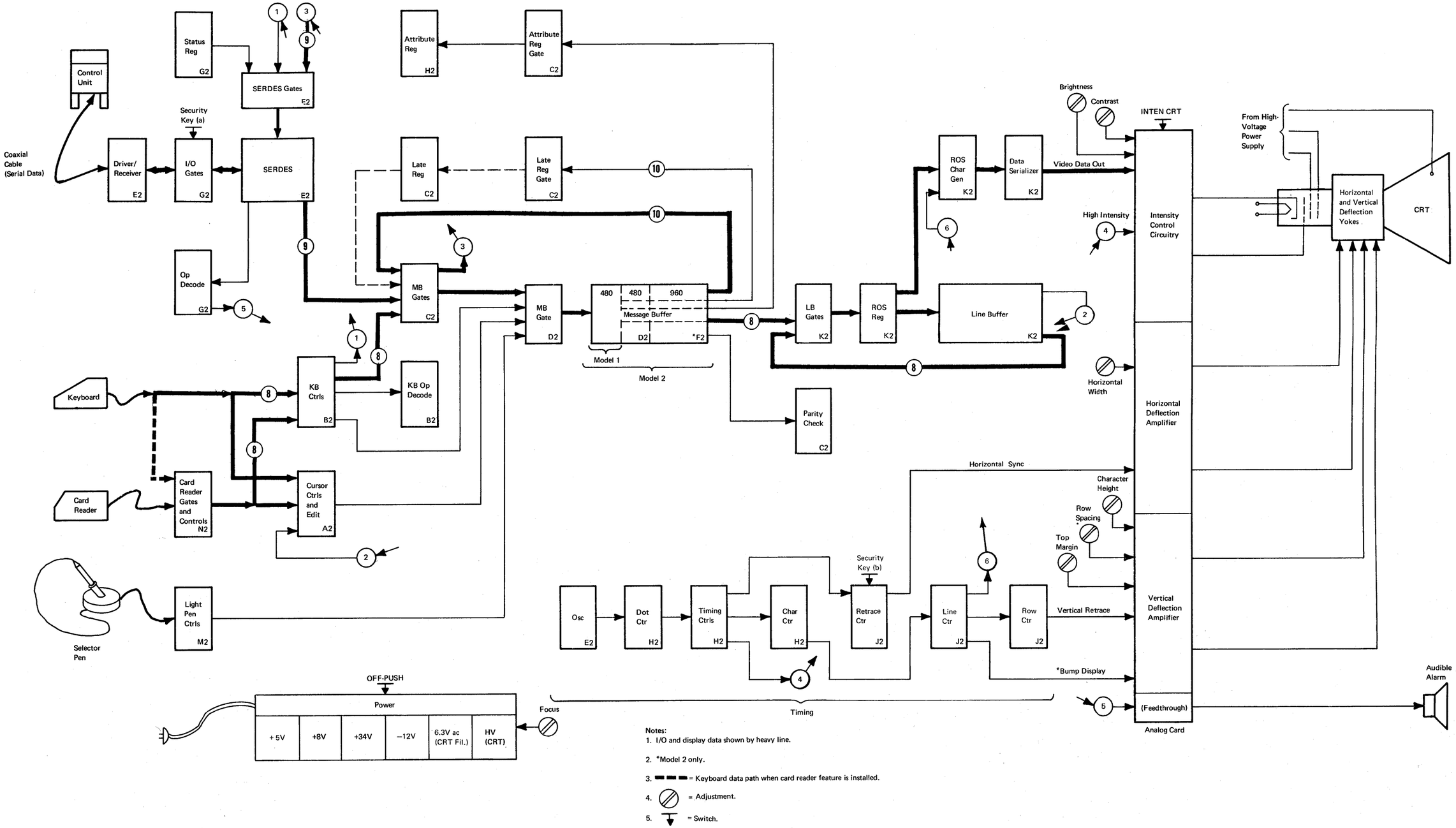
Attempted entry of alphabetic characters into the NUM/UNPROT field with numeric lock feature installed should cause the Input Inhibited indicator to turn on. Press the RESET key to turn off the Input Inhibit condition.

Notes:

1. If the above tests fail and the buffer attributes are suspected, they can be displayed by jumpering 01A A1H2D07 to ground.
2. If a problem is discovered while performing this test, refer to Symptom Index or Troubleshooting Diagrams to resolve the problem.
3. The dual intensity fields can be used when performing contrast adjustments.

