TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

TOPOGRAPHIC SUPPORT SYSTEM ANALYSIS SECTION MODEL ADC-TSS-12 NSN: 6675-01-105-5761

THIS MANUAL TOGETHER WITH TM 5-6675-323-14-2 SUPERSEDES
TM 5-6675-323-14 DATED 21 JUNE 1983

HEADQUARTERS, DEPARTMENT OF THE ARMY

3 SEPTEMBER 1985

WARNING

HIGH VOLTAGE is used in this equipment. DEATH ON CONTACT or severe injury may result if personnel fail to observe safety precautions.

Do not be misled by the term LOW VOLTAGE. Low voltage can cause serious injury or death.

Test procedures requiring the operator or maintenance personnel to investigate equipment or restore casualties with interlocks disconnected or covers removed may result in DEATH ON CONTACT if personnel fail to observe safety precautions.

Voltages in switches and circuit breaker panels may result in DEATH ON CONTACT if personnel fail to observe safety precautions.

Failure to ground the section or equipment may result in DEATH ON CONTACT if personnel fail to observe safety procedures.

For Artificial Respiration refer to FM 21-11.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Wear solvent-impermeable gloves and eye/face protective equipment when using solvent. Do not use near open flame or excessive heat. Flash point of solvent is 100° F to 138° F (38° C to 59° C).

WARNING

Rotating and spinning equipment may snag loose clothing, hair or jewelry resulting in SEVERE PERSONNEL INJURY.

WARNING

Attempting to move overweight or top heavy equipment that is unsecured may result in SEVERE PERSONNEL INJURY. Always have sufficient personnel and equipment to accomplish the task.

INTRODUCTION

This manual is divided into two volumes:

Volume 1, TM 5-6675-323-14-1 consists of Chapters 1 through 5 and Index.
Volume 2, TM 5-6675-323-14-2 consists of Chapters 6 through 16, Appendixes A through E, Glossary and Index.

The Appendixes and Glossary in Volume 2 are applicable to both volumes.

CHANGE No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 21 March 1988

Operator's, Organizational, Direct Support and
General Support Maintenance Manual

TOPOGRAPHIC SUPPORT SYSTEM
ANALYSIS SECTION
MODEL ADC-TSS-12
NSN: 6675-01-105-5761

TM 5-6675-323-14-1, 3 September 1985, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature-pointing hand.

Remove pages	Insert pages
i and ii	i and ii
1-19 and 1-20	1-19 and 1-20
2-1/2-2	2-1/2-2

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:
To be distributed in accordance with DA Form 12-25A, Operator, Unit, Direct Support and General Support Maintenance requirements for Topographic Support System, Analysis Section (ADC-TSS-12).

CHANGE No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 4 August 1986

Operator's, Organizational, Direct Support
and General Support
Maintenance Manual

TOPOGRAPHIC SUPPORT SYSTEM
ANALYSIS SECTION
MODEL ADC-TSS-12
NSN: 6675-01-105-5761

TM 5-6675-323-14-1, 3 September 1978, is changed as follows:

1. Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
1-13 and 1-14	1-13 and 1-14
1-53 and 1-54	1-53 and 1-54
1-61 through 1-64	1-61 through 1-64
1-71 and 1-72	1-71 and 1-72
1-99 and 1-100	1-99 and 1-100
3-51 and 3-52	3-51 and 3-52
3-149 and 3-150	3-149 and 3-150
3-221 and 3-222	3-221 and 3-222
4-7 and 4-8	4-7 and 4-8
4-21 and 4-22	4-21 and 4-22
4-27 and 4-28	4-27 and 4-28
4-33 and 4-34	4-33 and 4-34
5-41 and 5-42	5-41 and 5-42
5-45 and 5-46	5-45 and 5-46

2. Retain this sheet in front of manual for reference purposes.

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TECHNICAL MANUAL

NO. 5-6675-323-14-1

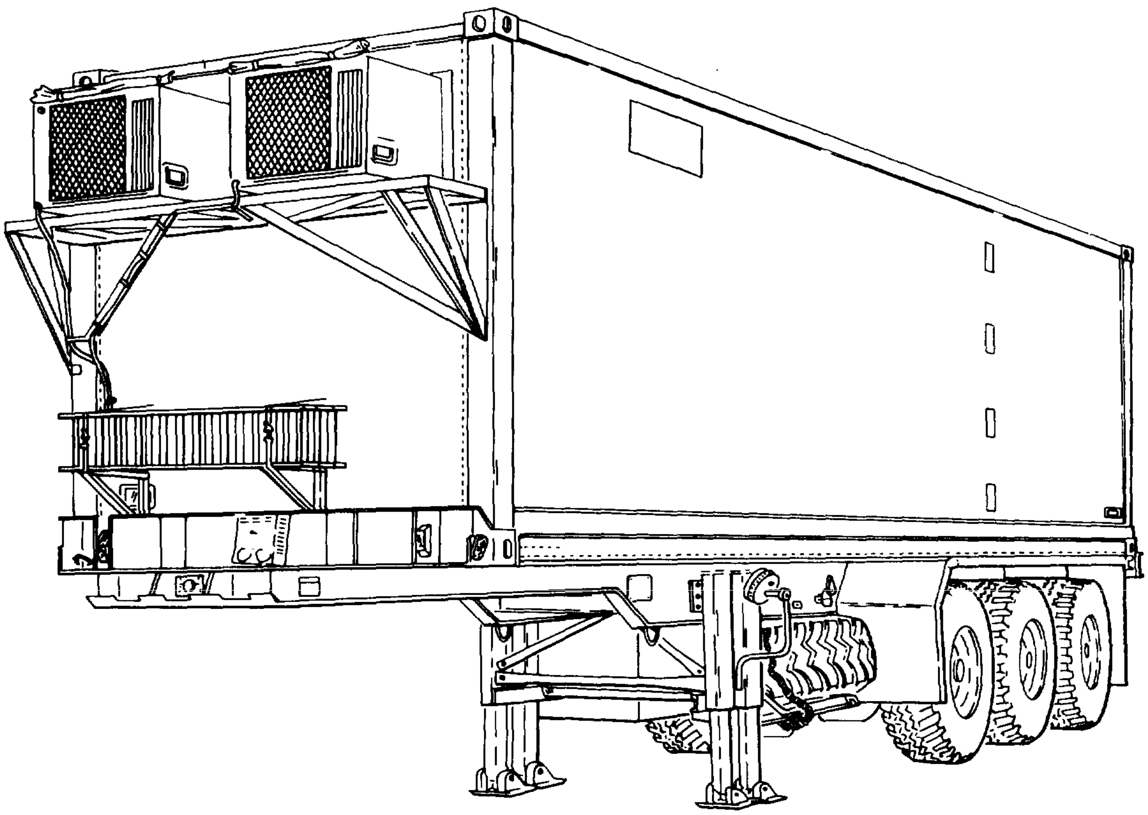
HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 3 September 1985

Operator's, Organizational, Direct Support and General Support Maintenance Manual

TOPOGRAPHIC SUPPORT SYSTEM
ANALYSIS SECTION
MODEL ADC-TSS-12
NSN: 6675-01-105-5761

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028(Recommended Changes to Publications and B1ank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Troop Support Command, ATTN:AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, M0 63120-1798. A reply will be furnished directly to you.



CHAPTER 1

ANALYSIS SECTION

Section I INTRODUCTION

1-1. GENERAL INFORMATION.

1-1.1 Scope. This manual contains operating and maintenance instructions for the ADC-TSS-12, Analysis Section, Topographic Support System (TSS). The purpose of the Analysis Section is to provide for the interpretation, evaluation, and update of Military Geopraphic Information (MGI). The trailer chassis is covered in TM 5-2330-305-14, Operator's, Organizational, Direct Support and General Support Maintenance Manual, Topographic Support System, Chassis, Semitrailer, IS0 Container Transporter. Repair parts and special tools are listed in TM 5-6675-323-24P, Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools List, Analysis Section, Topographic Support System. Lubrication instructions are contained in LO 5-6675-323-12, Lubrication Order, Analysis Section, Topographic Support System. All authorized equipment, supplies, and their locations for transport are shown in Location and Description of Major Components of this manual.

1-1.2 Purpose of Equipment. To provide a transportable facility for the interpretation, evaluation, and update of Military Geographic Information.

1-1.3 Maintenance Forms and Records. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, The Army Maintenance Management System (TAMMS).

1-1.4 Reporting Equipment Improvements (EIR's). If the Analysis Section needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you do not like about your equipment. Let us know why you do not like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at: U.S. Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We will send you a reply.

1-1.5 Destruction of Material to Prevent Enemy Use. For information on destruction of material to prevent enemy use, refer to TM 750-244-3, Procedures for Destruction of Equipment to Prevent Enemy Use.

1-1.6 Preparation for Storage or Shipment.

a. Perform your preparation for movement procedures.

b. For administrative storage of equipment, refer to TM 740-90-1.

c. The chapters of this manual describe special shipping instructions for major components located in the section.

d. In the event this equipment must be removed from the section for repair or replacement, contact your battalion for packing and shipping instructions.

1-2. EQUIPMENT DESCRIPTION.

1-2.1 Equipment Characteristics. Capabilities, and Features.

a. Air and sea transportable.

b. Transportable cross-country capability when mounted on trailer chassis.

c. Controlled internal environment.

1-2.2 Special Considerations.

a. Site must permit section to be leveled within ±2°, be well drained, and provide adequate overhead concealment. Wooded areas and other obstacles must not impede movement of transporters.

b. Dispersal of topographic sections is limited to the length of electric power transmission cable available for unit generators.

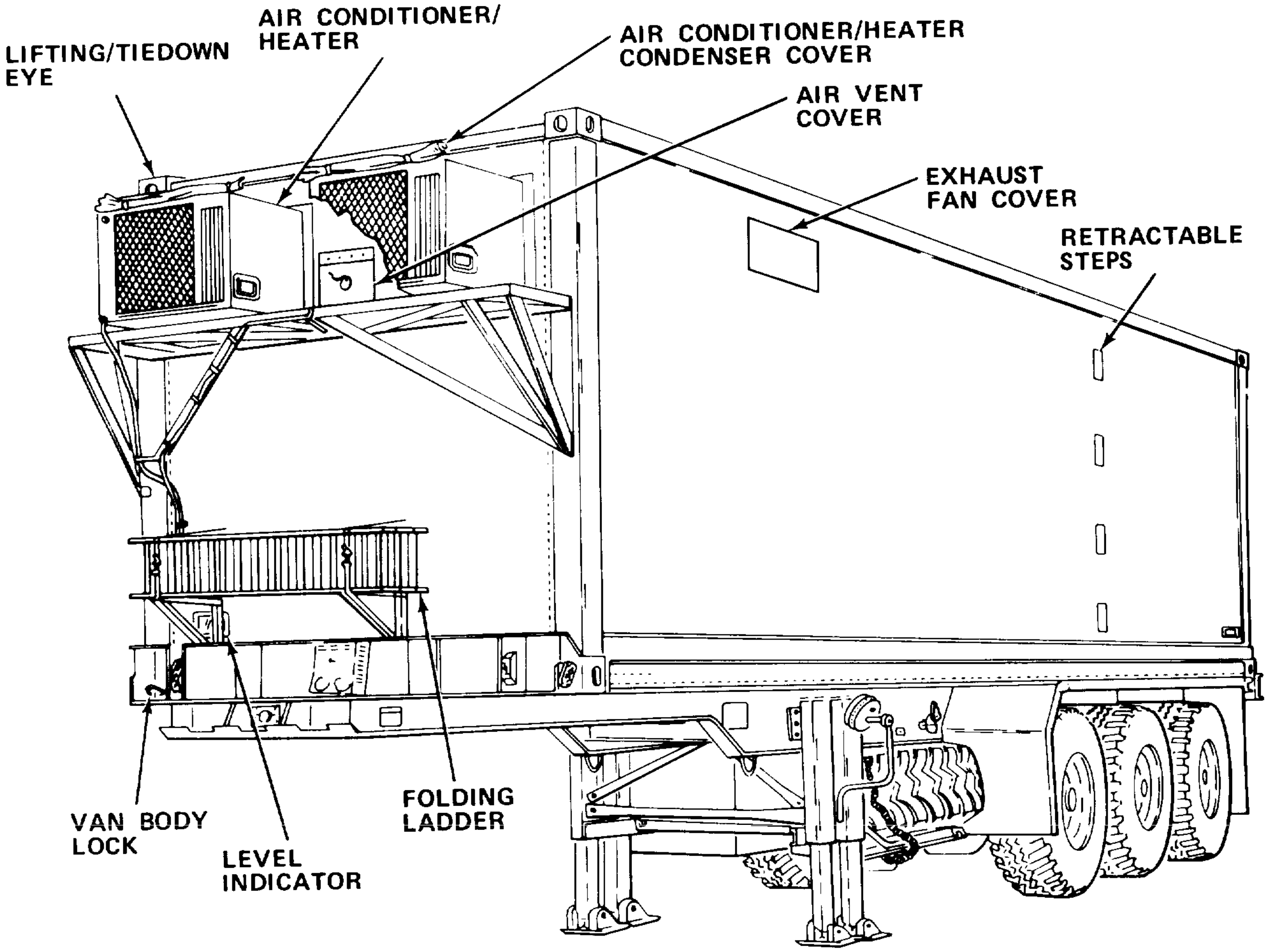
c. During site selection, avoid overhead power transmission lines to prevent danger from electric shock or electromagnetic interference.

d. Power is normally supplied by 60 kW generators. Commercial electric power should be used if it is compatible and available.

e. Cross-country capability of sections and transporters is limited. Relocation should be accomplished over hard-surfaced, all-weather roads whenever possible.

1-2.3 Location and Description of Major Components.

a. Roadside Exterior.



VAN BODY LOCK. Locks van body to trailer chassis.

AIR CONDITIONERS/HEATERS. Two air conditioner/heater units for internal environmental control.

LIFTING/TIEDOWN EYES. Attachment point for lifting or tying down van body.

AIR CONDITIONER/HEATER CONDENSER COVERS. Cover air conditioner/heater condensers to prevent water/air entering air conditioner/heater units when in transport or storage.

AIR VENT COVER. Covers air vent opening.

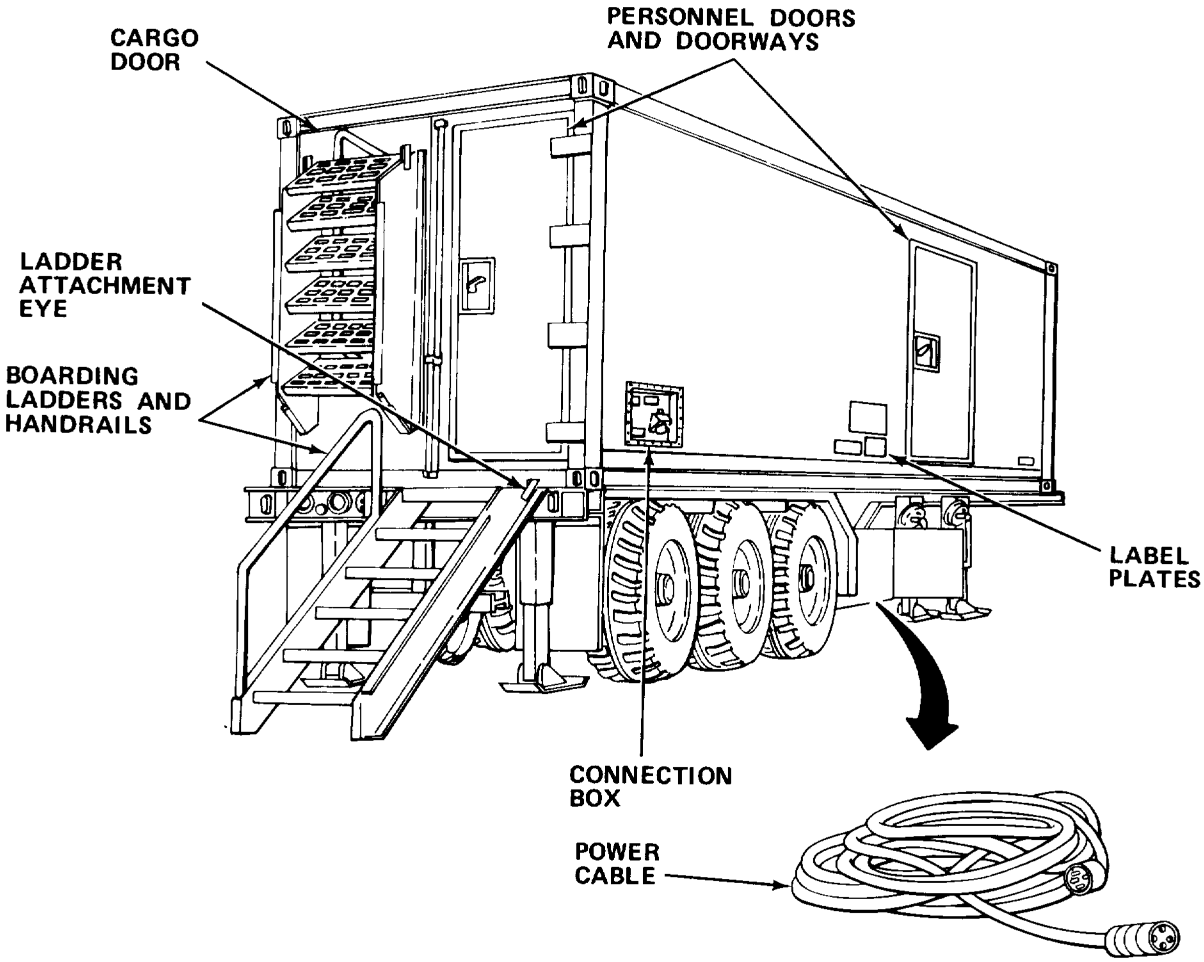
RETRACTABLE STEPS. Provide access to roof.

EXHAUST FAN COVER. Covers exhaust fan opening.

LEVEL INDICATORS. Indicate van body inclination.

FOLDING LADDER. Allows access to air conditioners and top of van.

b. Curbside Exterior.



CARGO DOOR. Access for equipment removal/installation.

PERSONNEL DOORS. Doors are 26.75 in. (67.9 cm) wide by 70.5 in. (178.8 cm) high.

PERSONNEL DOORWAYS. Doorways are 30.75 in. (78.1 cm) wide by 78.5 in. (199.4 cm) high.

LABEL PLATES. Provide weight/moment data,

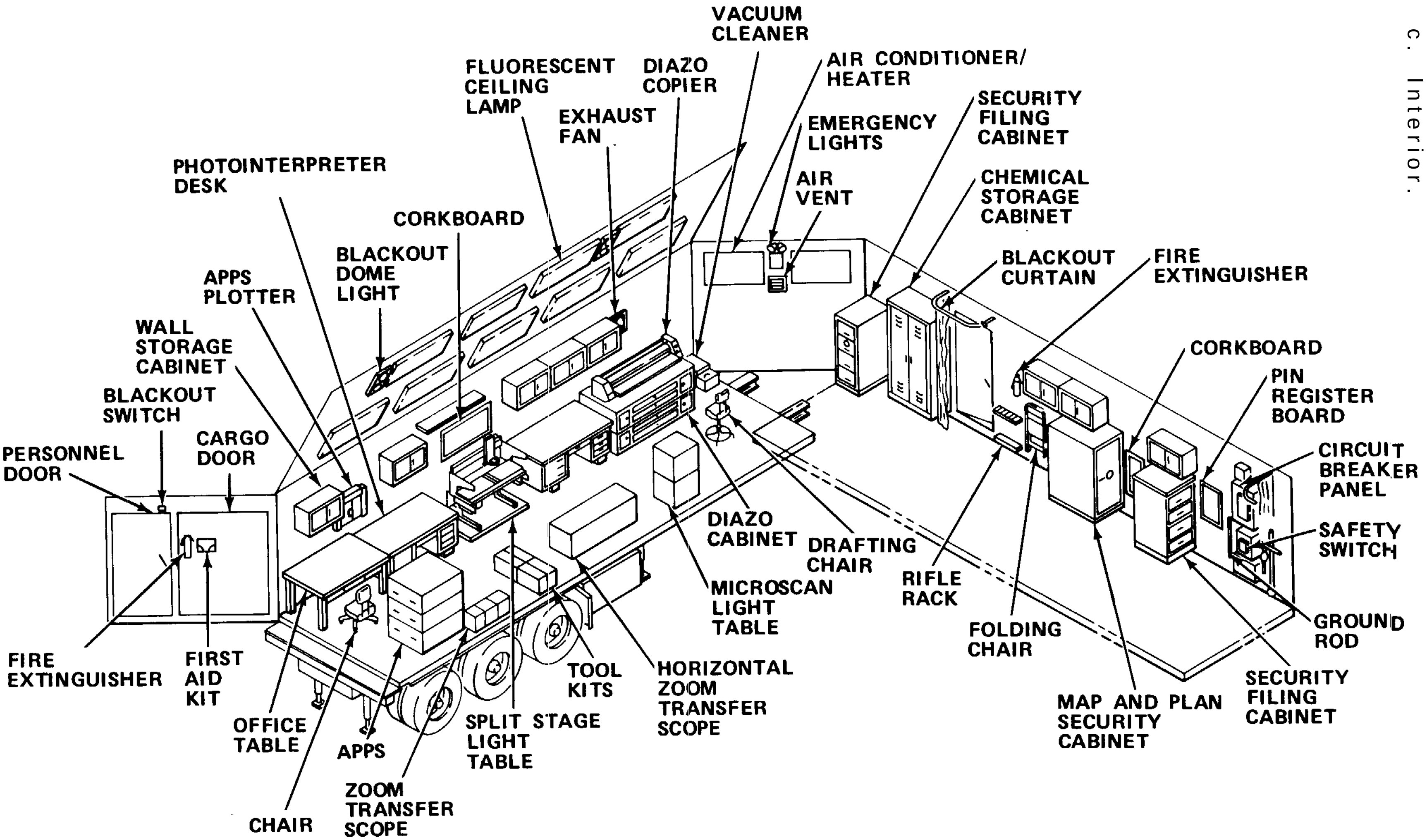
POWER CABLE. Power cable is in 50 ft (15.2 m) sections. (Stored in trailer chassis storage box.)

CONNECTION BOX. Contains terminals for ground cable, power cables, and telephone lines.

LADDER ATTACHMENT EYES. Attachment points for boarding ladders.

BOARDING LADDERS AND HANDRAILS. Provide access to section.

c. Interior.


VACUUM CLEANER
FLUORESCENT CEILING LAMP
DIAZO COPIER
AIR CONDITIONER/ HEATER
EXHAUST FAN
SECURITY FILING CABINET
EMERGENCY LIGHTS
PHOTOINTERPRETER DESK
AIR VENT
CHEMICAL STORAGE CABINET
CORKBOARD
BLACKOUT DOME LIGHT
BLACKOUT CURTAIN
FIRE EXTINGUISHER
APPS PLOTTER
WALL STORAGE CABINET
CORKBOARD
PIN REGISTER BOARD
BLACKOUT SWITCH
CIRCUIT BREAKER PANEL
PERSONNEL DOOR
CARGO DOOR
DIAZO CABINET
DRAFTING CHAIR
SAFETY SWITCH
MICROSCAN LIGHT TABLE
RIFLE RACK
GROUND ROD
FIRE EXTINGUISHER
FIRST AID KIT
FOLDING CHAIR
TOOL KITS
HORIZONTAL ZOOM TRANSFER SCOPE
SECURITY FILING CABINET
MAP AND PLAN SECURITY CABINET
OFFICE TABLE
SPLIT STAGE LIGHT TABLE
APPS
ZOOM TRANSFER SCOPE
CHAIR

PERSONNEL DOOR. Weatherproof, fitted with blackout switch.

BLACKOUT SWITCH. Turns ceiling lights off when activated.

CARGO DOOR. Access for equipment removal/installation.

OFFICE TABLE. Work station.

WALL STORAGE CABINET. Storage.

APPS PLOTTER. Wall storage for XY Plotter, component of AN/UYK-48 APPS.

PHOTOINTERPRETER DESK. Work station for zoom transfer scope.

BLACKOUT DOME LIGHT. Red-lensed, white-lensed 12 V ac light actuated when blackout switch operates, or from external power.

CORKBOARD. Vertical display board.

FLUORESCENT CEILING LAMP. White, two-level (high/low) overhead light.

EXHAUST FAN. Provides ventilation. Fitted with lightproof louvers and weatherproof cover.

DIAZO COPIER. Ammonia process copier.

VACUUM CLEANER. Cleaning equipment.

AIR CONDITIONER/HEATER. Internal environmental control.

EMERGENCY LIGHTS. Battery-powered lighting actuated by power failure.

AIR VENT. Permits filtered make-up air to enter section.

SECURITY FILING CABINET. Storage of classified material.

CHEMICAL STORAGE CABINET. Storage for diazo printer chemicals.

BLACKOUT CURTAIN. Lightproof cover for personnel door.

PIN REGISTER BOARD. Storage for pin register board.

CIRCUIT BREAKER PANEL. Circuit breakers with phase test indicator.

SAFETY SWITCH. Main power safety disconnect switch.

GROUND ROD. Electrical ground for section.

SECURITY FILING CABINET. Storage of classified material.

MAP AND PLAN SECURITY CABINET, Classified map stowage.

FOLDING CHAIR. Storage for transport.

RIFLE RACK. Weapon storage.

DRAFTING CHAIR. Adjustable height chair.

DIAZO CABINET. Storage for diazo bulk supplies.

MICROSCAN LIGHT TABLE. Storage for transport.

HORIZONTAL ZOOM TRANSFER SCOPE. Storage for transport.

SPLIT STAGE LIGHT TABLE. Contains two illuminated surfaces and movable mounting assembly for Stereoscope 95R.

TOOL KITS.

ZOOM TRANSFER SCOPE. Storage for transport.

APPS. Storage for transport.

CHAIR. Used at desk work station.

FIRST AID KIT. Limited first aid supplies.

FIRE EXTINGUISHER. Dry chemical fire extinguisher.

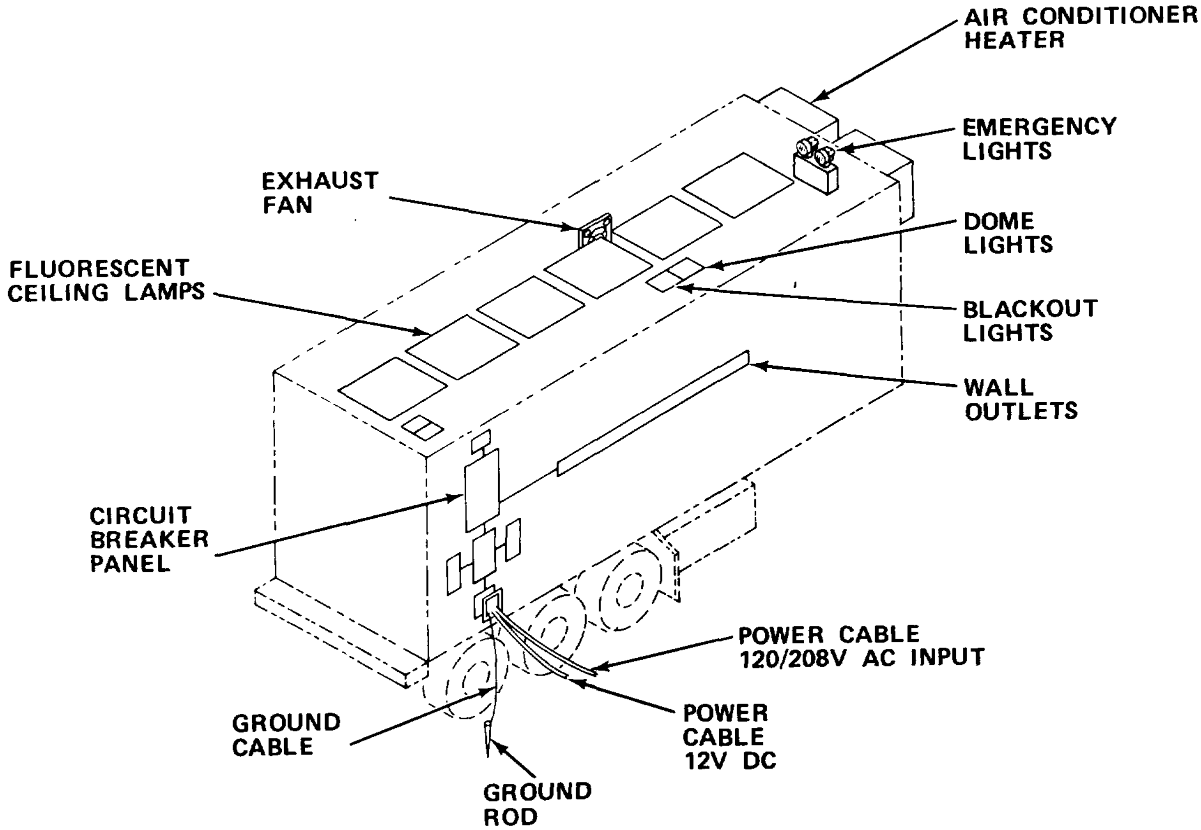
1-2.4 Equipment Data - ISO Container (Unmounted).

