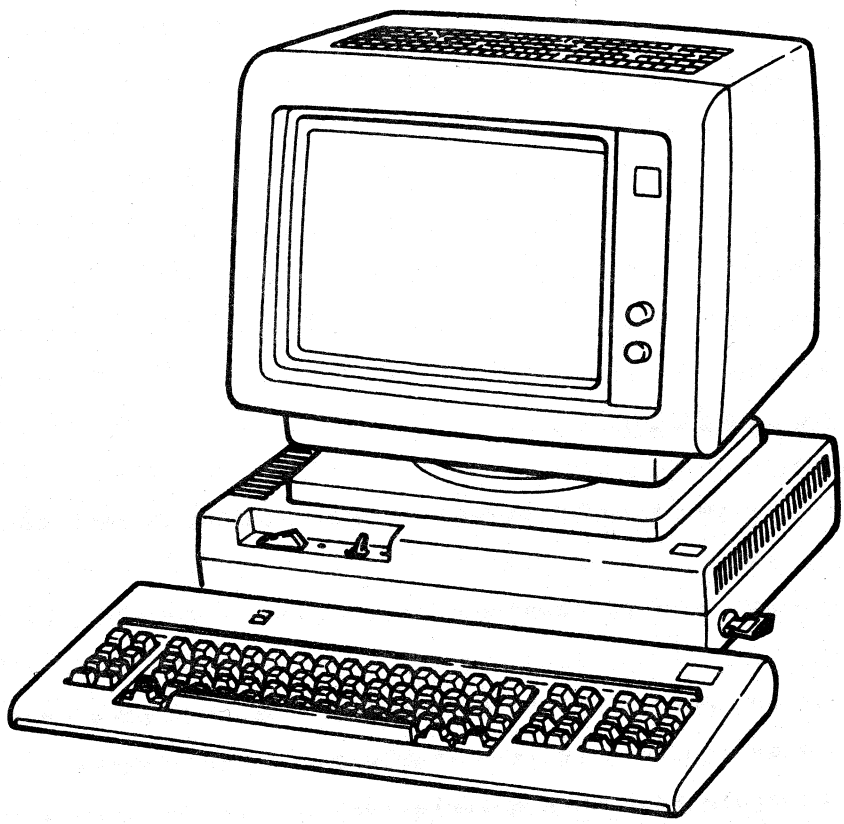
IBM

Repair Center
Maintenance
Information



3178

Display Station
Repair Center
Maintenance Information

SY18-2065-3

Fourth Edition (May, 1985)

This major revision obsoletes SY18-2065-2. Changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

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

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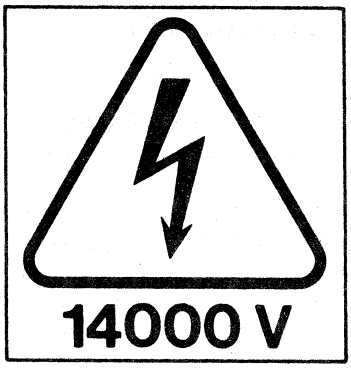
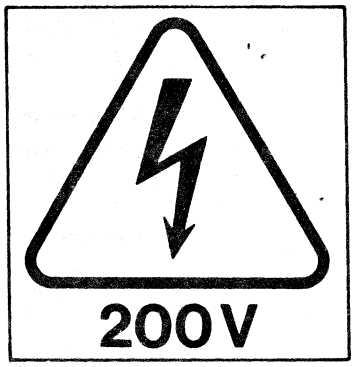
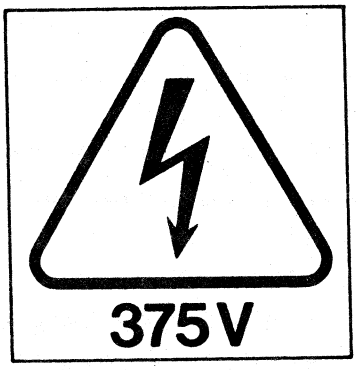
HAZARDOUS AREA LABEL

The following label may be found on the video or logic elements.







The symbol on this label means "HAZARDOUS AREA. TRAINED SERVICE PERSONNEL ONLY," and it specifies the voltage present in that work-station element.

DANGER
The areas of the analog card and video amplifier card have voltages in excess of 400 volts. Avoid working on the video element with power on. If absolutely required to have power on, use extreme caution while making any adjustments, and follow instructions in this document.

DANGER
This product is equipped with a power plug which is approved for use with this machine and meets standards for the user's safety. It is to be used with a properly grounded receptacle to avoid severe electrical shock.

DANGER
Video element must not be opened except in controlled repair center environment.

Rules for Safety

If (1) you know the safety rules for working with electrical and mechanical equipment and (2) you observe the rules, you can work safely with IBM equipment.

Do not fear electricity, but respect it.

While you are maintaining IBM equipment,
(1) observe every safety precaution possible and
(2) observe the following safety rules.

Work Environment

- Do not work alone in hazardous conditions or near equipment that has dangerous voltages. Always inform your manager if the conditions or voltages are a possible problem.
- Always look for possible hazards in your work environment. Examples of hazards are: moist floors, nongrounded extension cables, power surges, and missing safety grounds.
- Do not perform any action that makes the product unsafe or that causes hazards for the customer personnel.
- Before you start the equipment, ensure that other CSRs and customer personnel are not in a hazardous position.
- Do not wear loose clothing that can be trapped in the moving parts of a machine. Ensure that the sleeves of your clothing are fastened or are rolled above the elbow. If your hair is long, or if you wear a neck scarf, fasten it to make it safe.
- Insert your neektie into your clothing or fasten it with a clip (preferably nonconductive) at approximately 8 centimeters (3 inches) from its end.
- Lift the equipment or parts by standing or pushing up with your stronger leg muscles; this action removes the strain from the muscles in your back. Do not lift any equipment or parts that are too heavy for you.
- Put removed machine covers in a safe place while you are servicing the machine. Reinstall the covers before returning the machine to the customer.
- Always keep your CSR tool kit away from walk areas so that other persons cannot trip over it. For example, keep the kit under a desk or table.
- Observe good housekeeping practices in the area of the machines while you are performing maintenance and after completing it.
- After maintenance, reinstall all safety devices, such as guards, shields, labels, and ground wires. Exchange safety devices that are worn or defective. (**Remember**: the safety devices protect you from a hazard. You destroy their purpose if you do not reinstall them when you have completed the service call.)

Electrical Safety

- If possible, always unplug the power-supply cable before you work on a machine. When you switch off power at the wall box, lock the switch in the off position or attach a DO NOT OPERATE tag (Z229-0237) to the switch.

  Note: A non-IBM attachment to an IBM machine may be powered from another source and may be controlled by a different switch or circuit breaker.
- Switch off all power before (1) removing or assembling the main units of the equipment, (2) working near power supplies, (3) inspecting power supplies, or (4) installing changes in machine circuits.
- Unless the maintenance documents specifically instruct you, do not service the following parts with power on if the part is removed from its installed position in the machine: power supplies, pumps, blowers, motor generators, and other units with voltages that are more than 30 V ac or 42.4 V dc. (This rule ensures that correct grounding is maintained.)
- If you really need to work on equipment that has exposed live electrical circuits, observe the following precautions:

  - Ensure that another person who is familiar with the power-off controls is near you. Another person must be there to switch off the power, if necessary.

- Do not wear jewelry, chains, metal-frame eyeglasses, or other personal metal objects. (**Remember**: if the metal touches the machine, the flow of current increases because the metal is a conductor.)

- Use only insulated probe tips or extenders. (**Remember**: worn or cracked insulation is unsafe.

- Use only one hand while you are working on live equipment. Keep the other hand in your pocket or behind your back. (**Remember**: there must be a complete circuit for an electrical shock to occur. This precaution prevents your body from completing the circuit!)

- When you use a tester, set its controls correctly and use insulated probes that have the correct electrical specification.

- Do not touch objects that are grounded, such as metal floor strips, machine frames, or other conductors. Use suitable rubber mats obtained locally, if necessary.

- When you are working with machines having voltages more than 30 V ac or 42.4 V dc, observe the special safety instructions given in customer engineering memorandums (CEMs).

- Never assume: that power has been removed from a circuit. First, check that it has been removed.

- Do not touch live electrical circuits with the surface of a plastic dental mirror. (**Remember**: the surface of the dental mirror is conductive and can cause damage and personal injury.)

- If an electrical accident occurs:

  1. **Use caution; do not be a victim yourself.**

  2. **Switch off the power.**

  3. **Instruct another person to get medical aid.**

  4. **If the victim is not breathing, perform mouth-to-mouth rescue breathing. See "Electrical Accidents-First Aid" (following).**

Mechanical Safety

Do not touch mechanical parts when you are (1) lubricating a part, (2) checking for play, or (3) doing other similar work.

Safety Glasses

Wear safety glasses when:

- Using a hammer to drive pins or similar parts
- Using a power drill
- Using a spring hook to attach or remove a spring
- Soldering parts
- Cutting wire or removing steel bands
- Using solvents, chemicals, or cleaners to clean parts
- Working in any other conditions that could injure your eyes.

Tools, Testers, and Field-Use Materials

- Do not use tools and testers that have not been approved by IBM. Ensure that electrical hand tools, such as Wire-Wrap[1] tools and power drills, are inspected regularly.
- Exchange worn and broken tools and testers.
- Do not use solvents, cleaners, or oils that have not been approved by IBM.

[1]Trademark of the Gardner-Denver Co.

Summary

Prevention is the main aid to electrical safety. Always think about electrical safety and use good practice, for example:

- Ensure that the customer's power receptacle matches the IBM equipment specifications.
- Inspect power cables and plugs; check for loose, damaged, or worn parts.
- Review the procedure in the maintenance documents before you remove a part that can hold an electrical charge from the machine. Carefully discharge the necessary parts exactly as instructed by the procedure.
- Do not use a normal light (for example, a table lamp) as an extension trouble light at a machine.

Never assume that a machine or a circuit is safe. No machine is always completely safe. You may not know the exact condition of a machine because, for example:

- The power receptacles could be missing or defective.
- Safety devices or features could be missing or defective.
- The maintenance and/or changes history could be wrong or not complete.
- The design could have a problem.
- The machine could have damage, caused when it was shipped.
- The machine could have an unsafe change or attachment.
- An engineering change or a sales change could be wrongly installed.
- The machine could be deteriorated (1) because it is old or (2) because it operates in an extreme environment.
- A part could be defective, therefore causing a hazard.
- A part could be wrongly assembled.

These are some of the ways that the condition of the machine could affect safety. Before you start a service call or procedure, have good judgment and use caution.

Electrical Accidents—First Aid

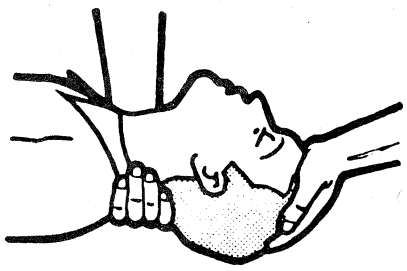
When performing rescue procedures for an electrical accident, do as follows:

- **Use Caution**: If the victim is still in contact with the electrical-current source, remove the power; to do this, you may need to operate the room emergency power-off (EPO) switch or the disconnecting switch. If you cannot find the switch, use a dry wooden rod or other nonconductive object to pull or push the victim away from contact with the electrical-current source.
- **Work Quickly**: If the victim is unconscious, he/she may need (1) mouth-to-mouth rescue breathing and possibly (2) external cardiac compression if the heart is not beating.
- **Call for the Rescue Service**: such as the ambulance or the hospital. Instruct another person to call for medical aid.

Determine if the victim needs mouth-to-mouth rescue breathing. If he/she does, perform the following steps.

CAUTION
Use extreme care when you perform rescue breathing for a victim who may have breathed-in toxic fumes. Do not breathe-in air that the victim has breathed-out.

1. Prepare for rescue breathing:
   a. Ensure that the victim's airway is open and that it is not obstructed; check the mouth for objects that may be obstructing the airway, such as chewing gum, food, dentures, or the tongue.
   b. Place the victim on his/her back, put one hand behind the victim's neck, and put the other hand on his/her forehead.
   c. Lift the neck with one hand, and tilt the head backward by pressing on the forehead with the other hand 1 .



1

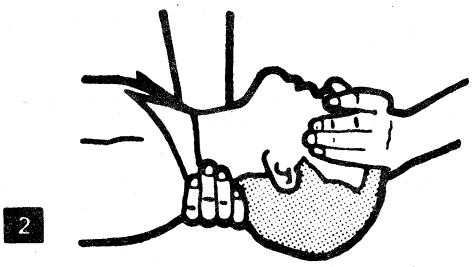
2. Look, listen, and feel to determine if the victim is breathing freely:

   a. Put your cheek near the victim's mouth and nose.

   b. Listen and feel for the breathing-out of air. At the same time, look at the victim's chest and upper abdomen to see if they move up and down.

3. If the victim is not breathing correctly:

   a. Keep the victim's head tilted backward (see 1). Continue to press on the forehead with your hand; at the same time, rotate this same hand so that you can pinch together the victim's nostrils with your thumb and finger 2



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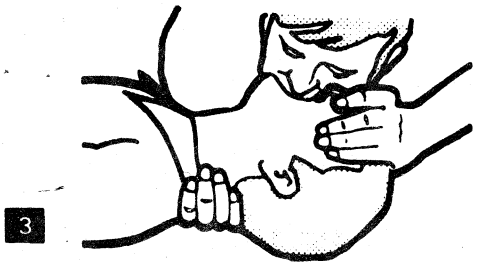
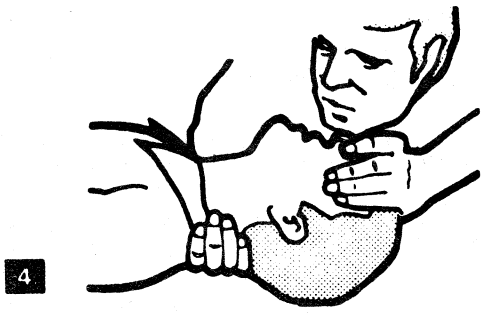
   b. Open your mouth wide and take a deep breath. Make a tight seal with your mouth around the victim's mouth 3 and blow into the victim's mouth.



3

   c. Remove your mouth to let the victim breath-out, and check that the victim's chest moves down 4



4

   d. Repeat steps b and c once every 5 seconds either until the victim breathes for himself/herself or until medical aid comes.

Reporting Accidents

Report, to your field manager, all electrical accidents, possible electrical hazards, and accidents that nearly occurred. (**Remember**: an accident that nearly occurs might be caused by a design problem; your immediate reporting ensures that the problem will be solved quickly.)

Report also all small electrical shocks. (**Remember**: a condition that causes a small shock need only differ slightly to cause serious injury.)

PREFACE

The IBM 3178 Display Station is a general-purpose terminal that consists of three work-station elements: the video element, logic element, and keyboard element. If one of the elements fails during operation, the customer will send it to the IBM repair center to be fixed. This document provides the information that the repair center customer engineer needs to analyze and repair elements returned by the customer. The reader is assumed to have a basic understanding of display stations and their relationship to a central processor.

This manual consists of the following chapters and appendixes:

Chapter 1, "Introduction" on page 1-1 gives a general description of the IBM 3178 and describes the maintenance approach.

Chapter 2, "Problem Analysis And Repair Procedures" on page 2-1 describes how to find and repair problems in the IBM 3178.

Chapter 3, "Test Procedures" on page 3-1 describes the offline and online test procedures for checking the IBM 3178. It also describes error messages that might appear during the online tests, and specifies the action to take if these error messages appear.

Chapter 4, "Removal and Replacement Procedures" on page 4-1 describes how to remove and replace field-replaceable units (FRUs).

Chapter 5, "Locations" on page 5-1 has illustrations showing where fuses, connectors, pins, labels, and other components are located. It also has tables that give pin assignments.

Chapter 6, "Tools and Test Equipments" on page 6-1 lists the tools and test equipments which are needed at each repair center.

Appendix A, "IBM 3178 Part Numbers" on page A-1 lists the part numbers of the FRUs.

Appendix B, "IBM 3178 Safety Inspection Guide" on page B-1 is to assist you identifying potentially unsafe conditions on machines that are being inspected. Each machine, as it was designed and built, had required safety items installed to protect the owners, operators and service personnel from injury. The checklist in this appendix addresses only those items.

Appendix C, "IBM 3178 Self Study Guide" on page C-1 describes how to study by yourself.

Other useful publications are:

IBM 3178 Display Station Description, GA18-2127, GN18-2214 (TNL), and GN18-2223 (TNL)

IBM 3178 Display Station Operator Reference and Problem Solving Guide, GA18-2128

CONTENTS

FIGURES

CHAPTER 1. INTRODUCTION

The IBM 3178 Display Station is a general-purpose terminal that consists of three work-station elements: the video element, logic element, and keyboard element. Figure 1-1 shows the IBM 3178 as it is for normal operation, and Figure 1-2 shows the individual work-station elements.

The IBM 3178 is available in four models. Model C1 has either a 75- or 76-key data entry keyboard, Model C2 has either an 87- or 88-key typewriter keyboard, Model C3 has an 87-key typewriter keyboard and Model C4 has an 87-key typewriter keyboard. No optional features exist.

VIDEO ELEMENT

The video element, which connects to the logic element by a cable, has an analog card and a 305-mm (12-inch) diagonal, cathode ray tube (CRT) display surface that can display up to 1920 characters (24 lines of 80 characters). The display surface also has an operator information area (line 25) that is separated from the remainder of the display image by a horizontal line.

As a convenience for the operator, the video element stand makes it possible to tilt and turn the video element.

KEYBOARD ELEMENT

The IBM 3178 keyboard element has either a 75- or 76-key data-entry or an 87- or 88-key typewriter type keyboard. Outside the area of the main keyboard are other keys with special functions. The keyboard element also has a clicker assembly.

Some of the keys are typematic, which means they will repeat their function for as long as they are held down. The typematic rate is 10 characters per second.

The keyboard element also connects to the logic element by a cable.

LOGIC ELEMENT

The logic element provides power and controls for the other elements. It has a logic board, and a power supply that generates +12 v dc, and +5 V dc. It also has fuses to protect the circuits from being overloaded, and cable connections for the video element, keyboard element, and a communication interface.

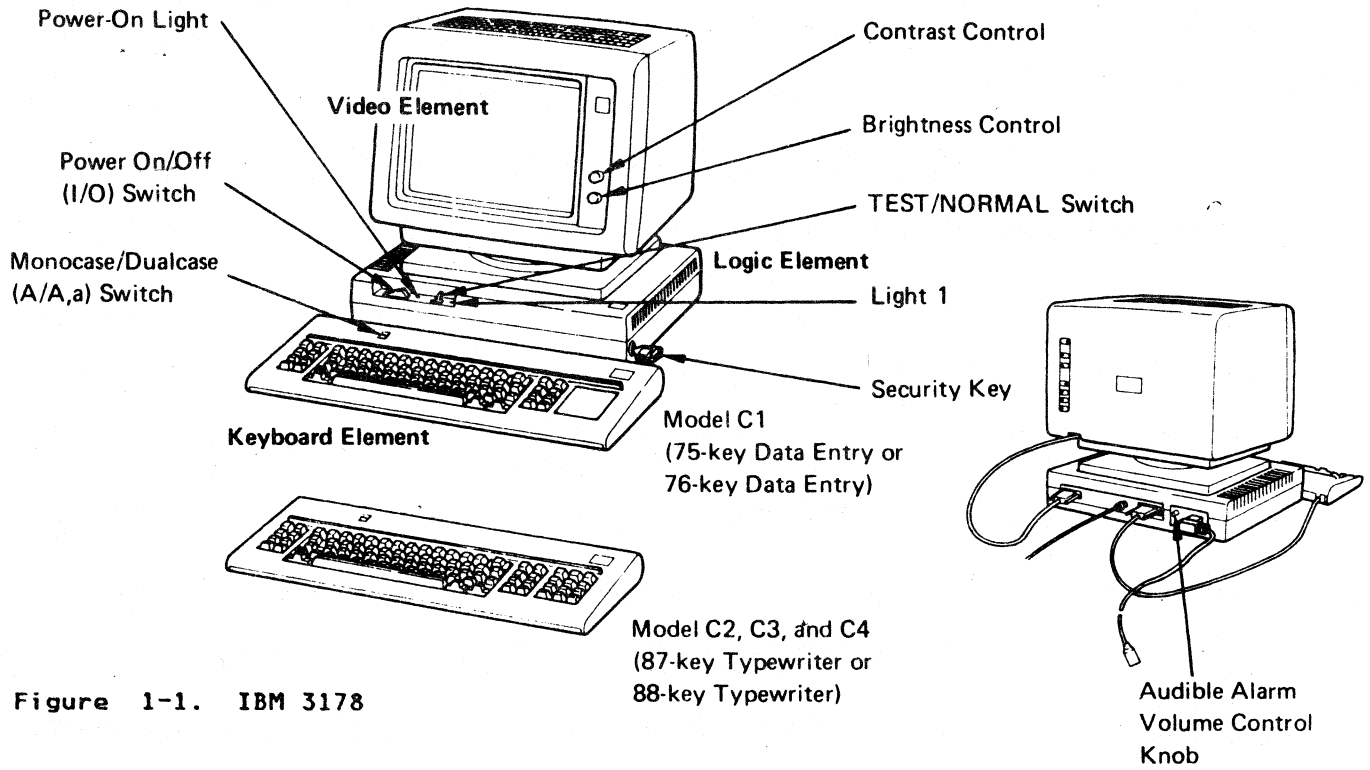
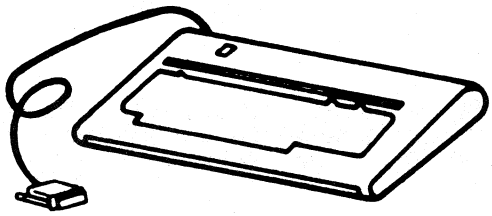
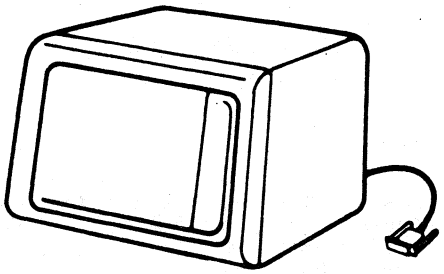


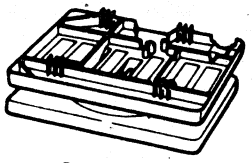
Figure 1-1. IBM 3178



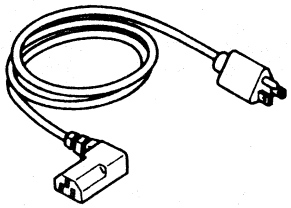
Keyboard Element



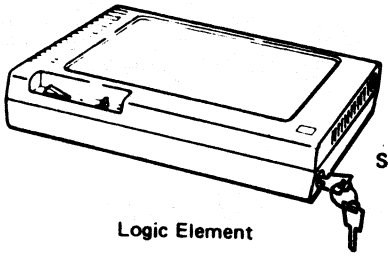
Video Element



Stand



Power Cord



Security Keys

Logic Element

Figure 1-2. Work-Station Elements

INDICATORS, SWITCHES, AND CONTROLS

The IBM 3178 has both visual and audible indicators, as well as various switches and controls. This section describes the indicators, switches, and controls.

INDICATORS

The visual indicators, which are on the logic element, are the Power-on indicator and a Light 1 indicator. The Power-on indicator is on when power is applied. The Light 1 indicator has dual functions. When the Test/Normal switch is set to the Test position, this indicator keeps blinking after a diagnostic function verifies IBM 3178 hardware. When the Test/Normal switch is set to the Normal position, this indicator appears if the controller sends a valid poll command.

The audible indicators are a keyboard clicker and an alarm. The keyboard clicker, when turned on, gives off a clicking sound each time a key is pressed. The absence of the sound tells the operator that something is wrong.

The audible alarm sounds under various conditions to attract the operator's attention.

SWITCHES AND CONTROLS

The IBM 3178 has the following switches and controls:

- A power switch, which is on the logic element, controls the application of power to all work-station elements.
- A Test/Normal switch, also on the logic element, sets the IBM 3178 to either the normal mode of operation or places it in an offline test mode.
- The Light 1 indicator blinks when the Test/Normal switch is set to Test. The indicator stays on when the switch is set to Normal and the station is connected to the controller.
- Contrast and brightness controls on the video element adjust the display image.
- An audible-alarm volume control at the rear of the logic element adjusts the sound level of the alarm.
- A Monocase/Dualcase (A/A, a) switch: When the switch is set to Monocase (A), all characters are displayed in uppercase only. When set to Dualcase (A, a), the characters are displayed in either uppercase or lowercase.
- A security keylock provides a key-controlled lock for the IBM 3178. When the key is in the off position or is removed, data cannot be entered, modified or displayed at the station.