CAUTION

When you have completed the offline tests, remove all test jumpers before reconnecting the signal cable to the display station.



Notes:
1. I/O and display data shown by heavy line.
2. *Model 2 only.
3. ▬ ▬ ▬ = Keyboard data path when card reader feature is installed.
4. ⊘ = Adjustment.
5. ⊤ = Switch.

Diagram 6-23. Data Flow

AC Capacitor Removal 5-10
Address Label 8-2
Addresses, Control Units and Display Stations 2-12
Adjustments:
  Analog Card 5-7
  Brightness 5-7
  Contrast 5-7
  Display Image 5-6
  Focus 5-7
  General 5-6
  Magnetic Centering Rings 5-7
  Power Control Switch 5-8, 5-9 (Diag 5-1)
  Yoke 5-7
  -12V Regulator Card 5-8
Alarm (*see* Audible Alarm)
Alignment Mask 2-3
Analog Card:
  Adjustments 5-7
  Removal 5-13
Analog Component Removal 5-12
APL:
  Keyboard 6-4, 6-6 (Diag 6-3)
  Keyboard Assembly Pin and Terminal Locations 7-1[illegible]
  Keyboard Codes 6-11 (Diag 6-8), 6-15 (Diag 6-10), 6-16 (Diag 6-11), 6-18 (Diag 6-12)
Arc-Suppression:
  Board (Model 1) 7-12 (Diag 7-15)
  Check 5-4
  Neon 6-3
ASCII:
  Character Differences 2-12 (Diag 2-9)
  Character Generators 6-3
  Keyboard Codes 6-22 (Diag 6-15)
  Keyboards 6-4
Audible Alarm 6-2
Audible Alarm Removal 5-20
Audible Feedback Assembly Removal 5-14
Audible Response 6-2

Box in Every Character Position 3-10 (Diag 3-14)
Brightness Adjustment 5-7
Brightness and Contrast Control:
  Removal 5-13
  Terminals 7-11 (Diag 7-13)

Card Reader (*see* Operator Identification Card Reader)
Centering Rings (*see* Magnetic Centering Rings)
Character Height 3-9 (Diag 3-8)
Character Height Adjustment 5-8
Checks:
  Keyboard 5-5
  Operational 5-1, 5-2
  Voltage 5-3, 8-1
Circuit Board and Electronics Assembly (Type B) 5-19 (Diag 5-12)
Codes, Keyboard 5-6, 6-3, 6-9 (Diag 6-7)
Component Locations:
  Discussion 7-1
  Display Station, Model 1:
    Front View 7-1 (Diag 7-1)
    Left-Side View 7-2 (Diag 7-2)
    Rear View 7-3 (Diag 7-3)
  Display Station, Model 2:
    Front View 7-4 (Diag 7-4)
    Left-Side View 7-6 (Diag 7-6)
    Right-Side View 7-5 (Diag 7-5)
  Keyboard:
    Type A 7-7 (Diag 7-7), 7-8 (Diag 7-8)
    Type B 7-15 (Diag 7-17), 7-16 (Diag 7-18), 7-17 (Diag 7-19)
Component Replacement (See removal entry for desired component.)
Contrast Adjustment 5-7
Control Unit Addresses 2-12
Controls:
  External 6-1
  Internal 6-2
Cover Removal:
  Display Station 5-9
  Keyboard 5-14
CRT:
  Glow 3-9 (Diag 3-9)
  Removal 5-12
Cursor in Every Row 3-10 (Diag 3-13)

Data Flow FO-1
Date Code, Keyboard 5-6
Diagnostic Programs 1-1, 2-3
Display Image Adjustment 5-6
Display Station Addresses 2-12
Display Station Test:
  Test Pattern 1 5-1
  Without Test Pattern 1 5-2

EBCDIC Keyboard Codes 6-3, 6-9 (Diag 6-7)
Encoding, Keyboard (Type A) 5-5, 6-26 (Diag 6-19)
External Controls 6-1
External Indicators 6-1 (Diag 6-1), 6-1

Failure Isolation 1-1
Feature Installation 8-1
Ferro Transformer:
  Removal 5-10
  50-Hz TB-1 8-1 (Diag 8-1)
Field Replaceable Units (FRU) 1-1
Focus Adjustment 5-7
Focus Problem 3-10 (Diag 3-18)
Fuse Removal 5-11

General Logic Probe 2-2 (Diag 2-1)
Glow on CRT 3-9 (Diag 3-9)