Dimensions	
Length	31.75 ft (9.68 m)
Width	8 ft (2.44m)
Height	8ft (2.44m)
Cubage	2038 ft^3 (57.7 m^3)
Connections	
Telephones	One telephone (three-post) connection
Power	19.4 kW. One 120/208 V, three-phase, four-wire connection and one 12 V dc connection
Ground	Ground lug
Air Conditioner/Heater (Two Units)	
Cooling	18,000 Btu/hr (5274 W) each
Heating	14,300 Btu/hr (4190 W) (Max) each
Power Requirements	208 V, 60 Hz, three-phase
Exhaust Fan	289 ft^3/min (8.18 m^3/min)
Air Vent	289 ft^3/min (8.18 m^3/min)
Weight	
Gross (Container and Chassis)	27,810 lbs (12,611.84 kg)
Tare (Container Only)	16,370 lbs (7423.80 kg)

1-3. TECHNICAL PRINCIPLES OF OPERATION.

1-3.1 General. The operation of major components located within the section are explained in the appropriate chapter for that equipment.

1-3.2 Electrical System.



GROUND ROD. Used to ground section.

GROUND CABLE . Used with ground rod.

CIRCUIT BREAKER PANEL. Contains voltage indicator, phase monitor, and circuit breakers.

WALL OUTLETS. Provide grounded outlets for portable or plug-in equipment.

DOME LIGHTS. White-lensed, 12 V dc lights powered from external source. Separately switched and fused.

EXHAUST FAN . Plug-in fan. Separately fused.

FLUORESCENT CEILING LAMPS. Two-level (high/low) overhead lights with blackout override switches.

EMERGENCY LIGHTS. Battery powered. Activated by power loss.

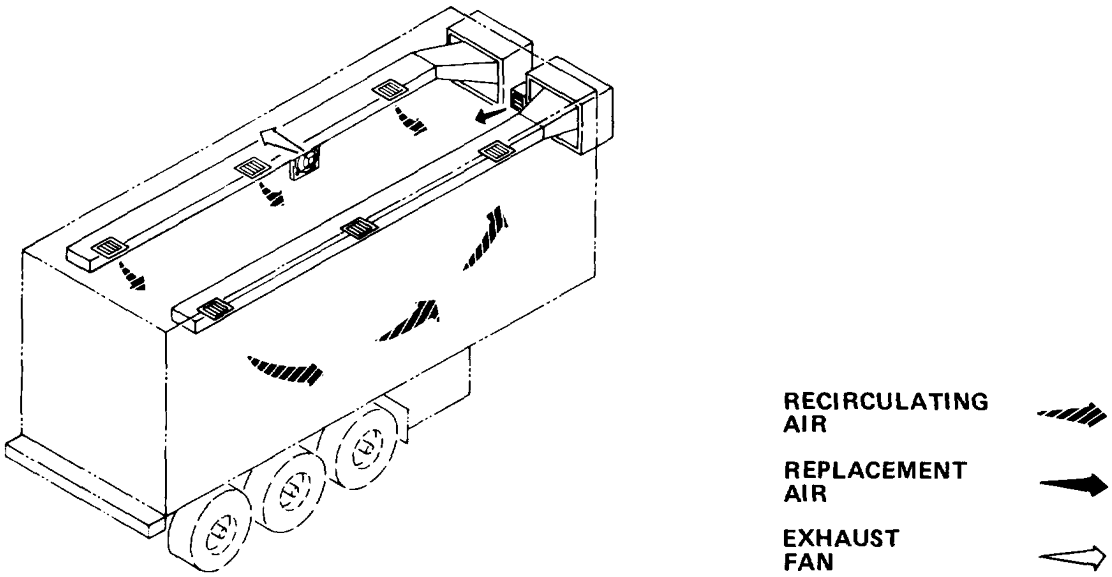
AIR CONDITIONER/HEATER. Air conditioner and electrical heater powered by three-phase, 208 V, 30 amp current.

BLACKOUT LIGHTS. Red-lensed, 12 V ac lights actuated when blackout switch operates.

POWER CABLES, Power input (120/208 V ac and 12 V de).

1-3.3 Wiring Diagram. A foldout wiring diagram is provided at the end of this manual .

1-3.4 Ventilation System.



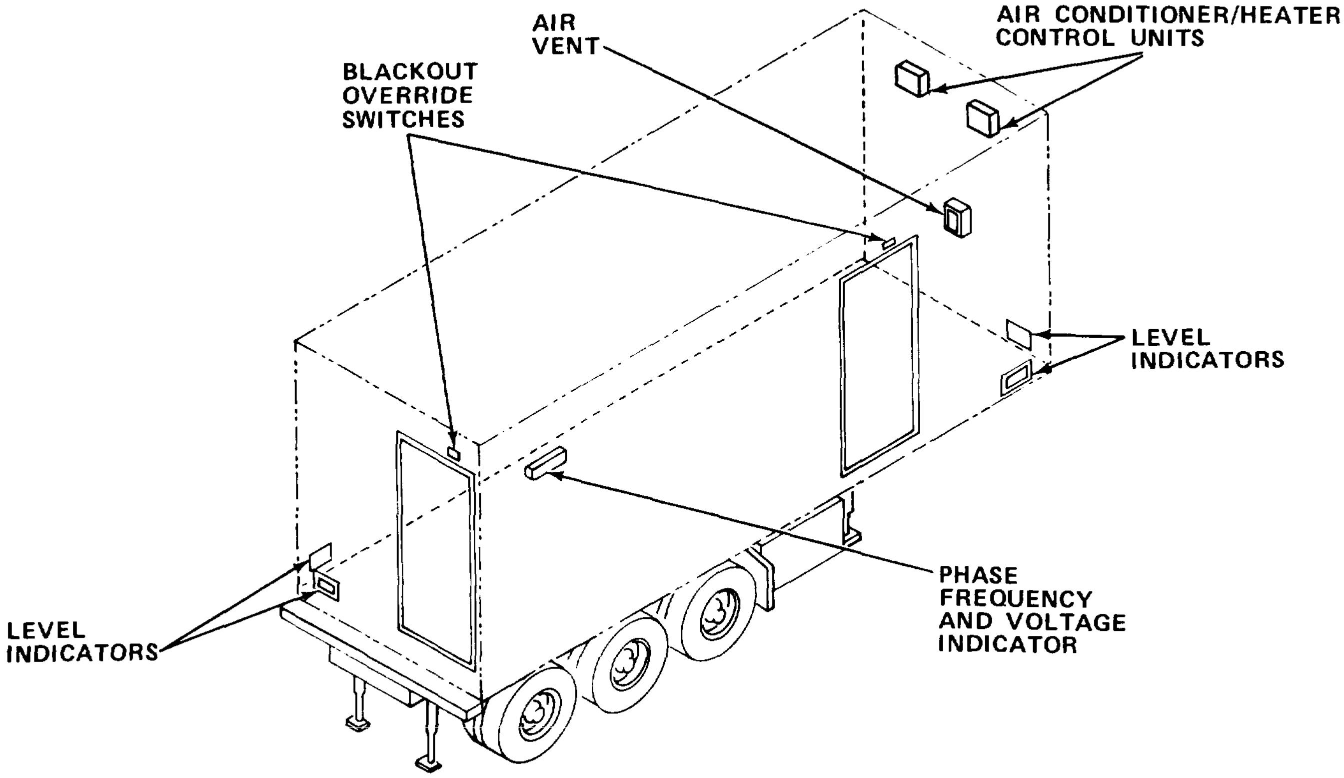
Exhaust fan exhausts air. Replacement air flows into the section through the air vent filter. Recirculating air is filtered as it enters the air conditioners/heaters. From the air conditioners/heaters, it flows through the ceiling vents and into the section.

NOTE

Detailed description of air conditioner/heater operation is contained in TM 5-4120-367-14, Operator's, Organizational, Direct Support, and General Support Maintenance Manual, Air Conditioner, Horizontal, Compact, 18,000 Btu/hr Cooling, and TM 5-4120-367-24P, Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair) for Air Conditioner, Horizontal, Compact, 18,000 Btu/hr (5274W).

Section II OPERATING INSTRUCTIONS

1-4. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS.



Control or Indicator	Function
Blackout Override Switches	Turn off illumination when doors are opened.
Air Vent	Permits make-up air to enter as required.
Air Conditioner/Heater Control Unit	Permits selection of air conditioner or heater mode of operation and temperature.
Phase, Frequency, and Voltage Indicator	Monitors electrical power, phase, frequency, and voltage.
Level Indicators	Used to level van body.

1-5. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES.

a. Before You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your before (B) PMCS.

b. While You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your during (D) PMCS.

c. After You Operate. Be sure to perform your after (A) PMCS.

d. If Your Equipment Fails to Operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA Pam 738-750.

1-5.1 PMCS Procedures.

a. PMCS are designed to keep the equipment in good working condition by performing periodic service tasks,

b. Service intervals provide you, the operator, with time schedules that determine when to perform specified service tasks.

c. The “Equipment is Not Ready/Available If" column is used for identification of conditions that make the equipment not ready/available for readiness reporting purposes or denies use of the equipment until corrective maintenance is performed.

d. If your equipment fails to operate after PMCS is performed, immediately report this condition to your supervisor.

e. Perform weekly as well as before operation if you are the assigned operator and have not operated the item since the last weekly or if you are operating the item for the first time.

f. Item Number column. Item numbers are assigned in chronological ascending sequence regardless of interval designation. These numbers are used for your “TM Number” column on DA Form 2404, Equipment Inspection and Maintenance Worksheet in recording results of PMCS.

g. Interval columns. This column determines the time period designated to perform your PMCS.

h. Item to be inspected and procedures column. This column lists functional groups and their respective assemblies and subassemblies as shown in the Maintenance Allocation Chart (Appendix B). The appropriate check or service procedure follows the specific item to be inspected.

i. Equipment is not ready/available if: column. This column indicates the reason or cause why your equipment is not ready/available to perform its primary mission.

j. List of tools and materials required for PMCS is as follows:

Item	Quantity
Wire Brush	1 ea
6 in. Adjustable Wrench	1 ea
Flat Tip Screwdriver	1 ea
Vacuum Cleaner	1 ea
Cheesecloth (Item 7, Appendix E)	ar
General Purpose Detergent (Item 9, Appendix E)	ar
Paint (Items 17, 17A and 17B, Appendix E)	ar
Paint Brushes	ar

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

B - Before | W - Weekly | AN - Annually | (Number) - Hundreds of Hours
D - During | M - Monthly | S - Semiannually
A - After | Q - Quarterly | BI - Biennially

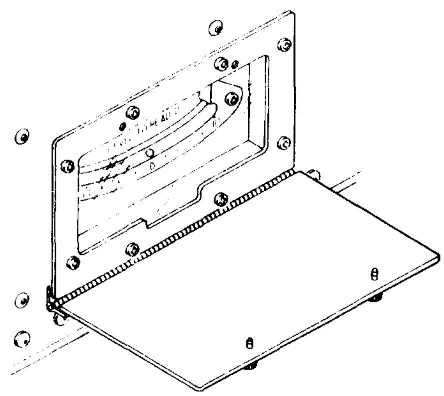
ITEM NO,	IN-TER VAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		VAN BODY	
		Inspect Exterior.	
1	B/W	1. Inspect surfaces for punctures, cracks, or open seams that could permit moisture to enter wall. 	Punctures, cracks, or open seams are present.
	B	2. Inspect four level indicators for damage and to check that section is level.	Indicators are broken.
		WARNING To prevent death or serious injury, do not handle or clean power cable or connectors when cable is connected to power source.	

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

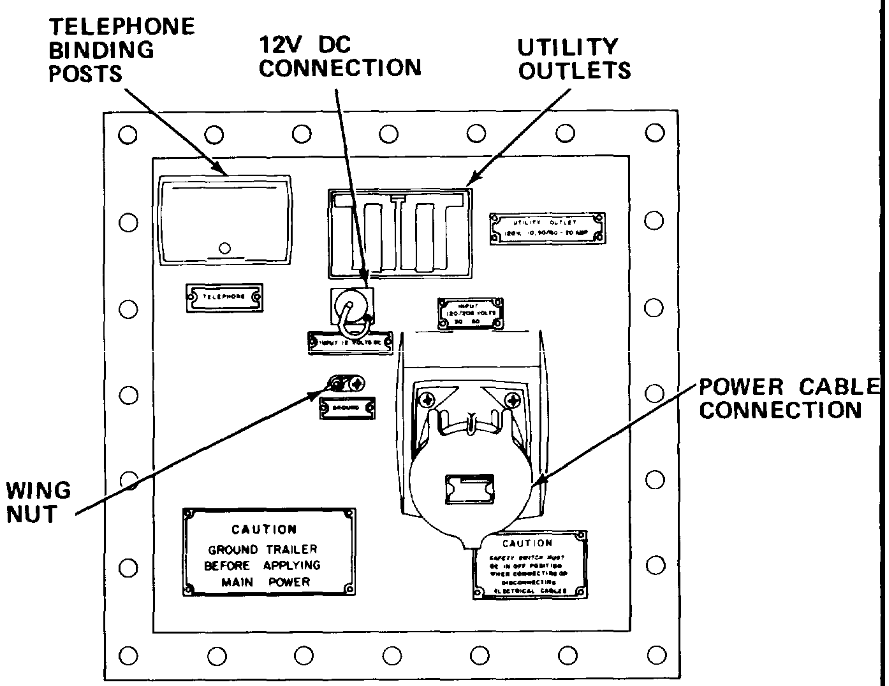
B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment is Not Ready/ Available If:
		VAN BODY - Cont	
1		Inspect Exterior - Cont	
	B	3. Inspect power cable assembly for dirt or damaged connectors. a. Wipe cable insulation with clean, dry cloth to remove dirt. b. Clean corrosion from terminals.	Connector damaged.



ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment is Not Ready/ Available If:
	B/W	4. Inspect power entry panel for accumulated dirt, water, or corrosion. Clean power entry panel.	
	B/W	5. Inspect power entry panel to be sure any unused receptacles are covered.	Missing covers.

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A After

W - Weakly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

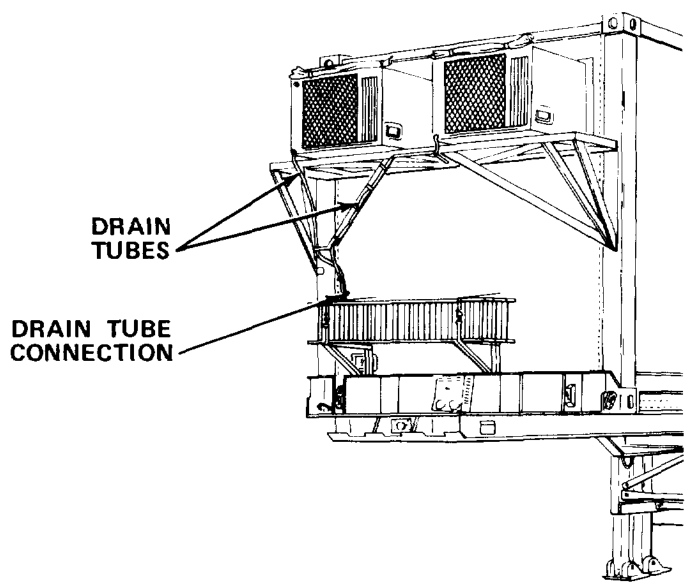
ITEM NO.	IN-TER VAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		VAN BODY - Cont	
1		Inspect Exterior - Cont	
			
	B/W	6. Inspect air conditioner/heater drain tube to be sure tube is positioned as shown. Check for breaks and crimps in hose and check connections for damage or leakage.	

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A . After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) . Hundred of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment is Not Ready/ Available If:
		VAN BODY - Cont	
1		Inspect Exterior - Cont	
	B/W	7. Inspect exhaust fan cover and air vent cover to be sure they are not blocked or clogged. Clean as required. Clean screen with vacuum cleaner as necessary.	

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready! Available If:
		VAN BODY - Cont	
1		Inspect Exterior - Cont	
	B/W	8. Visually inspect ground connections to be sure ground cable is connected to terminal lug and ground rod. If necessary, clean: **WARNING** Electrical shock hazard. Power cable must be de-energized before servicing entry panel connections. Death can result from failure to observe these safety precautions. a. Turn power off to cable. Disconnect from power source. b. Disconnect ground lug from ground rod. c. Clean lug, cable end, and rod with wire brush. d. Reconnect ground cable lug to rod. e. Disconnect ground cable end from entry panel. f. Clean terminal and cable end with wire brush. g. Reconnect ground cable to entry panel. h. Reconnect cable to power source. Turn power on.	Ground connections are broken or missing.
	B	9. Inspect boarding ladders for: a. Secure attachment of handrails. b. Steps not broken. c. Locking pins in place.	Steps are broken or will not lock in place.

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES—Cont.

B—Before | W—Weekly | AN—Annually | (Number) -Hundreds of Hours
D—During | M—Monthly | S —Semiannually
A—After | Q —Quarterly | BI —Biennially

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment is Not Ready/ Available If:
		VAN BODY—Cont	
1		Inspect Exterior—Cont	
		NOTE When mounted on trailer chassis, perform the following steps:	
	B/D/A	10. Inspect front and rear van body locks to be sure locks are fully engaged.	Lock disengaged
	Q	11. Inspect gaskets on personnel doors for leaks or damage	
	W	11.1 Inspect hinges for proper placement of hinge pins.	Missing hinge pins.
	Q	12. Clean and paint blistered, pitted, or flaking areas and bare metal spots in accordance with instructions contained in TM 43-0139, Painting Instructions for Field Use.	
2		Inspect Interior.	
	B/D	1. Test emergency lights by pressing test button.	Emergency lights do not light.
	W	2. Inspect power cords and cables to be sure wires are not kinked, cut, or cracked.	Wires or cables are cracked or cut
	W	3. Inspect plug connectors to be sure all plug connectors are tight and firmly seated. Tighten if necessary.	
	D	4. Inspect for burned out light bulbs and fluorescent lamps. Replace as required.	
	W	5. Inspect walls, ceiling, and floor for holes, open seams, or signs of seepage or leaks.	Leaks are present

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before, D - During, A - After; W - Weekly, M - Monthly, Q - Quarterly; AN - Annually, S - Semiannually, BI - Biennially; (Number) - Hundreds of Hours

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment is Not Ready/Available If:
		VAN BODY - Cont	
2		Inspect Interior - Cont	
	D	6. Check storage cabinets for broken hinge{, latches, and locks.	Hinge, latch, or lock is broken.
	B/M/A	7. Inspect fire extinguishers. Be sure security seals are not" broken.	Fire extinguisher is missing or seals are broken.
	Q	8. Inspect circuit breaker panel.	Circuit breaker is defective.
		NOTE Inspection is to be conducted on a not-to-interfere basis with work being conducted. Individual equipment will be inspected as directed by the appropriate chapter of this manual.	

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before W - Weekly AN - Annually (Number) - Hundreds of Hours
D - During M - Monthly S - Semiannually
A - After Q - Quarterly BI - Biennially

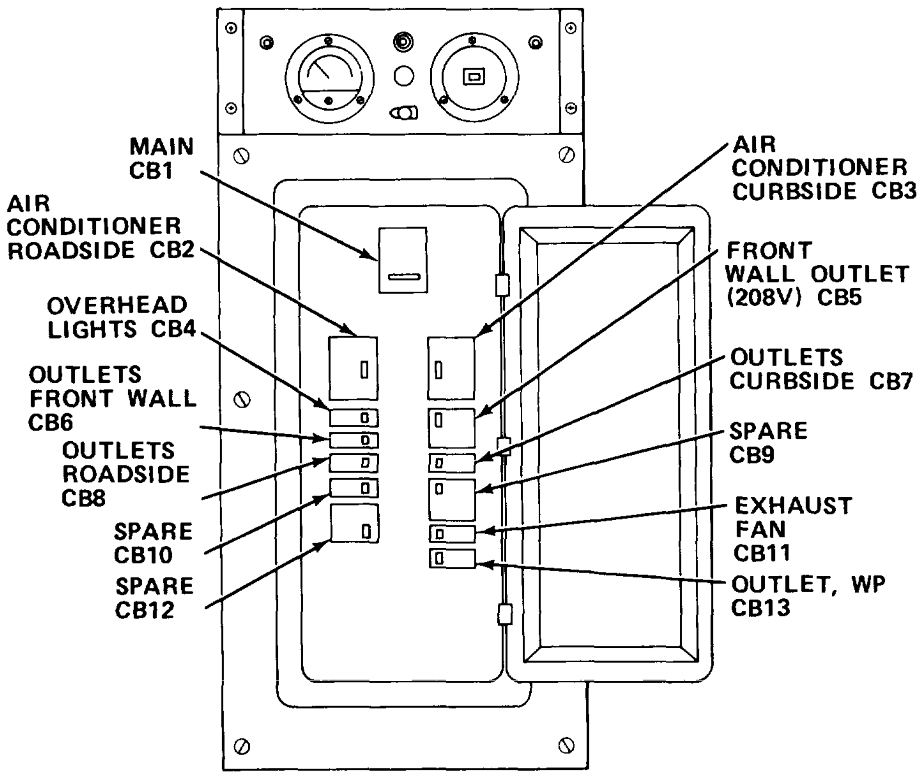
ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment is Not Ready/ Available If:
		VAN BODY - Cont	
2		Inspect Interior - Cont  a. Set main circuit breaker to ON. b. Set each circuit breaker to OFF, then ON.	

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		VAN BODY - Cont	
2		Inspect Interior - Cont	
	Q	9. Inspect light traps.	
		a. Turn on fluorescent lamps (high level).	
		b. Close entrance doors. Have exhaust fan and air vent open. Inspect for light leakage through vents.	Light leaks are present.
		c. Place light switches ON; blackout override switches OFF.	
		d. Open door and make sure internal lights go off.	Blackout system is inoperable.
	A	10. Inspect/clean interior. **WARNING** Death or serious injury may occur if wet or damp cloth is used to wipe or clean energized equipment, power cords, or cables. **CAUTION** Do not sweep interior. Dislodged dirt or dust will ruin optical, electronic, and photographic equipment and supplies.	
		a. Wipe vertical and horizontal painted surfaces with cleaning cloth moistened' with solution of general purpose detergent and fresh water until soil is removed from painted surfaces.	

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

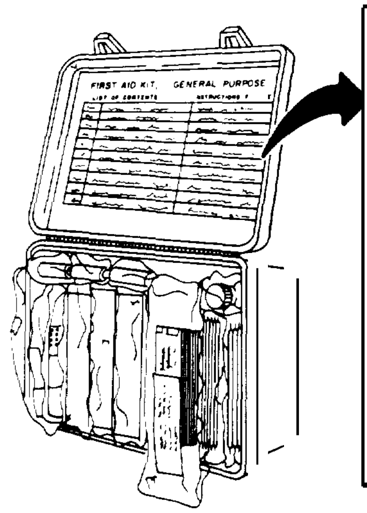
B - Before
D - During
A - After

W - Weakly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		VAN BODY - Cont	
2		Inspect Interior - Cont	
		b. Dry vertical and horizontal painted surfaces with clean cloth.	
		c. Vacuum interior of section to remove dirt and waste. Pay particular attention to work stations.	
	S	11. Inspect first aid kit.	



FIRST AID KIT, GENERAL PURPOSE

LIST OF CONTENTS		INSTRUCTIONS FOR USE
3 ROLLS	ADHESIVE TAPE SURGICAL, 1"X1½ YARDS	USE FOR MINOR CUTS AND CLOTHING REPAIR
18 EACH	BANDAGE, ADHESIVE, ¾"X3"	MINOR CUTS, AS REQUIRED
2 EACH	BANDAGE, GAUZE, COMPRESSED, CAMOUFLAGED, 3"X6 YARDS	CUT IN LENGTHS AS REQUIRED FOR BANDAGE INJURIES
1 EACH	BANDAGE, MUSLIN, COMPRESSED, CAMOUFLAGED, 37X37X52 INCH	USE FOR SLING
1 PKG	BLADE, SURGICAL PREPARATION RAZOR, STRAIGHT, SINGLE EDGE, 5s	SHAVING HAIR AND OPENING WOUNDS AS REQUIRED
1 PKG	COMPRESS AND BANDAGE, CAMOUFLAGED, 2"X2", 4s	FOR WOUNDS
3 EACH	DRESSING, FIRST AID, FIELD, 4X7 INCHES	FOR LARGE WOUNDS, EXCESSIVE BLEEDING
1 EACH	FIRST AID KIT, EYE DRESSING	FOR EYE WOUNDS, SEE INSTRUCTIONS
1 PKG	GAUZE, PETROLATUM, 3"X36", 3s	FOR BURNS, APPLY PAD OVER BURN
1 BTL	POVIDONE, IODINE SOLUTION, ½ OUNCE	AS DISINFECTANT AND CLEANSER OF CUTS AND WOUNDS. APPLY BEFORE BANDAGING
1 EACH	AMMONIA INHALANTS	CRUSH INHALANT BETWEEN FINGERS. HOLD A FEW INCHES FROM NOSE, HOLD CLOSER AS AMMONIA GETS WEAKER. WHEN TOO WEAK, USE FRESH INHALANT.
1* EACH	INSTRUCTION BOOKLET AND FIRST AID EXPLANATIONS	

a. Remove first aid kit from bracket.

b. Remove contents.

c. Inspect container for damage.

d. Inspect contents for damage. Then use checklist to inventory contents.

e. Replace damaged or missing items.

Table 1-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/Available If:
		<u>VAN BODY - Cont</u>	
2		<u>Inspect Interior - Cont</u>	
		f. Repack kit.	
		g. Reinstall kit.	
	B/W	12. Inspect blackout curtains.	
		a. Inspect blackout curtains and valances for tears, missing hooks, or broken eyelets.	Curtains damaged.
		b. Inspect nylon hook and pile tape on curtain and wall for security of attachment.	
3	B	<u>Inspect Air Conditioner/Heater.</u> Refer to TM 5-4120-367-14 for preventive maintenance checks and services.	
4	M	<u>Service Power Cable</u>.	
		WARNING	
		Electrical shock hazard. Power cable must be de-energized before servicing. Death or serious injury may occur from failure to observe this safety precaution.	
		1. Turn off safety switch.	
		2. Disconnect cable from power entry panel.	
		3. Wrap any cuts or abrasions in cable with electrical insulation tape.	
		4. Reconnect power cable to entry panel.	

1-6. OPERATION UNDER USUAL CONDITIONS. Operation of the Analysis Section consists of activation of power after the section has been located at the operation site and 12 V dc power disconnected.

1-6.1 Preparation for Use.

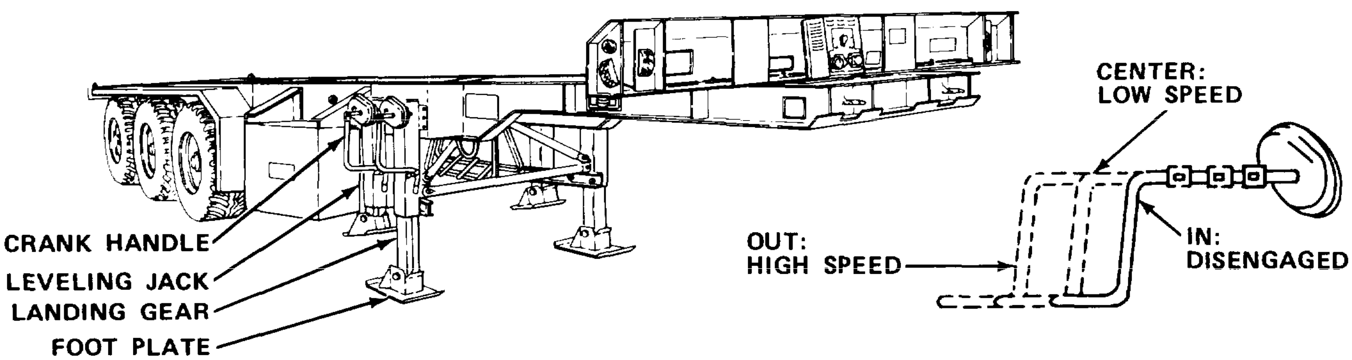
a. Procedures for leveling.