MAINTENANCE APPROACH

When a customer returns a IBM 3178 work-station element to the repair center, the repair center customer engineer verifies the symptom reported by the customer by using procedures in Chapters 2 and 3; replaces the failing field-replaceable unit (FRU) according to procedures in Chapter 4; then tests the operation by performing procedures in Chapter 3. The work-station element can then be returned to the customer. If an element is exchanged, the returned element becomes the property of IBM.

DATA FLOW

Figure 1-3 shows the IBM 3178 data flow.

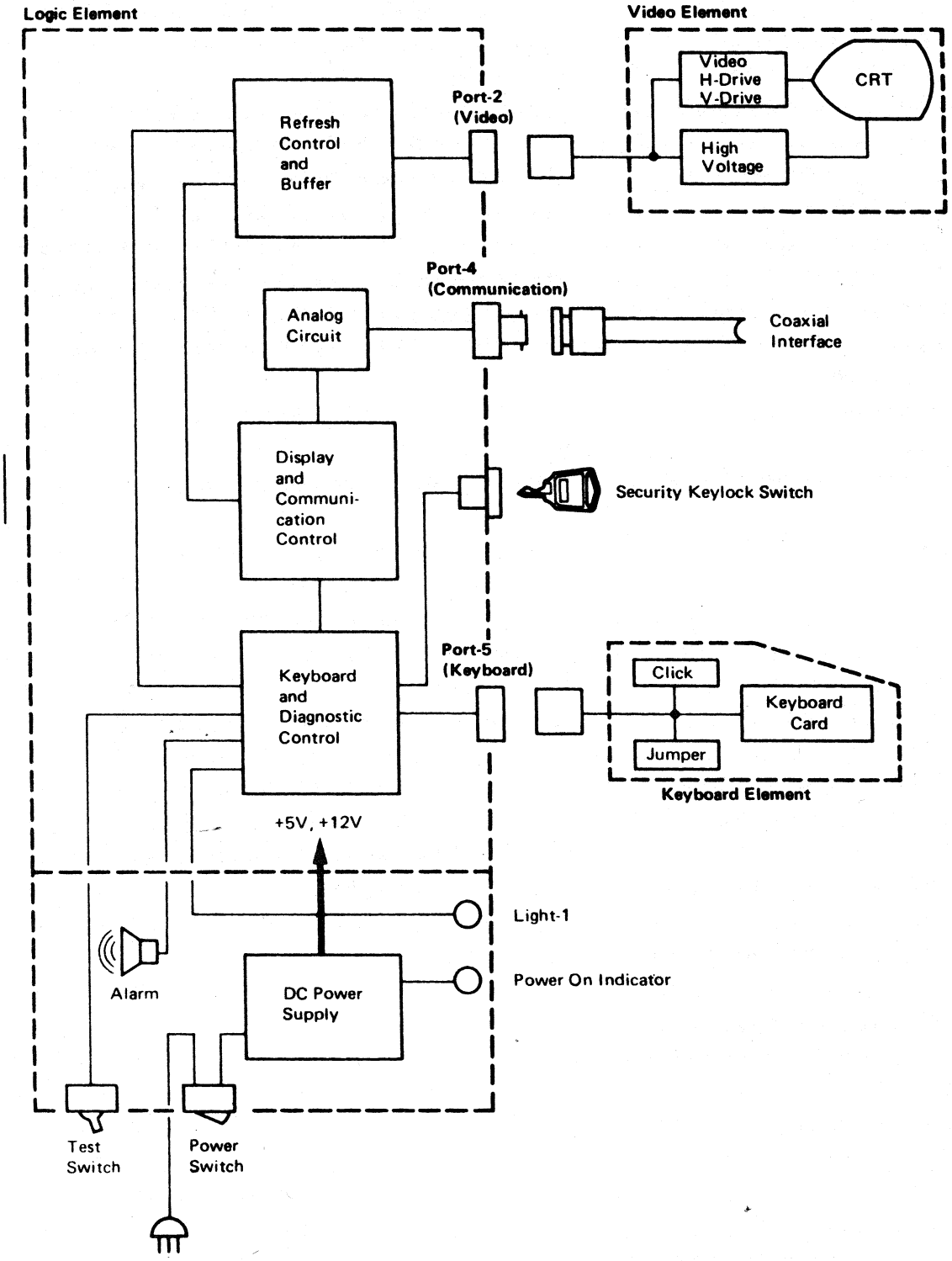


Figure 1-3. IBM 3178 Data flow

CHAPTER 2. PROBLEM ANALYSIS AND REPAIR PROCEDURES

This chapter describes the procedures for analyzing and repairing problems in work-station elements that have been returned by the customer. Be sure to review the IBM Repair Center Authorization form or the IBM Service/Replacement Order Form, which contains the customer's description of the problem.

This chapter is arranged by work-station element, with an "Error Code-to-FRU Lists" on page 2-11 and a "Symptoms-to-FRU List" on page 2-12 at the end of the chapter. If all three work station elements are received from the customer, refer to "Customer Problem Analysis and Resolution (CPAR)" in the IBM 3178 Display Station Operator Reference and Problem Solving Guide, GA18-2128, to isolate the failing element. If the IBM 3178 Display Station Operator Reference and Problem Solving Guide is not available, check each element according to the appropriate procedure in this chapter.

Where multiple FRUs are listed as probable causes of a problem, they are listed in the sequence of most-probable to least-probable cause.

After replacing any FRU, do the "Online Tests" on page 3-7 to verify the operation. If no trouble is found on the logic element, go to "Logic No Trouble Found (NTF) Procedure" on page 2-13.

Note: The video element stand, logic element mounting bracket, extension cables and switch control unit are purchased by the customer. Some elements returned by the customer may have these accessories with them. Be sure to return the purchased items to the customer after you have finished your repairs. Those accessories are not covered by the IBM maintenance agreement. You should advise the customer to purchase replacements from the local IBM branch office parts station (for US) or advise the customer to contact marketing representatives (for A/FE).

KEYBOARD ELEMENT

CAUTION
To avoid electrical shock, turn power off when replacing any FRU.

VISUAL CHECK

Check the keyboard for mechanical damage and replace any damaged parts. (See "Keyboard Element" on page 4-1)

KEYBOARD CABLE SHORT-CIRCUIT CHECK

Check the resistance at connector pins 2 and 14, and 6 and 14 of the keyboard cable (see Figure 2-1 on page 2-2). Refer to the following table and take the action specified.

Result	Action
Less than 3 ohms	Replace either the: •Keyboard assembly •Keyboard cable
3 ohms or more	Go to next check

SYMPTOM CHECK

1. Connect the keyboard element to video and logic elements that are known to be good.
2. Set the Test/Normal switch to Test.
3. Turn power on and run offline tests (see "Offline Tests" on page 3-1). If the offline tests fail, you should return to step 4.
4. Verify the symptom reported by the customer and exchange the suspected FRU if the symptom remains.

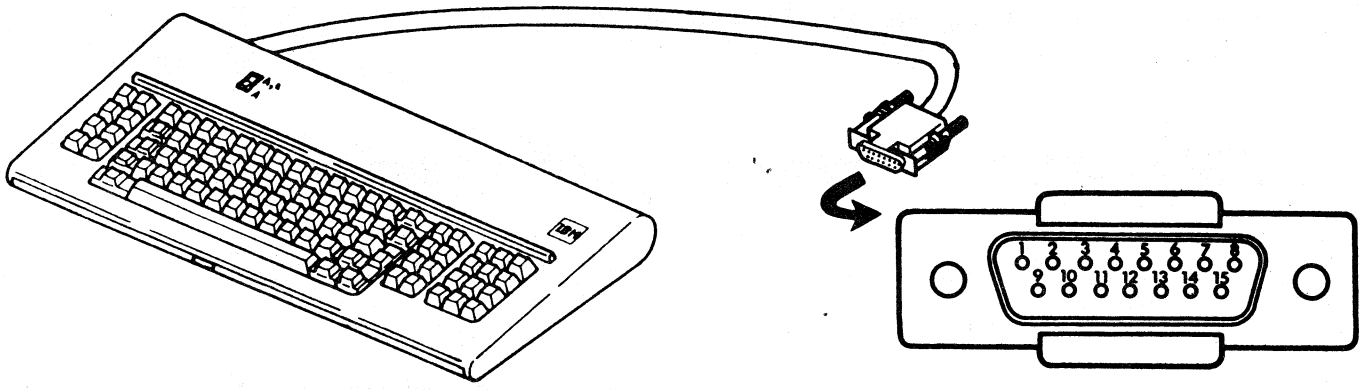


Figure 2-1. Keyboard Cable

Symptom	Failing FRU
Test pattern is not displayed correctly.	• Keyboard assembly • Keyboard cable
Clicker does not work.	• Clicker assembly • Keyboard assembly • Keyboard cable
Monocase/Dualcase Switch is not working.	• Keyboard assembly • Keyboard cable
Key(s) does not work.	• Keyboard assembly • Keyboard cable
Error in test function 3 of Test Mode 3 (Function Test)	• Jumper on the keyboard assembly (See Figure 5-5 on page 5-5) • Keyboard assembly • Keyboard cable
Other keyboard problems	• Keyboard assembly • Keyboard cable

KEYBOARD ASSEMBLY CHECK

1. Remove the keyboard top cover as described under "Keyboard Element" on page 4-1.
2. Turn the two screws ❶ counterclockwise, and adjust the keyboard assembly location to fit the top cover.
3. Reinstall in reverse sequence.

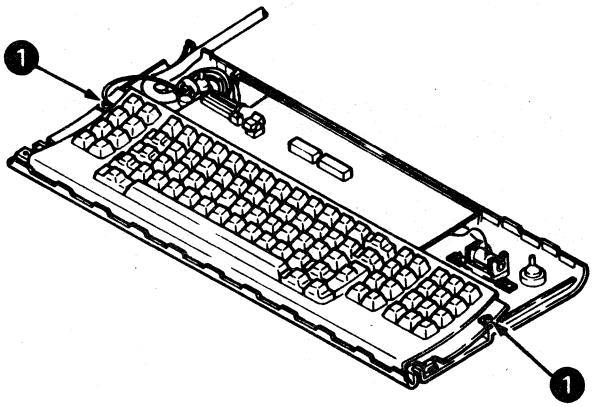


Figure 2-2. Keyboard CSA

VIDEO ELEMENT

DANGER

Areas of the analog card and video amplifier card (shown in the shaded area of Figure 2-3 have voltages in excess of 400 volts. Avoid working on the video element with power on. If absolutely required to have power on, use extreme caution while making any adjustments and follow instructions in this document.

CAUTION

To avoid electrical shock, turn power off and disconnect the power plug before exchanging any FRU.

CRTs are under a vacuum. All persons working near an exposed CRT should wear safety glasses and long-sleeved clothing (or comparable protection).

A static charge may be present at the anode lead. Before placing hands inside the video element, use an insulated jumper wire and momentarily ground the CRT anode to the CRT mounting screw. See Figure 2-3.

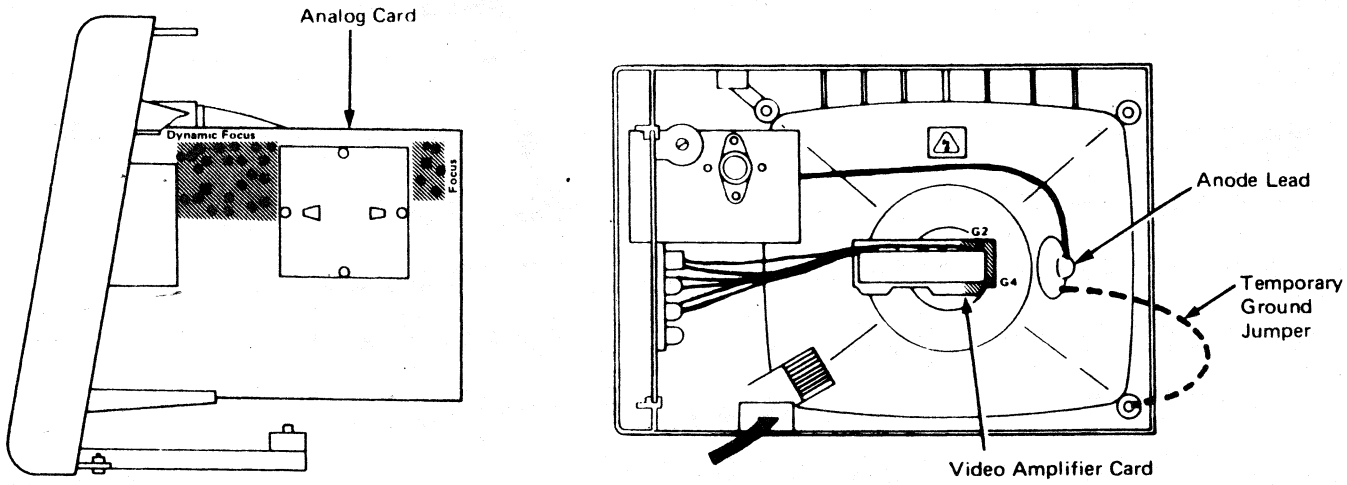


Figure 2-3. Analog Card and Video Amplifier Card

VISUAL CHECK

1. Check the brightness and contrast controls; replace any missing or broken knobs.

Note: See Chapter 4, "Removal and Replacement Procedures" on page 4-1 for removal and replacement procedures.

VIDEO CABLE SHORT-CIRCUIT CHECK

Check the resistance at connector pins 2 and 3, and pins 2 and 7 of the video cable (see Figure 2-4). Refer to the following table and take the action specified.

Result	Action
Less than 3 ohms	Replace analog card
3 ohms or more	Go to next check

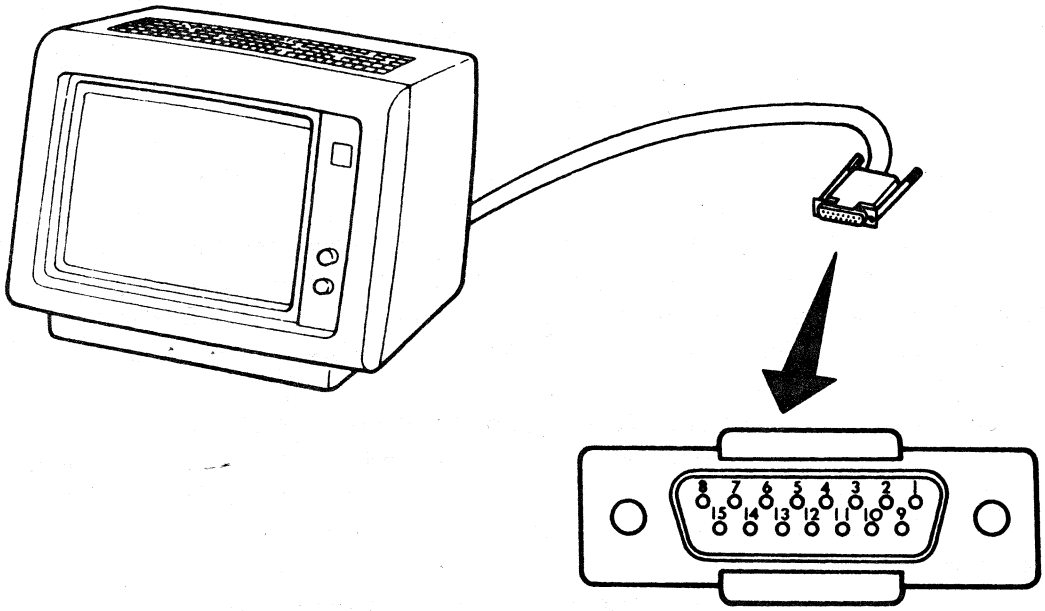


Figure 2-4. Video Cable

SYMPTOM CHECK

1. Connect the video element to keyboard and logic elements that are known to be good.
2. Set the Test/Normal switch to Test.
3. Turn power on.
4. Observe the displayed pattern and verify the symptom reported by the customer. Use the appropriate charts that follow to correct the problem.

Notes:

1. If the analog card is replaced, or any adjustment is made, do the "Final Check and Adjustments" on page 2-6 procedures.
2. See the label on the analog card for the locations of the potentiometers.
3. The adjustment tool, Part 5728554, may be needed to adjust the potentiometers on the analog card.

Chart A. Adjust the appropriate potentiometer. Exchange the suspected FRU if symptom remains.

Symptom	Potentiometer	Suspected FRU or Element
Display image is out of focus. Brightness cannot be increased.	FOCUS SUB BRIGHT	• Video element • Analog card
Brightness cannot be decreased. Vertical screen size is incorrect. Horizontal screen size is incorrect. Character height is uneven. Character width is uneven. Raster is moving vertically.	SUB BRIGHT HEIGHT WIDTH V-LIN H-LIN V-BOLD	• Analog card • Video element

Chart B. Exchange the suspected FRU.

Symptom	Suspected FRU or Element
Blank screen (No horizontal line)	• Fuse on analog card • Analog card • Video element
Center spot remains on screen after power is turned off. Only vertical line is displayed.	• Video element • Analog card
Only horizontal line is displayed. Contrast cannot be adjusted. Brightness is not constant over screen.	• Analog card • Video element
Display area is tilted. Display area is distorted. Screen surface is burned.	• Video element
Other problems	• Analog card

FINAL CHECK AND ADJUSTMENTS

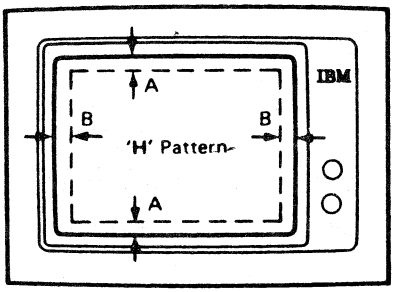
1. Run "H-Character Display (Test Case 2)" of the online test described in Chapter 3.

   Note: If the online test is not available, run the offline tests and key in all Hs (see "Offline Tests" on page 3-1).

2. Use the following table and check the displayed pattern. Adjust the potentiometer(s) as required.

   Note: Some types of analog cards may not have all of these potentiometers.

Check That	Potentiometer	Note
1. Display is stable vertically.	V-HOLD	
2. Character width is even.	H-LIN	
3. Horizontal size of display area is correct.	WIDTH[1]	Readjust H-LIN if this is adjusted.
4. Character height is even.	V-LIN	
5. Vertical size of display area is correct.	HEIGHT[1]	Readjust V-LIN if this is adjusted.
6. Brightness is correct.	SUB BRIGHT[2]	
7. Focus is correct.	FOCUS DYNAMIC FOCUS	Readjust FOCUS if this is adjusted.



Legend
A: 15.0 ±2.5 mm (0.59 ±0.10 in.)
B: 20.0 ±2.5 mm (0.79 ±0.10 in.)

Figure 2-5. H Pattern

---

[1] The size of the display area is as shown in Figure 2-5. This size is applicable when the supplied +12.0 V dc is nominal.

[2] Adjust so the background raster just disappears when the brightness control knob is set to maximum.

LOGIC ELEMENT

CAUTION
To avoid electrical shock:

1. Turn power off and disconnect the power plug before exchanging the power supply.
2. Turn power off before exchanging any other FRUs.

VISUAL CHECK

Check the logic element for mechanical damage and replace any damaged parts. (See "Logic Element" on page 4-8.)

POWER CHECK

1. Connect the power plug and the power cord to an outlet and turn power on.
2. Set the Test/Normal switch to Test.
3. Observe the Power-on and Light 1 indicators. Find the status of the indicators in the following table and take the action specified.

Symptom	Action
Both lights are off	Replace either: • AC fuse (F11) for high voltage machines (E/ME/A, 200 volts) only. **Note:** For high voltage machines (E/ME/A, 200 volts), the fuse is located outside of the power supply. See Figure 5-2 on page 5-2. • Power supply
Power-On light is on, and Light 1 is off.	Replace either: • Logic board • Power supply
Both lights stay on.	Replace logic board.
Power-On light is on, and Light 1 is blinking.	Go to next check.

LOGIC CHECK

Note: If the Security Keylock switch was not returned with the unit, you can perform the test by removing the four-position connector from the logic board.

1. Turn power off.
2. Connect the logic element to video and keyboard elements that are known to be good.
3. Set the Test/Normal switch to Test.
4. Turn power on and run the offline tests. (See "Offline Tests" on page 3-1) If the offline tests fail, return to next step.
5. Verify the symptom reported by the customer and perform the action described in the following table.

Result	Action
Error in test function 3 of Test Mode 1 (pattern Display).	Replace either: • Security key assembly • Logic board
Other test failed.	Replace either: • Logic board • Power supply • Security key assembly
Test good.	Go to next check.

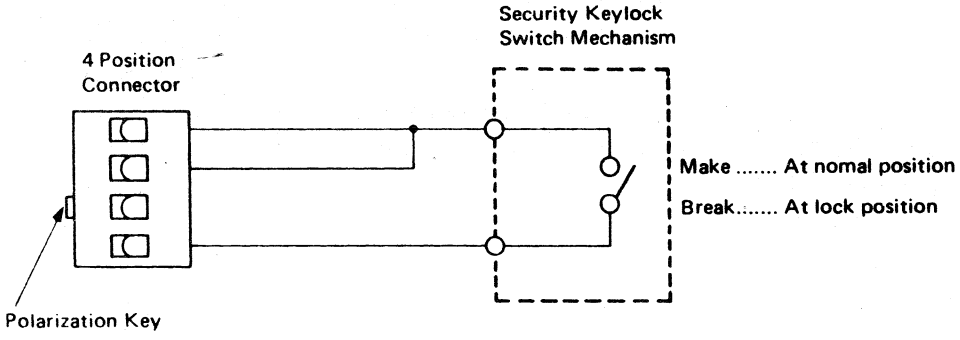


Figure 2-6. Security Keylock Switch Assembly

ADDITIONAL CHECKS FOR INTERMITTENT PROBLEMS

DC Voltage Check

1. Turn power off.
2. Remove the logic element cover.
3. Connect the logic element to keyboard and video elements that are known to be good.
4. Turn power on and measure the voltage at the points shown in Figure 2-7. The following table shows the voltage range.

Measurement	Voltage Range (v dc)
+5 v dc	4.6 to 5.5
+12 v dc	11.0 to 13.2

If any voltage is not within the above specifications, replace the power supply.

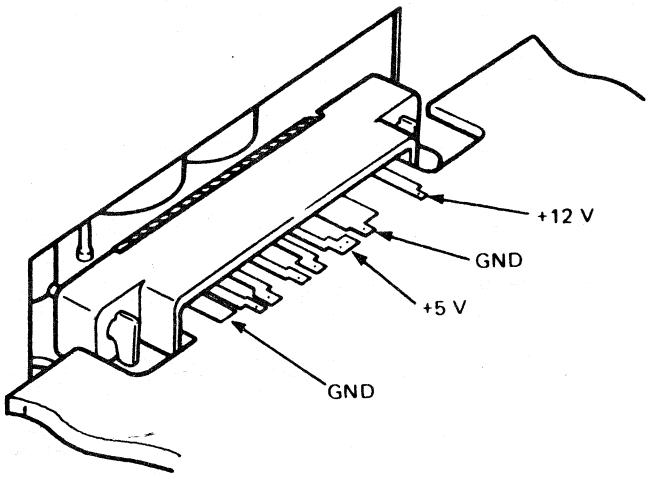


Figure 2-7. Logic Board Voltage-Measurement Points

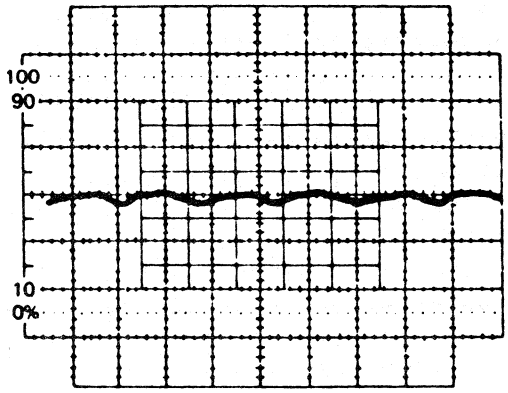
Power Ripple Check

1. Turn power off.
2. Remove the logic element cover.
3. Connect the logic element to keyboard and video elements that are known to be good.
4. Set up an oscilloscope as follows:
   a. Set power to on.
   b. Connect a 10:1 (10X) probe to CH 1 INPUT.
   c. Set A Triggering Source to INT.
   d. Set A Triggering Coupling to DC.
   e. Set SWEEP MODE to AUTO TRIG.
   f. Set TIME/DIV to 5 MSEC.
   g. Set MODE to CH 1.
   h. Set CH 1 AC/GND/DC switch to GND.
   i. Set CH 1 VOLTS/DIV to 5 MV.
   j. Set POSITION, INTENSITY, and FOCUS for a sharp trace in the center of the display.
   k. Connect the probe ground to the ground tab of the voltage-measurement point. (Use the short ground wire.)
   l. Set CH 1 AC/GND/DC switch to AC.
5. Set IBM 3178 power to on, and measure the ripple with the oscilloscope at the logic board voltage-measurement points (see Figure 2-7). Figure 2-8 on page 2-10 shows how the presentation should appear on the oscilloscope; the following shows the maximum ripple.