Hexadecimal Address Label 8-2
High-Voltage Check 5-4, 5-5
High-Voltage Power Supply 7-12 (Diag 7-14)
High-Voltage Power Supply Removal 5-11
Horizontal Sync Problem 3-10 (Diag 3-15)
Horizontal Width Adjustment 5-7

Image Out of Focus 3-10 (Diag 3-18)
Image Size (*see* Analog Card Adjustments)
Indicators:
  External 6-2
  Internal 6-3
Installation:
  Component (See removal entry for desired component.)
  Features 8-1
  Keyboard 8-1
  Operator Identification Card Reader 8-2
  Selector Light Pen 8-2
Intermittent Problems 3-2
Internal Controls 6-2
Internal Indicator 6-3

Jumper, Keyboard Feature 6-26 (Diag 6-18)

Key Module and Encoding (Type A) 5-5, 6-26 (Diag 6-19)
Keyboard:
  Audible Response 6-2
  Character Codes:
    APL 6-11 (Diag 6-8), 6-15 (Diag 6-10), 6-16 (Diag 6-11), 6-18 (Diag 6-12)
    ASCII and WTC Languages 6-22 (Diags 6-14, 6-15)
    Data Entry Keyboards 6-10
    Text Feature 6-5
    Typewriter and Operator Console 6-9
  Checks 5-5
  Component Locations:
    Type A 7-7 (Diag 7-7), 7-8 (Diag 7-8)
    Type B 7-15 (Diag 7-17), 7-16 (Diag 7-18), 7-17 (Diag 7-19)
  Component Removal 5-14
  Cover Removal 5-14
  Date Code 5-5
  Descriptions 5-5
  Feature Jumpers 6-26 (Diag 6-18)
  Installation 8-1
  Output Codes 5-6
  Removal from Display Station 5-14
  Return 5-5
  Strobe Check (Type A) 5-5
  Switch Module Removal (Type A) 5-15
  Tests 5-1
  Voltage Checks 5-5
Keyboards:
  APL – US 6-4, 6-6 (Diag 6-3)
  ASCII 6-4
  Data Entry 6-3, 6-7 (Diag 6-5)
  Operator Console 6-3, 6-7 (Diag 6-4)
  Text Feature 6-8 (Diag 6-6)
  Typewriter 6-3, 6-6 (Diag 6-2)
Keybutton Removal 5-15
Keybutton Support Module Removal (Type A) 5-17

Light Pen (*see* Selector Light-Pen)
Line on CRT 3-9 (Diag 3-10)
Line Voltage Check 8-1
Linearity Adjustment 5-8
Locations (*see* Component Locations)
Logic Board:
  Layout 6-27 (Diag 6-20), 6-28 (Diag 6-21), 6-29 (Diag 6-22)
  Removal 5-14
Logic Card:
  Data 6-23 (Diag 6-16)
  Removal 5-14
Logic Probe 2-1
Low-Voltage DC Checks 5-3
Low-Voltage Power Supply Removal 5-10
Low-Voltage Printed Circuit Board 7-9 (Diag 7-9)
Low-Voltage Printed Circuit Board Shield 7-10 (Diag 7-10)

Magnetic Centering Ring Adjustment 3-9 (Diag 3-7), 5-7
Maintenance Approach 1-2 (Diag 1-1)

No Horizontal Sync 3-10 (Diag 3-15)
No Interrow Spacing 3-10 (Diag 3-16)

Offline Selector Light-Pen Test A-1
Offline Maintenance 1-1
OFF-PUSH Switch Adjustment 5-8, 5-9 (Diag 5-1)
OLTs 2-3, 2-13
Online Maintenance 1-1
Operator Identification Card Reader:
  Installation 8-2
  Removal 5-21
  Test Card 2-3
  Tests 5-2
Oscilloscope 2-1
Out of Focus Image 3-10 (Diag 3-18)

Pin and Terminal Locations:
  Type A Keyboard 7-8 (Diag 7-8)
  Type B Keyboard 7-17 (Diag 7-19), 7-18 (Diag 7-20) 7-19 (Diag 7-21)
Pin Identification Data 6-29 (Diag 6-22)
Power Component Removal 5-10
Power Control Switch:
  Adjustment 5-8, 5-9 (Diag 5-1)
  Description 6-1
  Removal 5-14
Prime Power Box Removal:
  Model 1 5-10, 7-11 (Diag 7-12)
  Model 2 5-10
Probe Pin Data 6-25 (Diag 6-17)