CAUTION

Trailer-mounted section must be on surface that is approximately level to avoid unnecessary stress or twisting of chassis when section is leveled.

NOTE

- Snow or ice should be removed from under leveling foot plate before attempting to level section.
- Sand, soft ground, or mud requires that shoring or scrap material be placed under leveling foot plate to increase surface area and prevent sinking into surface.
- Be sure that air suspension is deflated as indicated in TM 5-2330-305-14.



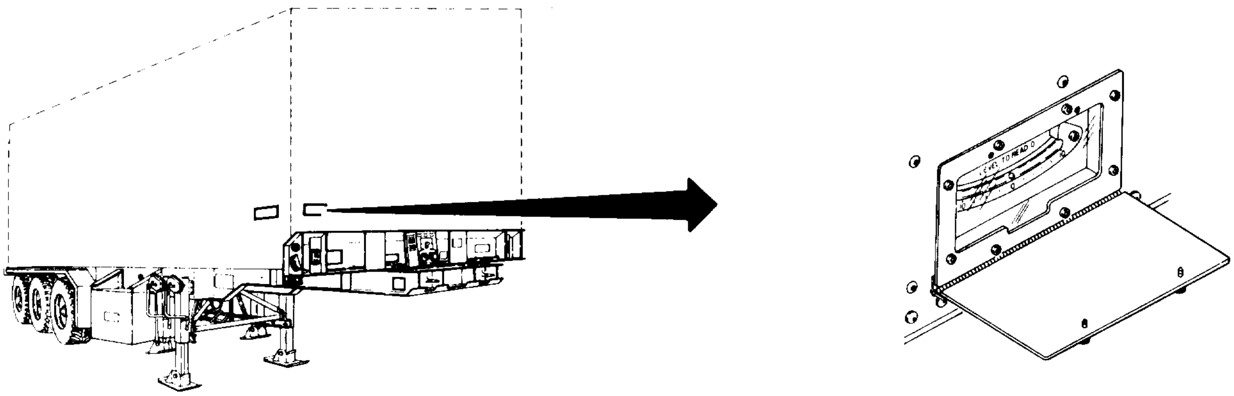
(1) Deflate air suspension in accordance with TM 5-2330-305-14.

(2) Approximately level trailer chassis by raising or lowering landing gear.

(3) Move handle from secured location and swing out.

(4) Pull crank handle on each leveling jack all the way out and engage. There are two positions when handle is engaged. Fully out is high speed. Partially out is low speed.

(5) Lower each leveling jack by turning crank to right at high speed until foot plate just contacts ground.

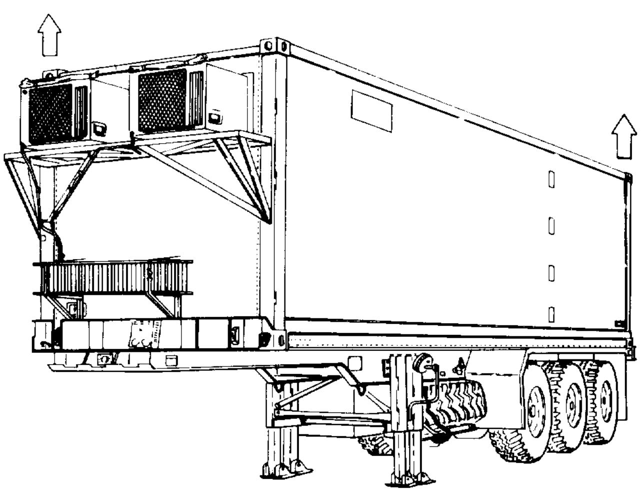


(6) Station personnel to have a clear view of level indicators at both front and rear of section.

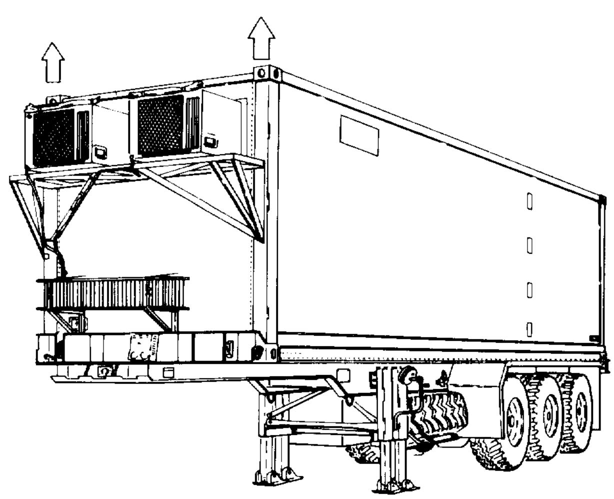
(7) Observe level indicators to determine which end and side must be raised.

CAUTION

Do not attempt to level section by lifting at diagonal corners, or frame will be twisted.

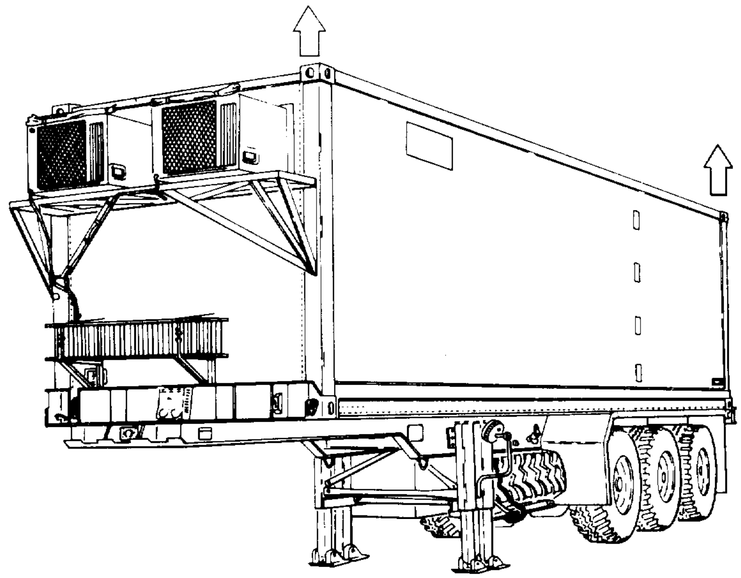


NO

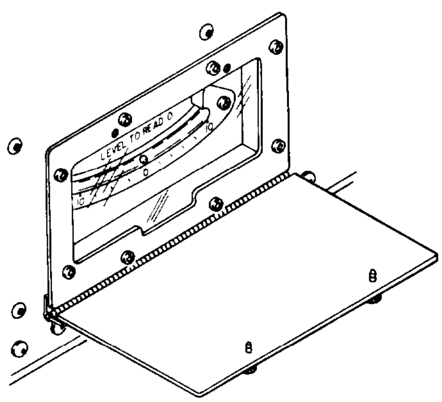


YES

(8) Raise low end by extending both leveling jacks at low end. Use low speed.



(9) Raise low side by extending both leveling jacks at low side.

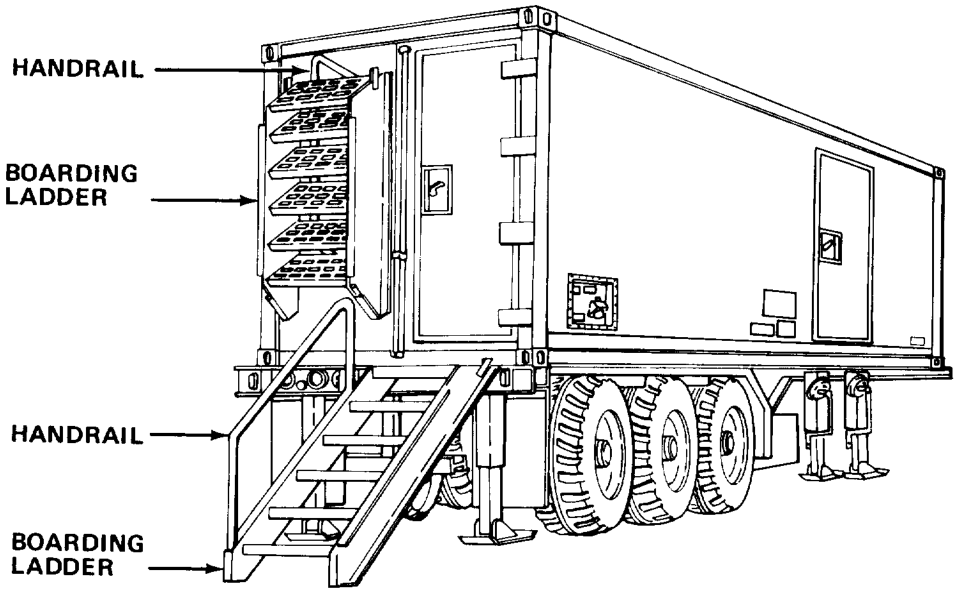


NOTE

Be sure ball is centered on all four level indicators ±2°.

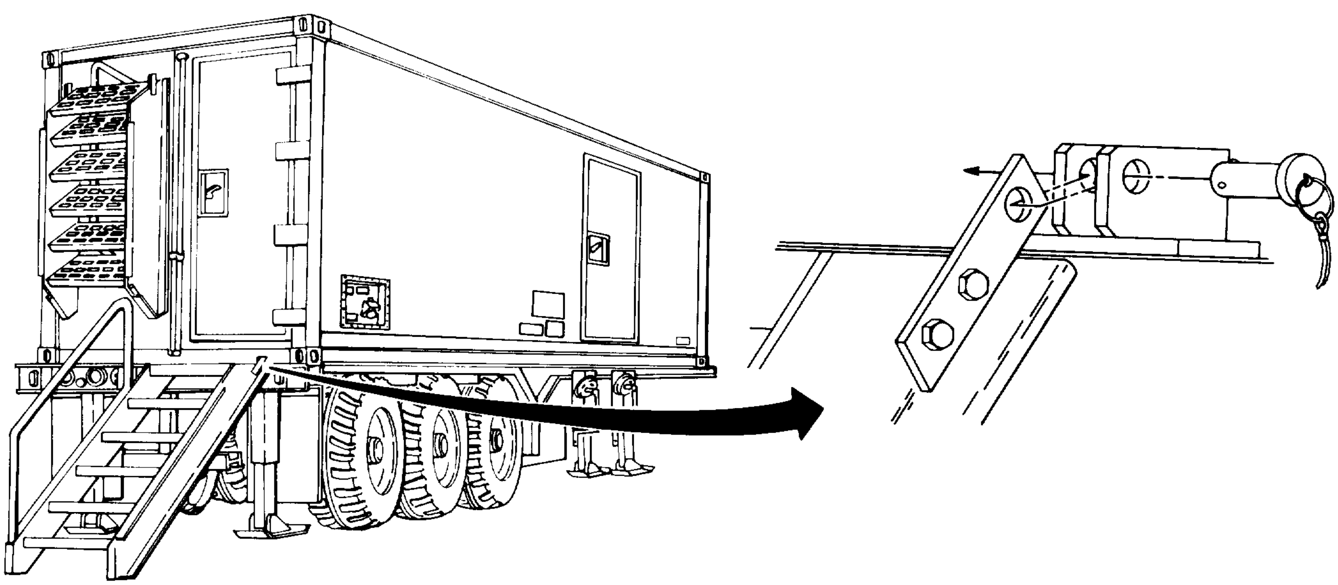
(10) Pull leveling crank handles away from trailer chassis, and lower crank handle to stowed position.

b. Procedures to activate section.

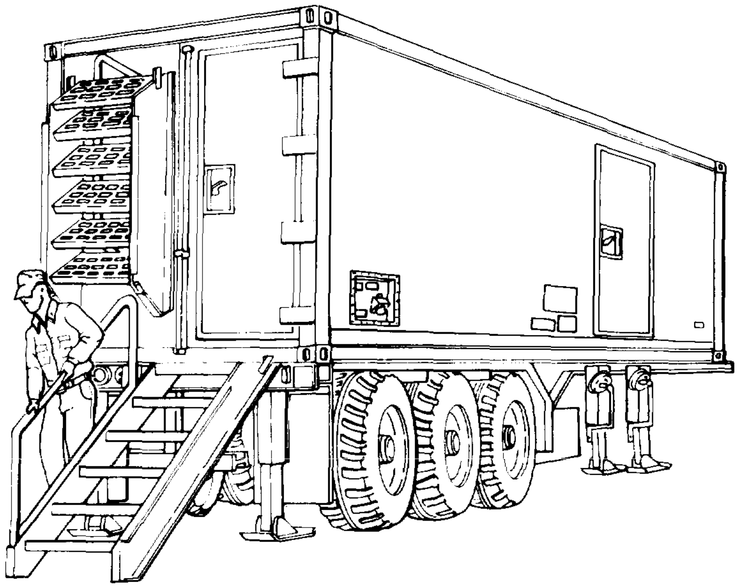


(1) Remove boarding ladders and handrails from rear of section.

(2) Remove handrails from ladders.



(3) Mount ladders at personnel doors and secure with locking pins.

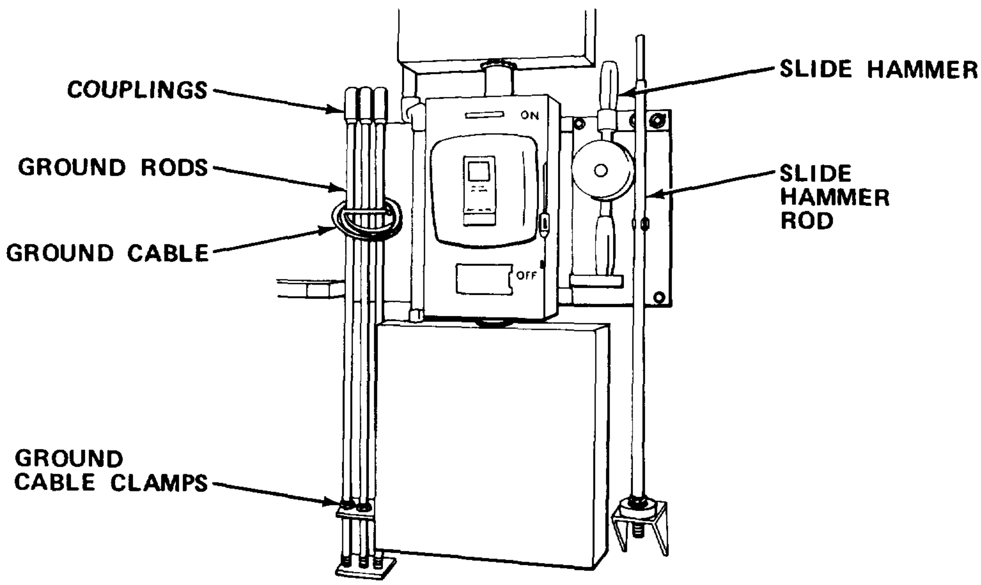


(4) Mount one handrail on each ladder.

(5) Enter section and check that safety switch, main circuit breaker, and all equipment power supply switches are off.

WARNING

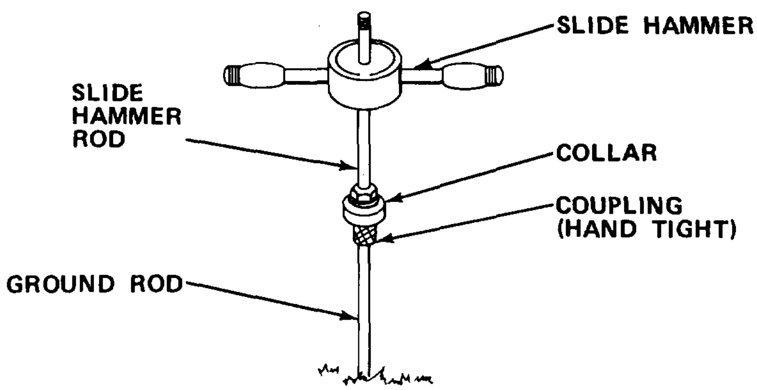
Death or serious injury may occur from connecting power cable to section before grounding.



(6) Remove ground rod, slide hammer, and ground cable from section.

NOTE

- Apply a thin film of grease to threaded ends of rods before driving into ground. This will permit easy disassembly upon removal from ground.
- Bottom ground rod must be numbered or identified so that it will always be the first rod driven into the ground.
- These instruction supplement TC 11-6, Grounding Techniques.



(7) Select an area as close to power entry panel as possible to install ground rod. Then assemble the first ground rod and coupling to the slide hammer rod.

CAUTION

Do not allow ground rod to rotate when removing the slide hammer rod. Rods must be kept screwed together to make a good electrical ground.

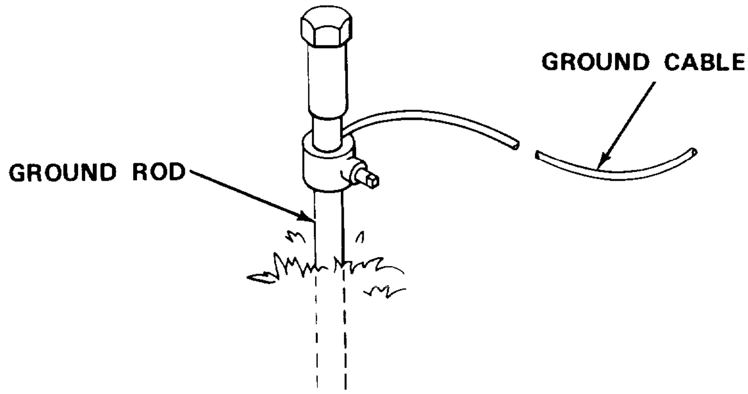
NOTE

Before driving ground rod be certain that rods meet inside coupling. Be sure collar is handtight against coupling.

(8) Place slide hammer on hammer rod end, and drive ground rod into ground. Remove slide hammer rod. Attach slide hammer rod to a new section of ground rod, and repeat procedure until only 12 in. (30.5 cm) of the third rod is above ground.

(9) Remove slide hammer and hammer rod, and place in section.

(10) Secure ground cable clamp and ground cable to ground rod.

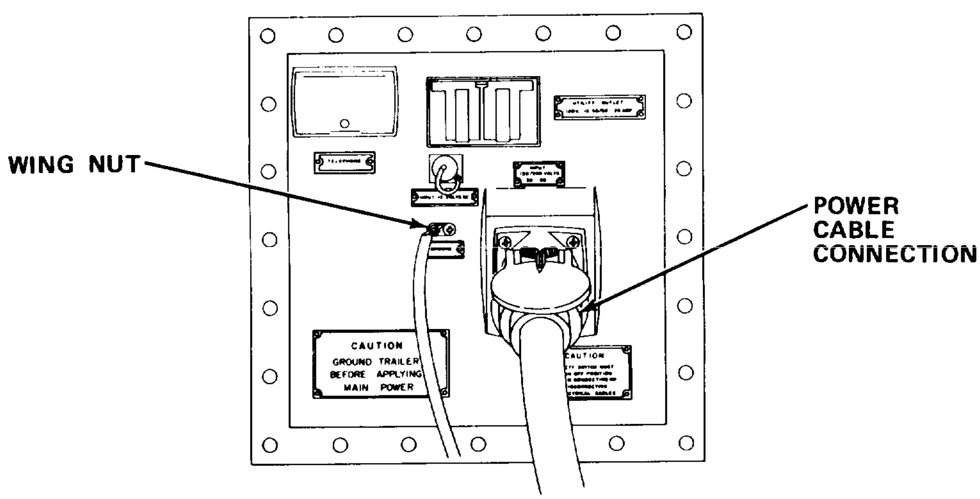


WARNING

To prevent death or serious injury, do not handle or clean power cable or connectors when cable is connected to power source.

NOTE

The section must be properly grounded before power is connected. If it is not possible to drive the three sections of ground rod fully into ground, the rods may each be driven into the ground separately and connected in series. If it is impossible to drive a ground rod, a suitable alternative ground must be found, such as a buried metal water pipe. See TC 11-6, Grounding Techniques for additional instructions.



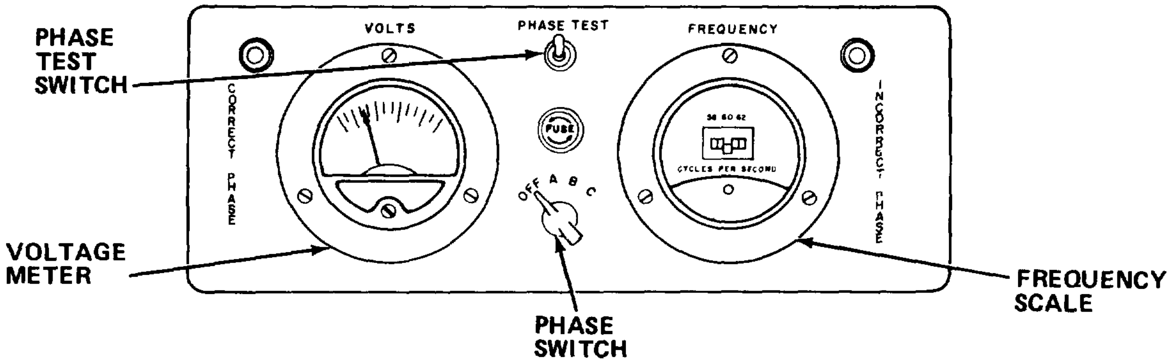
(11) Connect ground cable to ground lug with wing nut.

CAUTION

Be sure safety switch is off before connecting power cable to avoid equipment damage.

(12) Firmly connect the power cable to the power receptacle.

(13) Turn on safety switch.



CAUTION

Do not energize section if incorrect phase lamp lights. Damage to equipment may result.

(14) Check voltage and frequency as follows:

(a) Push phase test switch. Observe correct phase lamp lights.

(b) Turn phase switch to A.

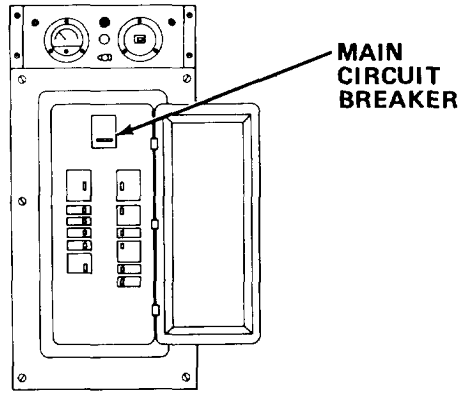
CAUTION

Voltage must be between 110 and 120, and frequency must be at 60 ±1 Hz on each leg before turning on main circuit breaker or damage to equipment may result.

(c) Read voltage on meter.

(d) Read frequency on scale.

(e) Repeat for positions B and C on phase switch.



(15) Set main circuit breaker ON.

NOTE

This step must be accomplished if section is placed in operation in darkness, fog, mist, or under blackout conditions.

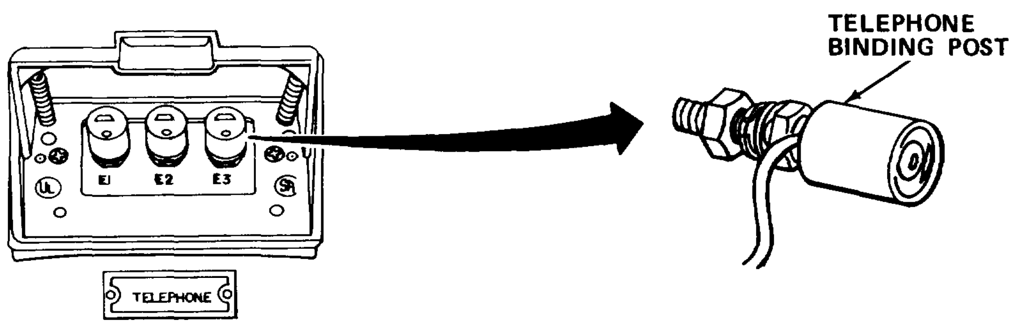
(16) Close blackout curtains, if required.

(17) Turn on circuit breakers in following order:

(a) Individual lighting.

(b) Curbside and roadside air conditioners/heaters.

(c) Curbside and roadside receptacles.



(18) Connect telephone lines to corresponding interior binding posts.

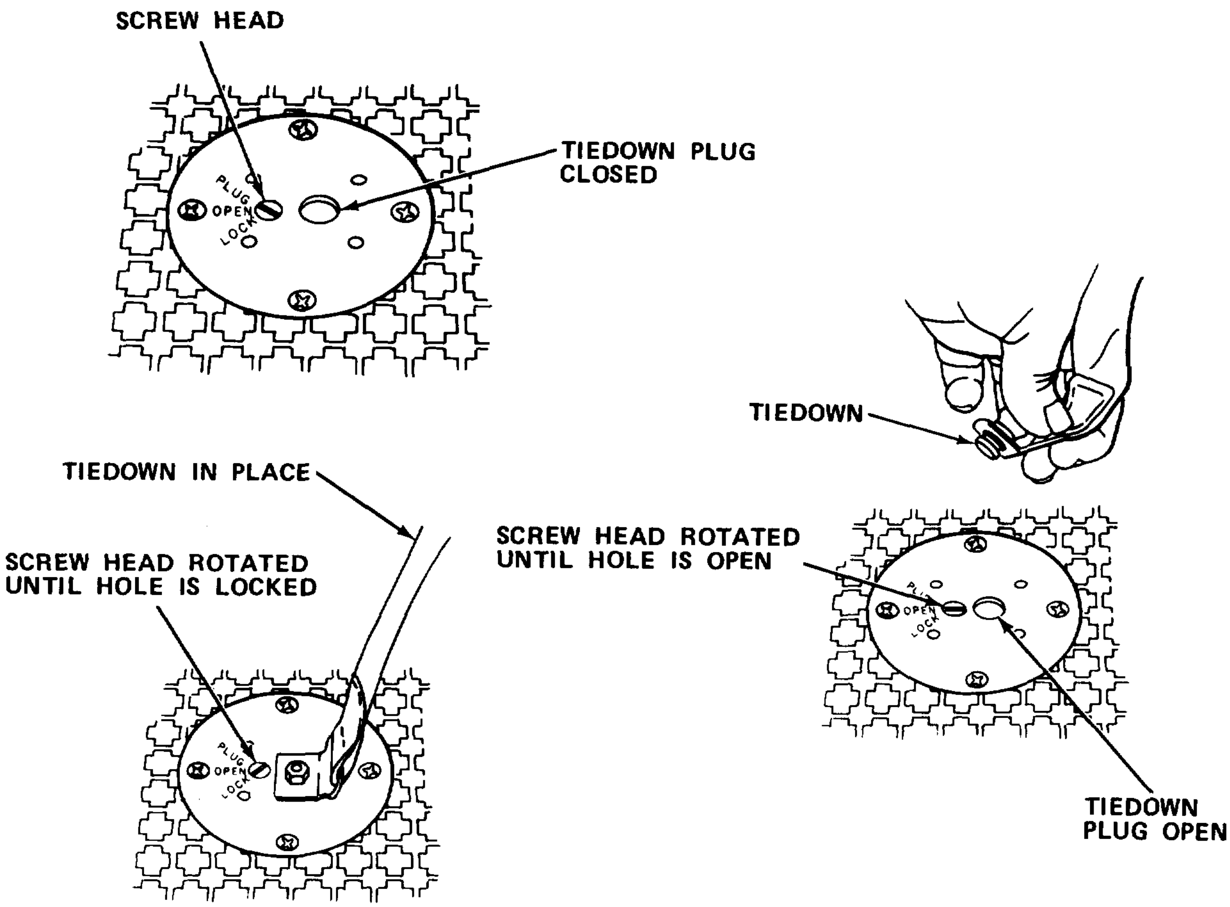
(19) Check blackout switches.

(20) Plug in emergency lighting and turn switch to READY.

(21) Fully deflate air shocks until split-stage light table rests on air shocks.