Measurement Point	Ripple Maximum Limit
+5 v dc (Range 4.6-5.5 v)	200 mv P-P
+12 v dc (Range 11.0-13.2 v)	12 mv P-P (see note)

Note: Ripple for the +12 V dc line is difficult to measure. Instead of measuring this line, observe the displayed pattern. Too much ripple on this line will cause the display to jitter.

If any ripple does not meet the preceding specifications, exchange the power supply.



Displayed voltage scale: 50 mV per cm.

Figure 2-8. Oscilloscope Presentation for Power Ripple Check

ERROR CODE-TO-FRU LISTS

A problem detected by the control unit will be indicated by a machine check error code in the operator information area. Figure 2-9 lists the error codes for the IBM 3274 Control Unit and IBM 3276 Display Station Control Unit. If the customer's description contains a machine check error code, use these lists.

Error Type	Error Code	Suspected FRU
IBM 3274 Machine Check	203	Logic board
	204	Logic board, power supply
	205	Logic board
	206	Logic board
	207	Logic board
	208	Logic board
	209	Logic board
	210	Jumper on keyboard assembly, keyboard assembly, cable, logic board
	211	Logic board
	212	Keyboard assembly, cable, logic board
IBM 3276 Machine Check	41	Keyboard assembly, cable, logic board
	42	Keyboard assembly, logic board
	69	Logic board
	70	Logic board, coaxial cable (or control unit failure)
	71	Logic board, coaxial cable
	72	Logic board
	73	Logic board, jumper on keyboard assembly, keyboard assembly, cable
	74	Logic board
	77	Logic board, power supply

Figure 2-9. Error Code-to-FRU List

SYMPTOMS-TO-FRU LIST

Figure 2-10 contains the symptoms and FRUs that could be a cause of the failure. The FRUs in the work-station elements are as follows:

- Logic element ..... Logic board, power supply, security key assembly
- Keyboard element .... Keyboard assembly, cable, clicker
- Video element .... Analog card

Symptom	Suspected FRU or Element
Light 1 stays off in Test mode.	Logic board, power supply, analog card
Light 1 stays on in Test mode.	Logic board, power supply
Test/Normal switch operation is failing.	Logic board, power supply
Security key operation is failing.	Security key assembly, logic board
Display is blank or has green background (no cursor, no divider line, and no characters).	Analog card, logic board, power supply
Display is blank with a divider line.	Logic board, power supply
Display is dim at maximum contrast or brightness.	Analog card, video element
Display is tilted.	Video element
Raster is visible at minimum brightness.	Analog card
Display size changes with brightness control.	Analog card, video element
Brightness or contrast control can't be adjusted.	Analog card, logic board
Display is out of focus.	Analog card, logic board, video element
Display is out of synchronization (moving).	Analog card, logic board
Display is shrunk or expanded.	Analog card, power supply, logic board (or voltage source)
Display is jittering or waving (horizontally).	Analog card, power supply (or magnetic field around IBM 3178)
Horizontal position is wrong.	Logic board, analog card, video element
Wrong character is display, or extra dots appear, or dots are missing.	Logic board
Cursor is wrong (missing, random location).	Logic board
Other display failure	Logic board, analog card, video element, power supply
One key fails.	Keyboard assembly
Keyboard is not working at all.	keyboard assembly, cable, logic board
Displayed character is different from the one entry.	keyboard assembly, logic board, cable
Clicker failure	Clicker, keyboard assembly, cable, logic board

Figure 2-10. Symptom-to-FRU List

LOGIC NO TROUBLE FOUND (NTF) PROCEDURE

1. Check the connectors screws.

   a. Check that all cables can be smoothly connected and disconnected from the logic element.

   b. Insert the video cable, keyboard cable, Coax cable into connector and **tighten** the screws.

   c. Check that all cables are firmly connected to the logic element by the screws.

2. Check all cables.

   a. Set the Test/Normal switch to Test, the monocase/dualcase switch (A/A,a) to Dualcase (A,a).

   b. Turn the security keylock clockwise.

   c. Switch on power switch.

   d. Shake the keyboard cable and video cable at the end where it attaches to logic element during a key-in operation.

3. If the above procedure finds no problem keep power on the logic element for three hours (Keyboard and video element do not need to be attached).

   a. Switch power off.

   b. Connect the keyboard and video element.

   c. Switch power on.

   d. Run the off-line test and on-line test.

If no errors occur, the element under test is NTF. If the element is a first time NTF, mark it by normal local NTF procedures and return to stock. If it is a second time, replace the logic board.

Time and Material Customers

Discuss the problem with the most experienced technician and, using this manual, determine the most probable failing FRU. The customer must be contacted and advised that the Repair Center has not been able to duplicate the failure. The customer must then decide if he or she wants a part replaced. No part should be replaced in a Time and Material element without authorization from the customer.

CHAPTER 3. TEST PROCEDURES

OFFLINE TESTS

The IBM 3178 offline tests are in the IBM 3178 logic. The test logic is activated when the Test/Normal switch is set to Test.

There are three test modes:

- Test Mode 1: Pattern Display Test
- Test Mode 2: Keyboard-to-CRT Test
- Test Mode 3: Function Test

Pattern Display Test (Test Mode 1)

Displays a predetermined pattern of characters.

Activity	Result
1. Make sure the security key is inserted and turned clockwise (horizontal position). 2. Set Test/Normal switch to Test.	Fills display with pattern of characters shown in Figure 3-1 on page 3-2. Compare the test pattern lines shown in Figure 3-1 (part 1 of 3) with the corresponding displayed lines. Verify that the characters are in correct sequence.
3. Set Monocase/Dualcase (A/A,a) switch to Dual case (A, a) position.	
4. Set Monocase/Dualcase (A/A, a) switch to Monocase (A) position. Set Monocase/Dualcase (A/A, a) switch to Dualcase (A, a) position.	Pattern is changed with those in Figure 3-1 (part 2 of 3).
5. Turn the security key counterclockwise (vertical position). Turn the security key clockwise (horizontal position).	Display is inhibited. Except for operator information area, screen is blanked.

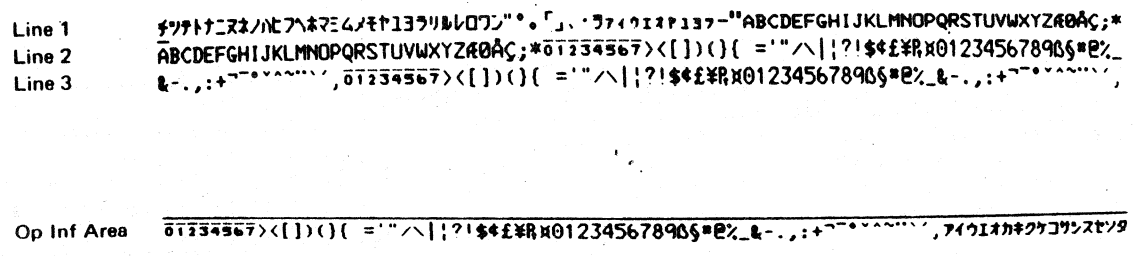
Note: The 76- and 88-key Katakana keyboards do not have a Monocase/Dualcase switch. Compare the test pattern lines shown in Figure 3-1 (Part 3 of 3).

Note:
Test pattern when the Monocase/Dualcase switch is set to A,a (Dualcase) position.

Figure 3-1 (Part 1 of 3). Test Mode 1 Test Pattern

Note:
Test pattern when the Monocase/Dualcase switch is set to A (Monocase) position.

Figure 3-1 (Part 2 of 3). Test Mode 1 Test Pattern



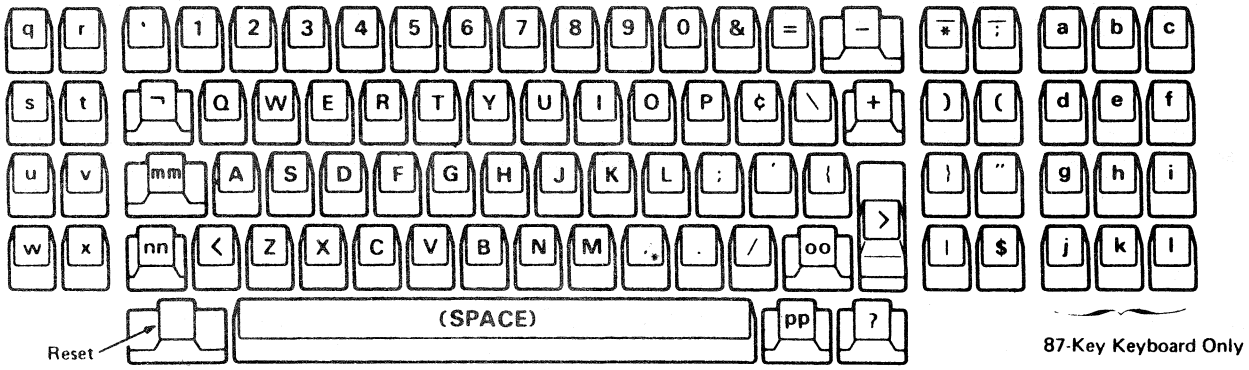
Note:
Test pattern for 76- and 88-key Katakana keyboards.

Figure 3-1 (Part 3 of 3). Test Mode 1 Test Pattern

Keyboard-to-CRT Test (Test Mode 2)

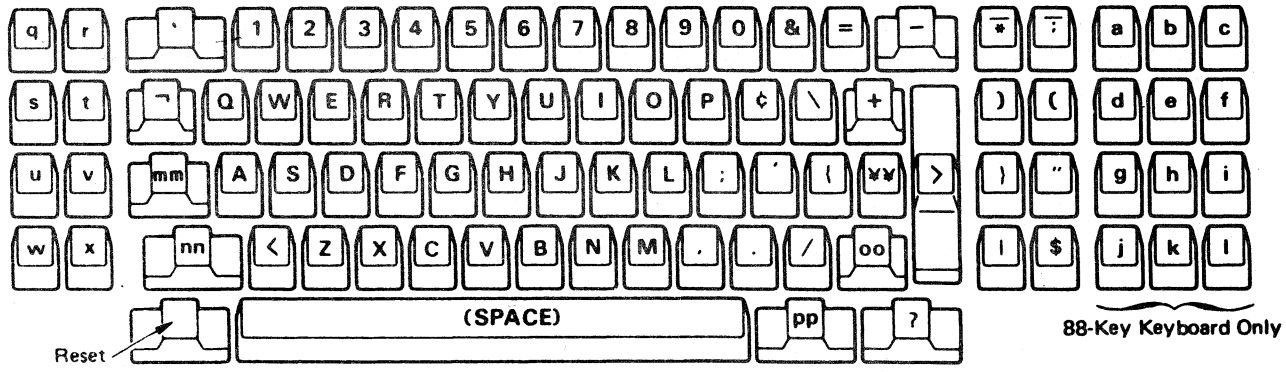
Displays keyed-in characters.

Activity	Result
Mode Entry: Automatic, after display is loaded with Mode 1 pattern of characters. Key in any characters, but do not press RESET.	Characters keyed in replace characters displayed in Test Mode 1, beginning at top left of display. Clicker sounds when each key is pressed, except the keys labeled nn, mm, oo, and pp, (YY, 76- and 88-key Katakana keyboards only) in Figure 3-2. **Note:** Regardless of the characters that appear on the keytops, the characters displayed are those shown in Figure 3-2. Notice that certain keys cause double-character entry, the first when the key is pressed, and the second when it is released; these are the keys labeled nn, mm, oo, and pp in Figure 3-2.



Note:
75- and 87-key Keyboards.

Figure 3-2 (Part 1 of 2). Key Identification for Test Mode 2



Note:
76- and 88-key Katakana keyboards.

Figure 3-2 (Part 2 of 2). Key Identification for Test Mode 2

Function Test (Test Mode 3)

Performs the IBM 3178's functions.

Activity	Result
1. Press the Reset key. **Note:** Regardless of the characters that appear on the keytops, the keys referred to in this test are those shown in Figure 3-2 on page 3-4.	
2. Press the C key. Press the Reset key.	The characters keyed in during Test-mode-2 are replaced by the Test-mode-1 pattern. **Note:** If the C key is pressed and held, a character C appears in the first position of the operator information area. In this case, press the Reset key and then retry.
3. Press the B key.	The symbol $\overline{2}$ appears in first position of the operator information area. (This is the correct response for power-on status.) The alarm sounds once.
4. Press the B key twice more (to clear the status). Press the Reset key.	The symbol $\overline{0}$ appears in the first position of operator information area.
5. Press the J key. Press the Reset key.	Terminal ID * appears in the first position of the operator information area. (Correct response for terminal identification.) **Note:** Where terminal ID contains: **u** for either a 75- or 76-key data entry keyboard (Model C1) **E** for either an 87- or 88-key typewriter keyboard (Models C2 and C4) **:** for an 87-key type-writer keyboard (Model C3 and Model C8 RPQ7L0587).
6. Press the K key. Press one of the following keys according to the function desired: **,** (comma) Reverse and blinking cursor **A** Normal cursor **B** Blinking cursor **C** Reverse cursor **F** Inhibit cursor **8** Inhibit display	
7. Press the Reset key, then the C key. Press the Reset key, then the B key twice, then the Reset key.	The Test-mode-1 pattern appears again. **Note:** If the C key is pressed and held, the character C appears in the first position of the operator information area. In this case, press the RESET key and then retry.

Activity	Result
8. Press the M key. 9. Press the 2 key twice. 10. Press the 4 key twice. 11. Press the 8 key twice. Press the Reset key, press the B key twice, then the RESET key. 12. Press the W key. Press the * key. Press the Reset key.	
13. Press the G key twice. Then press the Reset key. 14. Press the J key, then the Reset key. 15. Press the S key.	The first line is displayed. 22448800...ooghij...
16. Press the 2 key. Press the Reset key. 17. Press the J key, then the Reset key. 18. Press the Q key.	The cursor moves back to the last 2 entered.
19. Press the 8 key. Then press the Reset key. 20. Press the J key, then the RESET key. 21. Press the O (alphabet) key.	The cursor moves forward to the first 8 entered.
22. Press the I key.	The character I is inserted between 4 and 8. The cursor advances to the last 8 entered.

This ends the offline tests.

ONLINE TESTS (IBM SERIES/1 WITH FECPTS CONTROLLER)

The online tests are performed with the IBM 3178 connected to the Repair Center Communication Products Test System (RCCPTS) controller, which communicates with the Series/1. "Performing Online Tests," which appears later in this chapter, describes how to run the online tests.

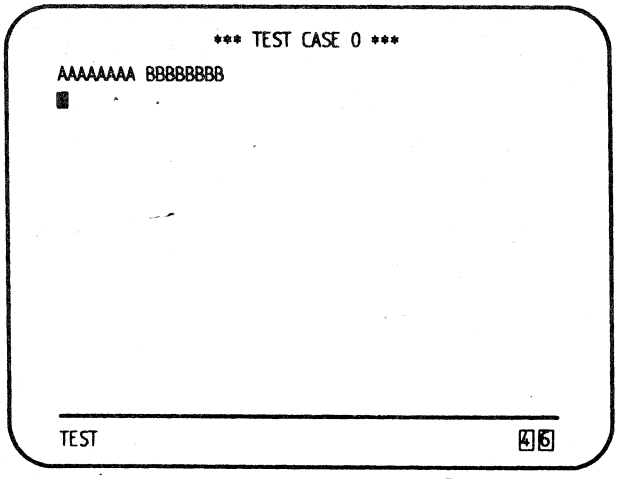
There are four online tests:

- Basic Commands Test (Test Case 0)
- All-Character Display (Test Case 1)
- H-Character Display (Test Case 2)
- Echo Test (Test Case 3).

Basic Commands Test (Test Case 0)

Test Case 0 is performed at the start of the online tests. It issues basic commands to the IBM 3178 and ensures that the logic element are functioning correctly. When the test is running, TEST appears in the operator information area and the IBM 3178 inhibits all other displays.

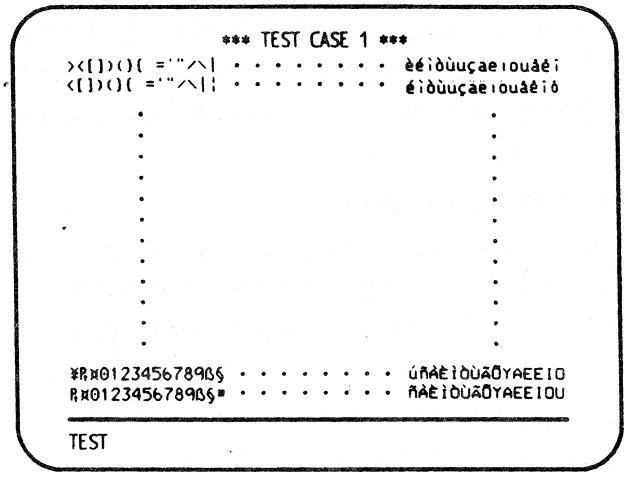
At the end of the test, the alarm sounds and the screen of the IBM 3178 is formatted as follows:



***** TEST CASE 0 ***** and **AAAAAAAA** are highlighted. A blinking, rectangular cursor is displayed at line 3. If an error is detected during the test, a message appears on the Series/1 console (see "Error Messages" on page 3-12). If no error is detected, GOOD COMPLETION appears on the Series/1 console.

All-Character Display (Test Case 1)

This test displays all graphic characters in the following format:



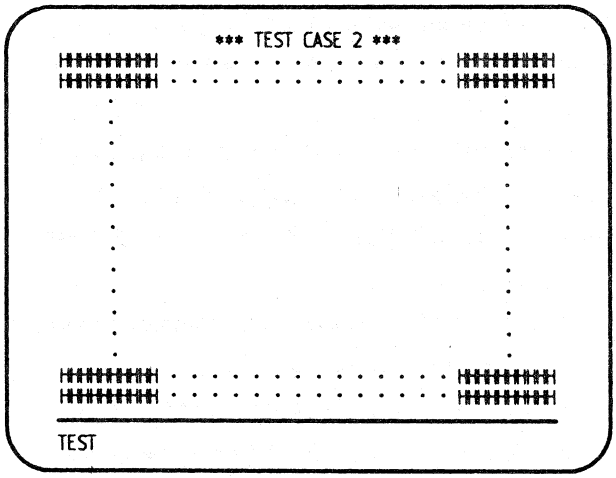
TEST CASE 1 *** is highlighted.

You can specify the number of lines to be displayed. If you specify more than 24 lines, the write operation wraps to the first line, and *** TEST CASE 1 *** is replaced by graphic characters.

If an error is detected during this test, an error message appears on the Series/1 console. If no error is detected and if the specified number of lines is sent to the IBM 3178, GOOD COMPLETION appears on the Series/1 console.

H-Character Display (Test Case 2)

This test displays the character H throughout the screen as follows:



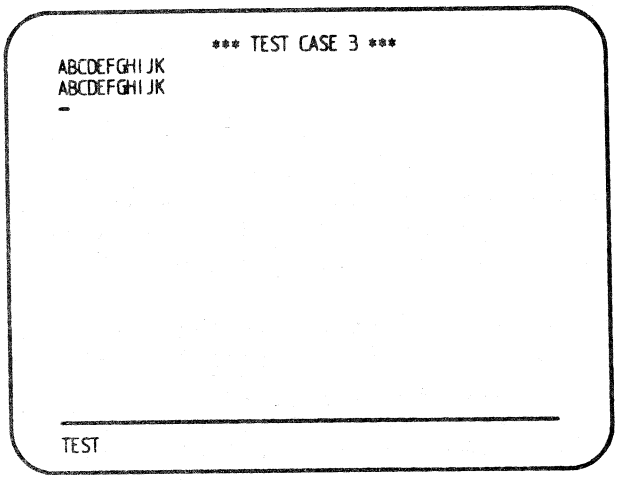
***** TEST CASE 2 ***** is highlighted.

You can specify the number of lines to be displayed. If you specify more than 24 lines, the write operation wraps to the first line, and *** TEST CASE 2 *** is replaced by H's.

If an error is detected during the test, an error message appears on the Series/1 console. If no error is detected and if the specified number of lines is sent to the IBM 3178, GOOD COMPLETION appears on the Series/1 console.

Echo Test (Test Case 3)

In this test, data is entered at the IBM 3178 keyboard. When the ENTER key on the IBM 3178 is pressed, the data that was entered is echoed to the IBM 3178 and displayed in the following format:



*** TEST CASE 3 *** is highlighted. After *** TEST CASE 3 *** is displayed, the alarm sounds.

Only alphabetic keys (A through Z), the Clear, Delete (), Insert (), Reset, Clicker (), and cursor-movement (↑, ↓, ->, <-) keys should be used to enter data. If other keys are pressed, # is displayed.

If the clear key is pressed, the screen is cleared and *** TEST CASE 3 *** is again displayed and the alarm sounds. If the delete key is pressed, the character at the position of the cursor is removed from the screen.

If the insert key is pressed, the IBM 3178 enters insert mode and INSERT MODE appears in the operator information area. In insert mode, pressing a graphic key causes the character to be inserted at the current cursor position. An attempt to enter data when the cursor is positioned outside the input area causes INPUT INHIBITED to appear in the operator information area and the alarm to sound. Pressing the reset key causes both INPUT INHIBITED and INSERT MODE to be removed from the operator information area. Pressing the Clicker key causes the clicking sound to be activated if it has been inhibited or to be inhibited if it has been activated. If one of the Cursor-movement keys is pressed, the cursor moves one location in the direction of the arrow on the keytop of the key that was pressed.

To complete the test, enter END and press the IBM 3178 ENTER key.

If an error is detected during the test, an error message appears on the Series/1 console. If the test completes with no error detected, GOOD COMPLETION appears on the Series/1 consoles.

Performing the Tests

The following steps describe how to perform the test. If an error message appears during the online test, refer to "Error Messages" in this chapter for the explanation and action to be taken.

Notes:

1. If PF3 on the Series/1 console is pressed during the test, the test ends.
2. For details about a particular test, refer to the appropriate description:

- Basic Command Test (Test Case 0)
- All-Character Display (Test Case 1)
- H-Character Display (Test Case 2)
- Echo Test (Test Case 3)

Operation	Console Screen	CE Action
STEP 1		
Invoke the test function.	ONLINE TEST SET UP THE DEVICE UNDER TEST PRESS ENTER	Connect the IBM 3178 to the test controller coaxial port (DCA 1), set the Monocase/Dualcase (A/A,a) switch to the Dualcase (A,a) position; turn the security key clockwise (horizontal position); and power on the IBM 3178.
Press the ENTER key		Go to step 2.
STEP 2		
	***** TEST CASE 0 ***** TEST CASE 0 STARTED. RUNNING	
	If an error is detected, RUNNING is replaced by ERROR (XX), and PRESS ENTER is displayed, where XX is the error code. Refer to "Error Messages" in this chapter. If the test completes with no errors detected, RUNNING is replaced by GOOD COMPLETION, and PRESS ENTER is displayed.	Execute "ERROR RECOVERY PROCEDURE", which is at the end of this procedure.
Press the ENTER key.		Go to step 3, 4, or 5, according to the display on the screen.
STEP 3		
	***** TEST CASE 1 ***** ENTER THE NUMBER OF LINES TO BE DISPLAYED:	
Enter two digits to specify the number of lines to be displayed.	***** TEST CASE 1 ***** TEST CASE STARTED. RUNNING	

Operation	Console Screen	CE Action
If only the ENTER key is pressed, or 99 is entered, the entered number is considered to be 23. 00 means loop. In this case, the only way to interrupt the test is to press PF3.	If an error is detected, RUNNING is replaced by ERROR (XX), and PRESS ENTER is displayed. XX is the error code. Refer to "Messages" in this section. If the test completes with no errors detected, RUNNING is replaced by GOOD COMPLETION, and PRESS ENTER is displayed.	Execute "ERROR RECOVERY PROCEDURE", which is at the end of this procedure.
Press the ENTER key.		Go to step 4, 5, or 6, according to the display on the screen.
STEP 4		
	***** TEST CASE 2 ***** ENTER THE NUMBER OF LINES TO BE DISPLAYED:	
Enter two digits to specify the number of lines to be displayed. If only the ENTER key is pressed, or 99 is entered, the entered number is considered to be 23. 00 means loop. In this case, the only way to interrupt the test is to press PF3.	***** TEST CASE 2 ***** TEST CASE 2 STARTED. RUNNING	
	If an error is detected, RUNNING is replaced by ERROR (XX), and PRESS ENTER is displayed. XX is the error code. Refer to "Error Messages" in this section. If the test completes with no errors detected, RUNNING is replaced by GOOD COMPLETION, and PRESS ENTER is displayed.	Execute the "ERROR RECOVERY PROCEDURE" at the end of this procedure.
Press the ENTER key.		Go to step 5, or 6, according to the display on the screen.
STEP 5		
	***** TEST CASE 3 ***** TEST CASE 3 STARTED. RUNNING	Perform the echo test. To complete the test, enter "END" at the IBM 3178 keyboard and press the IBM 3178 ENTER key.