Raster:
  Model 1 3-9 (Diag 3-11)
  Model 2 3-9 (Diag 3-12)
Regulator Card Adjustment (*see* -12V Regulator Card Adjustment)
Removal:
  Analog Components 5-12
  Audible Alarm 5-20
  Audible Feedback Assembly 5-14
  Brightness and Contrast Controls 5-13
  Covers 5-9
  CRT 5-12
  Keyboard from Display Station 5-14
  Keyboard Components 5-14
  Keybutton 5-15
  Logic Components 5-14
  Operator Identification Card Reader 5-21
  Power Components 5-10
  Power Control Switch 5-14
  Security Keylock 5-20
  Selector Light-Pen 5-21
  Yoke 5-13
Replacement, Component (See removal entry for desired component.)
Requesting RFTs 2-12
RFTs 2-3
Row Spacing Adjustment 5-8
Row Spacing Problem 3-10 (Diag 3-16)

Scan Lines 3-10 (Diag 3-17)
Security Keylock:
  General 6-1
  Removal 5-20
  Tests 5-1
Selector Light Pen:
  General 6-1
  Installation 8-2
  Removal 5-20
  Tests 5-2
Shift Key Module Check 5-6
Size, Image (*see* Analog Card Adjustments)
Spacebar Assembly:
  Checks 5-6
  Removal:
    Type A 5-17
    Type B 5-20
Strobe Check, Keyboard (Type A) 5-5
Symptom Index 1-1, 3-1, 3-3
Symptoms 1-2

Test Card 2-3
Test Pattern APL Keyboard 2-4, 2-11 (Diag 2-8)
Test Pattern ID Numbers 2-12 (Diag 2-10)
Test Pattern 1 2-4, 2-5 (Diag 2-4), 3-8 (Diags 3-1, 3-2)
Test Pattern 2 2-4, 2-7 (Diag 2-5), 3-8 (Diag 3-3)
Test Pattern 3 2-4, 2-8 (Diag 2-6), 3-8 (Diag 3-4)
Test Pattern 5 2-4, 2-9 (Diag 2-7)
Test Patterns 2-3
Tests:
  Keyboard 5-1
  Operator Identification Card Reader 5-2
  Security Keylock 5-1
  Selector Light Pen 5-2
Text Feature:
  Keyboard 6-8 (Diag 6-6)
  Keyboard Assembly Pin and Terminal Locations 7-19 (Diag 7-21)
  Keyboard Codes 6-13 (Diag 6-9), 6-20 (Diag 6-13)
Tools 1-1, 2-1
Top Margin Adjustment 5-8
Trouble Analysis 1-1
Troubleshooting Diagram Usage 4-1
Troubleshooting Diagrams 1-1, 4-3 through 4-31
Type A Keyboard:
  Description 5-5
  Locations 7-7 (Diag 7-7), 7-8 (Diag 7-8)
Type B Keyboard:
  Assembly 7-16 (Diag 7-18)
  Description 5-5
  Locations 7-15 (Diag 7-17), 7-16 (Diag 7-18), 7-17 (Diag 7-19), 7-18 (Diag 7-20), 7-19 (Diag 7-21)

Voltage Checks:
  Arc Suppression 5-4
  General 5-3
  High Voltage 5-4
  Keyboard 5-5
  Low Voltage 5-3
  6.3V AC 5-4
Voltage Distribution Board 7-10 (Diag 7-11)

Width Adjustment (*see* Horizontal Width Adjustment)
WTC Languages:
  Character Differences 2-12 (Diag 2-9)
  Keyboard Codes 6-22 (Diags 6-14, 6-15)

Yoke:
  Adjustment 5-7
  Problems 3-8 (Diags 3-5, 3-6), 3-11 (Diags 3-19 through 3-23)
  Removal 5-13

6.3V AC Check 5-4
-12V Regulator Card:
  Adjustment 5-8
  Removal 5-10

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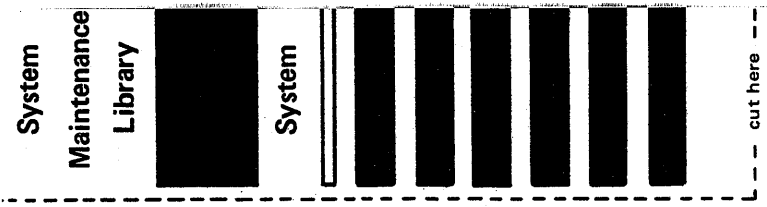

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