1-6.2 Preparation for Movement.

a. Inventory equipment and supplies.



b. Install tiedowns in tiedown sockets.

c. Secure authorized equipment in proper containers or as specified by appropriate chapters.

d. Secure straps and remove slack from tiedowns.

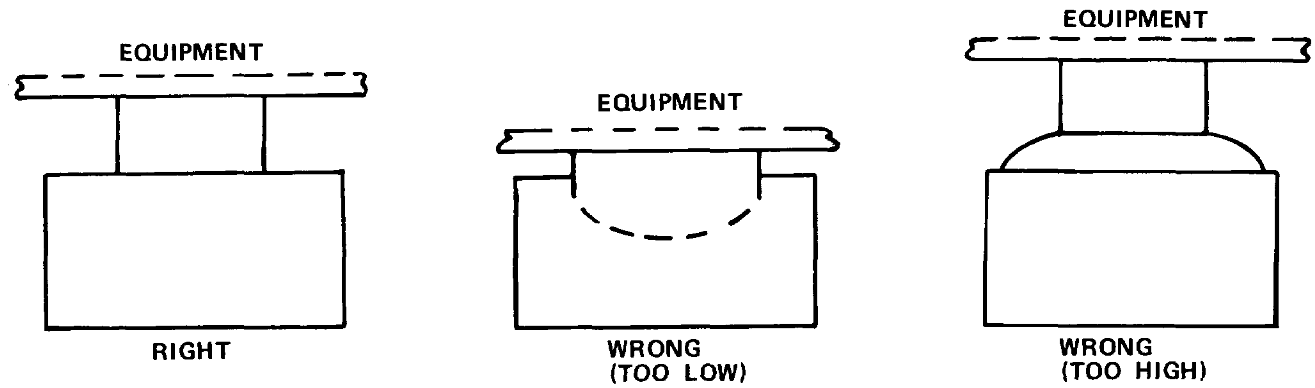
e. Inflate shock absorbers.

(1) Remove all valve caps.

CAUTION

To prevent damage to equipment or air shocks during transportation, inflate air shocks correctly. Do not exceed 70 psi (482 kPa) for the split-stage light table.

(2) Connect air hose to valve.



(3) Inflate each mount until top of diaphragm is level as shown.

(4) Reinstall valve caps.

WARNING

Death or serious injury may occur if power cable is disconnected while power is on.

f. Turn equipment switches off.

g. Turn main circuit breaker off.

h. Turn safety switch off.

i. Have power cable disconnected at power supply end. Then disconnect power cable from receptacle. Put cable in storage box on trailer chassis.

j. Turn emergency light switch off.

k. Disconnect telephone cables from power entry panel.

CAUTION

To prevent loss of rod or thread damage, do not allow ground rod to rotate and unscrew when removing the slide hammer rod.

l. Remove ground rod with slide hammer, and put ground rods, couplings, and slide hammer inside section. Clean threads on each ground rod before storing.

NOTE

Be certain exhaust fan and air vent covers are securely closed.

m. Reinspect section interior for loose equipment and close all vents.

n. Close section. Secure and lock all personnel doors and cargo door.

NOTE

Be sure air conditioner/heater covers are down and secured.

o. Remove handrails from boarding ladders.

p. Remove boarding ladders and insert handrails into back of ladders.

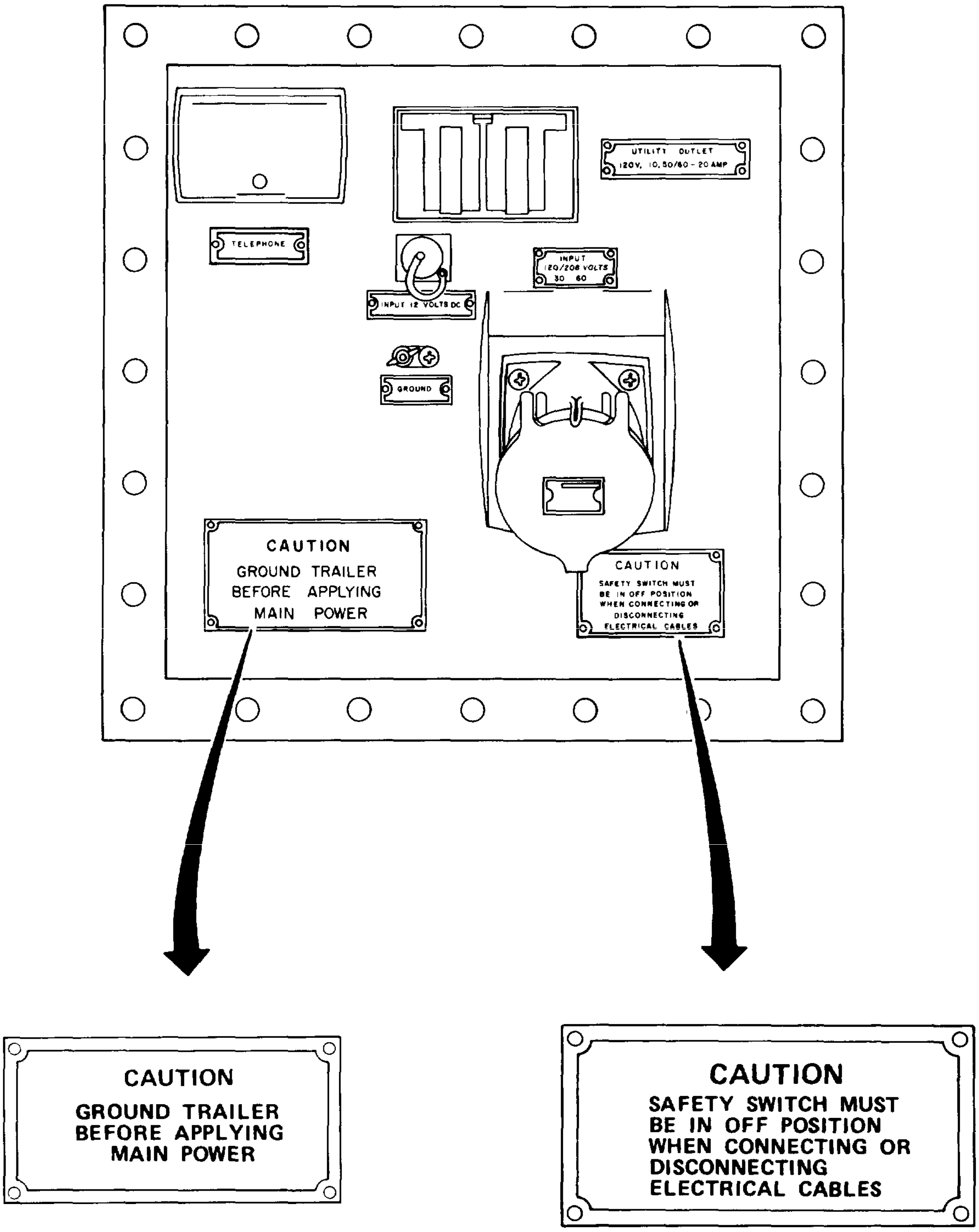
q. Secure ladders to back of section.

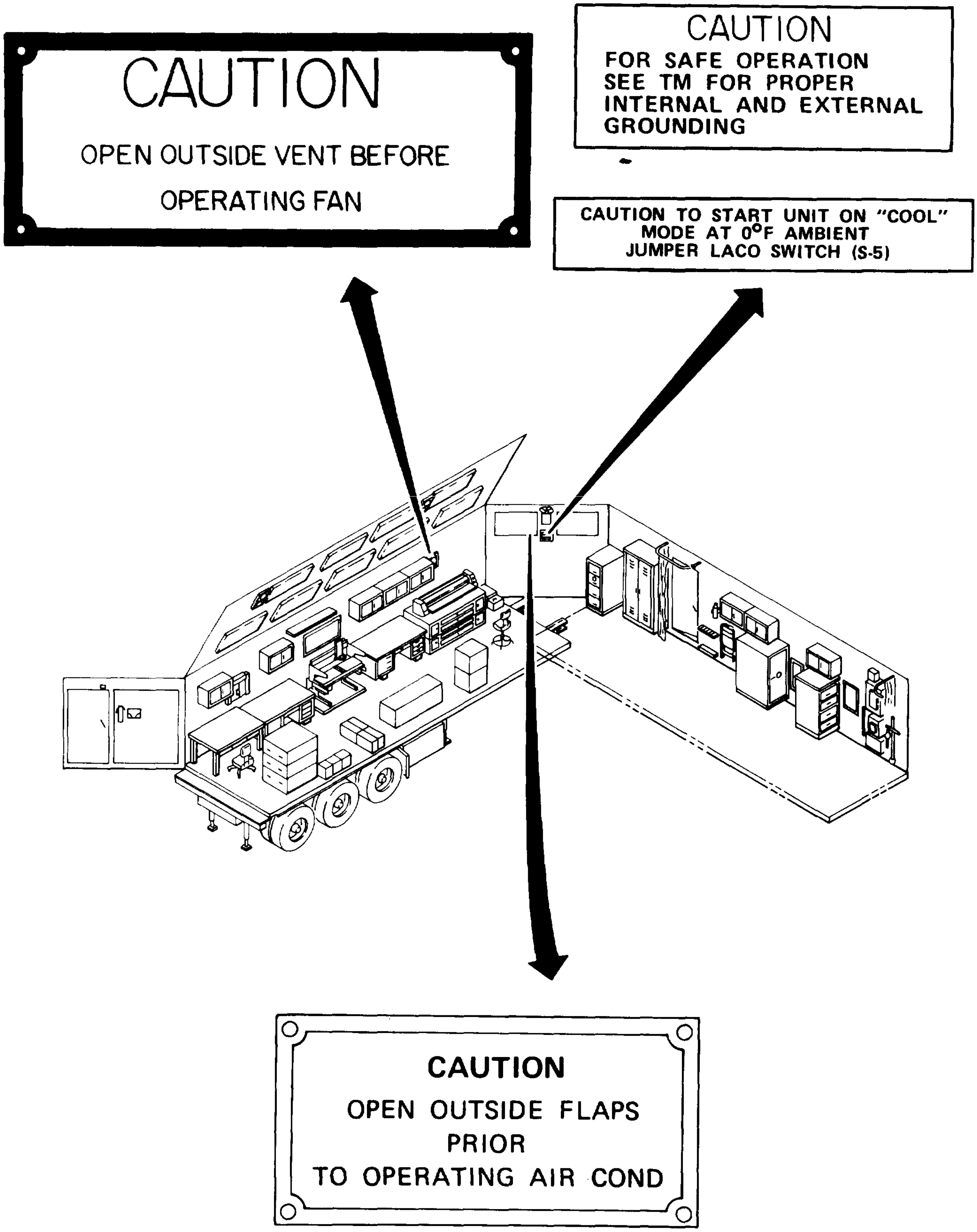
r. Fully extend landing gear.

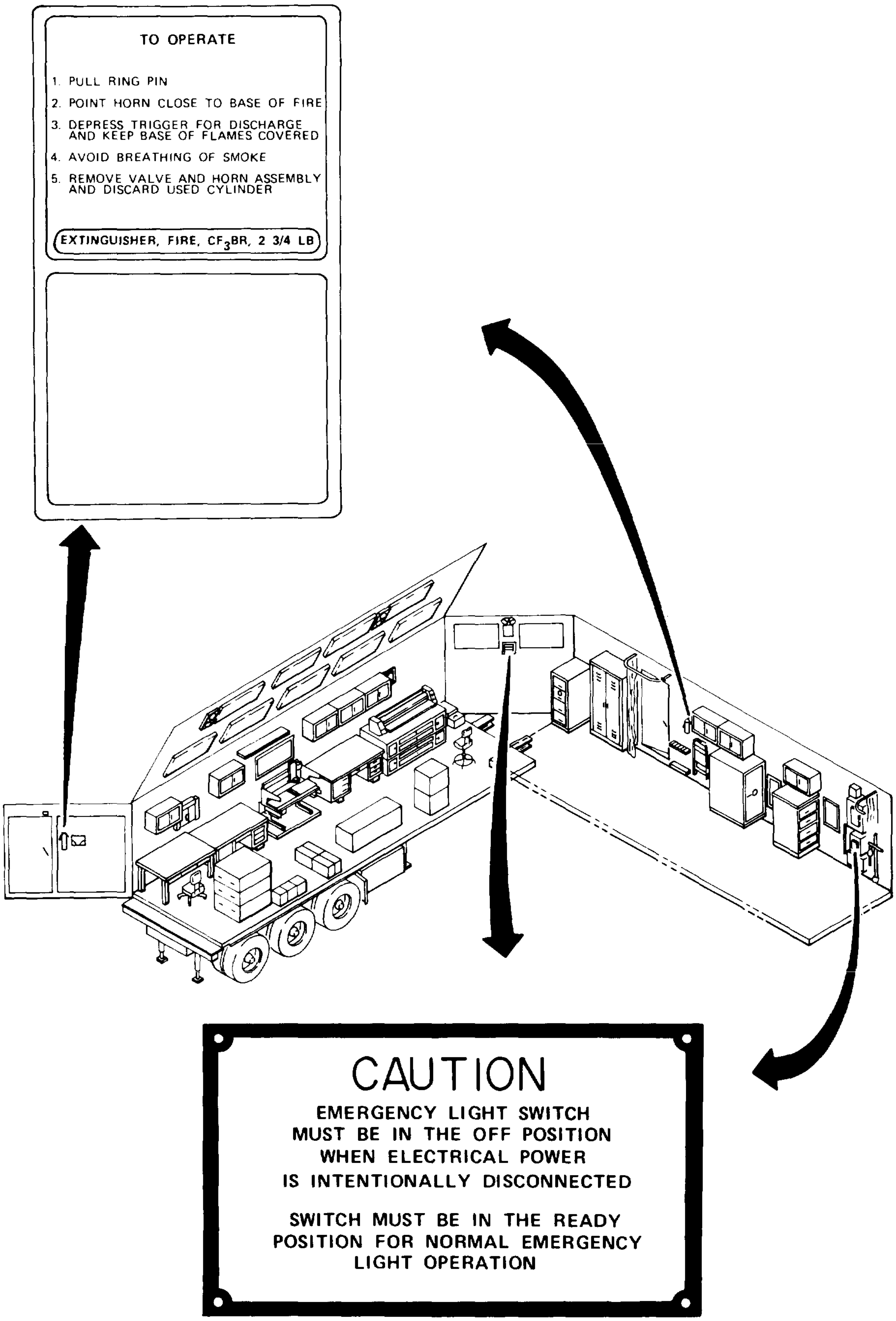
s. Retract leveling jacks.

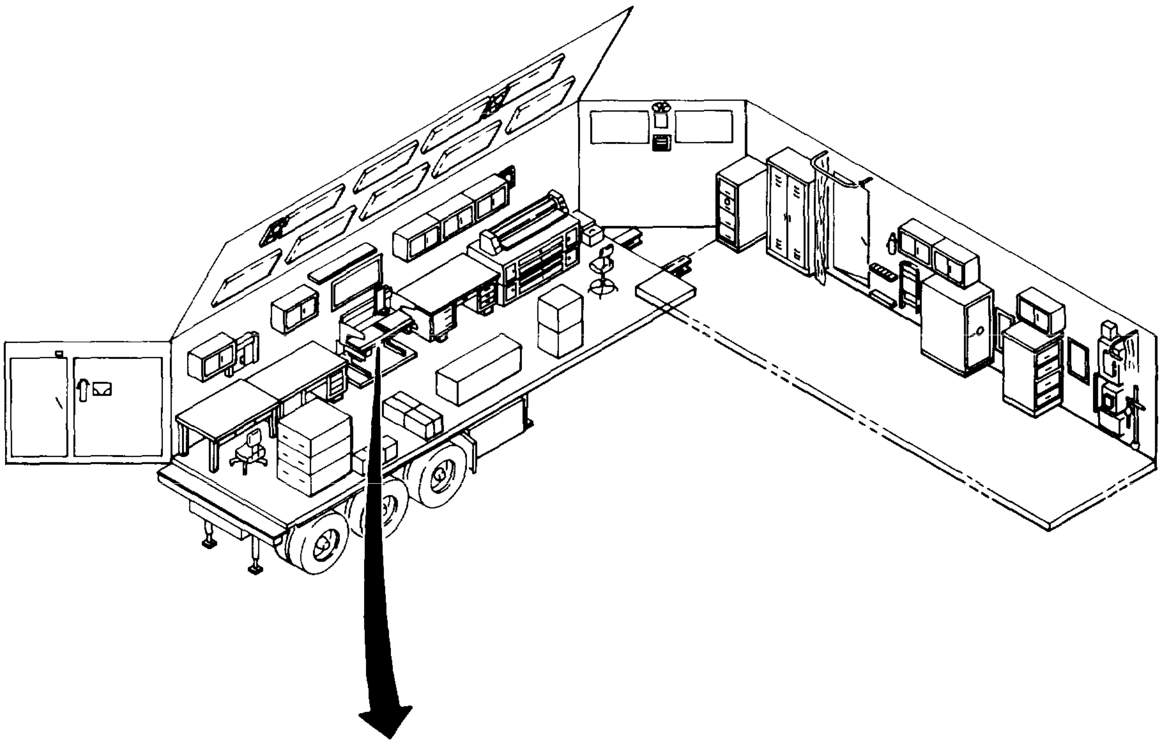
t. Visually inspect section exterior to be sure all equipment and covers are secured.

1-6.3 Operating Instructions on Decals and Instruction Plates.




CAUTION
OPEN OUTSIDE VENT BEFORE
OPERATING FAN
CAUTION
FOR SAFE OPERATION
SEE TM FOR PROPER
INTERNAL AND EXTERNAL
GROUNDING
CAUTION TO START UNIT ON "COOL"
MODE AT 0°F AMBIENT
JUMPER LACO SWITCH (S-5)
CAUTION
OPEN OUTSIDE FLAPS
PRIOR
TO OPERATING AIR COND

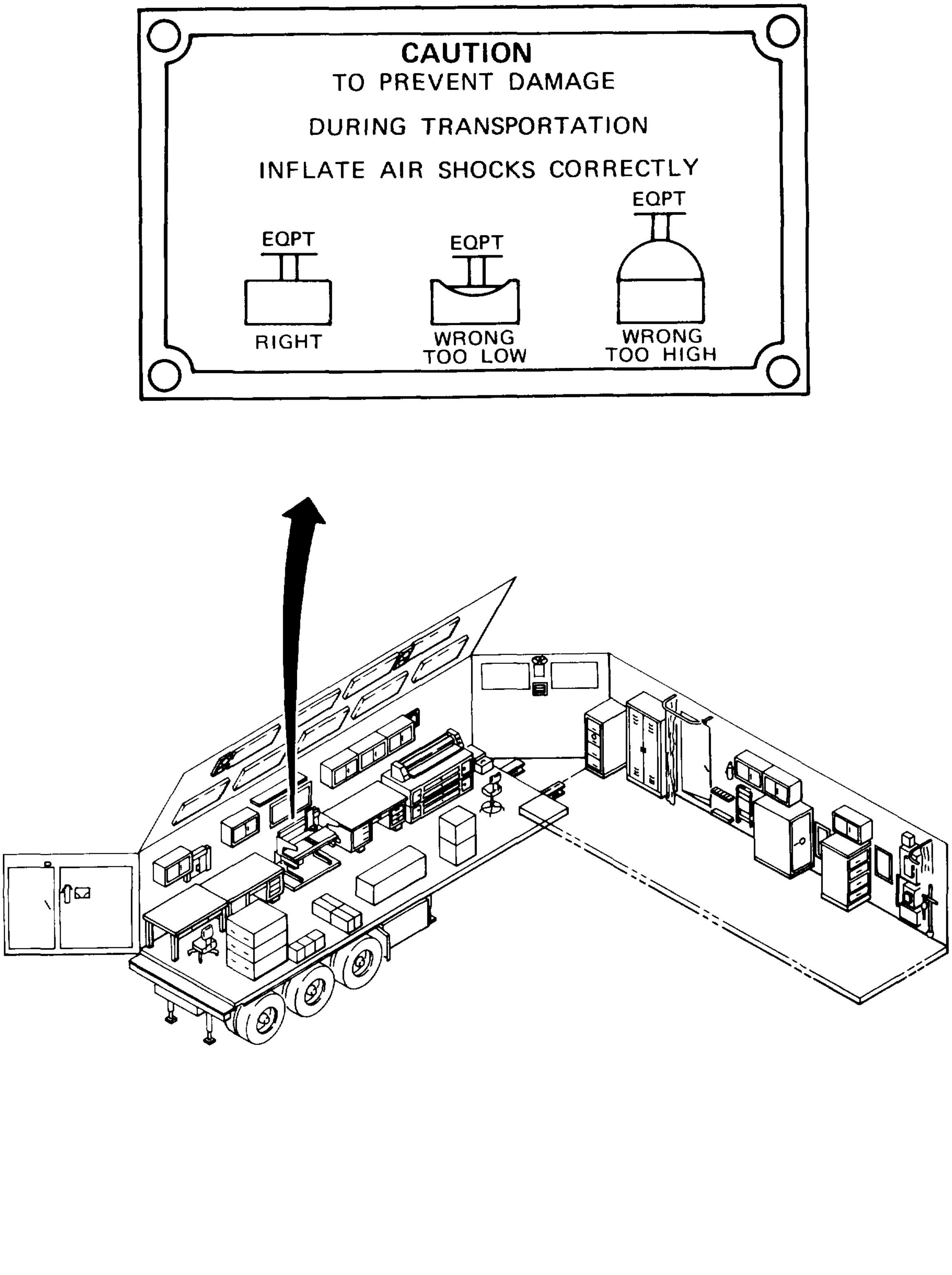

TO OPERATE
1. PULL RING PIN
2. POINT HORN CLOSE TO BASE OF FIRE
3. DEPRESS TRIGGER FOR DISCHARGE AND KEEP BASE OF FLAMES COVERED
4. AVOID BREATHING OF SMOKE
5. REMOVE VALVE AND HORN ASSEMBLY AND DISCARD USED CYLINDER
EXTINGUISHER, FIRE, CF_3BR, 2 3/4 LB
CAUTION
EMERGENCY LIGHT SWITCH MUST BE IN THE OFF POSITION WHEN ELECTRICAL POWER IS INTENTIONALLY DISCONNECTED
SWITCH MUST BE IN THE READY POSITION FOR NORMAL EMERGENCY LIGHT OPERATION



LOAD MUST BE PLACED ATOP MOUNT BEFORE INFLATING.
MAXIMUM INFLATION PRESSURES MUST NOT BE EXCEEDED.
MOUNT MUST BE DEFLATED BEFORE REMOVAL OF LOAD.

BARRY STABL-LEVL SLM-3
LOAD RATING: 75 to 300 LBS.
MAX INFLATION 70 P.S.I.

EQUIPMENT LOAD ON MOUNT MUST BE WITHIN LOAD RATING.
EQUIPMENT MOUNTING SURFACE MUST BE, OR ADAPTED TO BE FLAT
AND OF SIZE TO COVER ENTIRE OUTSIDE DIAMETER OF MOUNT.


CAUTION
TO PREVENT DAMAGE
DURING TRANSPORTATION
INFLATE AIR SHOCKS CORRECTLY
EQPT
RIGHT
EQPT
WRONG
TOO LOW
EQPT
WRONG
TOO HIGH

1-7. OPERATION UNDER UNUSUAL CONDITIONS.

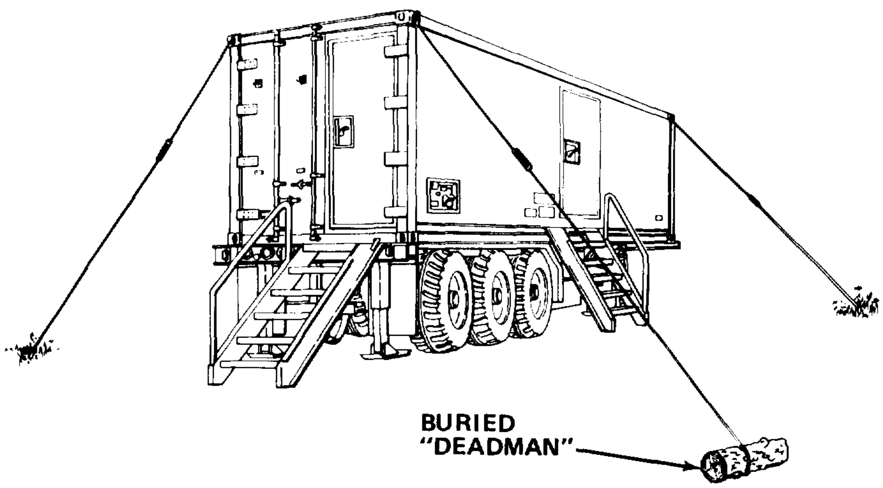
NOTE

Damage to container permitting light leaks, water, or dirt entry must be temporarily repaired using available material on hand. Maintenance personnel will conduct permanent repairs; however, crew must maintain operational capability of section.

1-7.1 Operation in High Wind or Storm Conditions.

a. Relocate section if trees or structures present hazard.

SUGGESTED METHOD OF ANCHORING THE SECTION IN HIGH WINDS



b. Secure section corners at lifting eyes to deadmen or substantial objects.

c. Remove all loose objects from area.

1-7.2 Operation in Cold Weather.

a. The operation of the internal equipment is performed within environmentally controlled conditions; however, in extreme cold, the main power supply cable and ground cable will become hard, brittle, and difficult to handle. When connecting or disconnecting cables, be careful that kinks and unnecessary loops will not result in permanent damage.

b. Make certain that connections and cable receptacles on the outside of the section are free of frost, snow, and ice.

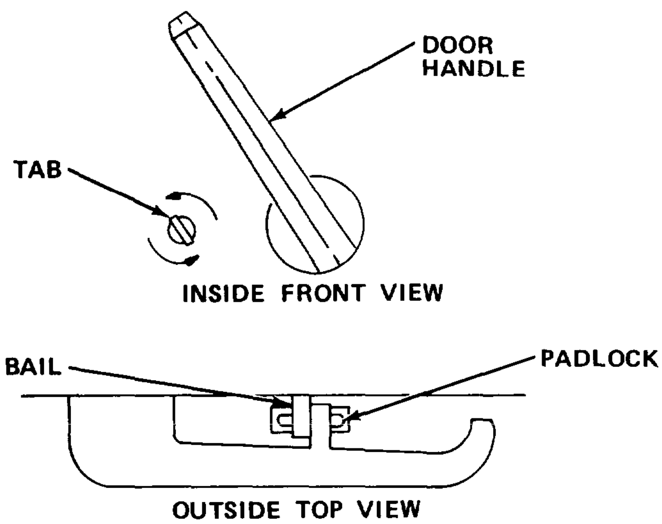
c. When section heaters are not operating or when the section is being transported, liquid consumable supplies may freeze, break their containers, then melt, and ruin equipment or documents. Store these items in an area to prevent equipment and document damage.

1-7.3 Operation in Extreme Heat. The operation of the internal equipment is performed within environmentally controlled conditions; however, during transportation or when air-conditioning units are not operating, consumable supplies may suffer reduced shelf life, and internal components may have accelerated deterioration of gaskets, seals, or insulation.

1-7.4 Operation in Tropical Conditions. Fungi, mildew, or mold will form on and in equipment, documents, and supplies if internal environmental control equipment is not operating and outside heat and humidity are allowed to enter the section.

1-7.5 Operation in Desert Conditions. Dust, grit, and sand will ruin supplies, equipment, and documents. Extreme care must be taken to prevent dust, grit, and sand from entering the section. Air filters will be changed whenever airflow is restricted, and cleaning of section interior must be conducted more frequently than specified by PMCS schedules.

1-7.6 Emergency Procedures. There are no specific emergency procedures for operation of the section.



1-7.7 Emergency Means of Exit. In the event personnel are locked in the section, the tab may be turned to the left until the bail on the padlock falls free. The door handle is now free to turn.