Operation	Console Screen	CE Action
	If an error is detected, RUNNING is replaced by ERROR (XX), and PRESS ENTER is displayed, XX is the error code. Refer to "Error Messages" in this section. If the test completes with no errors detected, RUNNING is replaced by GOOD COMPLETION, and PRESS ENTER is displayed.	Execute "ERROR RECOVERY PROCEDURE," which is at the end of this procedure.
Press the ENTER key		Go to step 6.
STEP 6		
	END OF TEST SET is displayed. When the ENTER key is pressed, the test is complete.	
ERROR RECOVERY PROCEDURE		
Press the ENTER key to display the debug option menu.	The debug option menu is displayed. Debug option menu: 1. RETRY executes the test that had the error, then returns to the debug option menu. 2. RESTART starts the test from the beginning. All requested tests will be run. RESTART must be used to complete the test.	Execute the action specified under "Error Messages" for the error code and retry the test.
Select RETRY or RESTART in the debug option menu to execute the test again.		

Error Messages

If an error is detected during the test, an error message appears on the Series/1 console in the form:

ERROR (XX)

where XX is an error code. The following table defines the error codes and specifies the action the CE should take.

Error Code	Meaning	CE Action
10	Basic command error	Replace the logic board.
20	Status transition	Replace the logic board. If the security key is not on, turn on the security key and retry the test.
21	Security key off error	Check that the security key is on. If the security key is on, replace the security key assembly or the logic board.
22	Monocase/dualcase switch error	Check the Monocase/Dualcase switch is in the Dualcase position. If the Monocase/Dualcase switch is in the Dualcase position, replace the keyboard assembly or the logic board.
30	Invalid terminal ID	Check the terminal ID jumper of the keyboard element. (See Figure 5-5 on page 5-5). If the terminal ID jumper is good, replace the keyboard assembly or the logic board.
40	Line parity error	Retry the test to see if the error is intermittently caused by noise. If the error is still present after the retry, replace the logic board.
50	Data parity error	Retry the test to see if the error is intermittently caused by noise. If the error is still present after the retry, replace the logic board.
60	Device check error	Replace the logic board.
70	Time-out error	If the IBM 3178 ENTER key was not pressed for about 30 seconds in test case 3, this error always occurs. Retry the test. Otherwise, replace the logic board.

Figure 3-3. Online-Test Error Codes and CE Action

ONLINE TESTS (MAINTENANCE DEVICE)

The online tests are performed with the IBM 3178 connected to the Maintenance Device (MD) through the coaxial interface adapter. "Performing the Tests", which appears later in this chapter, describes how to run the online tests.

The online tests consist of four tests:

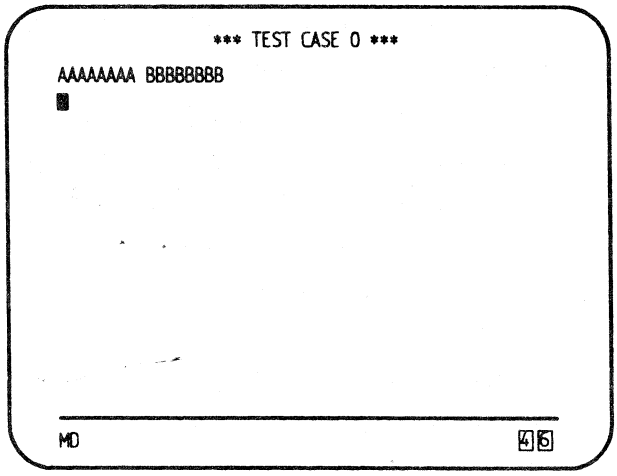
- Basic Commands Test (Test Case 0)
- All-Characters Display (Test Case 1)
- H-Character Display (Test Case 2)
- Echo Test (Test Case 3)

Basic Commands Test (Test Case 0)

Test Case 0 is performed at start of the online test to ensure that the logic element functions correctly.

It tests the basic command functions and read/write the buffer of the IBM 3178. During the test, many test patterns appear.

At the end of the test, the alarm sounds and the following screen appears:



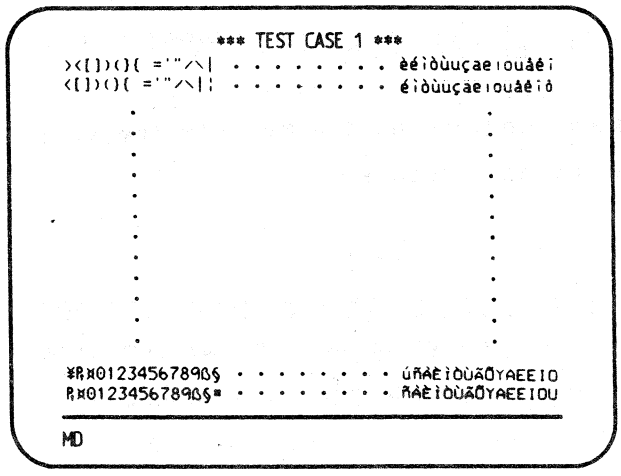
***** TEST CASE 0 ***** and **AAAAAAAA** are highlighted. A blinking rectangular cursor is displayed at the row 3.

Pressing the PF key on the MD causes the test to be interrupted.

If an error is detected, an error message appears on the MD. If the test completes with no errors detected, the END message appears on the MD.

All-Characters Display (Test Case 1)

This test displays all graphic characters as follows:



***** TEST CASE 1 ***** is highlighted.

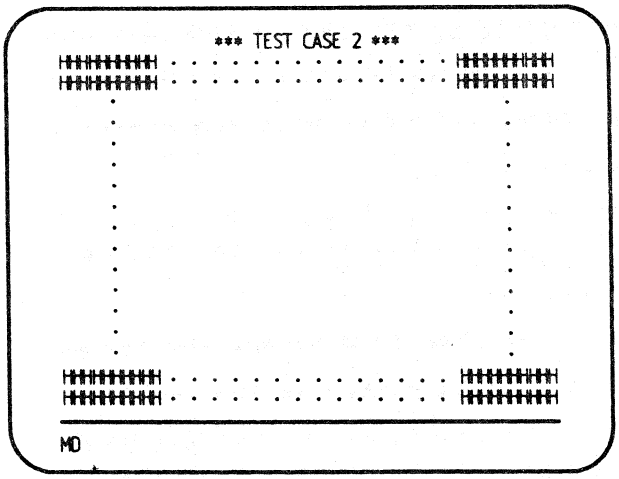
You can specify the number of lines to be displayed. If you specify more than 24 lines, the write operation wraps to the first line, and *** TEST CASE 1 *** is replaced by graphic characters.

Pressing PF key on the MD causes the test to be interrupted.

If an error is detected, an error message appears on the MD. If the test completes with no errors detected, the END message appears.

H-Character Display (Test Case 2)

This test displays the character H throughout the screen as follows:



***** TEST CASE 2 ***** is highlighted.

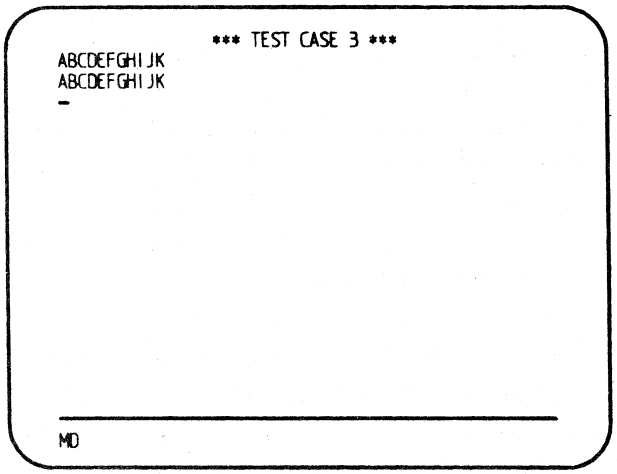
You can specify the number of lines to be displayed. If you specify more than 24 lines, the write operation wraps to the first line, and *** TEST CASE 2 *** is replaced by Hs.

Pressing PF key on the MD causes the test to be interrupted.

If an error is detected, an error message appears on the MD. If the test completes with no errors detected, the END message appears.

Echo Test (Test Case 3)

In this test, the data entered from the IBM 3178 keyboard is echoed to the IBM 3178 when the ENTER key on the IBM 3178 is pressed. The echoed data appears in the line following the entered data. The display format is as follows:



***** TEST CASE 3 ***** is highlighted. After *** TEST CASE 3 *** is displayed, the alarm sounds.

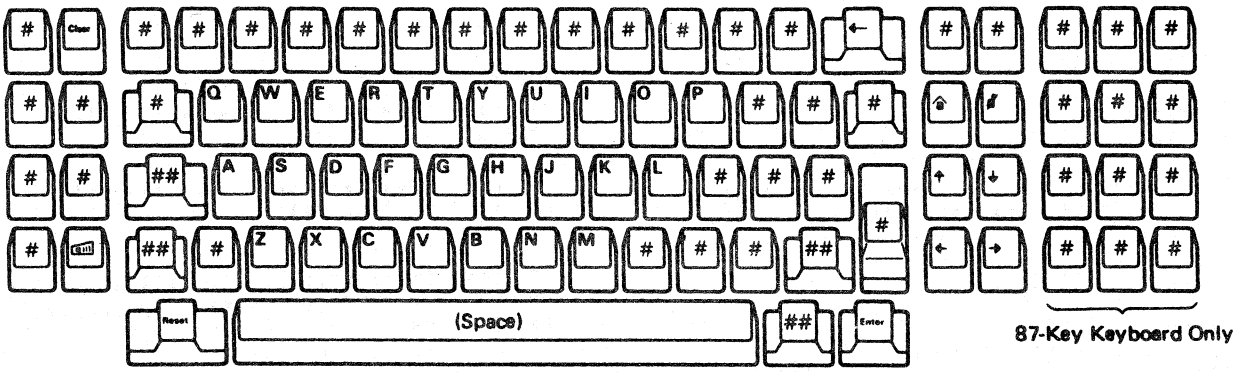
Only alphabetic keys (A through Z), and the Clear, Delete (d̸), Insert (â), RESET, Clicker (CLICK), and cursor-movement (↑, ↓, ->, <-) keys should be used to enter data. If other keys are pressed, # is displayed (See Figure 3-4 on page 3-15).

Note: Regardless of the characters that appear on the keytops, the characters displayed are those shown in Figure 3-4 on page 3-15.

If the Clear key is pressed, the screen is cleared. If the Delete key is pressed, the character at the position of the cursor is removed from the screen. If the Insert key is pressed, the IBM 3178 enters insert mode and INSERT MODE appears in the operator information area. In insert mode, pressing a graphic key causes the character to be inserted at the current cursor position. An attempt to enter data when the cursor is positioned outside the input area will cause INPUT INHIBITED to appear in the operator information area and the alarm to sound. Pressing the RESET key causes both INPUT INHIBITED and INSERT MODE to be removed from the operator information area. Pressing the clicker key causes the clicking sound to be activated if it has been inhibited or to be inhibited if it has been activated.

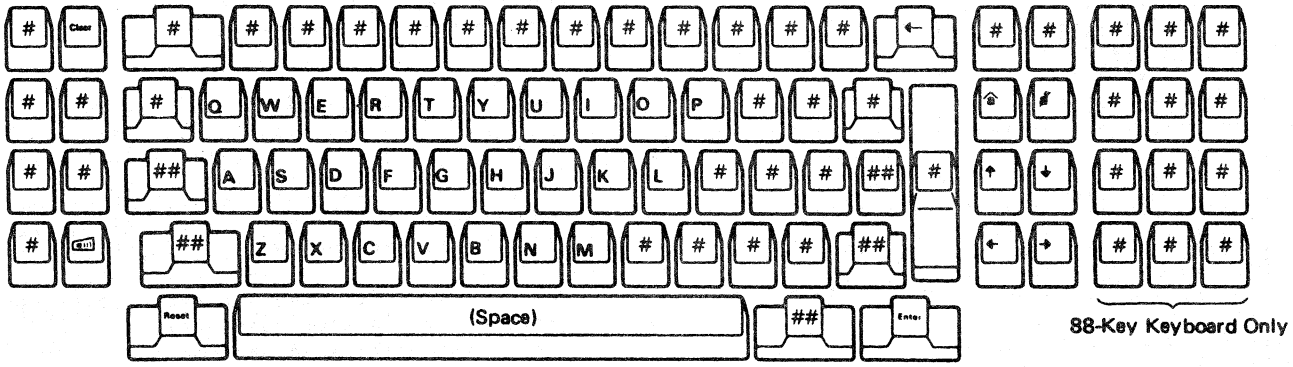
To complete the test, press the PF key on the MD.

If an error is detected, an error message appears on the MD. If the test completes with no errors detected, the END message appears.



Note:
87- or 75- key keyboard

Figure 3-4 (Part 1 of 2). Characters Displayed in Keying Operation



Note:
88- or 76- key keyboard

Figure 3-4 (Part 2 of 2). Characters Displayed in Keying Operation

Performing The Tests

The following procedure describes how to run the online tests.

1. Attach the coaxial interface adapter (Part 6052111) to the PIO connector on the MD.

2. Switch the MD to on.

3. Insert the IBM Repair Center Test Diskette for 3101/3102/3104/3178 /3179 (order number SY18-2068) and press the IPL button on the operator panel on the MD.

4. IPL messages will appear on the MD; then, the following messages will appear:

```
   REPAIR CENTER
    ONLINE TEST
        V3M0
PRESS ENT KEY.
```

   Press the ENT key on the MD.

5. After the ENT key on the MD is pressed, the following message appears on the MD:

```
ENTER DEVICE TYPE:
```

   Enter 3178 at the MD and press the ENT key on the MD.

   If REF key on the MD is pressed, information about supported device types appears.

```
ENTER DEVICE MODEL:
```

   Enter "C1", "C2", "C3", or "C4" at the MD and press the ENT key on the MD (Note: "C8" = "C3").

   If the REF key on the MD is pressed, information about supported device models appears.

```
ONLINE TEST
DEVICE TYPE: 3178
DEVICE MODEL: YY
ALL PARAMETER OK?
```

   "YY" is "C1", "C2", "C3", or "C4" at the is entered in the preceding step.

   If the device model is correct, press the YES key on the MD and go to step 6.

   If the device model is not correct, press the NO key on the MD and go to this step.

6. After the YES key on the MD is pressed, the following message appears on the MD:

```
CONNECT AND POWER ON
THE 3178.

PRESS ENT KEY.
```

   Connect the IBM 3178 to the MD through the coaxial interface adapter; set the Monocase/Dualcase switch to the Dualcase (A,a) position; turn on the security key (horizontal position); power on the IBM 3178; press ENT key on the MD.

   Note: The 76- and 88-key Katakana keyboards do not have the Monocase/Dualcase switch.

```
76/88 KEY
(JAPANESE KATAKANA)
KEYBOARD?
```

   If a 76- and 88-key Katakana keyboards is used, press the YES key on the MD. Otherwise press the NO key on the MD.

7. After the ENT key on the MD is pressed, the following message appears on the MD:

```
BASIC COMMANDS TEST
SHOULD BE EXECUTED?
```

   If you are repairing the logic element, press the YES key on the MD and go to step 8. Otherwise press the NO key on the MD. The test case selection menu appears. Go to step 9.

8. After the YES key on the MD is pressed in step 7, the basic command test (test case 0) starts and the following messages appear on the MD:

```
BASIC COMMANDS TEST
(TEST CASE 0)
RUNNING
PF KEY FOR EXIT.
```

If an error is detected, an error message appears (see "Error Messages" on page 3-19).

If the test completes with no errors are detected, or if you interrupt the test by pressing the PF key on the MD, the following message appears.

```
BASIC COMMANDS TEST
(TEST CASE 0)
END
PRESS ENT KEY.
```

Press the ENT key on the MD. The test case selection menu appears. Go to step 9.

9. After the ENT key on the MD is pressed in step 8, or the NO key on the MD is pressed in step 7, the test case selection menu appears on the MD:

```
SELECT TEST CASE
1 ALL CHAR DISPLAY
2 H CHAR DISPLAY
3 ECHO TEST   4 END
```

Enter 1, 2, 3, or 4 at the MD and press the ENT key on the MD to select the test case. Go to the corresponding step:

1-Go to step 10.
2-Go to step 11.
3-Go to step 12.
4-Go to step 13.

10. If option 1 is selected in step 9, the following message appears on the MD:

```
ENTER THE NUMBER OF
LINES (DEFAULT=23)
:
```

Enter the number of lines to be displayed on the screen of IBM 3178 (23 is the default; 00 means loop; 9999 is the maximum number that can be specified); then, press the ENT key on the MD.

```
ALL CHAR DISPLAY
(TEST CASE 1)
RUNNING
PF KEY FOR EXIT.
```

If an error is detected, an error message appears (see "Error Messages" on page 3-19).

If no errors are detected, or if you interrupt the test by pressing the PF key on the MD, the following message appears.

```
ALL CHAR DISPLAY
(TEST CASE 1)
END
PRESS ENT KEY.
```

Press the ENT key on the MD. The test case selection menu appears. Go to step 9.

11. If option 2 is selected in step 9, the following message appears on the MD:

```
ENTER THE NUMBER OF
LINES (DEFAULT=23)
:
```

Enter the number of lines to be displayed on the screen of the IBM 3178 (23 is the default; 00 means loop; 9999 is the maximum number that can be specified); then, press the ENT key on the MD.

```
H CHAR DISPLAY
(TEST CASE 2)
RUNNING
PF KEY FOR EXIT.
```

If an error is detected, an error message appears (see "Error Messages" on page 3-19).

If no errors are detected, or you interrupt the test by pressing the PF key on the MD, the following message appears.

```
H CHAR DISPLAY
(TEST CASE 2)
END
PRESS ENT KEY.
```

Press the ENT key on the MD. The test case selection menu appears. Go to step 9.

12. If option 3 is selected in step 9, the following message appears on the MD:

```
ECHO TEST
(TEST CASE 3)
RUNNING
PF KEY FOR EXIT.
```

Enter data for the echo test from keyboard of the IBM 3178. Press the PF key on the MD to complete the test.

If an error is detected, an error message appears (see "Error Messages" on page 3-19).

If no errors are detected, the following message appears.

```
ECHO TEST
(TEST CASE 3)
END
PRESS ENT KEY.
```

Press the ENT key on the MD. The test case selection menu appears. Go to step 9.

13. If option 4 is selected in step 9, the following message appears on the MD:

```
END OF PROGRAM.

PRESS ENT KEY.
```

Press the ENT key on the MD.

```
•END OF MAP• PRESS
RESET TO RESTART,
ANY OTHER FUNCTION
KEY TO TERMINATE
```

This completes the test.

If the test is to be restarted, press the RST key on the MD and go to step 5.

Error Messages

This section describes the error messages that appear during the online tests, and tells what the operator should do if a message appears.

```
ILLEGAL KEY RESPONSE
PRESS ANY FUNCTION
KEY TO CLEAR
```

Meanings: The keyboard/display response from the MD is not expected one. Press the ENT key on the MD to continue the test.

```
MDH31 K/D I/O ERROR
PRESS ANY FUNCTION
KEY TO CLEAR
```

Meanings: A keyboard/display I/O error occurred in the MD. Press the ENT key on the MD to continue the test.

```
TIMEOUT
ERROR.

PRESS ENT KEY.
```

Meanings: The IBM 3178 did not respond to the MD. Replace the logic board in the logic element. Restart the test.

```
BASIC COMMANDS
ERROR.

PRESS ENT KEY.
```

Meanings: The MD detected a command function error. Replace the logic board in the logic element. Restart the test.

```
INVALID TID
ERROR.

PRESS ENT KEY.
```

Meanings: The MD received an invalid terminal ID. Check the terminal ID jumper of the keyboard element (see Figure 5-5 on page 5-5). If the terminal ID jumper is correct, replace the keyboard assembly or the logic board. Restart the test.

```
SECURITY KEY
STATUS ERROR.

PRESS ENT KEY.
```

Meanings: Check that the security key is set to on (horizontal position). If it is set to on and this error occurs, replace the security key or the logic board in the logic element. Restart the test.

```
MONO/DUAL SWITCH
STATUS ERROR.

PRESS ENT KEY.
```

Meanings:

Check that the Monocase/Dualcase switch is set to the Dualcase (A,a) position. If the Monocase/Dualcase switch is set to Dualcase position and this error occurs, replace the keyboard assembly or the logic board in the logic element. Restart the test.

```
STATUS TRANSITION
ERROR.

PRESS ENT KEY.
```

Meanings: If you changed the switch status while the test was running, this error occurs. If this error occurs without changing the switch status, replace the logic board. Restart the test.

```
INVALID STATUS
ERROR.

PRESS ENT KEY.
```

Meanings:

The MD received an invalid status. Replace the logic board. Restart the test.

```
LINE PARITY
ERROR.

PRESS ENT KEY.
```

Meanings:

The MD detected a line parity error in the received data. Retry the test to

see if the error was caused by intermittent noise. If the error recurs, replace the logic board.

```
DATA PARITY
ERROR.

PRESS ENT KEY.
```

Meanings: The MD detected a data parity error in the received data. Retry the test to see if the error was caused by intermittent noise. If the error recurs, replace the logic board.

```
DEVICE CHECK
ERROR.

PRESS ENT KEY.
```

Meanings: An error was detected in the buffer of the IBM 3178. Replace the logic board. Restart the test.

```
ADAPTER
ERROR.

PRESS ENT KEY.
```

Meanings: The MD detected an error in the coaxial interface adapter attached to the MD. Verify that the adapter is attached correctly. Restart the test.

Note: To retry the test, press the ENT key on the MD. To restart the test, press the ENT key on the MD and then the RST key on the MD.

CHAPTER 4. REMOVAL AND REPLACEMENT PROCEDURES

This chapter describes how to remove and replace the FRUs of the work-station elements.

KEYBOARD ELEMENT

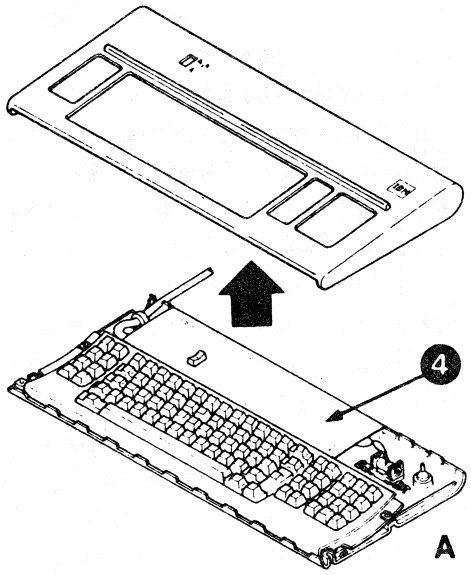
The keyboard element consists of:

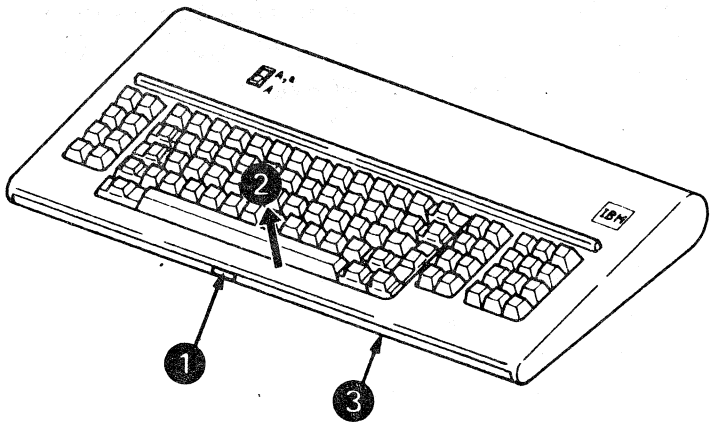
- Cover
- Keyboard assembly
- Clicker assembly
- Cable.

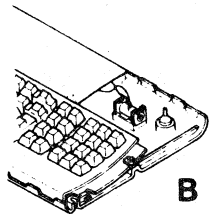
KEYBOARD ELEMENT COVER

See Figure 4-1.

1. Turn power to off and disconnect the power cord from the outlet.
2. Unplug the keyboard cable from the logic element.
3. Invert the keyboard element and remove the two screws from the corners of the base.
4. Return the keyboard element to its normal position.
5. Press the plastic tab ❶ inward using a screwdriver; push the top cover up ❷ , and lift the top cover from the base ❸ .
6. Reinstall in reverse sequence. If the keyboard is equipped with a soft plastic cover ❹ , ensure that it is not folded.







Note: The 76- and 88-key Katakana keyboards do not have a Monocase/Dualcase switch.

Figure 4-1. Keyboard Element Cover

KEYBOARD ASSEMBLY

See Figure 4-2.

1. Remove the keyboard top cover, as described under "Keyboard Element Cover" on page 4-1.
2. Disconnect the clicker cable connector ❶ from the keyboard assembly.
3. Disconnect the keyboard cable connector ❷ from the keyboard assembly.
4. Remove the two screws ❸ holding the keyboard assembly to the base, and lift the keyboard assembly from the base.
5. Reinstall in reverse sequence. If the keyboard is equipped with a soft plastic cover, ensure that it is not folded.

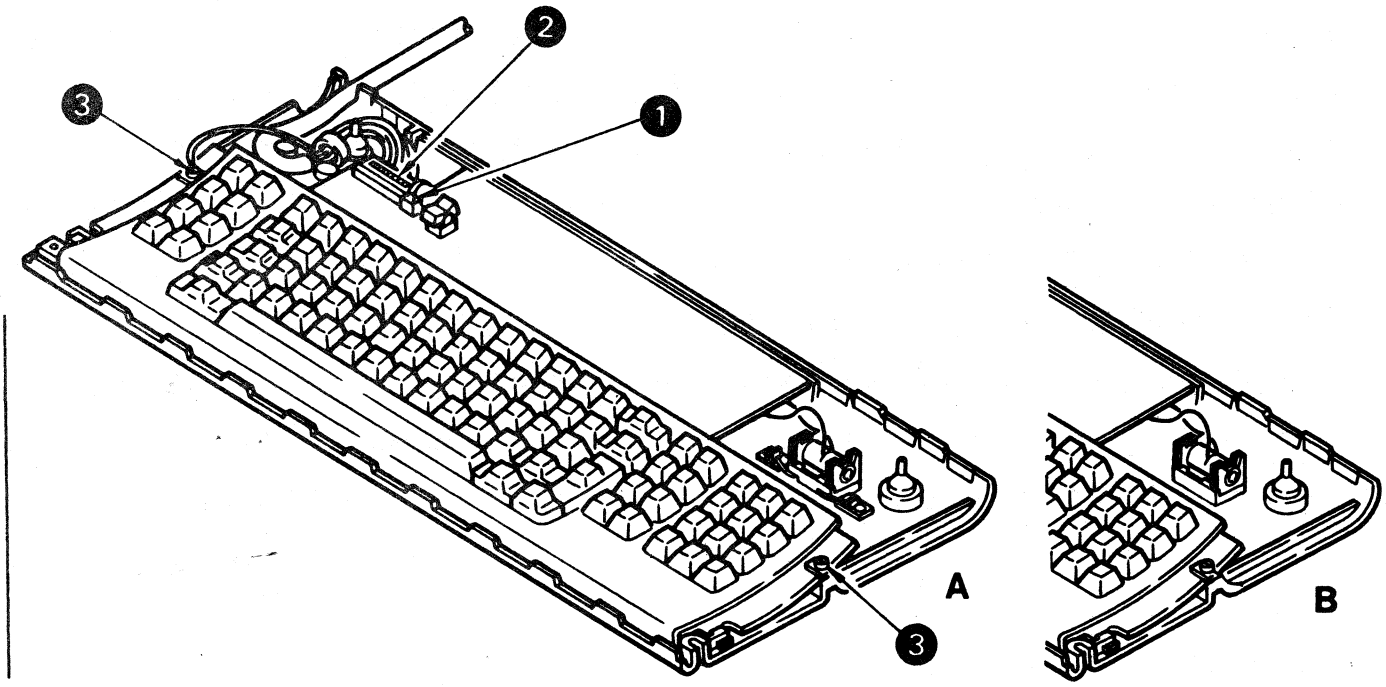
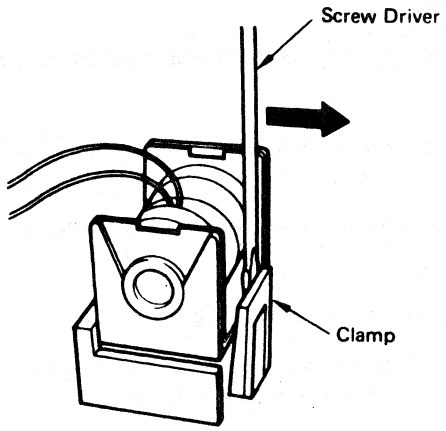


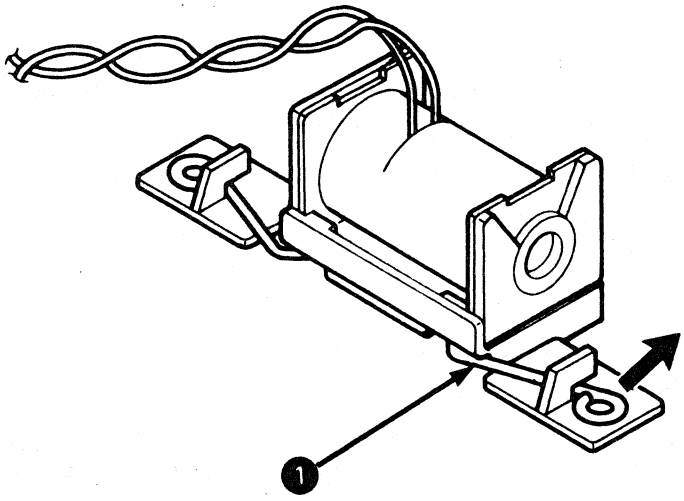
Figure 4-2. Keyboard Assembly

CLICKER ASSEMBLY

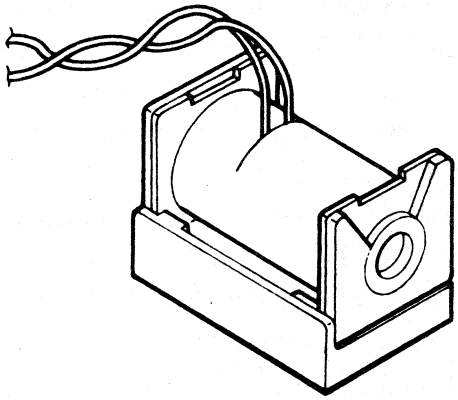
See Figure 4-3.

1. Remove the keyboard top cover as described under "Keyboard Element Cover" on page 4-1.
2. Disconnect the clicker cable connector from the keyboard assembly.
3. Depending on the type of assembly installed (see A and B below), remove the clicker assembly by sliding the bail fastener ❶ from the tabs (A) or unclamp the clicker by using a screw driver (B).
4. Reinstall in reverse sequence. If the keyboard is equipped with a soft plastic cover, ensure that it is not folded.





A



B

Figure 4-3. Clicker Assembly

KEYBOARD CABLE

See Figure 4-4.

Part required: Keyboard cable strap (Part 1159519)

1. Remove the keyboard top cover as described under "Keyboard Element Cover" on page 4-1.
2. Disconnect the keyboard cable connector from the keyboard assembly.
3. Remove the screw ❶ .
4. Using cutting pliers, cut the keyboard cable strap ❷ .
5. Remove the keyboard cable from the base.
6. Reinstall in reverse sequence. If the keyboard is equipped with a soft plastic cover, ensure that it is not folded.

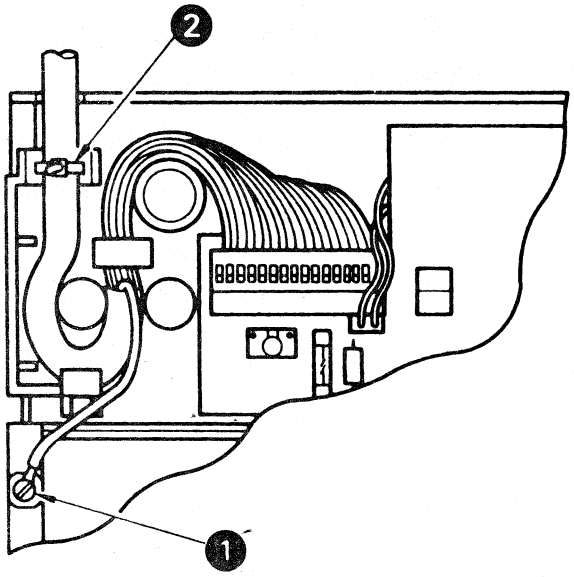


Figure 4-4. Keyboard Cable

VIDEO ELEMENT

The video element consists of:

- Contrast and brightness control knobs
- Rear cover
- Analog card
- CRT assembly.

CONTRAST AND BRIGHTNESS CONTROL KNOBS

1. Grasp the knob and pull it off.
2. Install a new knob by pushing it onto the shaft.

REAR COVER

See Figure 4-5.

CAUTION
A static charge may be present at the anode lead of the CRT; use an insulated jumper wire and momentarily ground the CRT anode terminal to the CRT mounting screw. (See "Video Element" on page 2-3).

1. Turn power to off and disconnect the power cord from the outlet.
2. Unplug the video cable from the logic element.
3. Invert the video element, remove the two white labels ❶ and the two screws ❷ from the base. (The screws are under the labels.)
4. Unfasten the video cable from the cable retainer of the base.
5. Return the video element to its normal position.
6. Remove the left plug ❸ and the right plug ❹ by inserting a screwdriver in the gap ❺ then twisting the screwdriver.
7. Remove two screws ❻ .
8. Pull the rear cover ❼ from the front assembly ❽ .
9. Reinstall in reverse sequence.

Notes:

1. Put new white labels over the bottom screws. The white labels are required for safety reasons. Do not return any video element to a customer without the labels.
2. The inside surface of each plug indicates whether it is a left (L) or right (R) plug.

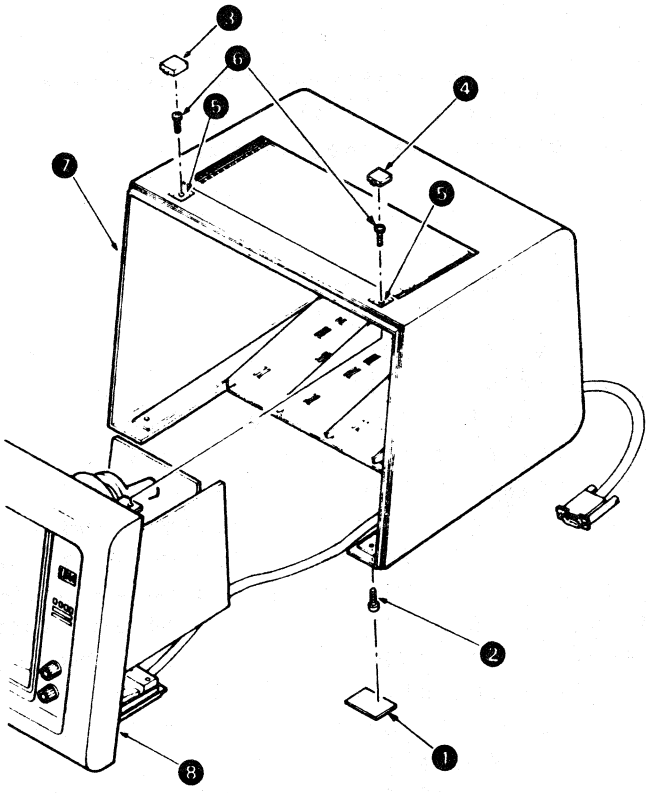


Figure 4-5. Video Element Cover

CABLE CLAMP

CAUTION
A static charge may be present at the anode lead of the CRT; use an insulated jumper wire and momentarily ground the CRT anode terminal to the CRT mounting screw. (See "Video Element" on page 2-3).

See Figure 4-6.

1. Remove the video element rear cover as described under "Rear Cover" on page 4-5 for the video element.
2. Remove the white label ❶ .
3. Remove the two screws ❷ .
4. Remove the screw ❸ .
5. Lift the cable clamp ❹ away from the front assembly.
6. Reinstall in reverse sequence.

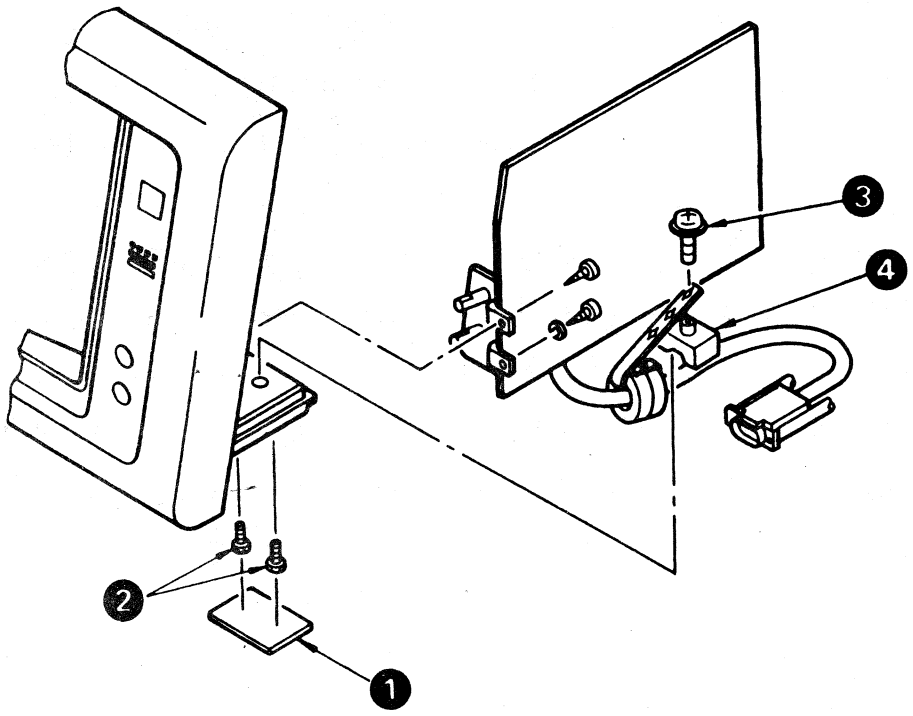


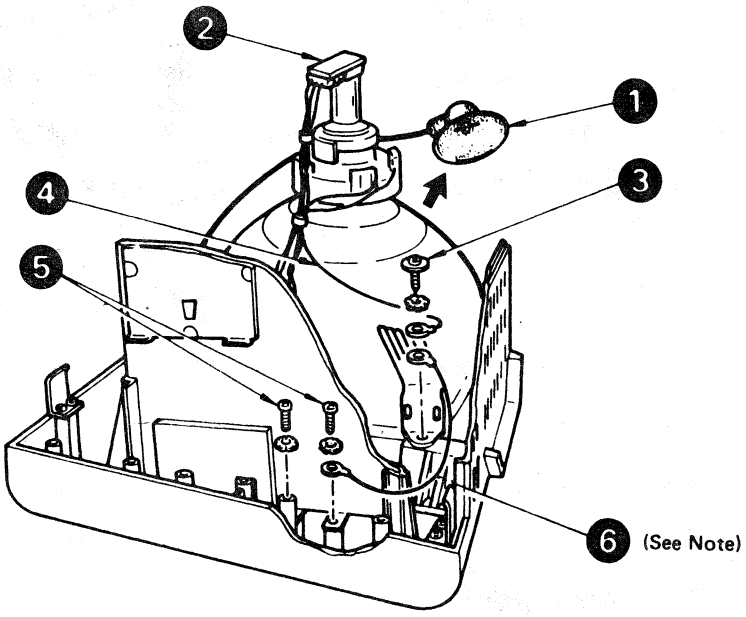
Figure 4-6. Cable Clamp

ANALOG CARD

CAUTION
A static charge may be present at the anode lead of the CRT; use an insulated jumper wire and momentarily ground the CRT anode terminal to the CRT mounting screw. (See "Video Element" on page 2-3).

See Figure 4-7.

1. Turn power off and disconnect the power cord from the outlet.
2. Remove the Brightness and Contrast Control knobs.
3. Remove the rear cover. (Discharge the static charge. See "Video Element" on page 2-3).
4. Remove the anode lead ❶ .
5. Carefully remove the small card ❷ connected to the CRT socket. (Do not break the glass extension in the center of the socket.)
6. Unsolder each of the four wires from the CRT yoke coil. Record or mark each wire color.)
7. Remove the cable clamp.
8. Remove the screw ❸ and the black wires ❹ and ❻ (See Note).
9. Remove the two analog-card holding screws ❺ and the black wire ❻ (See Note).
10. Reinstall the analog card in reverse sequence. (Do the "Final Check and Adjustments" on page 2-6).
11. Reinstall the rear cover. (Align the inside guide to the analog card.)



Note:
The black wire <6> is replaced by the insulated thin plate for video element, part 5894007, for E/ME/A.

Figure 4-7. Black Wire and Small Card

LOGIC ELEMENT

The logic element consists of:

- Cover
- Logic board assembly
- Power supply
- Security keylock assembly.

LOGIC ELEMENT COVER

See Figure 4-8.

1. Turn power to off and disconnect the power cord plug from the outlet.
2. Disconnect plugs ❶ from the logic element, then lift the video element ❷ from the top of the logic element.
3. Invert the logic element, and remove the single screw.
4. Return the logic element to its normal position.
5. Press the right plastic tab ❸ inward using a screwdriver, then push the top cover ❹ upward just far enough to release the tab.
6. Repeat step 5 for the left plastic tab ❸ ; lift the top cover ❺ from the base cover ❻ .
7. Reinstall the cover in reverse sequence.

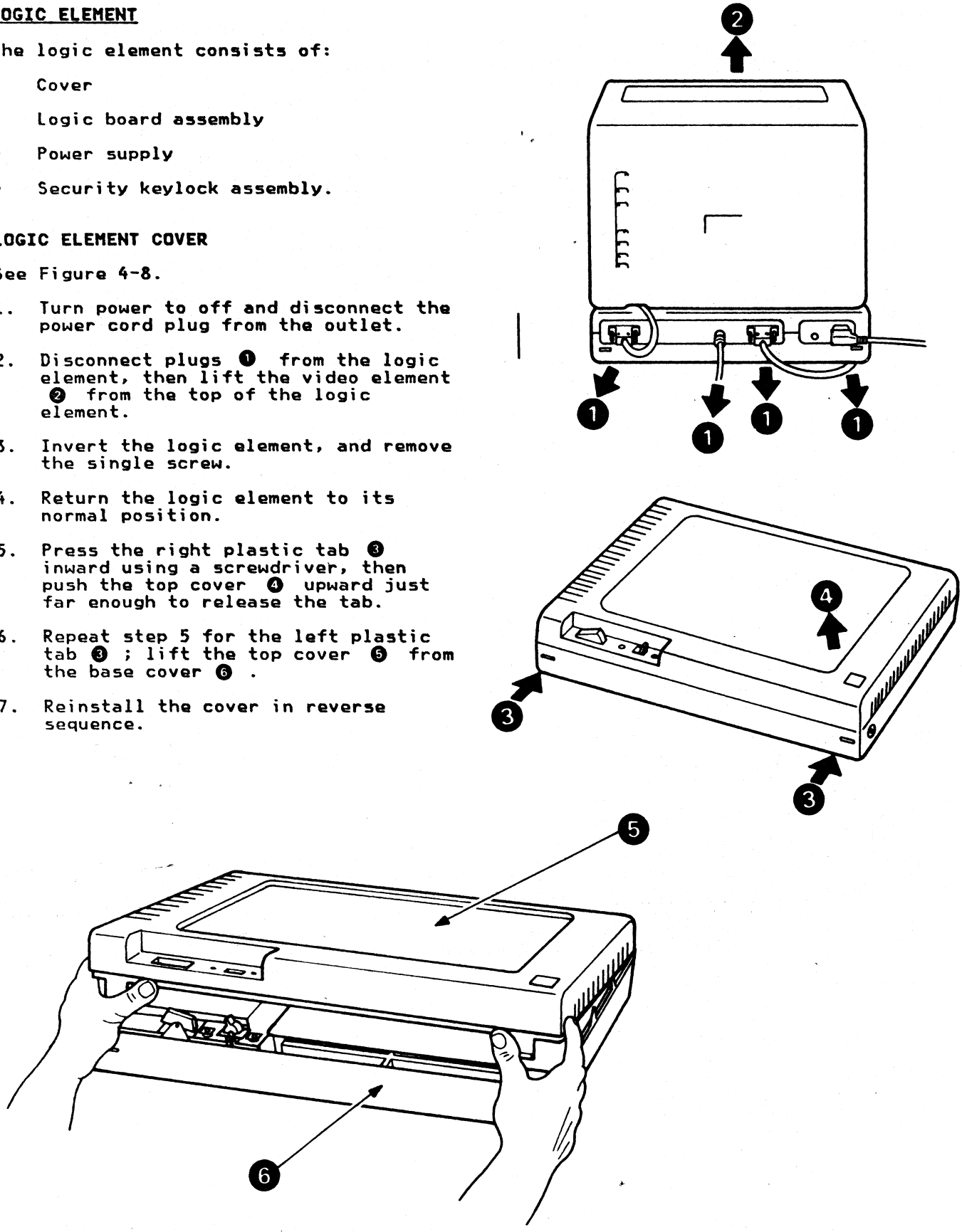


Figure 4-8. Logic Element Cover

LOGIC BOARD ASSEMBLY

See Figure 4-9.

1. Remove the logic element cover as described under "Logic Element Cover" on page 4-8.

2. Remove the screw ❶ connecting the logic board and power supply frame.

3. Remove the connector ❷ .

4. Lift edge ❸ slightly and pull the logic board ❹ from the connector ❺ .

5. Reinstall in reverse sequence.

Note: When reinstalling the screw ❶ , a torque of 1.1 to 1.5 newton meter (N•m) (10 to 13 inch-pounds) is required.

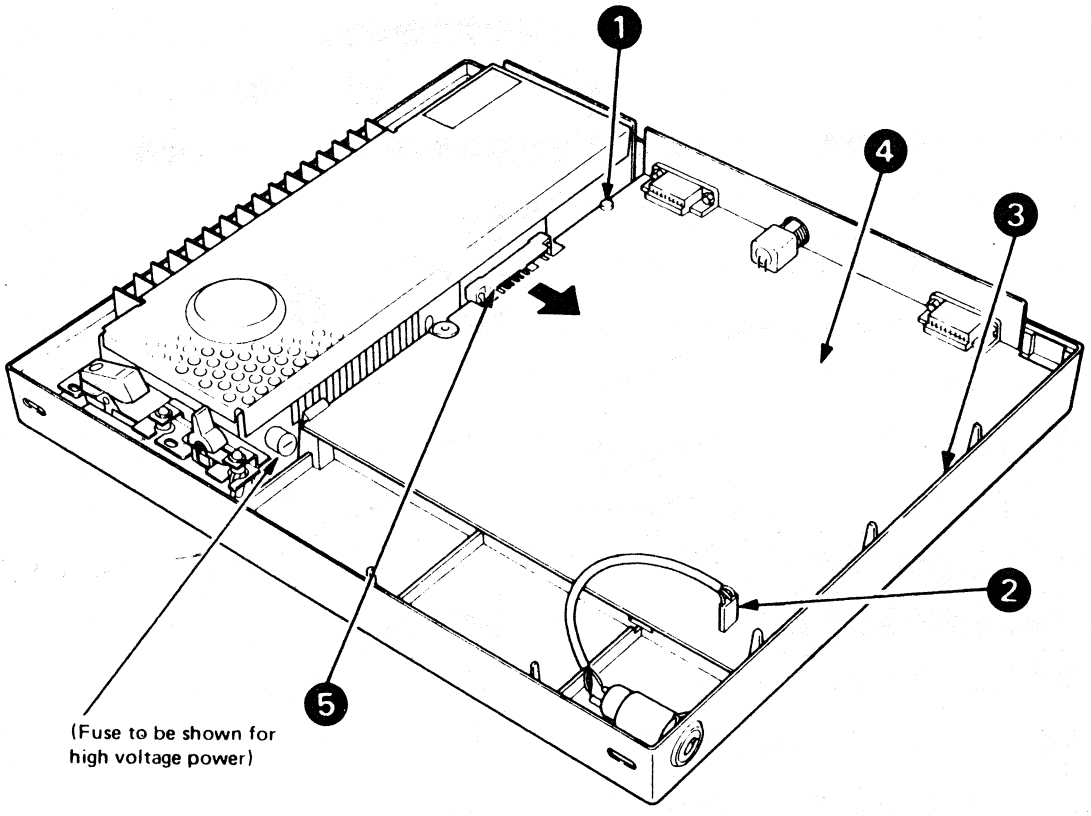


Figure 4-9. Logic Board Assembly

POWER SUPPLY

See Figure 4-10.