Section III OPERATOR MAINTENANCE

1-8. LUBRICATION INSTRUCTIONS.

a. Lubrication instructions for the Analysis Section are contained in LO 5-6675-323-12, Lubrication Order, Analysis Section, Topographic Support System. The intervals and man-hours specified in the Lubrication Order are based on normal operations. During inactive periods, lubrication periods may be extended with adequate preservation.

b. Topographic equipment and all optical equipment require special care in lubrication. When a specified lubricant is called for, substitutions are not authorized. Minimum amounts of lubricant are to be used and all excess lubricant is to be immediately removed. Spray lubricants must not be used in the vicinity of optical equipment unless optics are completely protected. No lubricant is to be applied unless a thorough cleaning is conducted first to remove dirt, dust, or abrasive material.

c. Be sure that you refer to the appropriate chapter before any equipment is stored after use, that the temperature has stabilized, and that lubrication required after use is accomplished.

1-9. TROUBLESHOOTING PROCEDURES.

a. The table lists the common malfunctions which you may find during operation or maintenance of the Analysis Section, or its components. You should perform the test/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all test or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

Table 1-2. TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. NO ELECTRICAL POWER TO SECTION.

WARNING

Death or serious injury may result. Do not perform any electrical maintenance or make electrical connections or disconnections at main power receptacle when power cable is energized.

Step 1. Observe voltage and frequency for phases A, B, and C. Read 115 ±5 V, 60 ±1 Hz.

(a) If voltage and frequency are correct, proceed to step 2.

(b) If voltage and frequency are incorrect, notify power supply supervisor.

CAUTION

Do not energize section if voltage or frequency is not correct. Damage to equipment may result.

Step 2. Press phase test switch on power panel for A, B, and C.

(a) If phases A, B, and C are correct, proceed to step 3.

(b) If incorrect phase lamp lights, notify power supply supervisor.

CAUTION

Do not energize section if incorrect phase lamp lights. Damage to equipment may result.

Step 3. Check safety switch position.

Table 1-2. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. NO ELECTRICAL POWER TO SECTION - Cont

(a) If safety switch is ON, proceed to step 4.

(b) If safety switch is OFF, turn ON.

Step 4. Check main circuit breaker position.

(a) If circuit breaker is ON, refer to direct/general support maintenance.

(b) If circuit breaker is OFF, turn ON.

(c) If circuit breaker trips repeatedly, notify power supply supervisor.

2. NO ELECTRICAL POWER TO EQUIPMENT.

Step 1. Check equipment power switch.

(a) If power switch is ON, proceed to step 2.

(b) If power switch is OFF, turn ON.

Step 2. Check power cord.

(a) If power cord is plugged in, proceed to step 3.

(b) If power cord is unplugged, plug in.

Step 3. Inspect circuit breaker panel for breakers in OFF position.

(a) If all circuit breakers are ON, refer to direct/general support maintenance.

(b) If any circuit breakers are OFF, turn ON.

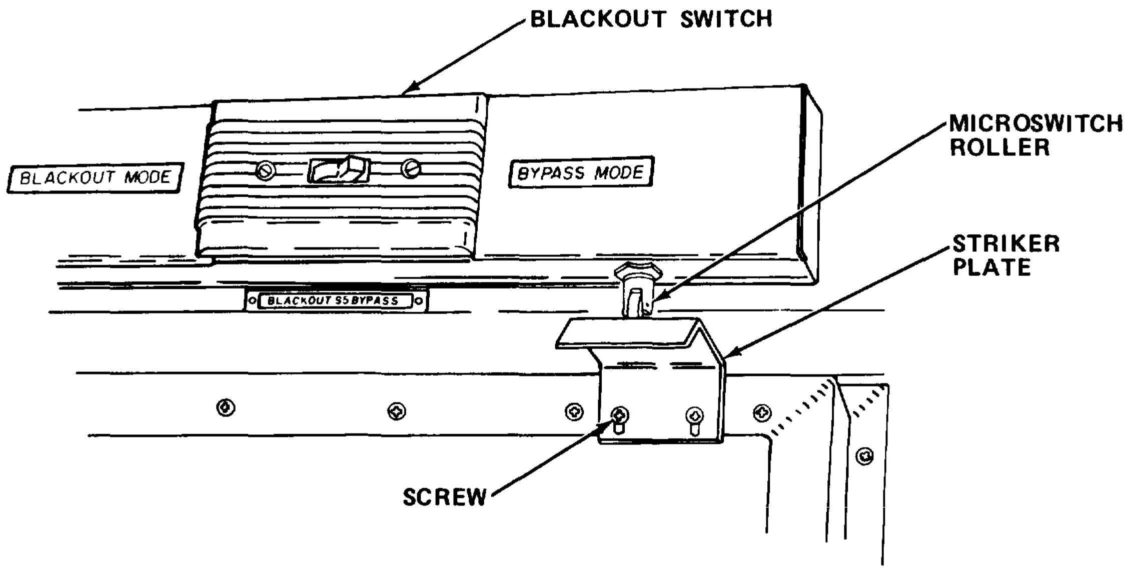
Table 1-2. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

3. BLACKOUT SWITCH DOES NOT OPERATE.



Step 1. Check blackout switch position.

(a) If switch is ON, proceed to step 2.

(b) If switch is OFF, reset switch to BLACKOUT.

Step 2. Check to see that striker plate contacts roller on microswitch.

(a) Loosen screws and move plate up or down until microswich. operates.

(b) If blackout switch still fails to operate, refer to organizational maintenance.

1-10. MAINTENANCE PROCEDURES.

a. This section contains instructions covering operator maintenance functions for the Analysis Section. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

INDEX

1-10.1 Replace Fluorescent Lamp.

MOS: 81Q, Terrain Analyst

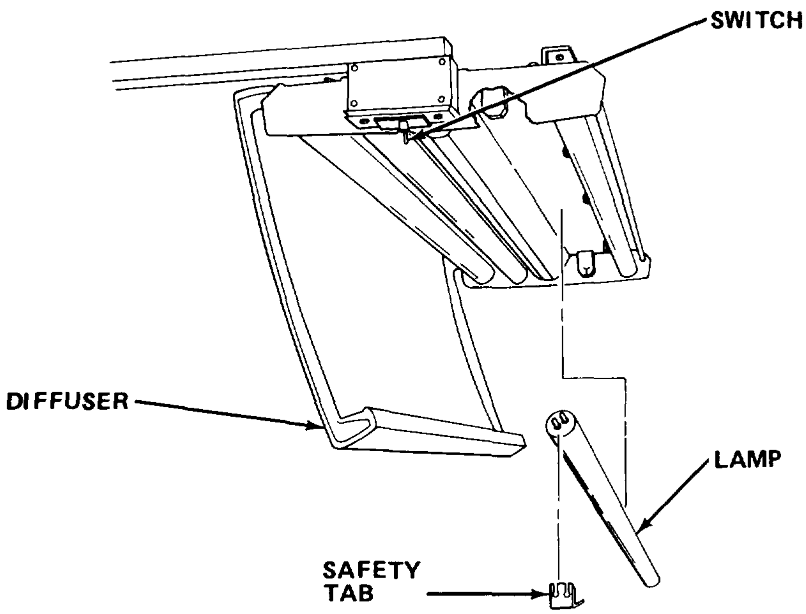
TOOLS: None

SUPPLIES: Fluorescent Lamp

WARNING

Death or serious injury may occur if power is left on while servicing lamp.

a. Turn switch OFF.



b. Gently pull diffuser from light bracket, and place diffuser out of the way to prevent damage.

c. Remove safety tab from lamp socket.

d. Rotate defective lamp until prongs are free from slot and remove.

e. Insert new lamp prongs into slot and rotate 90 degrees.

f. Reinstall safety tab into lamp socket.

g. Reinstall diffuser.

h. Turn power ON.

1-10.2 Service Ventilation Ducts.

MOS: 81Q, Terrain Analyst

TOOLS: Vacuum Cleaner
Flat Tip Screwdriver

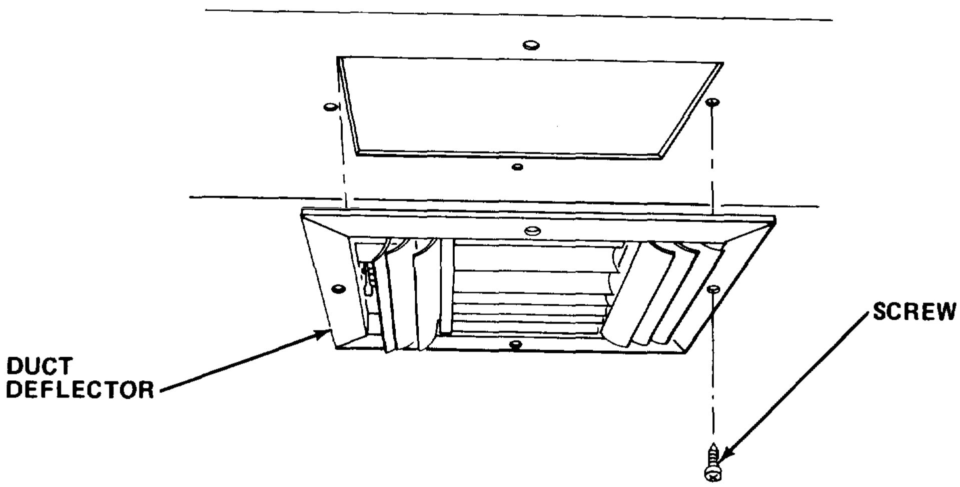
SUPPLIES: None

a. Cover equipment to prevent dust from entering equipment.

b. Close all doors and cabinets.

c. Remove any documents or other work that may be damaged by dirt/dust.

d. Turn off air conditioner/heater.



e. Remove four screws from each ventilation duct deflector.

f. Remove all duct deflectors.

g. Vacuum dirt or dust from deflector louvers.

h. Insert vacuum cleaner probe into ventilation duct at each deflector hole, and vacuum as far as probe will reach.

i. Reinstall deflectors and secure with four screws.

j. Turn on air conditioner/heater.

k. Vacuum any dislodged dirt or dust from interior of section.

l. Remove covers for operation.

1-10.3 Replace Blackout/Dome Light.

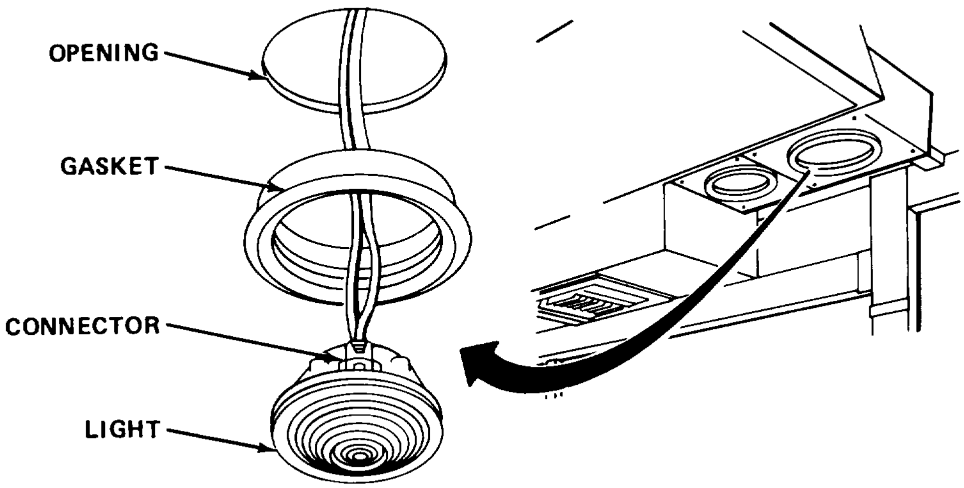
MOS: 81Q, Terrain Analyst

TOOLS: None

SUPPLIES: Light (12 V)
Silicone Spray (Item 27, Appendix E)

NOTE

Blackout light and dome light are sealed units. No bulb replacement is possible. Complete light must be replaced.



a. Push light and gasket up into opening.

b. Tilt and remove light and gasket from opening.

c. Disconnect defective light from connector.

d. Connect new light to connector.

e. Reinstall gasket in opening.

NOTE

The use of silicone spray on the gasket will help to position light.

f. Position light in gasket and push in.

Section IV ORGANIZATIONAL MAINTENANCE

1-11. LUBRICATION INSTRUCTIONS. This equipment does not require lubrication at this level of maintenance.

1-12. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT.

1-12.1 Common Tools and Equipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

1-12.2 Special Tools; Test, Measurement, and Diagnostic Equipment; and Support Equipment. Special Tools, TMDE, and Support Equipment is listed in the applicable repair parts and special tools list and in Appendix B of this manual.

1-12.3 Repair Parts. Repair parts for this equipment are listed in the Repair Parts and Special Tools List, TM 5-6675-323-24P covering organizational maintenance for this equipment.

1-13. SERVICE UPON RECEIPT.

NOTE

The section may be received mounted on a chassis, or as a van body for mounting on an available transporter, or on site. Inspection of the chassis is covered in TM 5-2330-305-14. Inspection of the air conditioner/heater is covered in TM 5-4120-367-14.

1-13.1 Checking Unpacked Equipment.

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6, Packing Improvement Report.

(1) Visually inspect the section exterior starting at the rear to cover rear, curbside, roadside, front, top, and bottom. Inspect for damage, tears, breaks or corrosion.

(2) Enter section and inspect for broken equipment, tool boxes, chairs, or equipment loose and not secured,

(3) Close doors and vents to determine if light leaks exist.

(4) Inspect doors for damage, torn or rotted seals, and tightness of closure.

(5) Inspect interior for evidence of water damage, fungi, mildew or corrosion.

(6) Report damage or discrepancies in accordance with AR 735-11 and AR 735-11-2.

b. Check the equipment against the packing list to see if shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

(1) Inventory section against Components of End Item and Basic Issue Items Lists (Appendix C).

(2) Inventory expendable supplies contained in section as shown in Appendix E.

(3) Conduct operational checks on equipment in accordance with the chapters in this manual when operators are available and power can be safely provided to the section.

c. Check to see whether the equipment has been modified.

1-14. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

a. PMCS are designed to keep the equipment in good working condition by performing certain tests, inspections, and services. The intervals provide you, the organizational technician, with time schedules that determine when to perform specified tasks.

b. Item number column. Item numbers are assigned in chronological ascending sequence regardless of interval designation. These numbers are used for your "TM Number" column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording the results of PMCS.

c. Interval columns. This column determines the time period designated to perform your PMCS.

d. Item to be inspected and procedures column. This column lists functional groups and their respective assemblies and subassemblies as shown in the Maintenance Allocation Chart (Appendix B). The appropriate check or service procedure follows the specific item to be inspected.

e. Preventive maintenance checks and services for the air conditioners/heaters are contained in TM 5-4120-367-14.

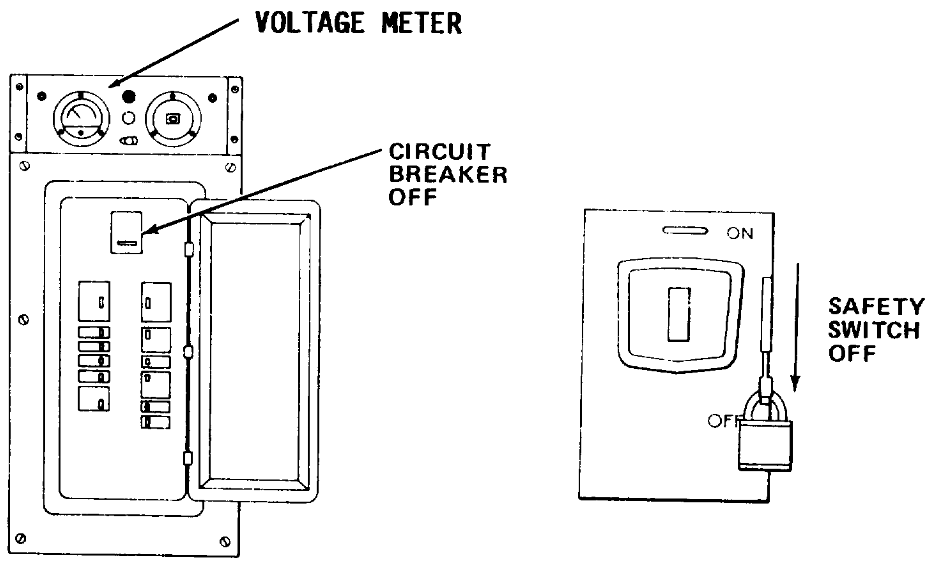
f. List of tools and materials required for PMCS is as follows:

Item	Quantity
Vacuum Cleaner	1 ea
8 in. Adjustable Wrench	1 ea
Cross Tip Screwdriver	1 ea
Flat Tip Screwdriver	1 ea
Spring Scale	1 ea
Padlock	1 ea
Flashlight	1 ea

Table 1-3. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

B - Before | W - Weekly | AN - Annually | (Number) - Hundreds of Hours
D - During | M - Monthly | S - Semiannually
A - After | Q - Quarterly | BI - Biennially

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE
		VAN BODY
1	M	Service Air Conditioner/Heater. Refer to TM 5-4120-367-14 for preventive maintenance checks and services.
2	M	Service Lighting System.



WARNING

Do not open circuit breaker panel or service electrical connections, cables, or switches until main power is off, and voltage meter confirms circuit is not energized. Death may result from failure to observe these safety precautions.

1. Turn off main circuit breaker. Turn off safety switch.

2. Padlock safety switch.

Table 1-3. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

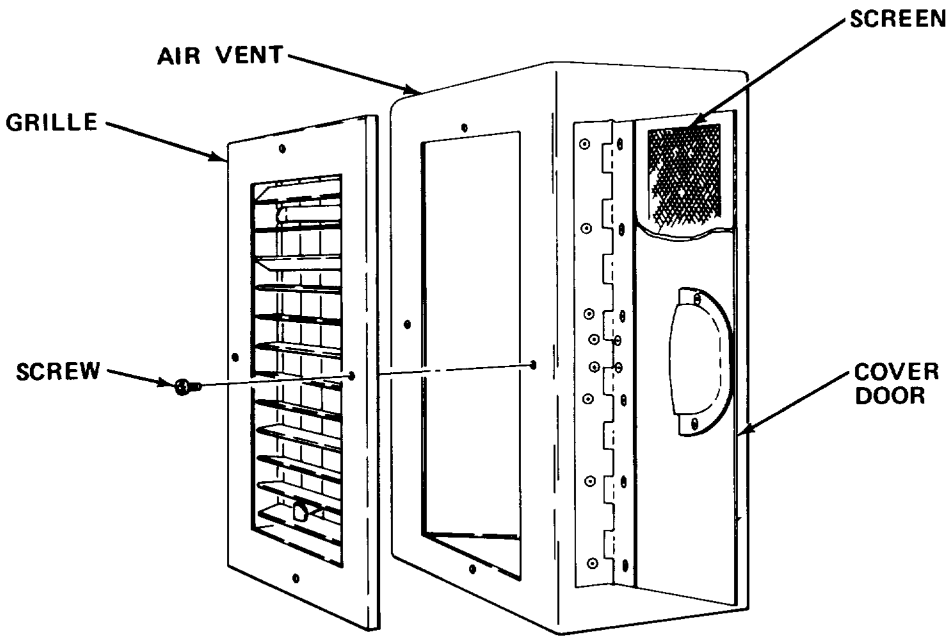
B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

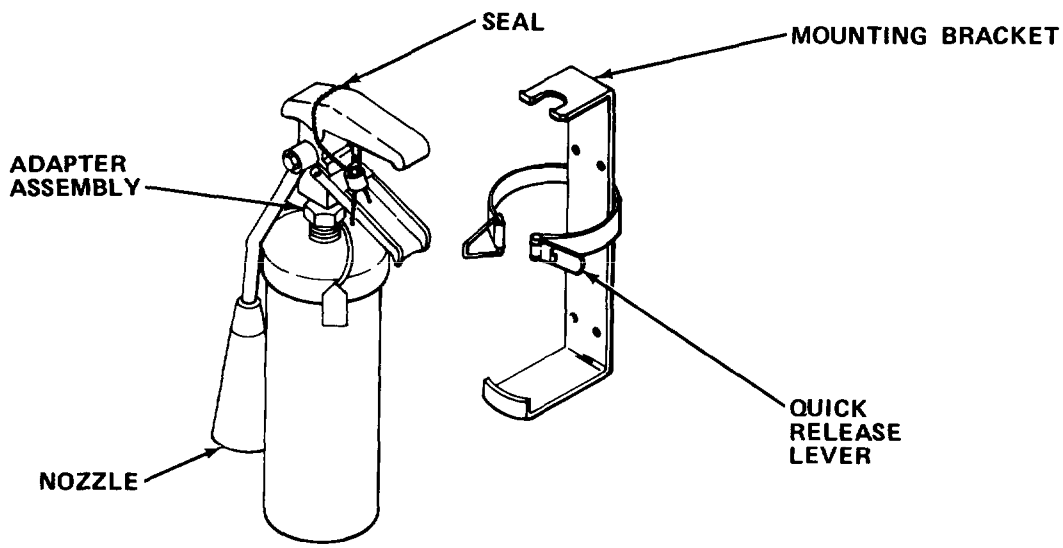
ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE
		VAN BODY - Cont
2	M	Service Lighting System - Cont
		3. Tighten all loose screws, bolts, and clamps.
		4. Check which switches, switch plate outlets, receptacles, and posts require repair.
		5. Check for loose screws and nuts on ceiling, console lights, circuit breaker panels, and conduits.
		6. Remove padlock.
		7. Turn on main circuit breaker and safety switch.
3	M	Service Air Vent



1. Remove screws from front of grille.
2. Remove front grille.

Table 1-3. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before	W - Weekly	AN - Annually	(Number) - Hundreds of Hours
D - During	M - Monthly	S - Semiannually	
A - After"	Q - Quarterly	BI - Biannially	

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE
		VAN BODY - Cont
3	M	Service Air Vent - Cont
		3. Using vacuum cleaner, clean screens on side doors. Vacuum inside of air vent.
		4. Reinstall grille and secure with screws.
4	M	Inspect Fire Extinguisher.
		
		1. Remove from mounting bracket. Check free movement of bracket.
		2. Inspect nozzle and adapter assembly for damage.
		3. Inspect seal. Be sure it is not broken.
	S	4. Weigh cylinder. Replace if gross weight has decreased by 6 oz (170 g) or more.

1-15. ORGANIZATIONAL TROUBLESHOOTING PROCEDURES.

a. Organizational troubleshooting procedures cover the most common malfunctions that may be repaired at the organizational level. Repair or adjustment requiring specialized equipment is not authorized unless such equipment is available. Troubleshooting procedures used by the operator should be conducted in addition to the organizational troubleshooting procedures.

b. This manual cannot list all the possible malfunctions or every possible test/inspection and corrective action. If a malfunction is not listed or is not corrected by a listed corrective action, notify your supervisor.

c. For unidentified malfunctions, use the facing schematic or the foldout located at the end of this manual for further fault analysis.

d. If any component of the Analysis Section does not power up when turned on, verify that 120 V ac is present at the receptacle. If voltage is not present, plug equipment into receptacle with power available and proceed with equipment troubleshooting. Perform no-power troubleshooting procedures for dead receptacle (Table 1-4).

Table 1-4. ORGANIZATIONAL TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

WARNING

Electrical shock hazard. Be sure power is off when checking continuity at troubleshooting points. Death or serious injury could result from failure to do so.

1. FLUORESCENT CEILING LAMP IS INOPERATIVE.

Step 1. Check for continuity of fluorescent lamp switch

(a) If continuity exists, proceed to step 2.

(b) If continuity does not exist, replace switch (paragraph 1-16.3).

Table 1-4. ORGANIZATIONAL TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. FLUORESCENT CEILING LAMP IS INOPERATIVE - Cont

Step 2. Check for continuity of lamp ballast.

(a) If continuity exists, proceed to step 3.

(b) If continuity does not exist, replace lamp ballast (paragraph 1-16.1).

Step 3. Check for shorts in RF filter.

Replace RF filter (paragraph 1-16.2).

2. EXHAUST FAN IS INOPERATIVE.

Check on/off switch for continuity.

(a) If continuity exists, replace fan (paragraph 1-16.9).

(b) If continuity does not exist, replace switch (paragraph 1-16.4).

3. EMERGENCY LIGHTS ARE INOPERATIVE.

Press in test indicator.

If lamps do not light, replace emergency light assembly (paragraph 1-16.11).

4. NO POWER TO EQUIPMENT.

Step 1. Check circuit breaker ON/OFF position.

(a) If circuit breaker is ON, proceed to step 2.

(b) If circuit breaker is OFF, turn ON.

Table 1-4. ORGANIZATIONAL TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

4. NO POWER TO EQUIPMENT - Cont

(c) If circuit breaker trips repeatedly, notify power supply supervisor.

Step 2. Check circuit breaker input for 120 V ac.

(a) If input voltage is present, proceed to step 3.

(b) If input voltage is not present, refer to direct/general support maintenance for repair or replacement of defective wiring.

Step 3. Check circuit breaker output for 120 V ac.

(a) If output voltage is present, proceed to step 4.

(b) If output voltage is not present, refer to direct/general support maintenance for circuit breaker replacement (paragraph 1-20.5).

Step 4. Remove receptacle and check for 120 V ac input.

(a) If present, replace receptacle (paragraph 1-16.6).

(b) If not present, refer to direct/general support maintenance for repair or replacement of defective wiring.

1-16. MAINTENANCE PROCEDURES.

a. This section contains instructions covering organizational maintenance functions for the Analysis Section. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

INDEX

1-16.1 Replace Fluorescent Lamp Ballast.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

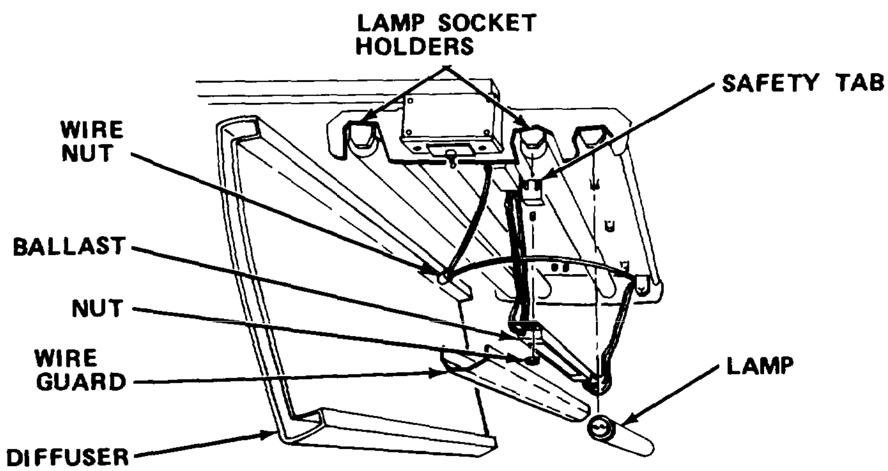
TOOLS: Flat Tip Screwdriver
1/4 in. Wrench
1/4 in. Drive Socket Set
Scribe

SUPPLIES: Lamp Ballast
Wire Ties

WARNING

Death or serious injury may occur unless overhead light circuit breaker and main circuit breaker are turned off before working on light fixture.

a. Turn off overhead light, circuit breaker and main circuit breaker.



b. Remove diffuser from light fixture.

c. Remove safety tabs and lamps. Place in diffuser.

d. Squeeze light wiring guard and remove.

e. Remove wire ties as required.

f. Tag wires from ballast for reference.

9“ Disconnect ballast wire from wire nut connection.

h. Pry out lamp socket holder with flat tip screwdriver.

i. Using scribe, depress wire clips and disconnect ballast wiring.

j. Remove nut and defective ballast.

k. Install new ballast and connect wires to corresponding lamp socket holders.

l. Secure with nut.

m. Reconnect ballast wire to wire nut connection.

n. Remove tags.

o. Install new wire ties.

NOTE

Be sure wires are free of kinks and do not interfere with placement of wire guard.

p. Reinstall wire guard.

q. Reinstall lamp and safety tabs.

r. Reinstall diffuser.

s. Turn on overhead light circuit breaker and main circuit breaker.

1-16.2 Replace Radio Frequency (RF) Filter.