1. Remove the logic element cover and the logic-board assembly as described under the preceding procedures.
2. Disconnect the power cord plug ❶ from the power supply.
3. Disengage the two plastic tabs ❷ ; pivot the supply upward and pull it out from the two tabs on the opposite side ❸ .
4. Reinstall in reverse sequence.

SECURITY KEYLOCK ASSEMBLY

1. Remove the connector from the logic board.
2. Remove the nut or the clip from the keylock switch.
3. Remove the keylock switch from the base cover.
4. Reinstall in reverse sequence.

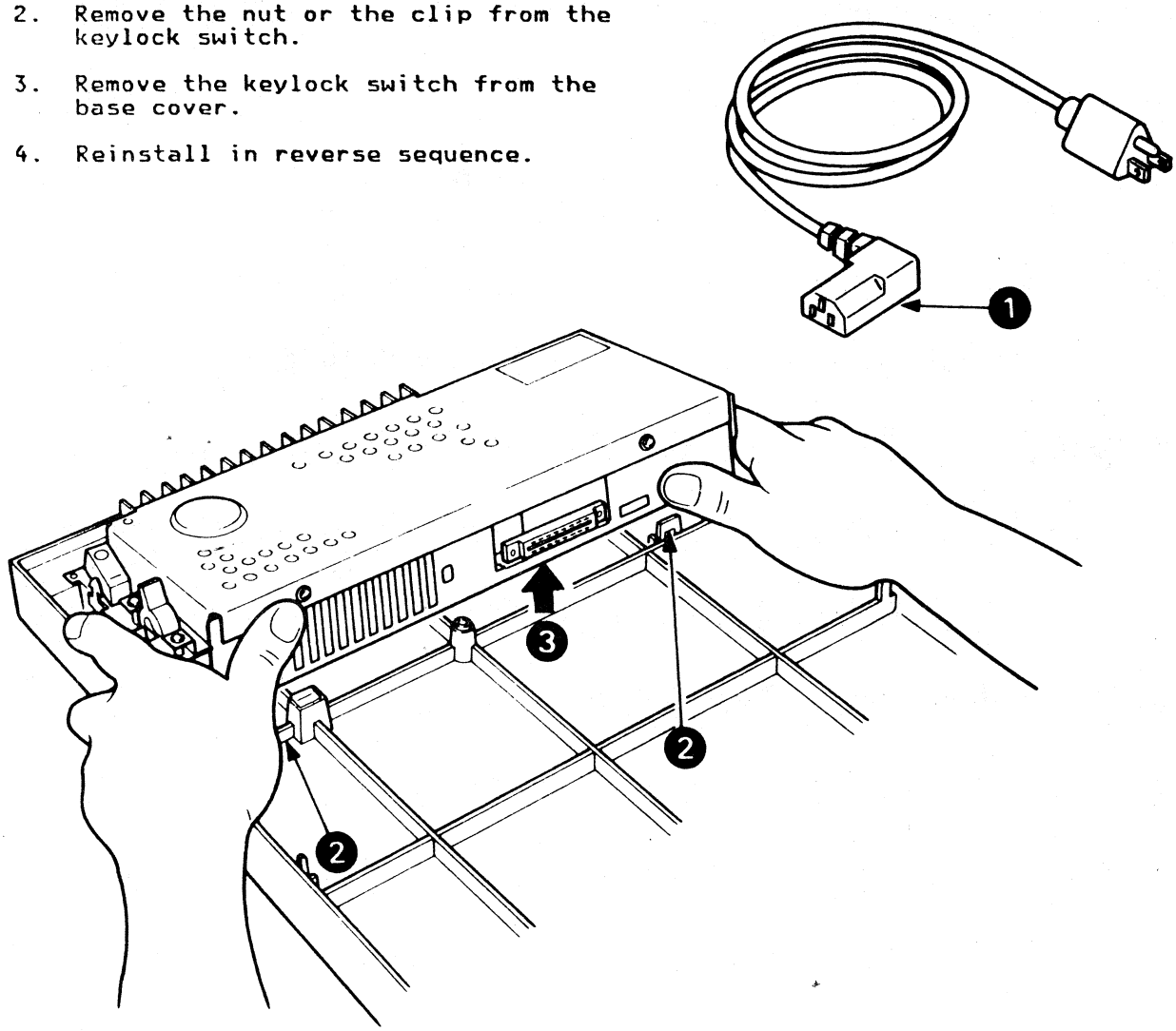


Figure 4-10. Power Supply

CHAPTER 5. LOCATIONS

The illustrations and tables in this chapter enable the user to locate field-replaceable units (FRUs), major assemblies, connectors, indicators, and switches, and to determine pin assignments. The nomenclature used is the same as that used on the unit or in engineering drawings.

DANGER

This product is equipped with a power plug which is approved for use with this machine and meets the standards for the user's safety. It is to be used with a properly grounded receptacle to avoid severe electrical shock.

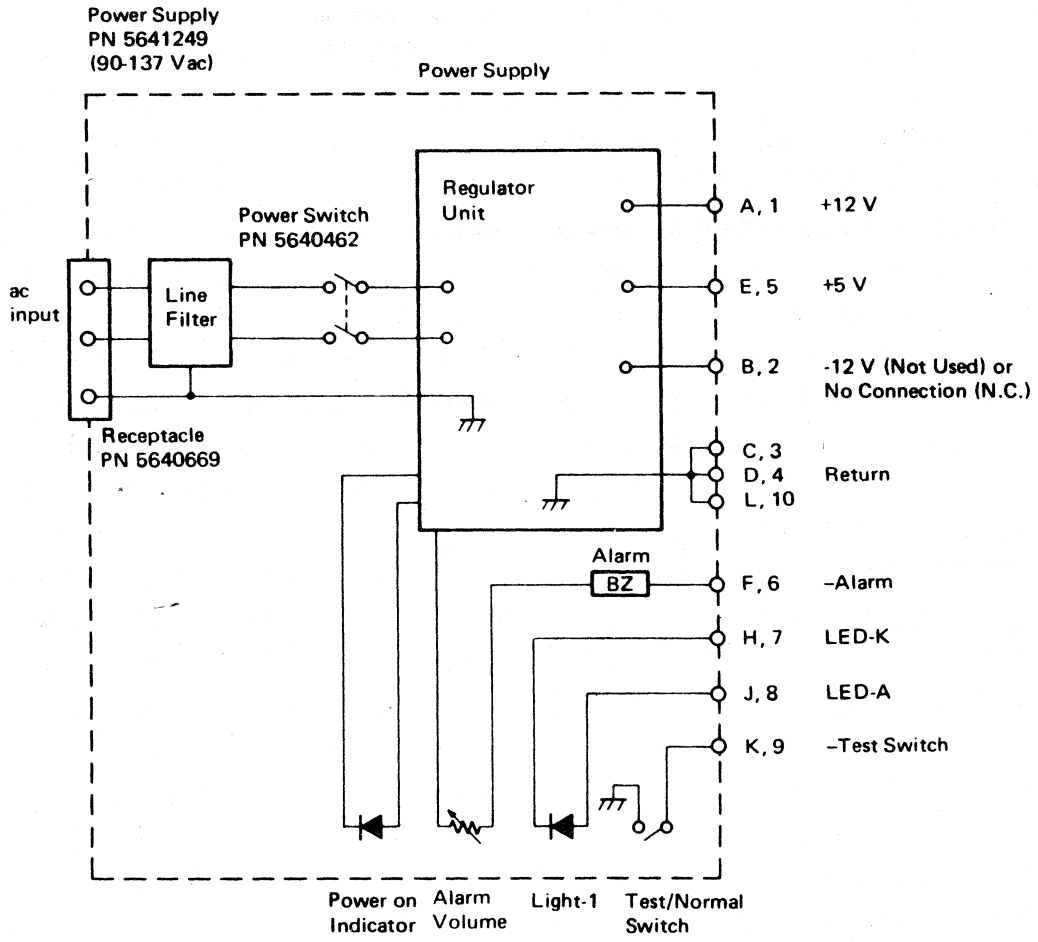


Figure 5-1. Power-Supply Schematic (Low Voltage)

DANGER

This product is equipped with a power plug which is approved for use with this machine and meets the standards for the user's safety. It is to be used with a properly grounded receptacle to avoid severe electrical shock.

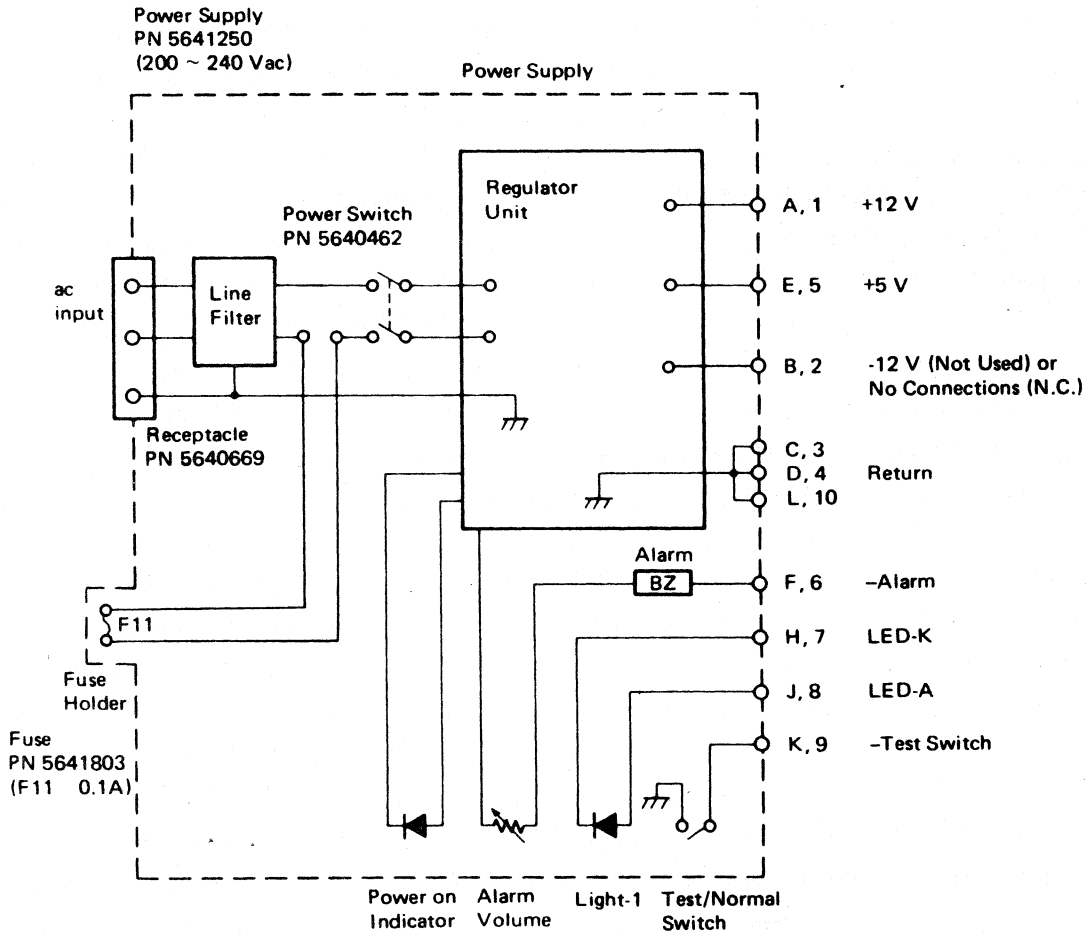
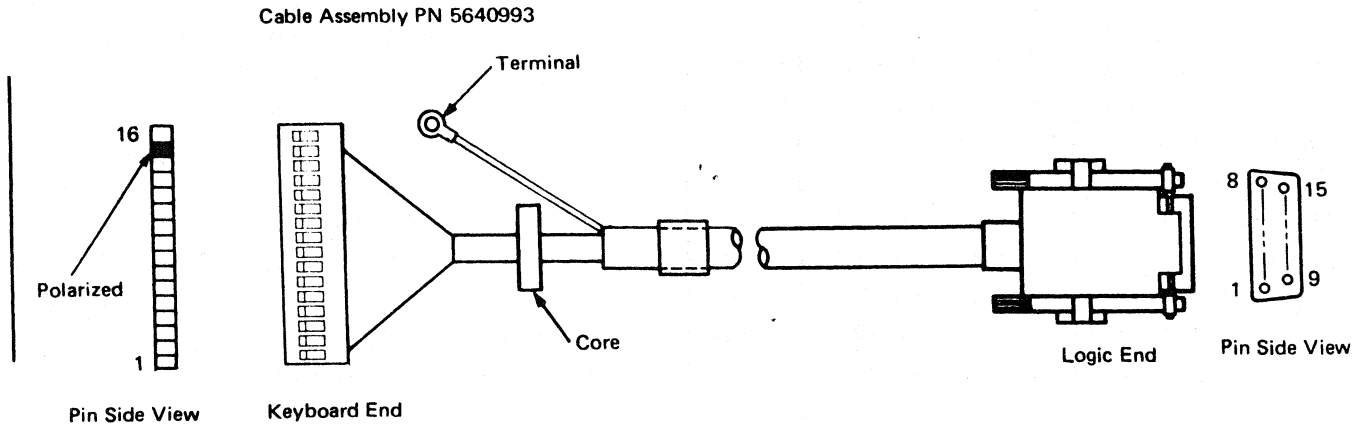
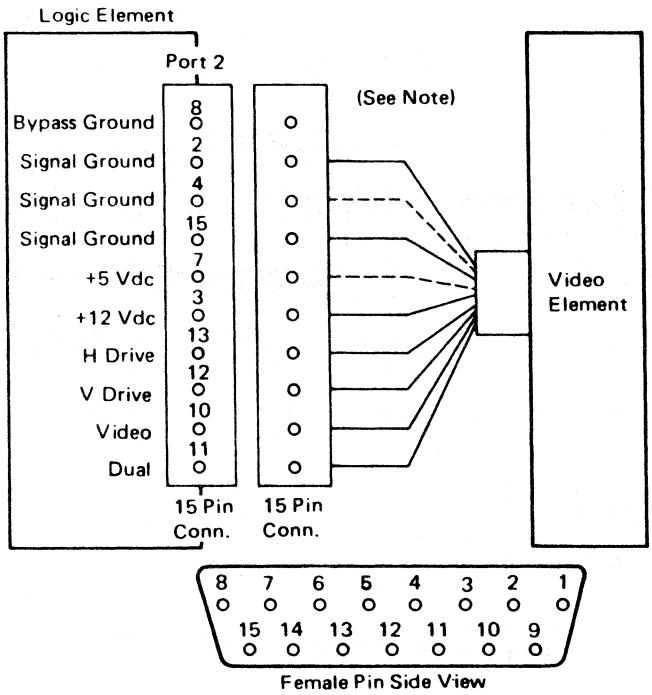


Figure 5-2. Power-Supply Schematic (High Voltage)



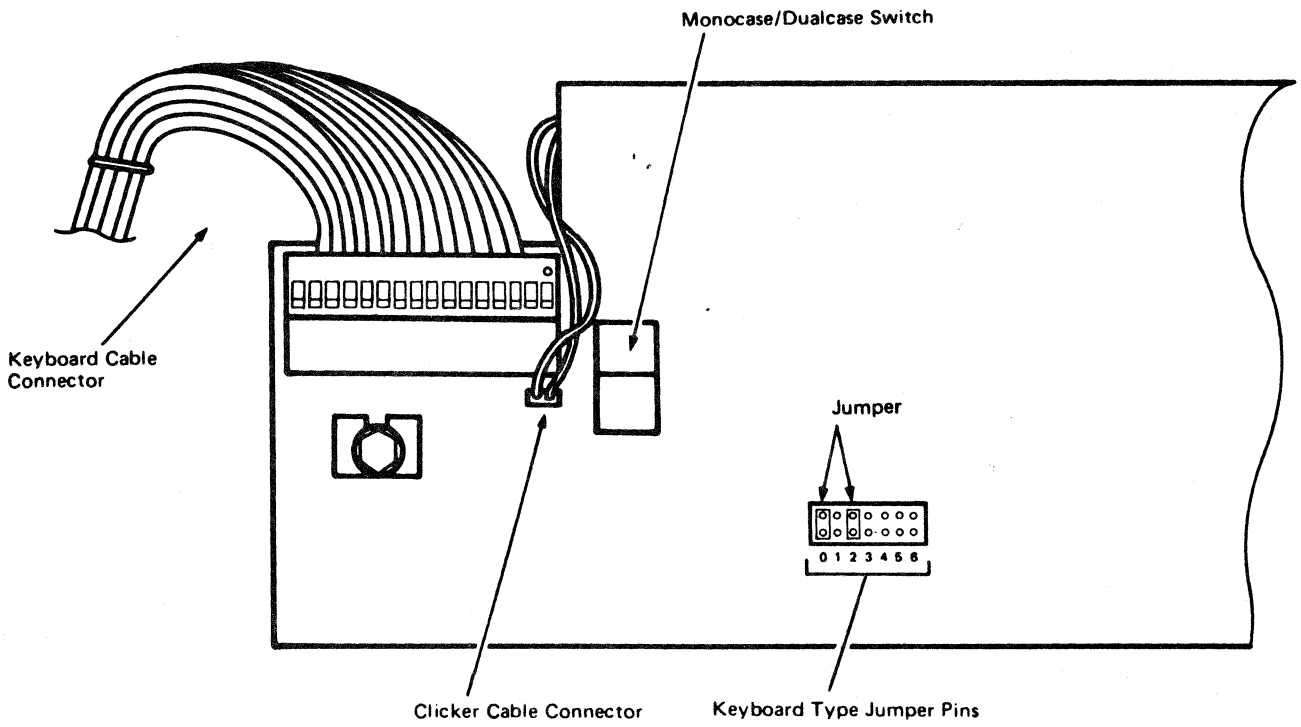
Wire No.	Wire Color	Keyboard End	Controller End	Line Title
1	Pink	2	2	+5 V dc
2	Red	7	9	Srl Data Clk
3	Aqua	9	4	Kda
4	Black	14	13	Cmd 1
5	Brown	5	10	Ack
6	White	13	12	Cmd 0
7	Blue	12	3	Por
8	Gray	8	5	Srl Data
9	Orange	1	6	Clicker Power
	Inner Drains	4, 6, 11, 16	7, 8, 14	Gnd
	Outer Drains	Terminal	1, 15	Gnd

Figure 5-3. Keyboard Cable and Pin Assignments



Note:
Signal ground at pin 4, and +5 V dc at pin 7, may or may not be used depending on the engineering change level of the video element.

Figure 5-4. Video Cable and Logic Element Pin Assignments



Keyboard Type	Jumper Positions						
	0	1	2	3	4	5	6
75-Key Data Entry Keyboard (Model C1)	X			X			
87-Key Typewriter Keyboard (Models C2 and C4)	X		X				
76-Key Data Entry Keyboard (Katakana)(Model C1)	X			X	X	X	X
88-Key Typewriter Keyboard (Katakana)(Model C2)	X		X		X	X	X
87-Key Typewriter Keyboard (Model C3)(US-ENGLISH only)			X	X			
87-Key Typewriter Keyboard (Model C8 RPQ7L0587)		•	X	X			

X Indicates that a jumper (Part 1650667) is needed.

• Jumper 1 is to inhibit the numeric lock feature.

Figure 5-5. Keyboard Type Jumpers

CHAPTER 6. TOOLS AND TEST EQUIPMENTS

The following tools and test equipment are needed at each repair center to maintain the IBM 3178:

1. CE meter
2. CE tool bag
3. Known good video, logic and keyboard elements
4. Series/1 with Repair Center Communication Products Test System (RCCPTS) or Maintenance Device (MD)
5. Adjustment tool for potentiometers, Part 5728554
6. IBM Repair Center Test Diskette for IBM 3101/3102/3104/3178/3179 (order number SY18-2068)
7. Coaxial Interface Adapter (Part 6052111).

APPENDIX A. IBM 3178 PART NUMBERS

This appendix provides the part numbers for the IBM 3178 FRUs. It consists of several figures with index numbers. Each figure has an associated list with the part numbers keyed to the callouts in the figure.

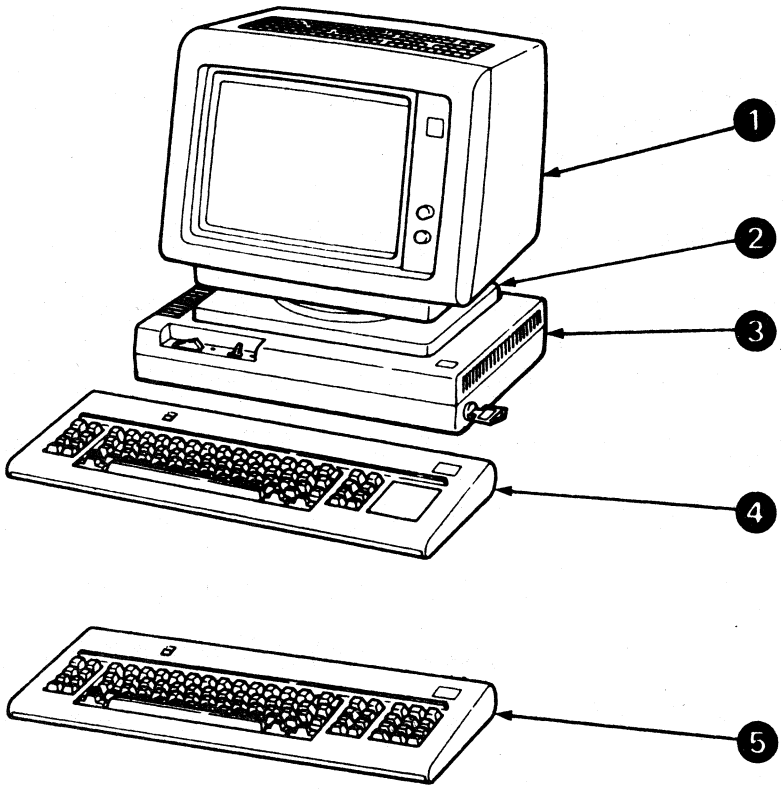


Figure A-1. IBM 3178 Final Assembly

Figure Callout	Part Number	Units Per Asm.	Description 1 2 3 4
1	5894000	REF	VIDEO ELEMENT, FOR US AND A/FE
	5894007	REF	VIDEO ELEMENT, FOR E/ME/A
			FOR DETAILS, SEE LIST A-4
2	5641300	REF	VIDEO ELEMENT STAND, FOR US AND A/FE
	5641790	REF	VIDEO ELEMENT STAND, FOR E/ME/A
			FOR DETAILS, SEE LIST A-9
3	5640980	REF	LOGIC ELEMENT, FOR US AND A/FE (LOW VOLTAGE)
	5641793	REF	LOGIC ELEMENT, FOR A/FE (HIGH VOLTAGE)
	5640982	REF	LOGIC ELEMENT, FOR E/ME/A (HIGH VOLTAGE)
			FOR DETAILS, SEE LIST A-6
4	5640991	REF	KEYBOARD ASSEMBLY, 75-KEY FOR US ENGLISH
	4742679	REF	KEYBOARD ASSEMBLY, 75-KEY
			FOR CANADIAN/FRENCH
	4742681	REF	KEYBOARD ASSEMBLY, 75-KEY
			FOR SPANISH SPEAKING
	4742680	REF	KEYBOARD ASSEMBLY, 76-KEY
			FOR KATAKANA
	4742686	REF	FOR FRENCH QWERTY
	4742687	REF	FOR FRENCH AZERTY
	4742688	REF	FOR AUSTRIAN/GERMAN
	4742689	REF	FOR ITALIAN
	4742690	REF	FOR UK-ENGLISH
	4742691	REF	FOR BELGIAN
	4742692	REF	FOR DANISH
	4742693	REF	FOR NORWEGIAN
	4742694	REF	FOR PORTUGUESE
	4742695	REF	FOR SPANISH
	4742696	REF	FOR SWEDISH
	4742698	REF	FOR SWISS/FRENCH
	4742699	REF	FOR SWISS/GERMAN
	5640967	REF	FOR US-ENGLISH (E/ME/A EXCEPT GERMAN)
	5641667	REF	FOR US-ENGLISH (GERMAN)
|	6052105	REF	FOR US-ENGLISH (NETHERLANDS)
|	6052106	REF	FOR SWEDISH (FINLAND)
5	5640987	REF	KEYBOARD ASSEMBLY, 87-KEY US ENGLISH
	4742683	REF	KEYBOARD ASSEMBLY, 87-KEY
			FOR CANADIAN/FRENCH
	4742685	REF	KEYBOARD ASSEMBLY, 87-KEY
			FOR SPANISH SPEAKING
	4742684	REF	KEYBOARD ASSEMBLY, 88-KEY
			FOR KATAKANA
	4742700	REF	FOR FRENCH QWERTY
	4742701	REF	FOR FRENCH AZERTY
	4742702	REF	FOR AUSTRIAN/GERMAN
	4742703	REF	FOR ITALIAN
	4742704	REF	FOR UK-ENGLISH
	4742705	REF	FOR BELGIAN
	4742706	REF	FOR DANISH
	4742707	REF	FOR NORWEGIAN
	4742708	REF	FOR PORTUGUESE
	4742709	REF	FOR SPANISH
	4742710	REF	FOR SWEDISH
	4742712	REF	FOR SWISS/FRENCH
	4742713	REF	FOR SWISS/GERMAN
	5640968	REF	FOR US-ENGLISH (E/ME/A EXCEPT GERMAN)
	5641668	REF	FOR US-ENGLISH (GERMAN)
|	6052102	REF	FOR US-ENGLISH (NETHERLANDS)
|	6052103	REF	FOR SWEDISH (FINLAND)
	6052101	REF	KEYBOARD ASSEMBLY, 87-KEY US ENGLISH MODEL C3
	6052141	REF	KEYBOARD ASSEMBLY, 87-KEY US ENGLISH MODEL C4

Figure A-2. Final Assembly Part Number List

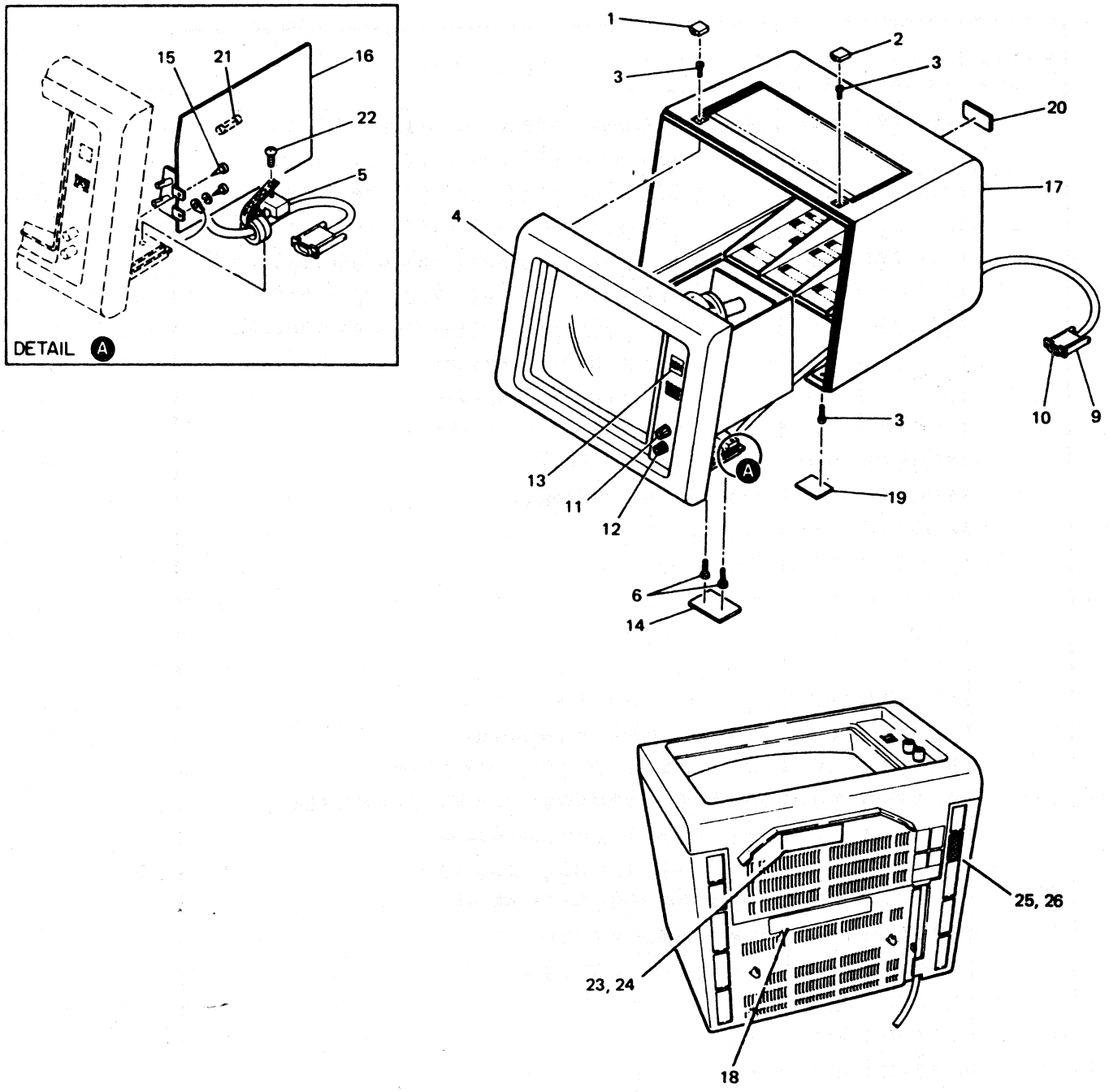


Figure A-3. Video Element

Figure Callout	Part Number	Units Per Asm.	Description 1 2 3 4
1	5640452	1	. PLUG, LEFT
2	5640585	1	. PLUG, RIGHT
3	5640459	4	. SCREW, PAN HD, PLUS - M4 X 12 LG SUBSTITUTE PART NO. 1621062
4	REF.	1	. FRONT ASSEMBLY
5	5640460	1	. . CLAMP, CABLE SUBSTITUTE PART NO: 167338
6	5640574	2	. . SCREW, SELF-TAP
9	5640560	2	. . STUD
10	5640735	2	. . RETAINER
11	5641794	1	. . KNOB ASSEMBLY, CONTRAST
12	5641795	1	. . KNOB ASSEMBLY, BRIGHTNESS
13	2684095	1	. . MARK, LOGO
14	5894234	1	. . LABEL, BEZEL
15			
16	5641799	1	. ANALOG CARD - CRT ASSEMBLY, FROM SERIAL 23-00001 TO 23-N2869 FOR US AND A/FE
	6052134	1	. ANALOG CARD - CRT ASSEMBLY, FROM SERIAL 23-N2870 FOR US AND A/FE
	6052104	1	. ANALOG CARD - CRT ASSEMBLY, FROM SERIAL 55-00001 TO 55-99999 FOR E/ME/A
	8116607	1	. ANALOG CARD - CRT ASSEMBLY, FROM SERIAL 55-A0000 FOR E/ME/A
17	5640582	1	. COVER, REAR
18	5640888	1	. LABEL, CAUTION FOR US AND A/FE
	5641228	1	. LABEL, CAUTION FOR E/ME/A
19	5894227	2	. LABEL, WHITE
20	5894225	1	. LABEL
21	6827897	1	. FUSE, ANALOG, 2 A SUBSTITUTE PART NO. 333952
22	5894233	1	. SCREW-SELF TAP
23	5641661	1	. LABEL, SERIAL NUMBER
24	5641662	1	. LABEL, CLEAR FOR US AND A/FE
25	5641785	1	. LABEL, RID TAG
26	5894266	1	. LABEL, RID TAG FOR REPLACED MACHINES

Figure A-4. Video Element Part Number List

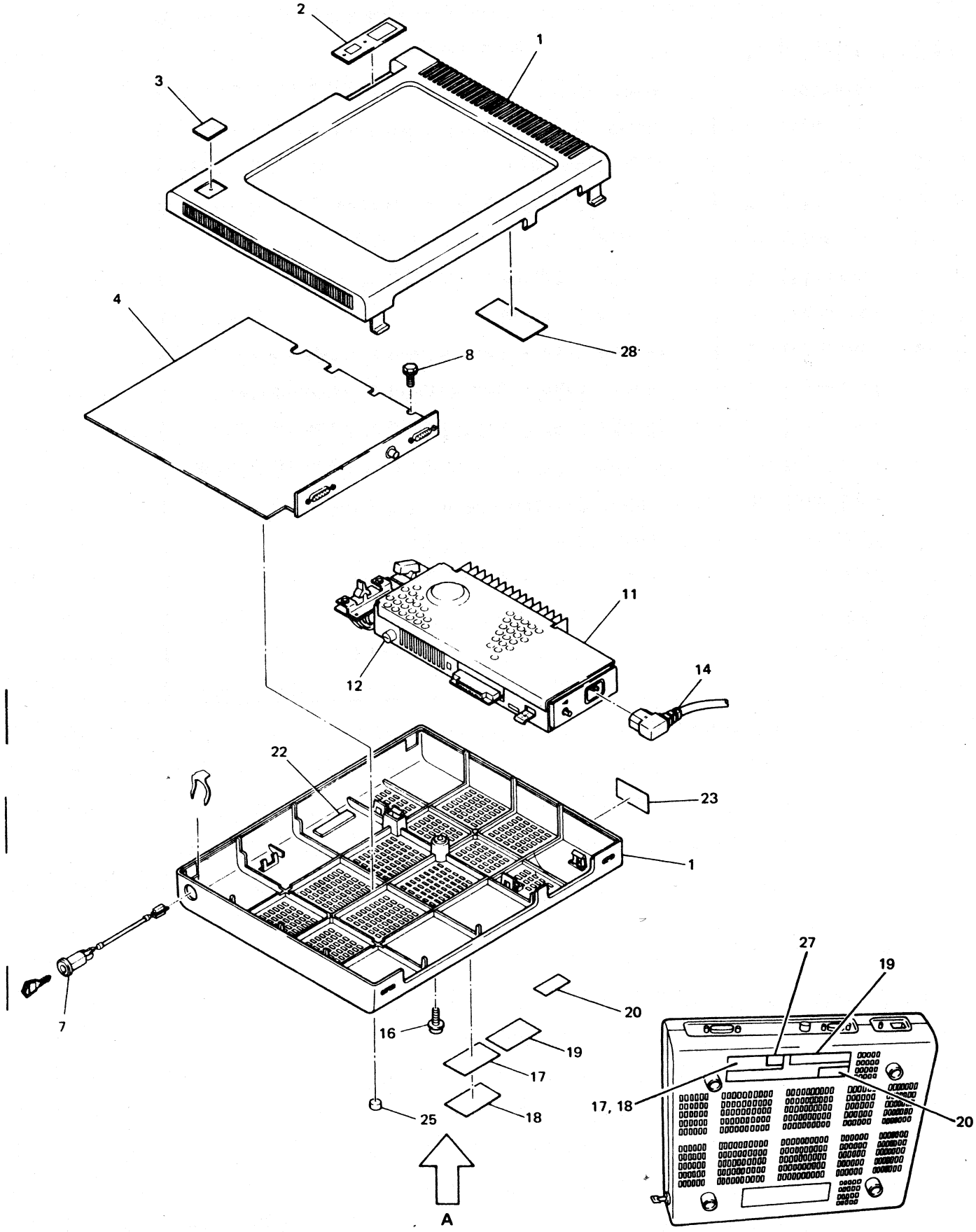


Figure A-5. Logic Element

View A

Figure Callout	Part Number	Units Per Asm.	Description 1 2 3 4
1	5641832	1	. COVER GROUP - KIT FOR US AND A/FE (SEE NOTE 1)
	6052142	1	. COVER GROUP - KIT FOR E/ME/A (SEE NOTE 1)
2	5641241	1	. PLATE, SWITCH
	5641278	1	. PLATE, SWITCH, JAPAN
3	5640989	1	. PLATE, NAME
4	6052127	1	. CARD ASSEMBLY
7*	5641791	1	. SECURITY KEY ASSEMBLY (TUBULAR TYPE) (SEE NOTE 1 AND 2)
*	6112987	1	. SECURITY KEY ASSEMBLY (FLAT TYPE) (SEE NOTE 1 AND 2)
8	8323229	1	. SCREW
11	5641249	1	. POWER SUPPLY ASSEMBLY, LOW VOLTAGE
	5641250	1	. POWER SUPPLY ASSEMBLY, HIGH VOLTAGE
12	5641803	1	. FUSE, AC, 1A, 250V FOR HIGH VOLTAGE
14*	5640670	1	. CORD ASSEMBLY FOR US AND CANADA 1.8M (SEE, LIST A-6 Part 2 of 2) (SEE NOTE 3)
*	5640671	1	. CORD ASSEMBLY FOR US AND CANADA 3M (SEE NOTE 3)
16	6052098	1	. SCREW
17*	5641661	1	. LABEL, SERIAL NUMBER RID TAG (SEE NOTE 4)
18*	5641662	1	. LABEL, CLEAR FOR LOW VOLTAGE MACHINES (SEE NOTE 4)
19*	5641238	1	. LABEL, POWER RATING, LOW VOLTAGE (SEE NOTE 4)
*	5641239	1	. LABEL, POWER RATING, HIGH VOLTAGE (SEE NOTE 4)
20*	5641816	1	. LABEL, UL/CSA FOR LOW VOLTAGE MACHINES (SEE NOTE 4)
22*	5641661	1	. LABEL, SERIAL NUMBER (SEE NOTE 4)
23*	6052100	1	. LABEL, FCC FOR LOW VOLTAGE MACHINES (SEE NOTE 5)
25	5641811	4	. FOOT, RUBBER
25	6238481	4	. FOOT, CORK
27	5894266	1	. LABEL, RID TAG FOR REPLACED MACHINES
28	5641818	1	. LABEL, FE REPAIR FOR E/ME/A
29	5640888	1	. LABEL, WARNING

Notes:

a. When replacing the cover, use the proper type of security key assembly depending on the orientation of D-shape hole on the cover. (Figure callouts 1 and 7)

b. When replacing the security key assembly, use the same type as the original. (Figure callout 7)

c. When replacing the cord assembly, the same length as the original must be used. (Figure Callout 14)

d. When laser print is applied instead of these labels, these labels may be omitted. (Figure callouts 17, 18, 19, 20 and 22)

e. When FCC marking is molded in, this label may be omitted. (Figure Callout 23)

Figure A-6 (Part 1 of 2). Logic Element Part Number List

Figure Callout	Part Number	Units Per Asm.	Description 1 2 3 4
			. CORD ASSEMBLY,
REF	5640670	1	. USA 1.8M
REF*	6952298	1	(SEE NOTE)
REF	5640671	1	. USA 3M/CANADA
REF*	6952297	1	. USA 2.8M/CANADA (SEE NOTE)
REF	5640662	1	. ARGENTINA
REF*	6952288	1	(SEE NOTE)
REF	5640662	1	. BRUNEI, MALAYSIA, SINGAPORE, HONG KONG
REF*	4449006	1	(SEE NOTE)
REF	5640663	1	. INDONESIA
REF*	4449003	1	(SEE NOTE)
REF	5640664	1	. AUSTRALIA, NEWZEALAND
REF*	4449000	1	(SEE NOTE)
REF	5640668	1	. CHILE
REF*	4449002	1	(SEE NOTE)
REF	5640671	1	. BAHAMAS, BARBADOS, BERMUDA, BOLIVIA, COLOMBIA, COSTA RICA, DOMINICAN REPUBLIC, ECUADOR, EL SALVADOR, GUATEMALA, GUYANA, HONDURAS, JAMAICA, KOREA, MEXICO, NETHERLANDS ANTILES, NICARAGUA, PANAMA, PHILIPPINES, TAIWAN, TRINIDAD TOBAGO, VENEZUELA, JAPAN
REF*	6952297	1	(SEE NOTE)
REF	5641389	1	. SRI LANKA
REF*	4449008	1	(SEE NOTE)
REF	5640661	1	. AUSTRIA, BELGIUM, EGYPT, FINLAND, FRANCE, GERMANY, ICELAND, LEBANON, NORWAY, PORTUGAL, SPAIN, SUDAN, SWEDEN, SYRIA, YUGOSLAVIA, ROECE
REF*	4449003	1	(SEE NOTE)
REF	5640662	1	. BAHRAIN, IRELAND, JORDAN, KUWAIT, QATAR, SAUDI ARABIA, SIERRA LEONE, UK
REF*	4449006	1	(SEE NOTE)
REF	5640665	1	. SWITZERLAND
REF*	4449007	1	(SEE NOTE)
REF	5640666	1	. SOUTH AFRICA
REF*	4449008	1	(SEE NOTE)
REF	5640667	1	. DENMARK
REF*	4449005	1	(SEE NOTE)
REF	5640668	1	. ITALY
REF*	4449002	1	(SEE NOTE)
REF	5640672	1	. ISRAEL
REF*	4449001	1	(SEE NOTE)
REF	5641082	1	. NETHERLANDS
REF*	4449003	1	(SEE NOTE)

Note:
New part as substitution.

Figure A-6 (Part 2 of 2). Logic Element Part Number List

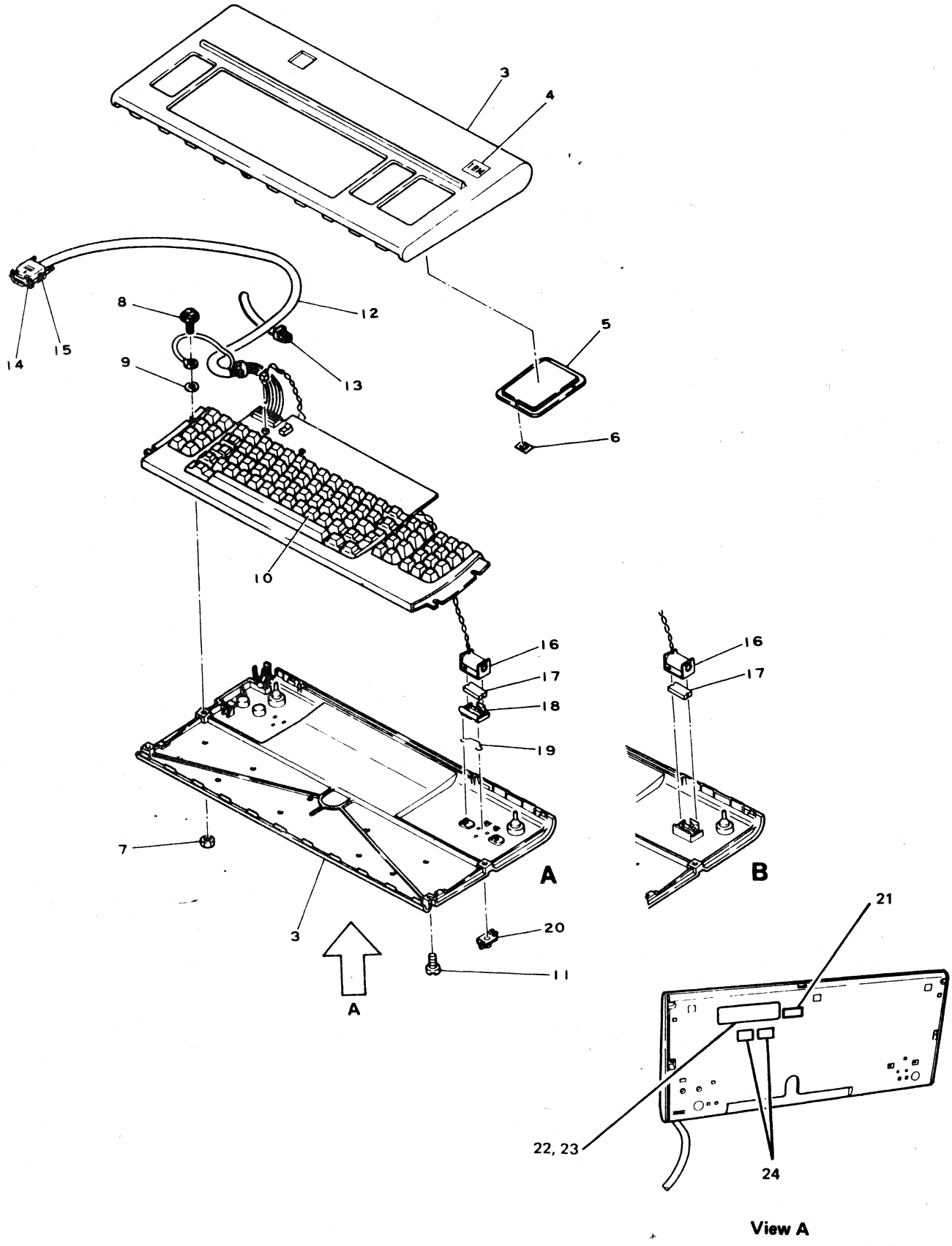


Figure A-7. Keyboard Element

Figure Callout	Part Number	Units Per Asm.	Description 1 2 3 4
3	5641654	1	. COVER ASSEMBLY KIT
	5641809	1	. COVER ASSEMBLY KIT, FOR KATAKANA
4	5894063	1	. PLATE, LOGO
5	5894057	1	. COVER, PAD, FOR 75/76-KEY KEYBOARD ONLY
6	308196	3	. CLIP, FOR 75/76-KEY KEYBOARD ONLY
7	1622403	2	. NUT
8	8323229	2	. SCREW
9	4942270	2	. WASHER
10	9995689	1	. US-ENGLISH 75 KEY -US/AFE
	9995697	1	. US-ENGLISH 87 KEY -US/AFE
	9995691	1	. CANADIAN/FRENCH 75 KEY
	9995699	1	. CANADIAN/FRENCH 87 KEY
	9995692	1	. KATAKANA 76 KEY
	9995700	1	. KATAKANA 88 KEY
	9995694	1	. SPANISH SPEAKING 75 KEY
	9995702	1	. SPANISH SPEAKING 87 KEY
	4580833	1	. FRENCH QWERTY 75 KEY
	4580860	1	. FRENCH QWERTY 87 KEY
	4580846	1	. FRENCH AZERTY 75 KEY
	4580859	1	. FRENCH AZERTY 87 KEY
	4580834	1	. AUSTRIAN/GERMAN 75 KEY
	4580847	1	. AUSTRIAN/GERMAN 87 KEY
	4580835	1	. ITALIAN 75 KEY
	4580848	1	. ITALIAN 87 KEY
	4580836	1	. UK-ENGLISH 75 KEY
	4580849	1	. UK-ENGLISH 87 KEY
	4580837	1	. BELGIAN 75 KEY
	4580850	1	. BELGIAN 87 KEY
	4580838	1	. DANISH 75 KEY
	4580851	1	. DANISH 87 KEY
	4580839	1	. NORWEGIAN 75 KEY
	4580852	1	. NORWEGIAN 87 KEY
	4580840	1	. PORTUGUESE 75 KEY
	4580853	1	. PORTUGUESE 87 KEY
	4580841	1	. SPANISH 75 KEY
	4580854	1	. SPANISH 87 KEY
	4580842	1	. SWEDISH 75 KEY
	4580855	1	. SWEDISH 87 KEY
	7899540	1	. SWISS/FRENCH 75 KEY
	7899539	1	. SWISS/FRENCH 87 KEY
	7899538	1	. SWISS/GERMAN 75 KEY
	7899537	1	. SWISS/GERMAN 87 KEY
	9995689	1	. US-ENGLISH 75 KEY-E/ME/A
	9995697	1	. US-ENGLISH 87 KEY-E/ME/A
	6110674	1	. US-ENGLISH 87 KEY-MODEL C3
	1435255	1	. US-ENGLISH 87 KEY-MODEL C4
11	5894004	2	. SCREW
	5894004	2	. SCREW, FOR KATAKANA
12	5640993	1	. CABLE ASSEMBLY
13	1159519	1	. CABLE STRAP
14	5640560	2	. STUD
15	5640735	2	. RETAINER
16	6052124	1	. CLICKER
17	1742663	1	. CUSHION

Figure A-8 (Part 1 of 3). Keyboard Element Part Number List

Figure Callout	Part Number	Units Per Asm.	Description 1 2 3 4
18*	1742664	1	. CRADLE (SEE NOTE)
19*	1742658	1	. BAIL FASTENER (SPRING) (SEE NOTE)
20	5641298	2	. FOOT ASSEMBLY
21	5894266	1	. LABEL, RID TAG FOR REPLACED MACHINES
	5641785	1	. LABEL, RID TAG
22	5640695	1	. LABEL, SERIAL NUMBER FOR E/ME/A
	5641661	1	. LABEL, SERIAL NUMBER FOR US AND A/FE
23	5641662	1	. LABEL, CLEAR FOR US-ENGLISH (US AND A/FE AND CANADIAN/FRENCH
24	811825	2	. LABEL,
25	5641820	1	. LABEL, FE REPAIR FOR E/ME/A
26	1853030	1	. SWITCH ASSEMBLY

Note:
When the clicker is snapped in (in case of B), the cradle and the bail fastener may be omitted.