MOS: 83FJ6, Reproduction Equipment Repairer
or
41B, Topographic Instrument Repair Specialist

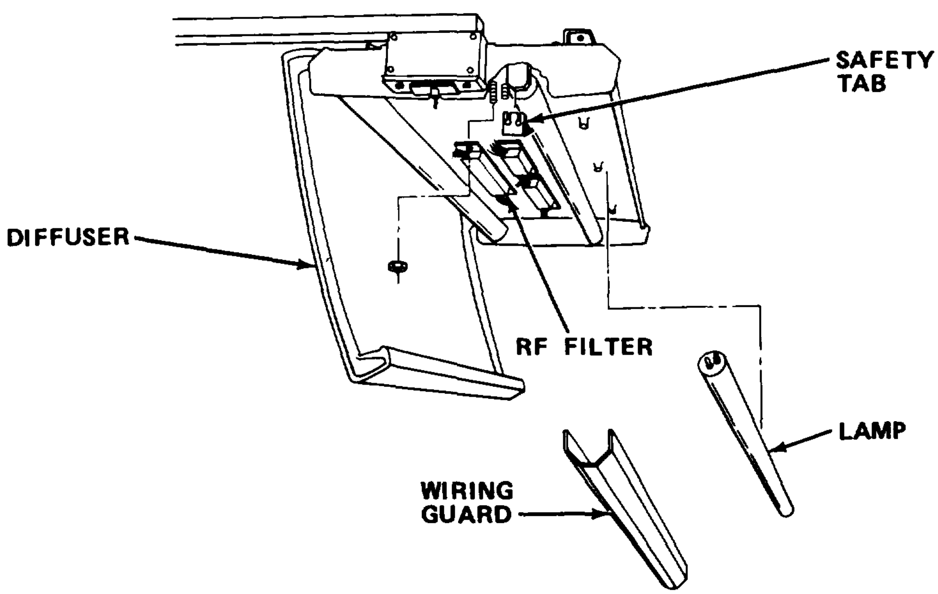
TOOLS: Flat Tip Screwdriver
1/4 in. Wrench
1/4 in. Drive Socket Set

SUPPLIES: RF Filter
Wire Ties

WARNING

Death or serious injury may occur unless overhead light switch is turned OFF before working on light fixture.

a. Turn overhead light switch OFF.



b. Remove diffuser from light fixture.

c. Remove safety tabs and lamps. Place in diffuser.

d. Squeeze light wiring guard and remove.

e. Remove wire ties as required.

f. Tag wires to filter.

g. Remove wire nuts and disconnect filter wires.

h. Remove nuts and defective filter.

i. Install new filter. Secure with nuts.

j. Reconnect filter wires and secure with wire nuts.

k. Remove tags.

l. Install new wire ties.

NOTE

Be sure wires are free of kinks and do not interfere with placement of wire guard.

m. Reinstall wire guard.

n. Rein-stall lamps and safety tabs.

o. Reinstall diffuser.

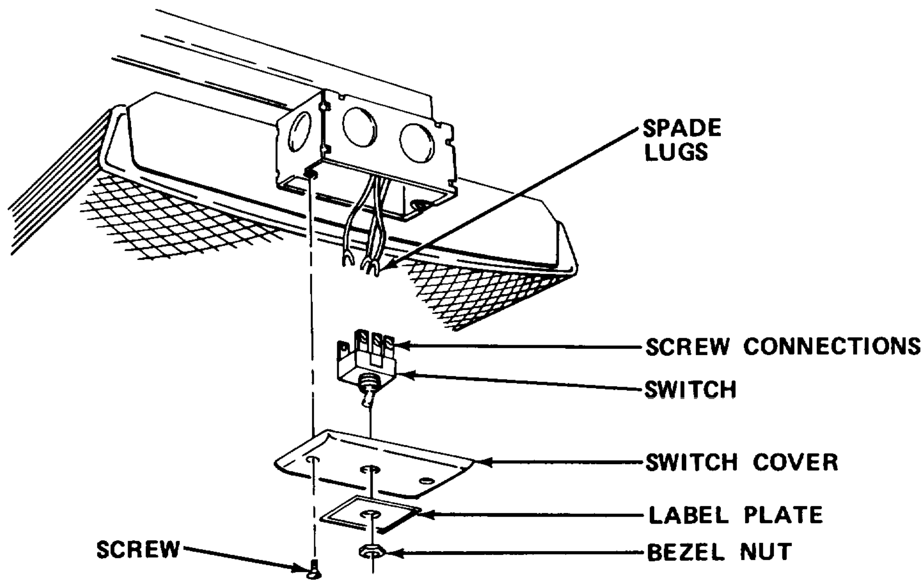
p. Turn on light switch.

1-16.3 Replace Fluorescent Lamp Switch.

MOS: 83FJ6, Reproduction Equipment Repairer
or
41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver
Needle Nose Pliers
Flashlight

SUPPLIES: Switch Assembly



WARNING

Death or serious injury may occur if lighting circuit breaker is not turned off before working on lamp assembly.

NOTE

Alternate lighting is required to perform this task.

a. Turn circuit breaker OFF.

b. Remove bezel nut.

c. Note notch on label plate and remove label plate.

d. Loosen screws.

NOTE

Note position of cover and reinstall as noted.

e. Remove cover plate.

f. Tag and disconnect wires from defective switch.

g. Install new switch, connect wires, and remove tags.

h. Insert switch through cover plate and label plate.

NOTE

Be sure label plate is in same direction as when removed. Secure with bezel nut.

i. Aline cover plate with holes and secure with screws.

j. Turn circuit breaker ON.

1-16.4 Replace On/Off Switch.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

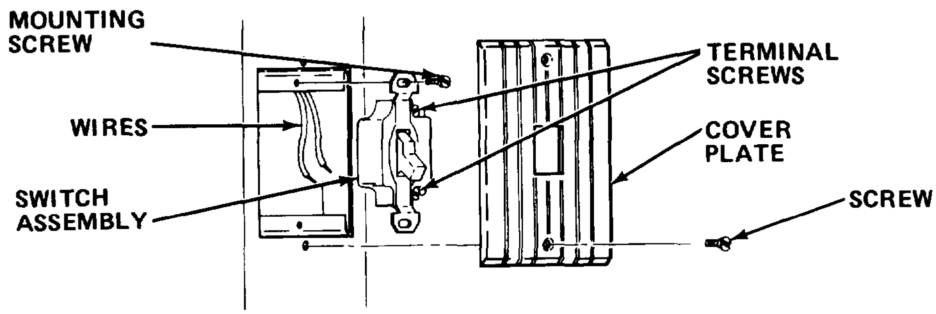
TOOLS: Flat Tip Screwdriver

SUPPLIES: Switch

WARNING

Death or serious injury may occur if switch circuit breaker is not turned off before working on switch.

a. Turn off appropriate circuit breaker.



b. Remove screws.

c. Remove cover plate.

d. Remove mounting screws.

e. Pull switch assembly from wire guide to gain access to wires.

f. Loosen terminal screws; then disconnect wires.

g. Install new switch.

h. Reconnect wires.

i. Guide switch into wire guide, alining holes.

NOTE

Be sure wires are not kinked or strained.

j. Reinstall mounting screws.

k. Reinstall cover plate and secure with screws.

l. Turn on switch circuit breaker.

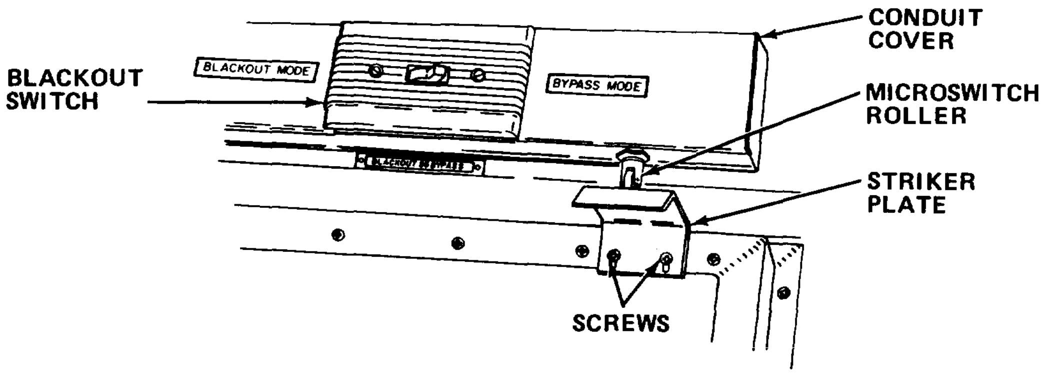
1-16.5 Replace Blackout/Dome Light Microswitch.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver
6 in. Adjustable Wrench

SUPPLIES: Microswitch



WARNING

Death or serious injury may occur from electrical shock unless power is off before servicing.

a. Turn off blackout/dome light circuit breaker.

b. Remove conduit cover.

c. Remove nut and pull out switch to expose wiring.

d. Disconnect wires from defective switch.

e. Connect wires to new switch.

f. Install switch and secure with nut.

g. Adjust striker plate until plate contacts roller.

h. Reinstall conduit cover.

i. Turn on circuit breaker.

1-16.6 Replace ace Receptacle.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

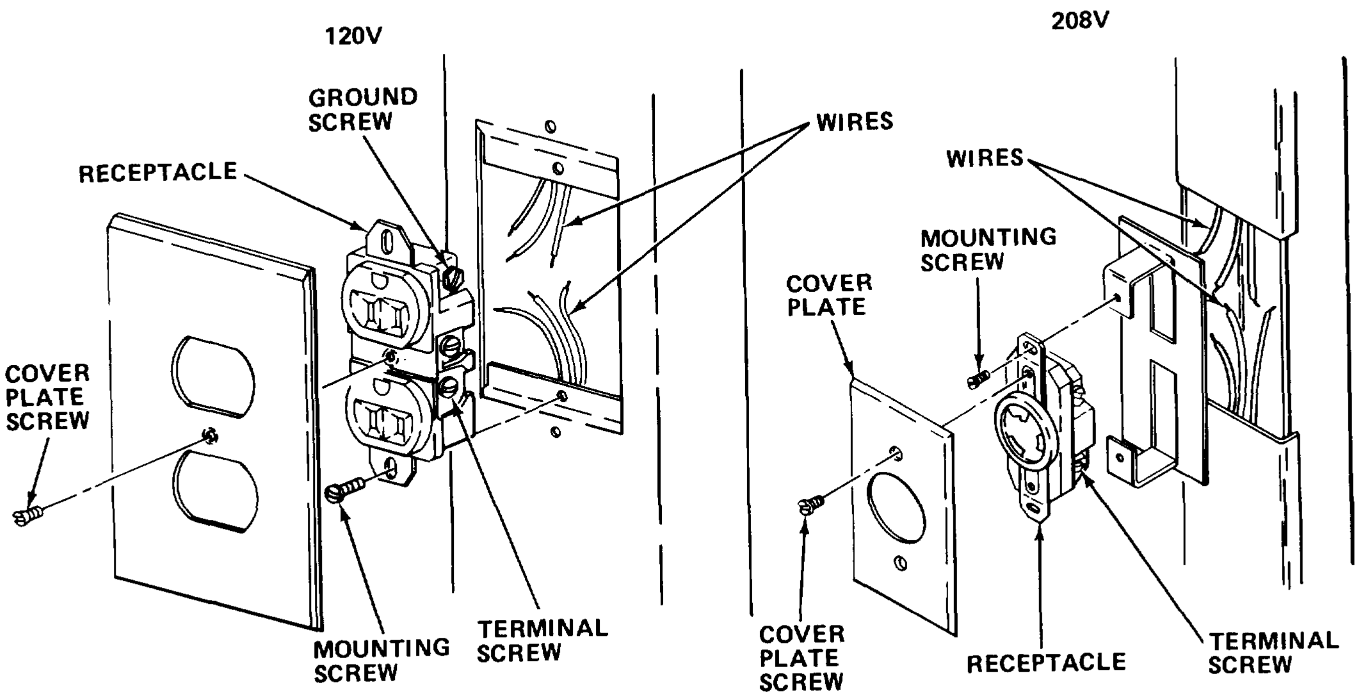
TOOLS: Flat Tip Screwdriver

SUPPLIES: Receptacle

WARNING

Death or serious injury may occur if receptacle circuit breaker is not turned off before working on receptacle.

a. Turn off receptacle circuit breaker.



b. Remove cover plate screws.

c. Remove cover plate.

d. Remove mounting screws.

e. Withdraw receptacle to gain access to wires.

f. Loosen terminal screws and ground screw. Then disconnect wires.

g. Reconnect wires. Connect green (ground) wire first.

h. Install new receptacle.

i. Guide receptacle into wire guide.

NOTE

Be sure wires are not kinked or strained.

j. Secure receptacle with screws.

k. Reinstall cover plate. Secure with screws.

l. Turn on receptacle circuit breaker.

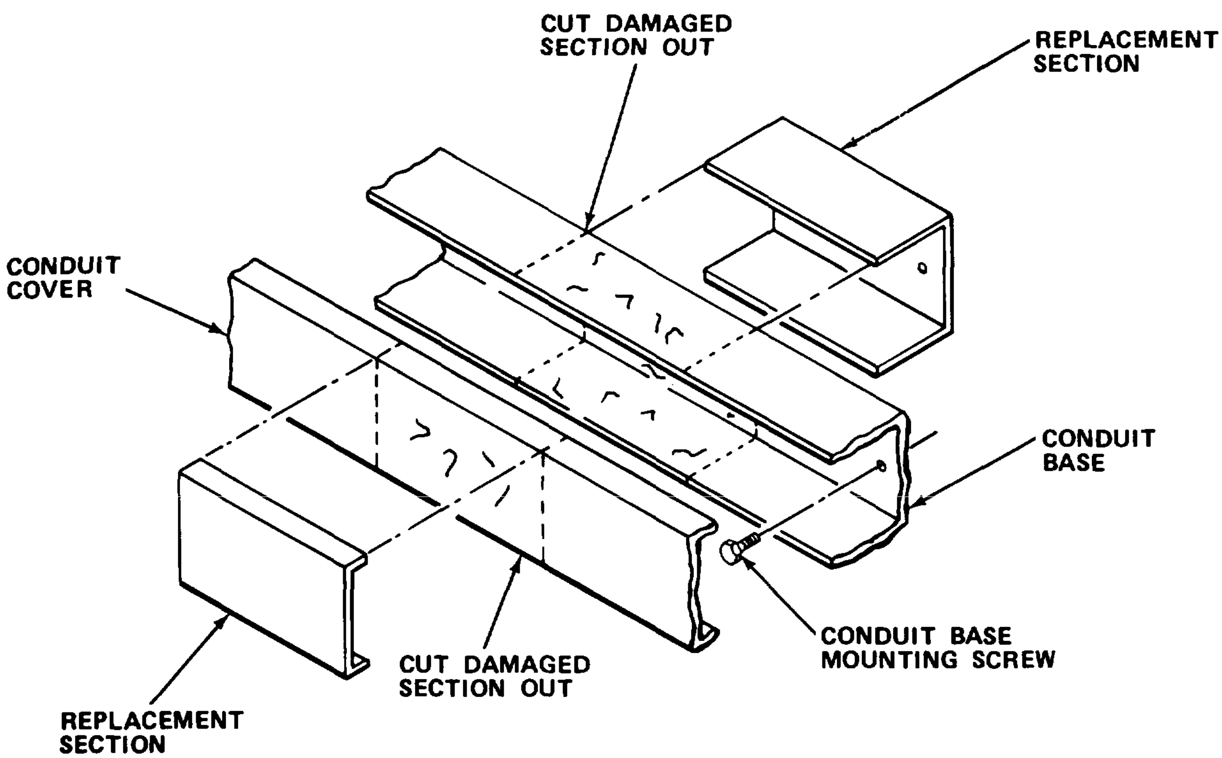
1-16.7 Replace Wire Molding.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver
Hacksaw
Flashlight
Paint Brush
Multimeter
Drill and Bits
File
Machinist Rule

SUPPLIES: Paint (Item 18, Appendix E)
Cheesecloth (Item 7, Appendix E)
Conduit Base
Conduit Cover
Padlock



WARNING

Death or serious injury may occur from failure to turn off and padlock safety switch before repairing molding.

NOTE

Alternate lighting is required to perform this task.

a. Turn off and padlock safety switch.

b. Remove conduit cover.

c. Inspect wires for damage.

NOTE

Refer to direct support maintenance for wiring repair if necessary.

d. Loosen wiring and carefully pull it from the entire base section.

e. Remove screws and base from wall.

f. Mark and measure damaged area on molding. Record measurement.

g. Cut damaged area from molding.

h. Cut section from new molding to the length recorded in step f.

i. Using damaged area as a template, mark mounting holes on new piece.

j. With a number 25 drill bit, drill holes in new molding.

k. With file, remove all burred edges.

l. Paint base section as required.

m. Reinstall conduit base on wall with screws.

n. Carefully place wiring back in conduit base.

o. Reinstall cover on base.

p. Test wiring for continuity between power wires and conduit. If there is continuity, determine and correct grounding fault.

q. Test wiring with power on.

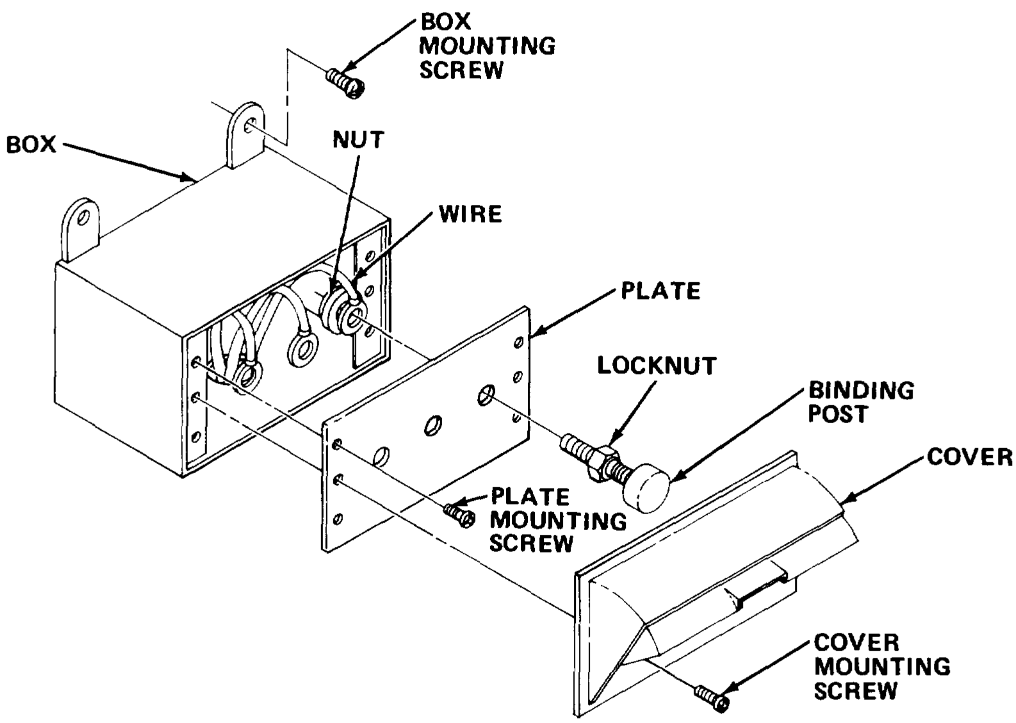
1-16.8 Repair Telephone Binding Post Assembly.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Cross Tip Screwdriver
1/2 in. Combination Wrench

SUPPLIES: Binding Post Box
Binding Posts



a. Remove cover mounting screws. Remove cover.

b. Remove plate mounting screws to gain access to back of plate.

c. Tag wires for identification.

d. Remove nuts and wires from binding posts.

e. If required, remove box mounting screws and replace box.

f. Replace any defective binding posts. Secure wires to new posts and remove tags.

g. Reinstall box assembly and plate, and secure plate with screws.

h. Secure cover with screws.

1-16.9 Replace Exhaust Fan.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

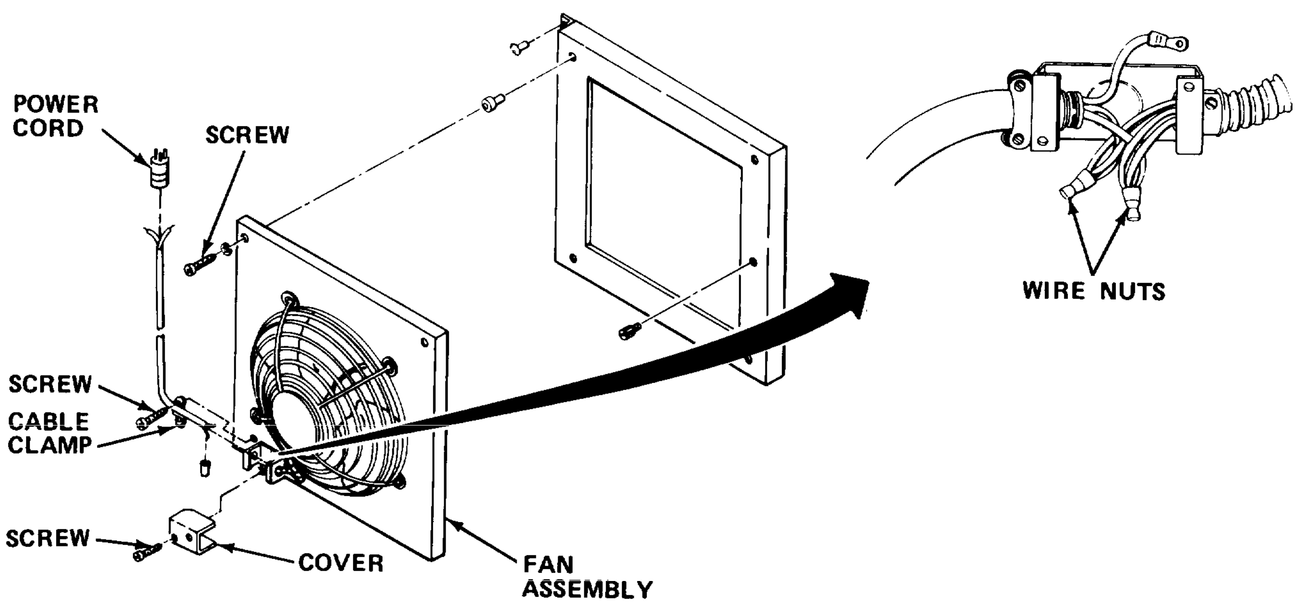
TOOLS: Flat Tip Screwdriver
Cross Tip Screwdriver
Wire Cutters

SUPPLIES: Fan Assembly
Wire Nuts
Power Cord

WARNING

Death or serious injury may occur if power is left on. Turn fan switch OFF and unplug power cord before working on exhaust fan.

a. Unplug power cord.



b. Remove screws and place fan assembly on work surface.

c. Loosen screws on cable clamp.

d. Remove screws and cover.

e. Tag wires and cut wire nuts from wires.

f. Remove power cord from defective fan assembly.

g. Install new fan.

h. Install new power cord.

i. Connect wires with wire nuts and remove tags.

j. Tighten cable clamp screws.

k. Reinstall cover. Secure with screws.

l. Reinstall fan assembly. Secure with screws.

m. Plug in power cord.

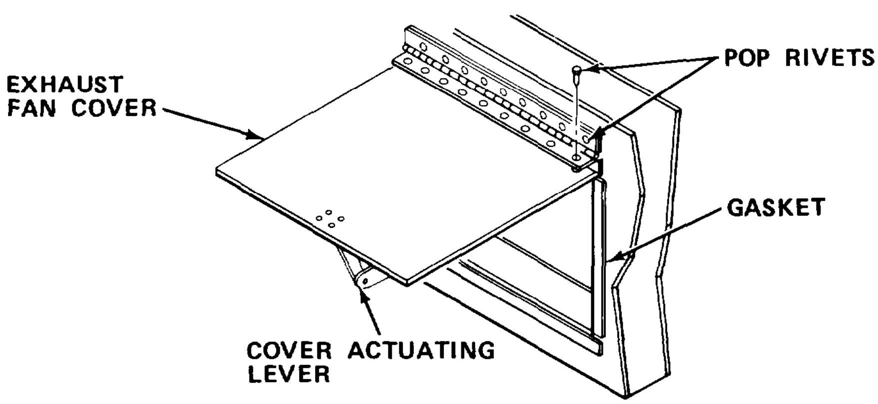
1-16.10 Replace Exhaust Fan Cover.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Drill and Bits
Pop Rivet Gun
Scraper

SUPPLIES: Pop Rivets
Exhaust Fan Cover
Gasket
Solvent P-D-680 (Item 25, Appendix E)
Adhesive (Item 2, Appendix E)
Cheesecloth (Item 7, Appendix E)
Impermeable Gloves
Goggles



a. Drill pop rivets from hinged cover to remove vent cover.

b. Remove defective vent cover and transfer mounting hardware to new cover.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Wear solvent-impermeable gloves and eye/face protective equipment when using solvent. Do not use near open flame or excessive heat. Flash point of solvent is 100° F to 138° F (38° C to 59° C).

c. Scrape gasket off section and clean area with solvent P-D-680.

d. Secure new gasket to section with adhesive.

e. Aline exhaust fan vent cover and pop rivet to hinge.

f. Test cover for tightness of closure.

1-16.11 Replace Emergency Light Assembly.

MOS: 83FJ6, Reproduction Equipment Repairer

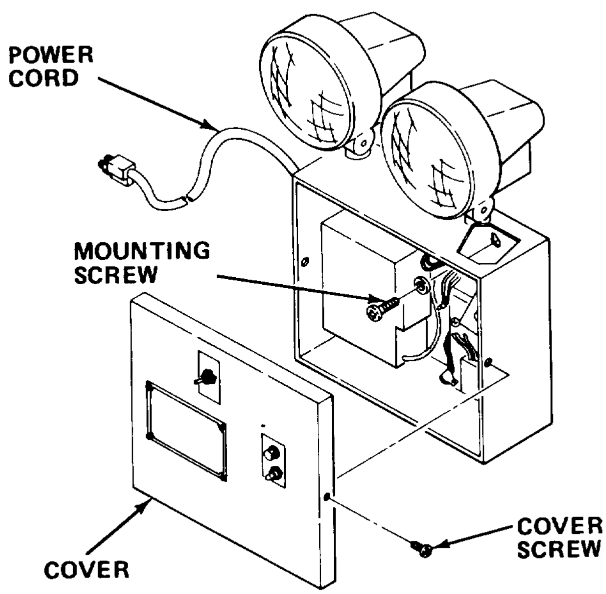
41B, Topographic Instrument Repair Specialist

TOOLS: Cross Tip Screwdriver
Flat Tip Screwdriver

SUPPLIES: Emergency Light Assembly

WARNING

Death or serious injury may occur if power cord is not unplugged before servicing light.



a. Unplug power cord.

b. Remove cover screws. Move cover out of way.

c. Remove mounting screws.

d. Remove emergency light assembly.

e. Install new emergency light assembly. Secure with screws.

f. Secure cover with screws.

g. Plug in power cord.

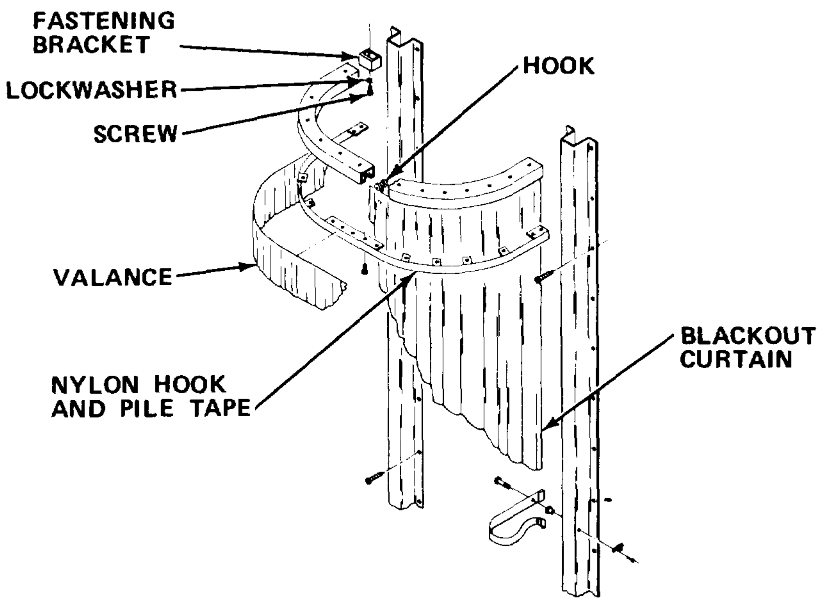
1-16.12 Repair Blackout Curtain.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Cross Tip Screwdriver

SUPPLIES: Hooks
Valance
Curtain
Nylon Hook and Pile Tape
Adhesive (Item 2, Appendix E)



a. Remove curtain from hooks.

b. Pull curtain and valance from nylon hook and pile tape.

c. Remove end screw, lockwasher, and fastening bracket from ceiling.

d. Replace damaged hooks.

e. Reinstall fastening bracket with hooks. Fasten with end screw and lockwasher.

f. Glue loose nylon hook and pile tape to wall or bracket. Replace tape if worn out.

g. Hook curtain to bracket.

h. Attach valance.

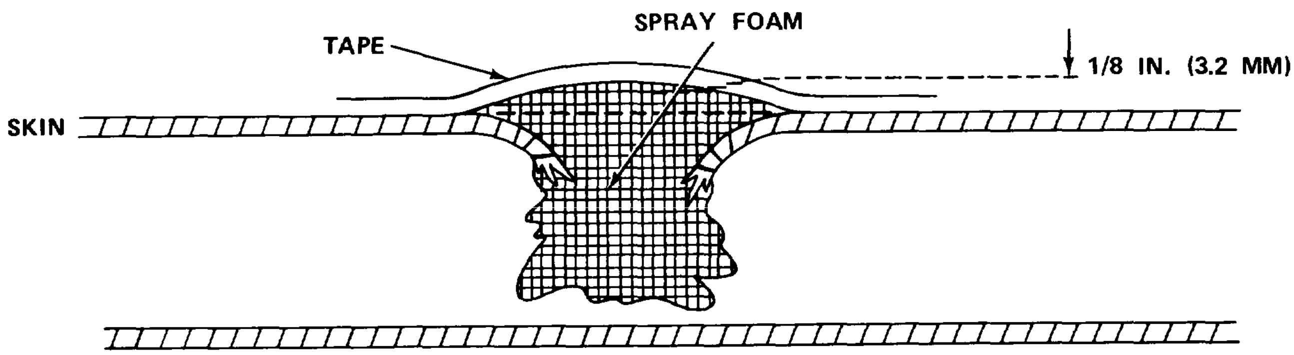
i. Check curtain for free movement.

1-16.13 Repair Van Body Skin (Temporary).

MOS: 52C, Utilities Equipment Repairer

TOOLS: Pliers
Ball Peen Hammer
Scissors or Utility Knife

SUPPLIES: Cloth Duct Sealing Tape (Item 29, Appendix E)
Silicone Sealant (Item 23, Appendix E)
Sprayfoam (Item 28, Appendix E)
Cheesecloth (Item 7, Appendix E)



a. Bend broken edges of punctured skin inward into puncture hole. Do not attempt to remove fragments of skin by bending or pulling outward. Bend skin inward only enough to put broken edges below surface of unbroken skin.

b. Remove any loose fragments of foam which are not now held in place by bent broken skin. Removing small pieces of foam or dust is more important than removing chunks.

c. Using cloth slightly dampened with water, wipe area around puncture to remove any dirt or mud and wipe dry.

d. Inject sprayfoam into puncture. Mound sprayfoam to about 1/8 in. (3.2 mm) above surface of unbroken skin. Apply bead of sealant about 1/4 in. (6.4 mm) wide over all cuts in skin leading out from puncture. Do not smooth out sealant.

e. Plan how puncture is to be covered with tape before applying any tape. Length and width of tape, number of tape strips, overlapping, and how tape is applied will affect sealing capability of repair. Each piece of tape should extend about 1-1/2 in. (3.81 cm) beyond sealant it will cover. If this will require more than one strip of tape, tape should overlap about 1/2 in. (12.7 mm). If three or more strips of tape are required, center strip should be applied first.

f. Holding it taut, apply tape perpendicular to panel skin. Do not apply with rolling motion either end-to-end or center-to-ends. Do not rub each strip in place individually. Apply all strips lightly with proper overlap and rub into place.

g. If necessary, damaged tape can be replaced; however, it should be removed with careful peeling motion to avoid damage to sealant. If sealant also peels back, new sealant should be applied. Complete removal of old sealant is not necessary. Permanent repair by direct support, or higher category of maintenance, should be made as soon as possible.

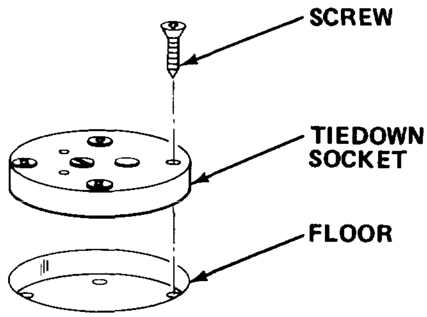
1-16.14 Replace Tiedown Socket.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Cross Tip Screwdriver
Flat Tip Screwdriver

SUPPLIES: Tiedown Socket



a. Remove screws from tiedown socket.

b. Pry defective socket from floor.

c. Install new tiedown socket. Rotate new tiedown socket enough to avoid installing screws in old screw holes.

d. Reinstall screws.

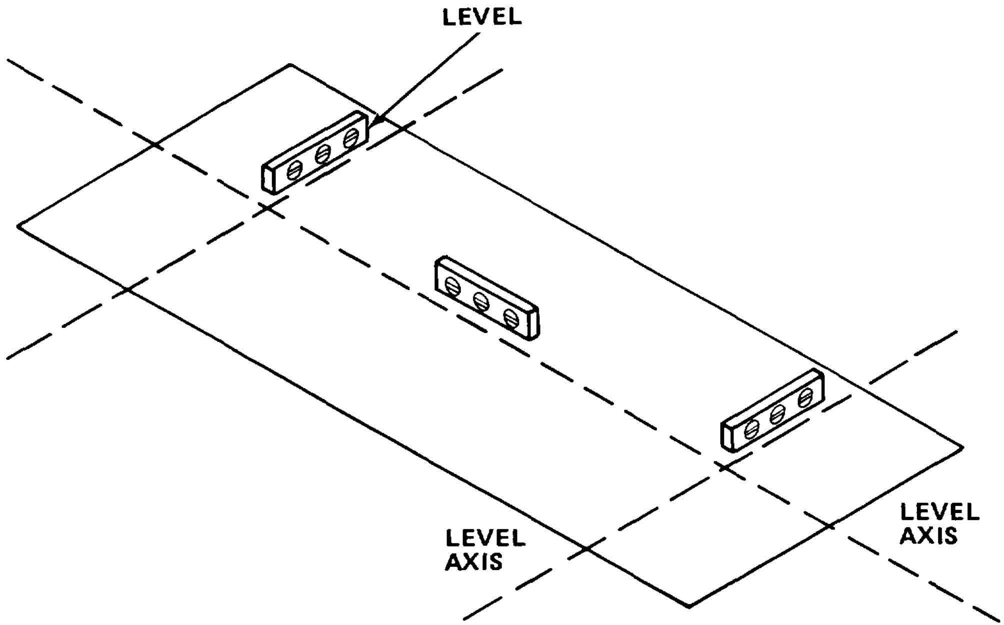
1-16.15 Repair Level Indicator.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

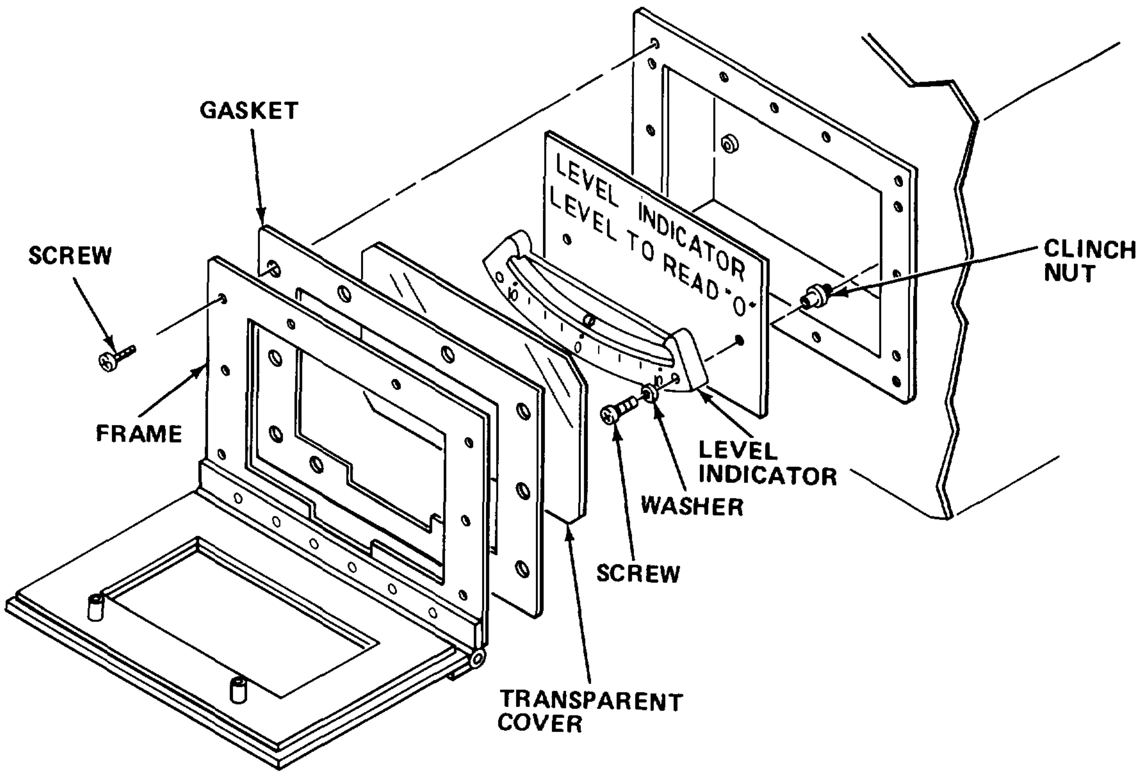
TOOLS: Carpenter's Level
Cross Tip Screwdriver
Knife, TL-29

SUPPLIES: Level Indicator
Gasket



a. Level section using level indicators. Then confirm section is level by using carpenter's level on floor inside section.

b. Adjust section leveling jacks until section is level as indicated by carpenter's level at front-rear and left-right at each end as shown in illustration.



c. Loosen knurled screws and move cover away from level assembly.

d. Remove screws and washers to release frame and gasket.

e. Remove transparent cover.

f. Remove screws and washers to remove level indicator.

g. Replace level assembly and secure with screws and washers.

h. Reinstall transparent cover.

i. Install new gasket.

j. Reinstall frame and secure with screws and washers.

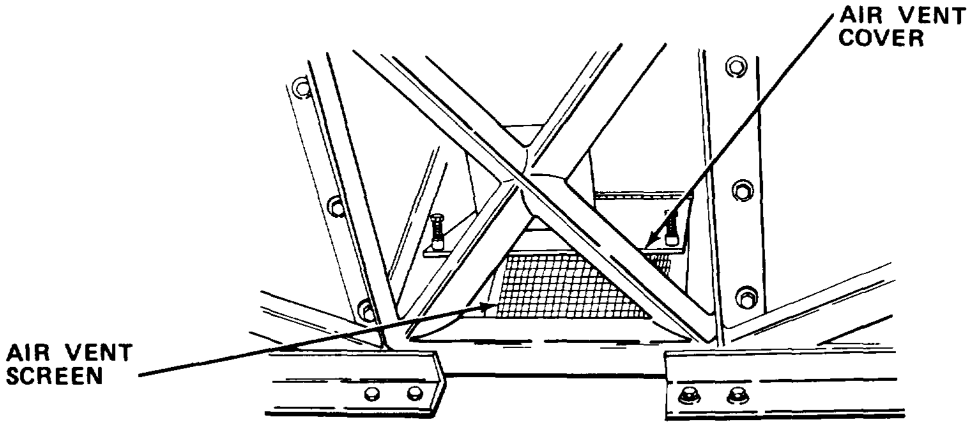
1-16.16 Replace Air Vent Screen.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Cross Tip Screwdriver
Scissors

SUPPLIES: Rubber Adhesive (Item 2, Appendix E)
Nylon Screen (Item 22, Appendix E)



a. Raise access cover and remove screws holding screen frame to section.

b. Remove screen and frame.

c. Clean all old screen material and adhesive from frame.

d. Cut new screen material to size and attach to frame with adhesive.

e. Reinstall frame to section and secure with *screws.* Lower cover.

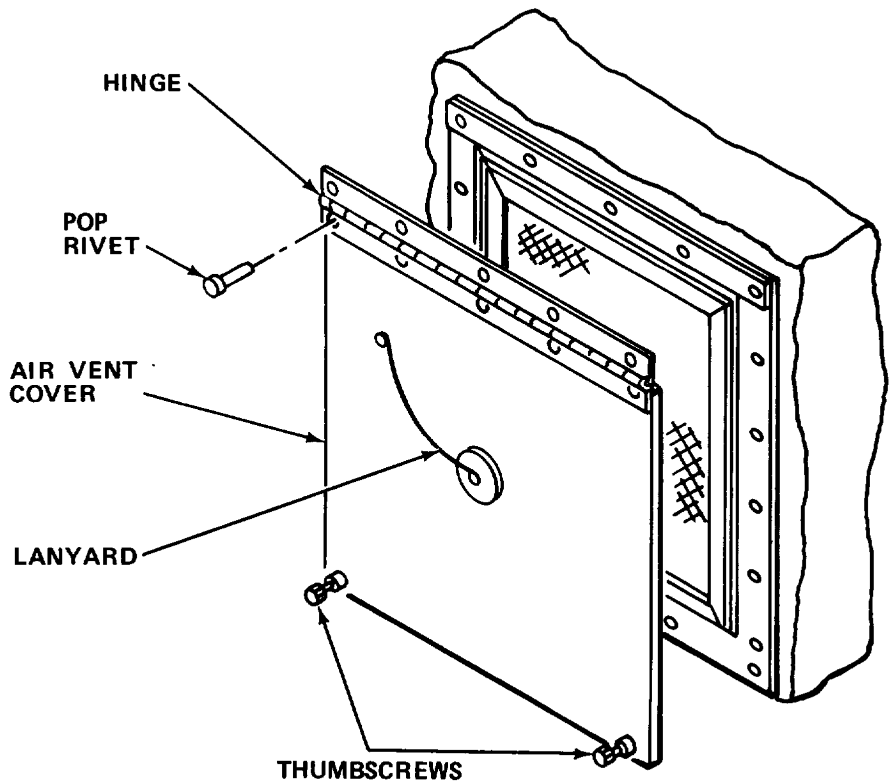
1-16.17 Replace Air Vent Cover.

MOS: 83FJ6, Reproduction Equipment Repairer

41B, Topographic Instrument Repair Specialist

TOOLS: Drill and Bits
Pop Rivet Gun

SUPPLIES: Vent Cover
Pop Rivets



a. Loosen thumbscrews.

b. Drill pop rivets from hinge. Remove air vent cover.

c. Aline holes and pop rivet new air vent cover to section.

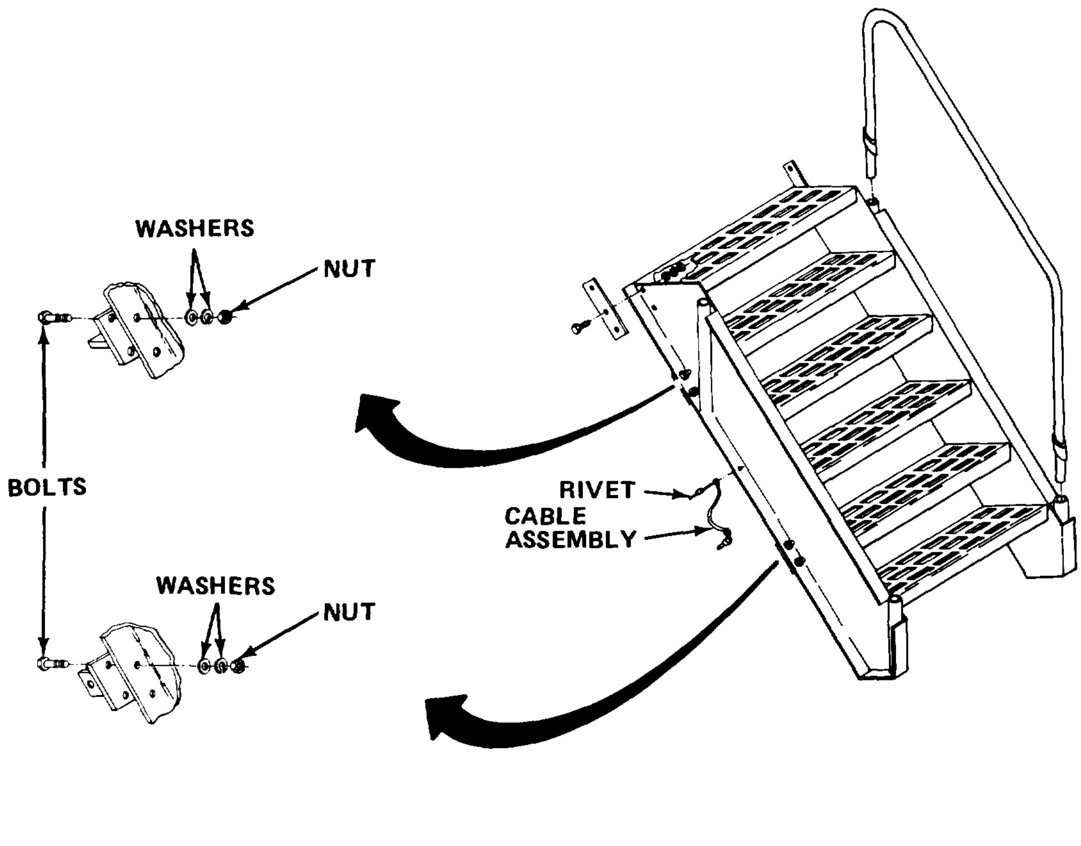
d. Tighten thumbscrews.

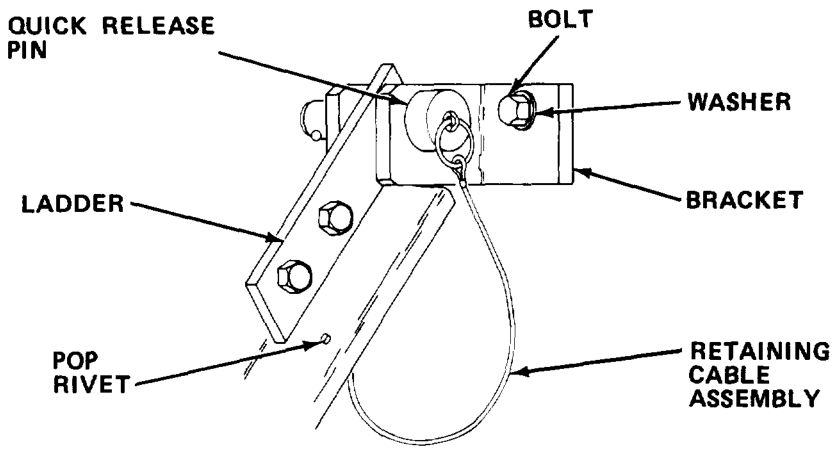
1-16.18 Repair Personnel Ladder.

MOS: 63W, Wheel Vehicle Repairer

TOOLS: Drill and Bits
Pop Rivet Gun
9/16 in. Combination Wrench
8 in. Adjustable Wrench

SUPPLIES: Cable Assembly
Quick Release Pins
Pop Rivets
Mounting Brackets





a. Remove ladder from mounting bracket.

b. Remove bolts, washers, and nuts securing damaged mounting brackets to ladder.

c. Remove damaged cable assembly from ladder by drilling out rivet.

d. Reinstall or install new mounting brackets. Secure with bolts, washers, and nuts.

e. Rivet new cable assembly to ladder.

NOTE

Be sure ladder mounting brackets fit section on rear door and under personnel doors.

f. Reinstall ladder on mounting bracket.

1-17. PREPARATION FOR STORAGE OR SHIPMENT.

a. Section may be stored or shipped either mounted on trailer chassis or unmounted. Preparation of trailer chassis is covered in TM 5-2330-305-14 and should be referred to when trailer-mounted section is prepared for storage and shipment. TM 5-4120-367-14 must be reviewed for instructions covering air conditioner/heater.

b. Remove consumable supplies that have limited shelf life or broken seals. Replace missing items and be sure that all remaining consumable supplies are at authorized levels. Be sure all major components are operational.

c. Remove all unauthorized or personal equipment from section.

d. Move all classified material or sensitive data to proper storage. Complete all accountability and/or transfer of documents.

e. Refer to Preparation for Movement (paragraph 1-6.2) and follow applicable steps and any additional steps directed by proper authority.

Section V DIRECT/GENERAL SUPPORT MAINTENANCE

1-18. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE) ; AND SUPPORT EQUIPMENT

1-18.1 Common Tools and Equipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

1-18.2 Special Tools; Test. Measurement, and Diagmostic Equipment; and Support Equipment. Special Tools, TMDE, and Support Equipment is listed in the applicable repair parts and special tools list and in Appendix B of this manual.

1-18.3 Repair Parts. Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 5-6675-323-24P covering direct/general support maintenance for this equipment.

1-18.4 Electrical System. Direct/general support level of maintenance for the repair of the section's electrical system will consist of electrical wiring repair using standard electrical wiring repair procedures.

1-19. DIRECT/GENERAL SUPPORT TROUBLESHOOTING PROCEDURES.

a. Direct/general support troubleshooting procedures cover the most common malfunctions that may be repaired at the direct/general support level. Repair or adjustment requiring specialized equipment is not authorized unless such equipment is available. Troubleshooting procedures used by lower level maintenance should be conducted in addition to the direct/general support troubleshooting procedures.

b. This manual cannot list all the possible malfunctions or every possible test/inspection and corrective action. If a malfunction is not listed or is not corrected by a listed corrective action, notify your supervisor.

c. For unidentified malfunctions, use the facing schematic or the foldout located at the end of this manual for further fault analysis.

Table 1-5. DIRECT/GENERAL SUPPORT TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. PERSONNEL/CARGO DOORS DO NOT CLOSE COMPLETELY.

Step 1. Check that latch rollers rotate freely.

Replace latches (paragraph 1-20.2).

Step 2. Check to see if latch rods are bent.

Replace latch rods (paragraph 1-20.2).

Step 3. Check to see if door gasket is torn or broken.

Replace door gasket (paragraph 1-20.3)

2. PERSONNEL/CARGO DOORS DO NOT LATCH PROPERLY.

Check door latch for missing or damaged components.

Replace door latch (paragraph 1-20.2)

3. AIR OR WATER ENTERS SECTION AROUND DOOR.

Check to see if door gasket if worn or broken.

Replace door gasket (paragraph 1-20.3)

Table 1-5. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

4. RECEPTACLES DO NOT OPERATE BUT CIRCUIT BREAKERS ARE ON.

WARNING

Turn off main circuit breaker before inspecting or servicing circuit breakers or receptacles. Failure to do so may result in death or serious injury.

Step 1. Check to see if power cable is firmly connected to power entry panel.

Connect power cable.

Step 2. Check to see if voltage meter and frequency scale and INCORRECT PHASE or CORRECT PHASE lamp indicate necessary power.

Notify your supervisor for service of power supply at source.

5. CIRCUIT BREAKERS TRIP CONTINUALLY.

WARNING

Turn off and padlock safety switch before inspecting or servicing circuit breakers or receptacles. Failure to do so may result in death or serious injury.

Step 1. Check to see if receptacles are overloaded.

Reconnect equipment to different receptacles.

Step 2. Check to see if receptacles are damaged.

Replace receptacles (paragraph 1-16.6)

1-20. MAINTENANCE PROCEDURES.

This section contains instructions covering direct/general support maintenance functions for the Analysis Section. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

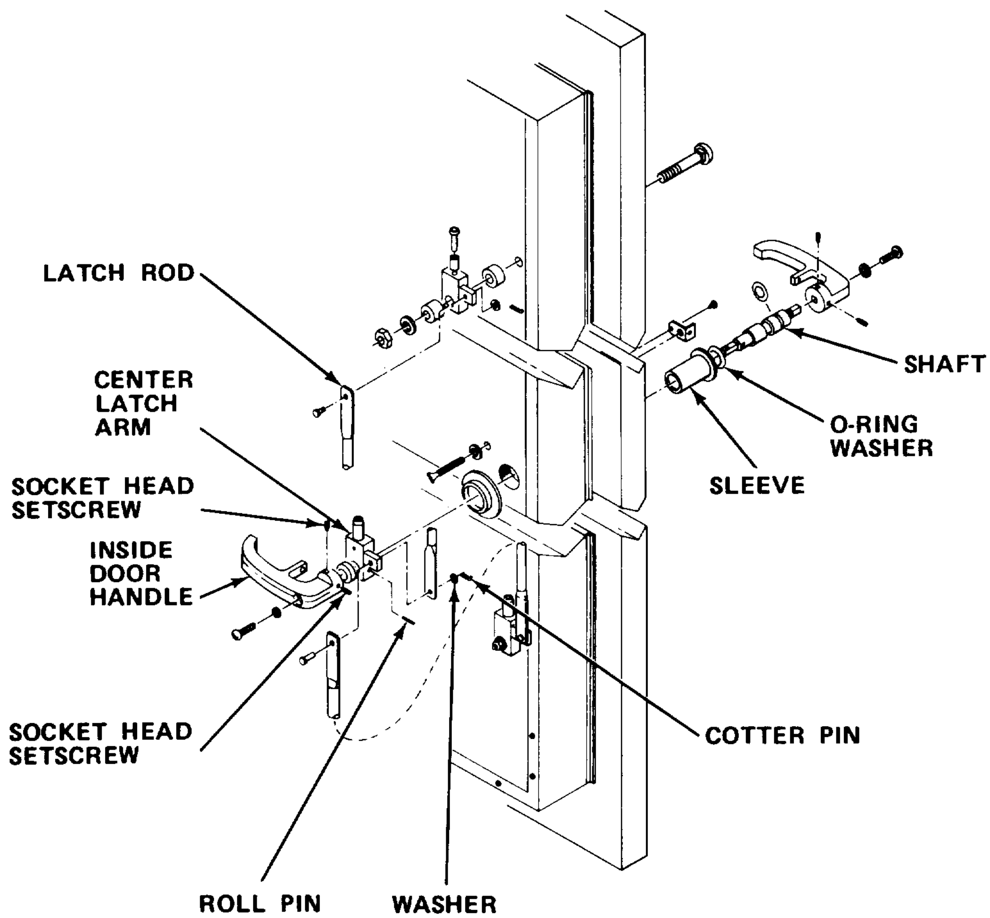
INDEX

1-20.1 Repair Personnel Door Handle.

MOS: 63W, Wheel Vehicle Repairer

TOOLS: Cross Tip Screwdriver
Needle Nose Pliers
15/16 in. Combination Wrench
Hammer
Center Punch
1/8 in. Hex Head Key Wrench

SUPPLIES: O-Ring Washer
Sleeve
Roll Pin
Personnel Door Handle
Cheesecloth (Item 7, Appendix E)
Oil, Lubricating, General Purpose (Item 14, Appendix E)
Hand Oiler
Cotter Pin



a. Loosen screw and socket head setscrews. Remove defective inside door handle.

b. Remove cotter pin and pins from center latch arm assembly.

c. Move latch rods out of way.

d. Punch roll pin from center latch arm assembly and pull latch arm assembly from shaft.

e. Withdraw latch and defective door handle.

f. Inspect all components for wear.

g. Replace worn O-ring washer and sleeve.

h. Replace other worn components as needed.

i. Reinstall latch and new door handle.

j. Aline center latch arm assembly on shaft. Secure with new roll pin.

k. Aline latch rods. Attach to latch arms with pins, washers, and new cotter pin.

l. Reinstall new inside door handle.