Figure A-8 (Part 2 of 3). Keyboard Element Part Number List

Figure Callout	Part Number	Units Per Asm.	Description 1 2 3 4
REF	1642317		. SPACE BAR
			. KEY BUTTON GROUP
	4580803	1	. CANADIAN/FRENCH 75 KEY
	4580811	1	. CANADIAN/FRENCH 87 KEY
	4580804	1	. JAPANESE KATAKANA 76 KEY
	4580812	1	. JAPANESE KATAKANA 88 KEY
	4580861	1	. FRENCH QWERTY 75 KEY
	4580888	1	. FRENCH QWERTY 87 KEY
	4580874	1	. FRENCH AZERTY 75 KEY
	4580887	1	. FRENCH AZERTY 87 KEY
	4580862	1	. AUSTRIAN/GERMAN 75 KEY
	4580875	1	. AUSTRIAN/GERMAN 87 KEY
	4580863	1	. ITALIAN 75 KEY
	4580876	1	. ITALIAN 87 KEY
	4580864	1	. UK-ENGLISH 75 KEY
	4580877	1	. UK-ENGLISH 87 KEY
	4580865	1	. BELGIAN 75 KEY
	4580878	1	. BELGIAN 87 KEY
	4580866	1	. DANISH 75 KEY
	4580879	1	. DANISH 87 KEY
	4580867	1	. NORWEGIAN 75 KEY
	4580880	1	. NORWEGIAN 87 KEY
	4580868	1	. PORTUGUESE 75 KEY
	4580881	1	. PORTUGUESE 87 KEY
	4580869	1	. SPANISH 75 KEY
	4580882	1	. SPANISH 87 KEY
	4580870	1	. SWEDISH 75 KEY
	4580883	1	. SWEDISH 87 KEY
	7899544	1	. SWISS/FRENCH 75 KEY
	7899543	1	. SWISS/FRENCH 87 KEY
	7899542	1	. SWISS/GERMAN 75 KEY
	7899541	1	. SWISS/GERMAN 87 KEY
	4580806	1	. SPANISH SPEAKING 75 KEY
	4580814	1	. SPANISH SPEAKING 87 KEY
	9995705	1	. US-ENGLISH 75 KEY-MODEL C1
	4580809	1	. US-ENGLISH 87 KEY-MODEL C2
	6110700	1	. US-ENGLISH 87 KEY-MODEL C3
	1435269	1	. US-ENGLISH 87 KEY-MODEL C4

Figure A-8 (Part 3 of 3). Keyboard Element Part Number List

APPENDIX B. IBM 3178 SAFETY INSPECTION GUIDE

SAFETY INSPECTION GUIDE

MACHINE TYPE

IBM 3178 SERIAL # _____

PREPARATION

Before starting this procedure, ensure that machine power is off and all electrical power has been removed from the machine.

Completion of "Electrical Safety Training Course for IBM Customer Engineers" (self study course 77170 or current level) is required.

Reference items:

- Current CEMs and ECAs
- Minimum space requirements (You can obtain this information from the IBM 3178 Display Station Description, GA18-2127)
- Electrical Safety for IBM Customer Engineers (S229-8124).

Use the documents listed above as required to ensure that all safety requirements have been met.

GENERAL GUIDELINES

The purpose of this inspection guide is to assist you in identifying possible unsafe conditions that may exist on machines that are being inspected. Each machine, as it was designed and built, had required safety items installed to protect the owners, operators, and service personnel from injury. This checklist addresses only those items. Good judgement should be used to identify potential safety conditions not covered by this inspection guide.

If any unsafe conditions are present, you must determine how serious the apparent hazard could be and whether you can continue without first correcting the problem.

Consider these conditions and the safety hazards they present:

- Electrical:

  The primary power or an electrically charged frame can cause serious or fatal electrical shock.

- Grounding:

  Proper installation of frame grounds

- Wiring:

  Insulation should not be damaged, cable ties and clamps should be installed where appropriate.

- Explosive:

  For example, bulging capacitors can cause serious injury.

- Mechanical hazards:

  Missing safety covers may expose hazardous areas.

- Chemical:

  Use of chemicals, or solvents other than those specified by IBM.

CAUTION
Switch power off and disconnect the power plug from the power outlet.

GENERAL

CHECK:

_____ Covers for sharp edges, burrs, and damage.

_____ Cables for correct routing, wear, pinched areas, or frays. Cable ties should be installed as necessary.

_____ The main power switch for proper mechanical and electrical operation.

_____ Check the power cord:

___ For a factory molded plug with no alterations (except E/ME/A).

___ For adequate insulation.

___ For being properly secured.

___ For any non-IBM alterations that may expose

a customer or servicing CE to safety hazards.

If safety hazards are present, contact your manager.

VIDEO ELEMENT

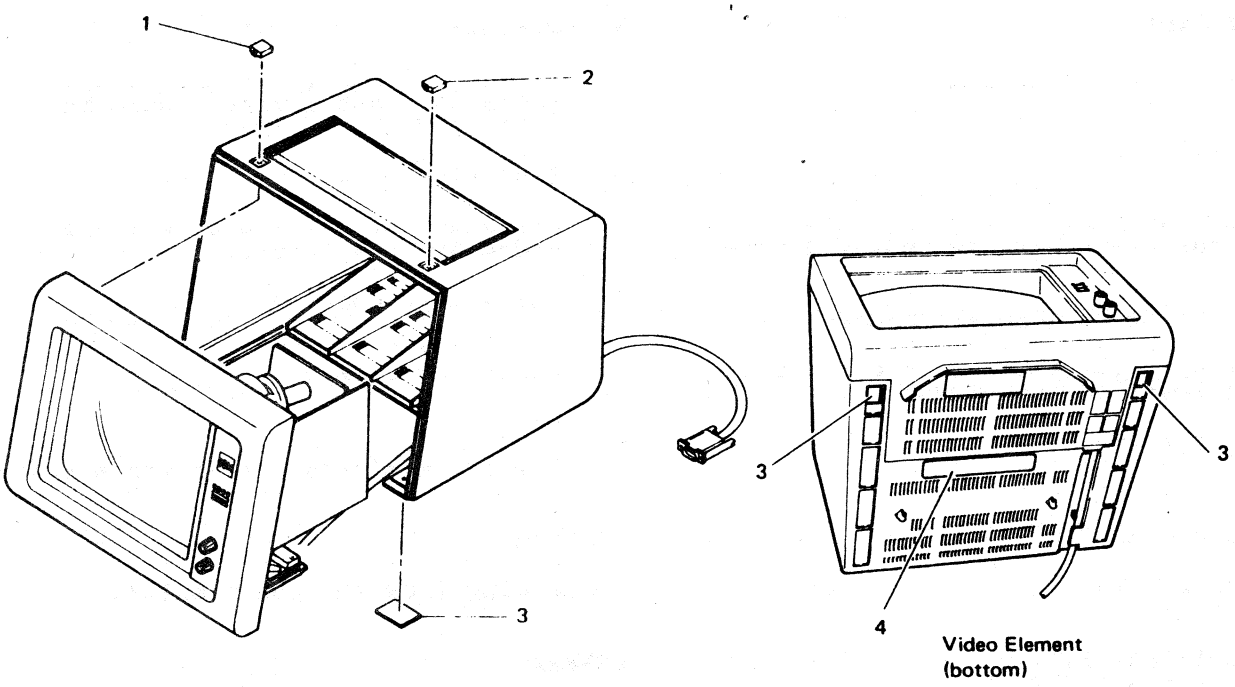


Figure B-1. Video Element

CHECK:

Ensure that the following plugs and labels are installed:

___ Part 5894227 Label - white <3>(x2)

___ Part 5640452 Plug - Left <1>

___ Part 5640585 Plug - Right <2>

___ Part 5640888 Label <4> - Caution for US, AFE

___ Part 5641228 Label <4> - Caution for EMEA

LOGIC ELEMENT

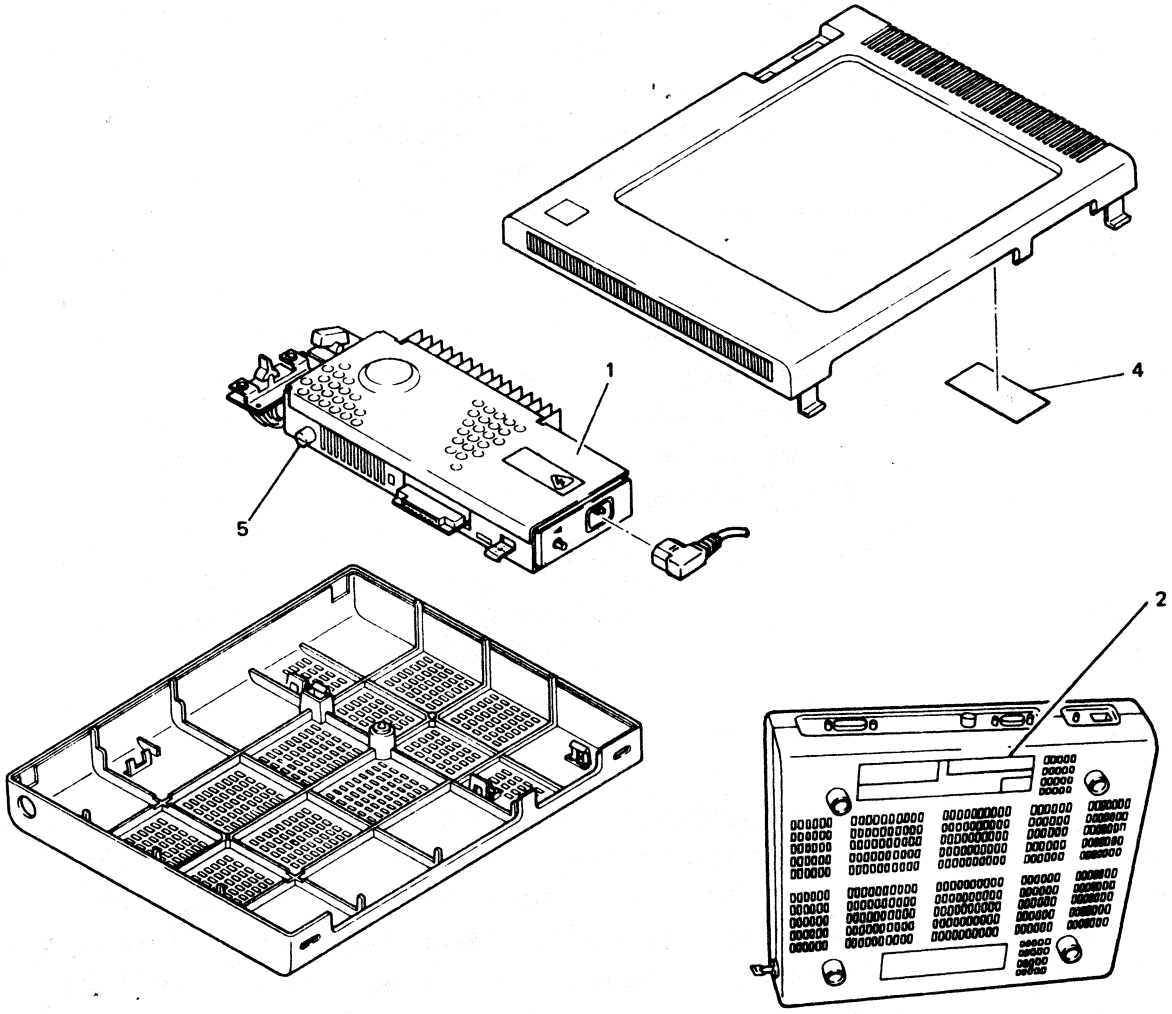


Figure B-2. Logic Element

CHECK:

Ensure that the following labels are installed:

___ Part 5640696 or Part 6052136 Label Warning - LOW VOLT <1>

___ Part 5640697 or Part 6052138 Label Warning - HIGH VOLT <1>

___ Part 5641238 Power Rating Plate - Low Voltage <2>

___ Part 5641239 Power Rating Plate - High Voltage <2>

___ Part 5641818 Label -FE repair for E/ME/A <4>

Note: Part 5641238 and 5641239 may be omitted when laser print is applied instead of the label.

Ensure that the proper fuse is installed for E/ME/A <5>:

KEYBOARD ELEMENT

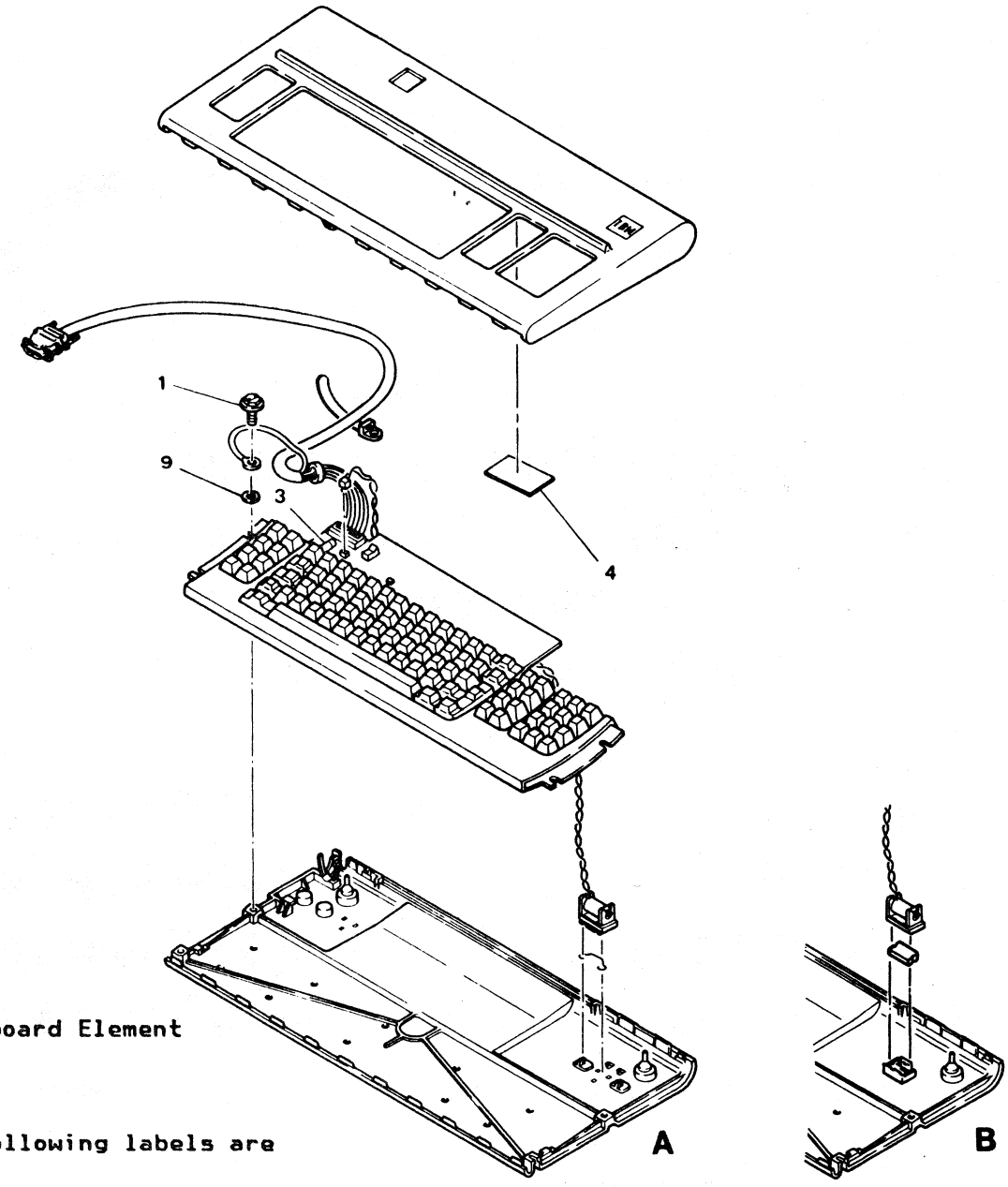


Figure B-3. Keyboard Element

CHECK:

Ensure that the following labels are installed:

___ Part 5641820 Label -FE repair for E/ME/A <4>

Ensure that the screw is installed for proper grounding. <1> <2>

Ensure that the proper fuse <3> is installed.

APPENDIX C. IBM 3178 SELF STUDY GUIDE

INTRODUCTION

The purpose of this section is to help Repair Center technicians develop an effective maintenance approach for the IBM 3178 Display Station.

All time spent using this section of the maintenance manual for learning purposes should be recorded using Service Code 50.

PRODUCT DESCRIPTION

The IBM 3178 Display Station is a low priced display. The IBM 3178 Display is a 12-inch , 1920 character display.

SYSTEM SUPPORT

The IBM 3178 may be attached to the IBM 3274, IBM 3276, or the IBM 4300.

Hardware Component Description

The IBM 3178 contains three customer replaceable elements (video, keyboard, logic) and two customer replaceable items (video stand and power cord).

HARDWARE COMPONENT DESCRIPTION

Video Element

The video element contains a dark face 12-inch high resolution CRT. Solid state television technology is employed.

The screen surface can be cleaned with a dry, soft, clean cloth. DO NOT USE A WET CLOTH, ABRASIVES, OR CHEMICAL CLEANERS.

The video element contains the Analog Card which is the only Field Replaceable Unit (FRU) in the Video.

Keyboard Element

The IBM 3178 keyboard has either a 75 or 76-key data-entry or an 87- or 88-key typewriter type keyboard and attaches to the logic element via a cable.

The keyboard contains the following FRUs:

1. Keyboard CSA (Common Sub-Assembly)
2. Keyboard cable
3. Covers

Logic Element

The logic element contains a logic card and power supply with adapters for the following:

1. Keyboard element
2. Video element
3. Coaxial Cable interface

A security lock is supplied with each IBM 3178. The key may be removed in the off position. Every logic element returned to stock must contain two security keys.

The logic element contains the following FRUs:

1. Logic card
2. Security lock
3. Security Keys
4. Covers
5. Power Supply

Video Stand

A video stand is allows the video element to be tilted from 0 or -2 to +20 degrees (US/AFE) or -2 to +20 degrees (E/ME/A) and rotated left or right 90 degrees. The video stand is not repairable and should be thrown away if defective.

Power Cord

A removable power cord is available in two lengths; 1.8m (US only) or 2.8m. The power cord is not repairable and should be thrown away if defective.

SPECIAL FEATURES

There are no special features for the IBM 3178.

MAINTENANCE STRATEGY

GENERAL INSTRUCTIONS

The maintenance strategy for the IBM 3178 is to attach a suspected failing element into a known good working machine (Golden Unit) for fault detection.

Once installed and powered on, a series of diagnostics known as the Basic Assurance Test (BAT) will automatically run.

If errors are detected during the BAT, record the error, check the "Symptoms-to-FRU List" on page 2-12, to identify the suspected failing Field Replaceable Unit (FRU).

To identify the suspected failing FRU use the following procedures located in Chapter 2 for each element.

Keyboard Element	"Keyboard Element" on page 2-1
Video Element	"Video Element" on page 2-3
Logic Element	"Logic Element" on page 2-7

If the BAT runs correctly, proceed with test procedures listed in "Offline Tests" on page 3-1 and the on-line test procedures listed in "Online Tests" on page 3-7 for fault detection.

"Error Code-to-FRU Lists" on page 2-11 is provided for use when the customer supplies system error code information on the S/ROF.

Note: These error codes cannot be recreated in a Repair Center environment.

Chapter 4, "Removal and Replacement Procedures" on page 4-1, describes the removal and replacement procedures for all FRUs. This chapter is divided into sections for each element.

ELEMENT REPAIR STRATEGY

Chapter 2, "Problem Analysis And Repair Procedures" on page 2-1, provides a useable and effective approach to element repair and FRU isolation. This chapter is divided into sections for each element.

Video Element

"Video Element" on page 2-3 contains instructions for servicing the IBM 3178 video element. These instructions must be followed when any repair activity is to be performed. Once the failing FRU is identified, "Video Element" on page 4-5 should be used for video FRU removal and replacement.

Keyboard Element

"Keyboard Element" on page 2-1 contains instructions for servicing the IBM 3178 keyboards. These instructions must be followed when any repair activity is to be performed. Once the failing FRU is identified, "Keyboard Element" on page 4-1 should be used for keyboard FRU removal and replacement.

Logic Element

"Logic Element" on page 2-7 contains instructions for servicing the IBM 3178 logic element. "Logic Element" on page 4-8 should be used for assistance in any logic FRU removal and replacement. Read these sections to become familiar with the maintenance approach for the logic element.

Note: All logic elements must be checked to ensure that two security keys are attached before returning the element to stock.

NO TROUBLE FOUND (NTF) PROCEDURES

"Logic No Trouble Found (NTF) Procedure" on page 2-13 contains instructions for handling NTF logic element returned for repair.

TECHNICAL SUPPORT STRUCTURE

Repair Center technicians requiring technical assistance not provided in the Repair Centers should do the following in the order listed:

1. Check RETAIN for assistance or fix information
2. Obtain all published CEMs and Service Aids for assistance
3. Contact your support structure

RETAIN and all published CEMs and Service Aids should be checked before utilizing your support structure.

IPAR RECORDING INSTRUCTIONS

IPAR reporting is required for all repair incidents on the IBM 3178. A IPAR Code Guide has been provided to all Repair Centers.

SELF EVALUATION

SELF TEST

1. When is the Error Code-to-FRU list used?

2. What procedures should be followed when more than one FRU is listed as probable cause in the Symptom-to-FRU list?

3. If Off-line Tests are being run, what steps are taken to exit these tests?

4. When would you see a 2xx error code during testing?

5. What functions and operations are verified by the Off-line Test Pattern?

6. If a customer provided an error code of 41 where would you find the information for which FRU to replace?

7. What procedures should be followed AFTER any repair action is performed?

8. Under what conditions should Service Business Product Planning or CETO (EMEA) or CSTO (AFE) be contacted for technical assistance to the Repair Centers?

9. If the Off-line tests run successfully and no obvious problems are found, the element should be returned to stock or to the customer, depending upon the service offering. (T/F)

ANSWERS

1. When the customer has provided a problem description.

2. Where multiple FRUs are listed as probable cause of a problem, they are listed in the sequence of most-probable to least-probable. The FRUs should be replaced, separately, in that order.

3. To exit the Off-line Test, switch the Test/Normal switch to Normal.

4. This type of error code cannot be recreated in the RC and can only be seen on the S/ROF form when the customer has provided the error code information.

5. The Off-line Test Pattern is used to verify the following:

   a. Keyboard ID jumper
   b. Keyboard to display operations
   c. Character set pattern
   d. High Intensity
   e. Controller Command Simulation

6. The information for what FRU to replace is found in the Error code-to-FRU list.

7. Perform the "Offline Tests" on page 3-1.

8. Service Business Product Planning, CETO EMEA, and CSTO AFE should be contacted for assistance after RETAIN and all published CEMs and Service Aids have been checked for fix information. To inform SBPP of any quality problems or problems fixes not found in the RCMI, Retain , or published CEMs and Service aids.

9. (False) The "Logic No Trouble Found (NTF) Procedure" on page 2-13 should be followed when all tests run successfully and no trouble is found on an element.

IBM 3178 Display Station Repair Center
Maintenance Information

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