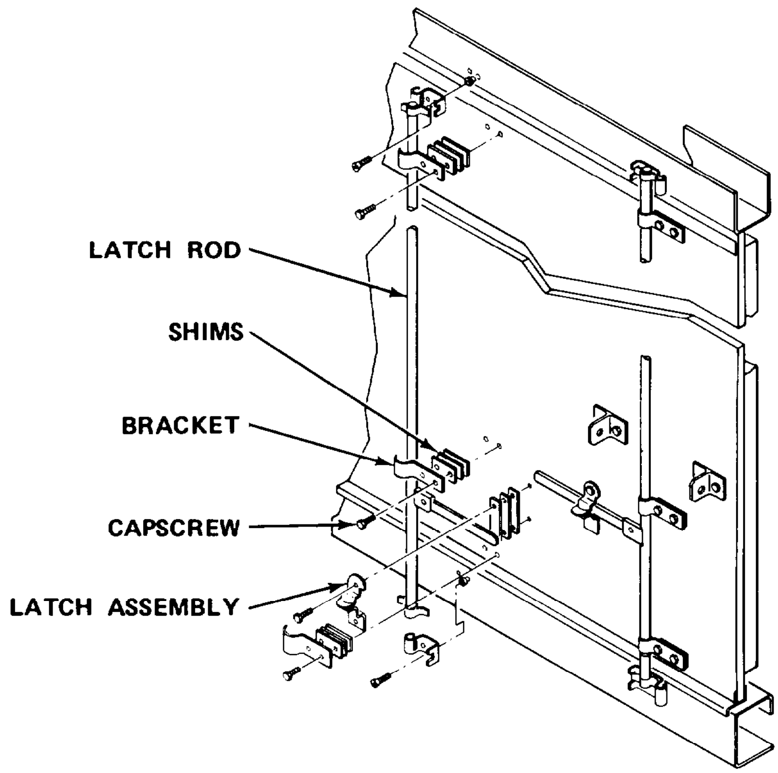
m. Lightly oil all moving parts. Wipe up surplus oil.

1-20.2 Replace Cargo Door Latch Assembly.

MOS: 63W, Wheel Vehicle Repairer

TOOLS: 9/16 in. Combination Wrench

SUPPLIES: Cargo Door Latch Assembly



a. Unlock latch.

b. Remove capscrews and washers from brackets. Remove brackets and shims.

c. Remove defective latch assembly and latch rod.

d. Install new latch assembly and latch rod.

e. Reinstall shims, brackets, washers, and capscrews.

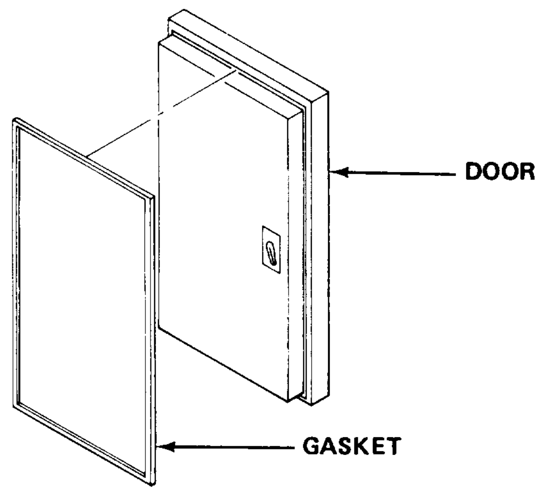
f. Check movement of latch rod and latch assembly. Lock latch.

1-20.3 Replace Personnel/Cargo Door Gasket.

MOS: 63W, Wheel Vehicle Repairer

TOOLS: Knife

SUPPLIES: Vinyl Gasket
Adhesive (Item 2, Appendix E)
Solvent P-D-680 (Item 25, AppendixE)
Impermeable Gloves
Goggles



a. Open door completely and secure in open position.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonged skin contact. Wear solvent-impermeable gloves and eye/face protective equipment when using solvent. Do not use near open flame or excessive heat. Flash point of solvent is 100° F to 138° F (38° C to 59° C).

b. Remove defective gasket by prying gasket from door. Scrape traces of gasket and adhesive from door. Wash with solvent P-D-680.

c. Coat gasket area on door with adhesive.

d. Firmly press new gasket onto door.

e. Wipe excess adhesive from gasket.

f. Close door and wipe excess adhesive from door and frame.

g. Allow adhesive to dry before using door.

1-20.4 Replace Personnel/Cargo Doors.

MOS: 63W, Wheel Vehicle Repairer

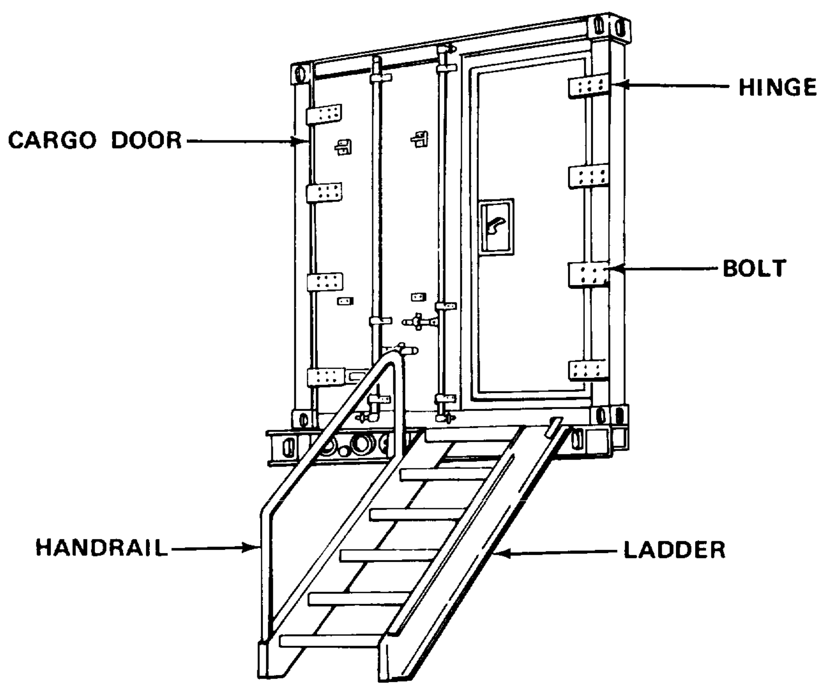
PERSONNEL: Two persons are required to perform this procedure.

TOOLS: Pop Rivet Gun
Electric Drill and Bits
Hoist
3/4 in. Combination Wrench
Paint Brush

SUPPLIES: Personnel/Cargo Door
Pop Rivets
Vinyl Gasket
Paint (Item 17, Appendix E)
Paint (Item 18, Appendix E)
Adhesive (Item 2, Appendix E)
Cheesecloth (Item 7, Appendix E)

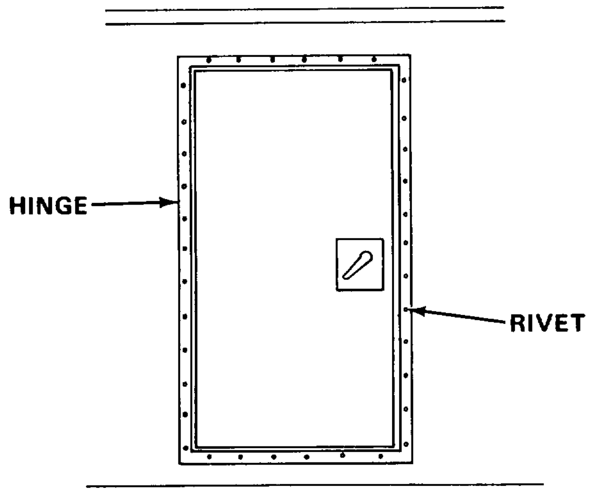
WARNING

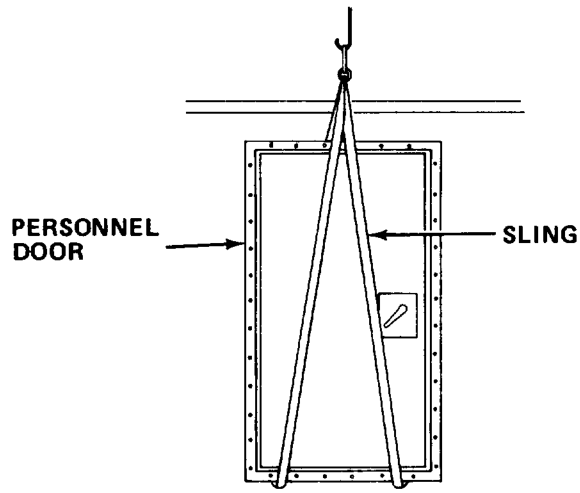
To prevent personal injury or equipment damage, do not attempt to remove doors unless suitable lifting equipment and hoist are available.



a. Remove handrails and ladders if rear cargo door is to be replaced.

b. Unlock and open door to be replaced.





c. Place sling around door and put a slight strain on hoist to remove weight from hinges.

d. Remove bolts from hinges on rear personnel door. On side personnel door, drill out pop rivets from hinge. Remove hinges from door.

e. Remove damaged door using hoist.

f. Install new door using hoist.

g. Reinstall hinges on rear personnel door. Secure with bolts. Reinstall hinges on side personnel door. Secure with pop rivets.

h. Remove sling from door.

i. Install new gaskets on door after it is mounted (paragraph 1-20.3).

j. Repaint as needed.

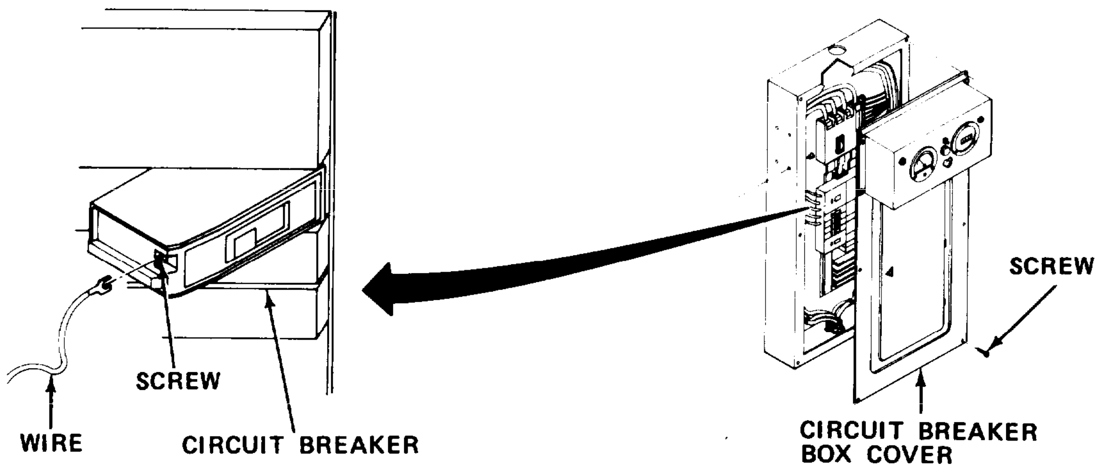
k. Close and lock door.

1-20.5 Replace Circuit Breaker.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Flat Tip Screwdriver
Multimeter

SUPPLIES: Circuit Breaker



WARNING

Turn off and padlock safety switch. Turn off all individual circuit breakers before inspecting or servicing circuit breakers. Failure to do so may result in death or serious injury.

a. Turn off and padlock safety switch. Turn off individual circuit breakers.

b. Remove circuit breaker box cover.

c. Use multimeter to make sure voltage is not present.

d. Remove defective circuit breaker by pushing and snapping out of place.

e. Tag and remove wires from defective circuit breaker.

f. Pull circuit breaker from panel.

g. Reconnect wires to new circuit breaker. Secure wires with screws.

h. Install new circuit breaker by pushing and snapping into place.

i. Reinstall circuit breaker box cover.

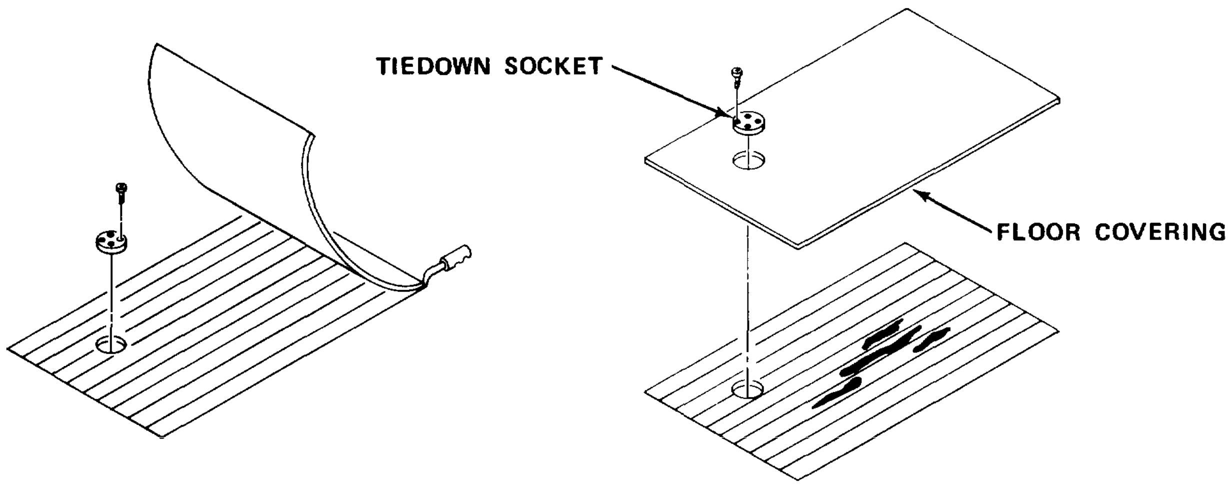
j. Remove padlock and turn on safety switch and individual circuit breakers.

1-20.6 Repair Floor Covering.

MOS: 52C, Utilities Equipment Repairer

TOOLS: Utility Knife
Cross Tip Screwdriver
Scraper
Straightedge

SUPPLIES: Vinyl Floor Covering
Epoxy Resin (Item 21, Appendix E)
Floor Patch (Item 10, Appendix E)
Cheesecloth (Item 7, Appendix E)
Adhesive (Item 3, Appendix E)



a. Cut a rectangular area from damaged floor covering.

b. Remove tiedown socket. Remove damaged floor covering.

c. Cut new floor covering to fit. Apply adhesive to floor. Press down new floor covering.

d. Reinstall tiedown socket.

1-20.7 Repair Van Bodv Skin (Permanent).

MOS: 63W, Wheel Vehicle Repairer

TOOLS: Pop Rivet Gun
Electric Drill and Bits
Paint Brush

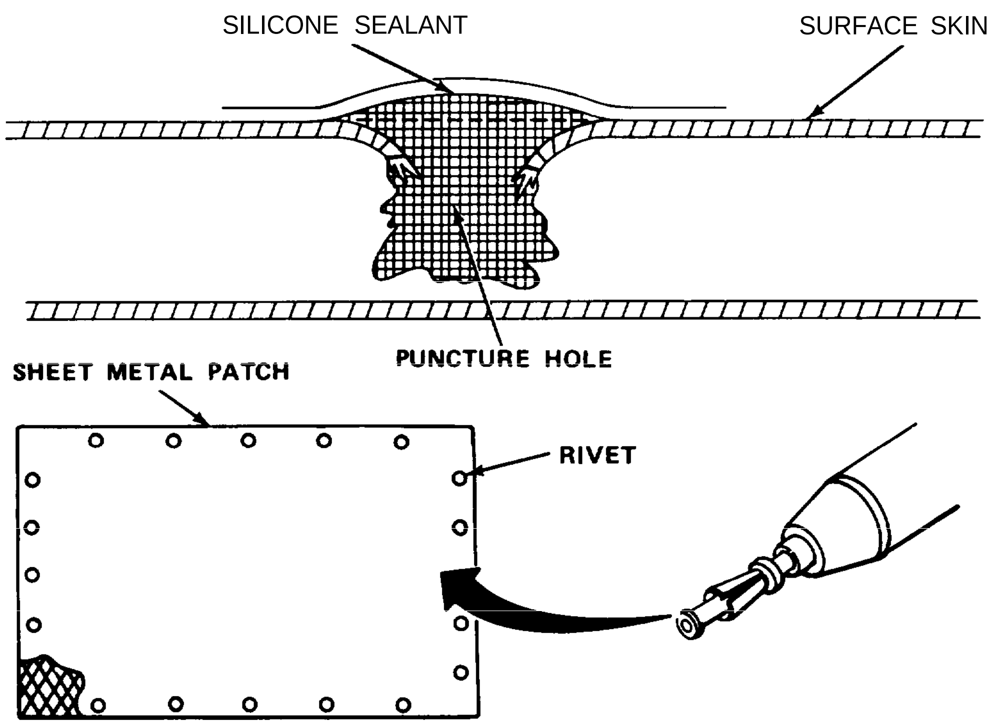
SUPPLIES: Pop Rivets
Sprayfoam (Item 28, Appendix E)
Silicone Sealant (Item 23, Appendix E)
Sheet Metal
Paint (Items 17, 17A and 17B, Appendix E)
Cheesecloth (Item 7, Appendix E)

a. Bend broken edges of skin inward into puncture hole. Do not attempt to remove fragments of skin by bending or pulling out.

b. Remove any loose fragments of foam.

c. Use cloth dampened with water to clean area around puncture. Wipe dry.

d. Inject sprayfoam into puncture. Fill to 1/8 in. (3.2.mm) above surface of unbroken skin. Apply sealant to cracks leading to puncture.



e. Prepare sheet metal patch large enough to cover damaged area with overlap.

f. Place patch over damaged area and mark all around edges of patch.

g. Drill holes 1 in. (25.4 mm) apart.

h. Apply sealant to edges of patch.

i. Apply patch to van body.

j. Install pop rivets beginning at center of each side. Rivets should be placed 1 in. (25.4 mm) apart.

k. Paint as needed.

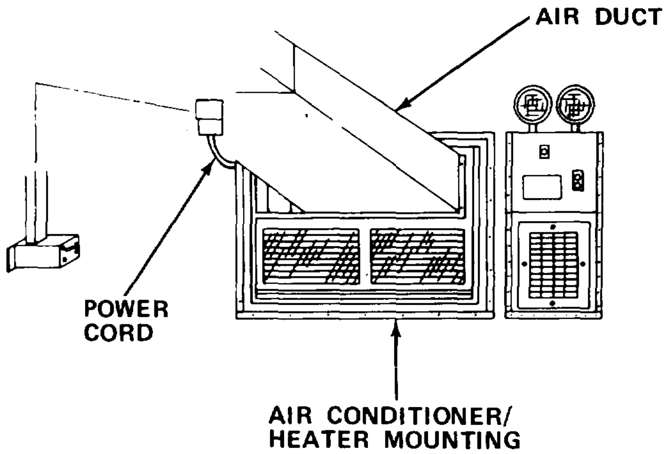
1-20.8 Replace Air Conditioner/Heater.

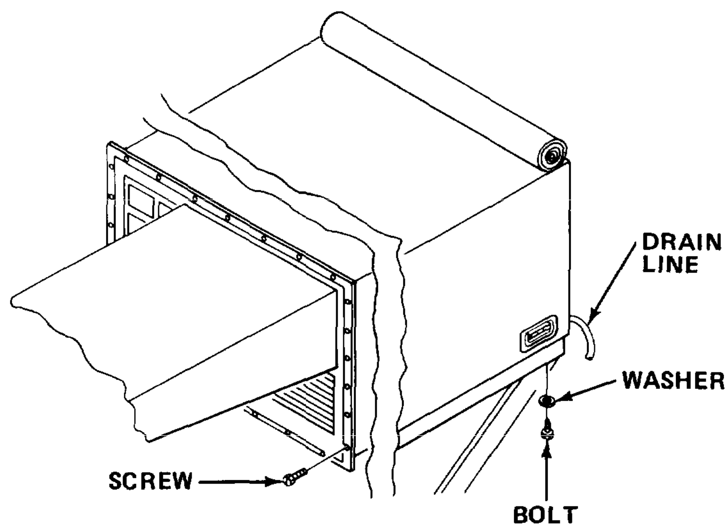
MOS: 63W, Wheel Vehicle Repairer

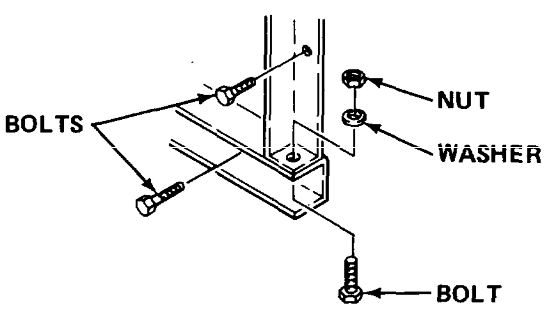
PERSONNEL: Two persons are required to perform this procedure.

TOOLS: Cross Tip Screwdriver
Lifting Equipment
8 in. Adjustable Wrench
7/16 in. Combination Wrench

SUPPLIES: Air Conditioner/Heater
Solvent P-D-680 (Item 25, Appendix E)
Gasket
Silicone Sealant (Item 23, Appendix E)
Adhesive (Item 2, Appendix E)







WARNING

- Use hoist or proper lifting equipment to replace air conditioner/heater. Failure to do so may result in death or serious injury.
- Turn off air conditioner/heater circuit breaker and unplug power cord. Failure to do so may result in death or serious injury.

a. Turn off air conditioner/heater circuit breaker. Unplug or disconnect power cord as appropriate.

b. Remove screws holding air duct to air conditioner/heater.

c. Remove nut, washer, and screw from each corner of air conditioner/heater mounting. Remove screws securing mounting to section.

d. Disconnect drain line from air conditioner/heater.

e. Attach sling to lifting handles. Raise hoist enough to remove slack from sling.

f. Remove mounting bolts and washers.

g. Slide out air conditioner until other lifting handles are free. Attach sling to handles.

h. Raise defective air conditioner/heater with hoist until unit is free from brackets and section.

i. Place air conditioner/heater on flat-bed truck or pallet.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Avoid repeated and prolonqed skin contact. Wear solvent-impermeable" gloves and eye/face protective equipment when using solvent. Do not use near open flame or excessive heat. Flash point of solvent is 100° F to 138° F (38° C to 59° C).

j. Clean sealant from opening using dry cleaning solvent P-D-680.

k. Remove damaged gasket and replace with new gasket.

l. Raise air conditioner/heater until it rests on air conditioner/heater brackets.

m. Remove two sling hooks as unit is eased into hole until grille touches duct.

n. Remove remaining sling.

o. Reinstall washers and mounting bolts.

p. Reconnect drain lines.

q. Reinstall screws securing air conditioner/heater mounting to section wall. Reinstall screw, washer, and nut to each corner of mounting.

r. Reinstall screws securing air duct to air conditioner/heater.

s. Reconnect or plug in power cord. Turn on air conditioner/heater circuit breaker.

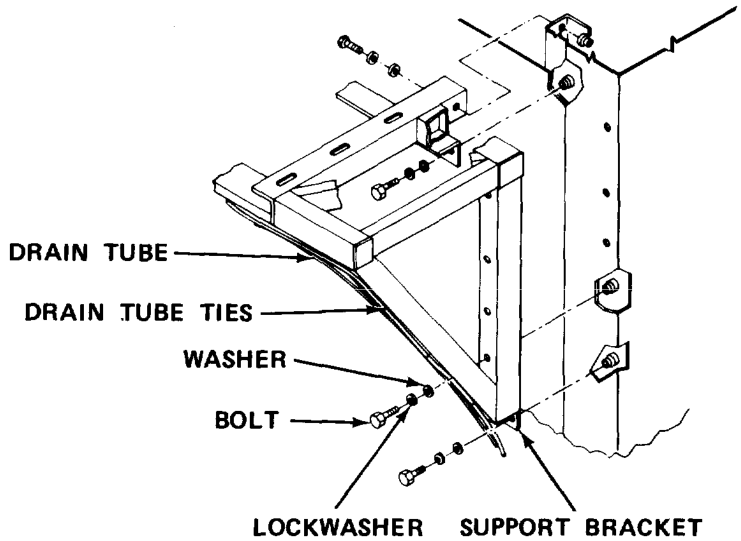
1-20.9 Replace Air Conditioner Support Bracket.

MOS: 63W, Wheel Vehicle Repairer

PERSONNEL: Two persons are required to perform this procedure.

TOOLS: 9/16 in. Combination Wrench
Lifting Equipment
Knife, TL-29

SUPPLIES: Air Conditioner Support Bracket
Drain Tube Ties



WARNING

Serious injury to personnel or damage to equipment may occur unless two or more personnel are used to remove and replace air conditioner/heater because of weight and balance of air conditioner/heater.

a. Remove air conditioner/heater (paragraph 1-20.8).

b. Cut drain tube ties, and remove drain tube from support bracket.

c. Remove bolts, lockwashers, and washers securing support bracket.

d. Remove defective support bracket.

e. Install new support bracket. Secure to section with bolts, lockwashers, and washers.

f. Reinstall drain tube on support bracket, and secure with new ties.

g. Reinstall air conditioner/heater (paragraph 1-20.8).

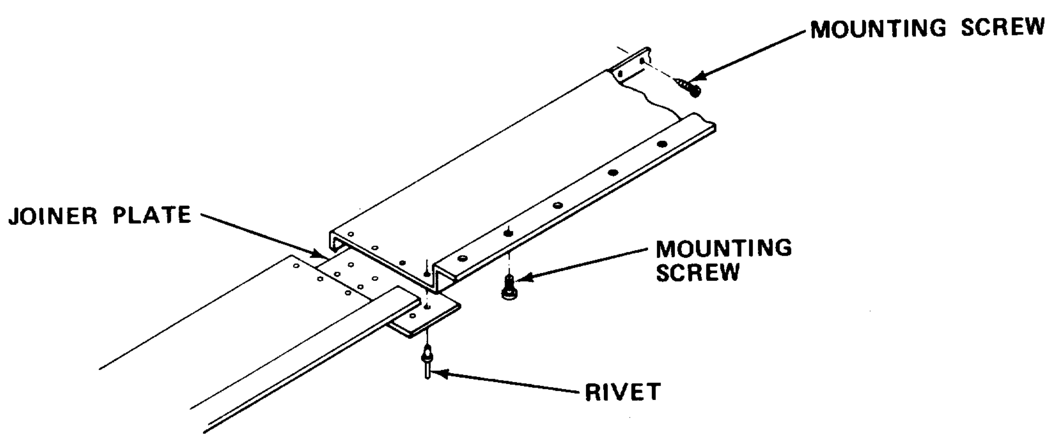
1-20.10 Replace ace Ventilation Duct.

MOS: 52C, Utilities Equipment Repairer

TOOLS: Hacksaw
Electric Drill and Bits
Ball Peen Hammer
Pop Rivet Gun
Paint Brush
Cross Tip Screwdriver

SUPPLIES: Silicone Sealant (Item 23, Appendix E)
Wood Block
Pop Rivets
Paint (Item 18, Appendix E)
Cheesecloth (Item 7, Appendix E)
Salvaged Ventilation Duct

a. Turn off air conditioner/heater so air will not blow through duct.



b. Drill rivets from damaged section of duct. Remove joiner plates.

c. Remove mounting screws to remove damaged sections of duct.

d. Straighten remaining sections of duct at edges using hammer and wood block.

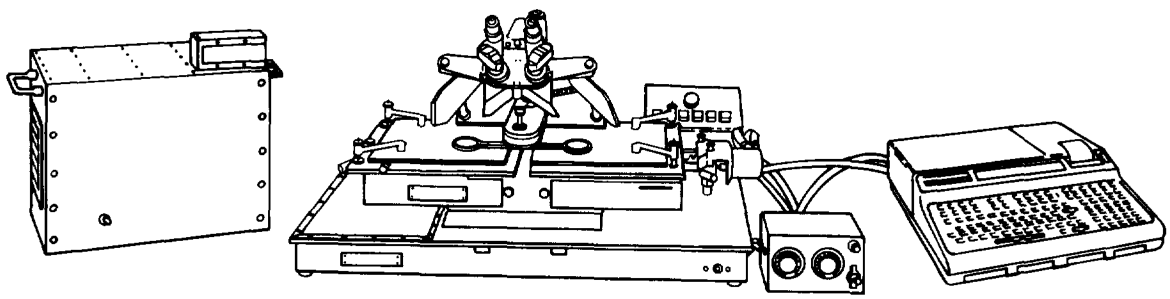
e. Place sealant on mounting edges.

f. Install new duct section cut from salvaged duct. Secure with screws.

g. Reinstall joiner plates. Install rivets to secure.

h. Paint as necessary.

i. Turn on air conditioner/heater.



CHAPTER 2

ANALYTICAL PHOTOGRAMMETRIC POSITIONING SYSTEM (APPS)

Section I INTRODUCTION

2-1. GENERAL INFORMATION.

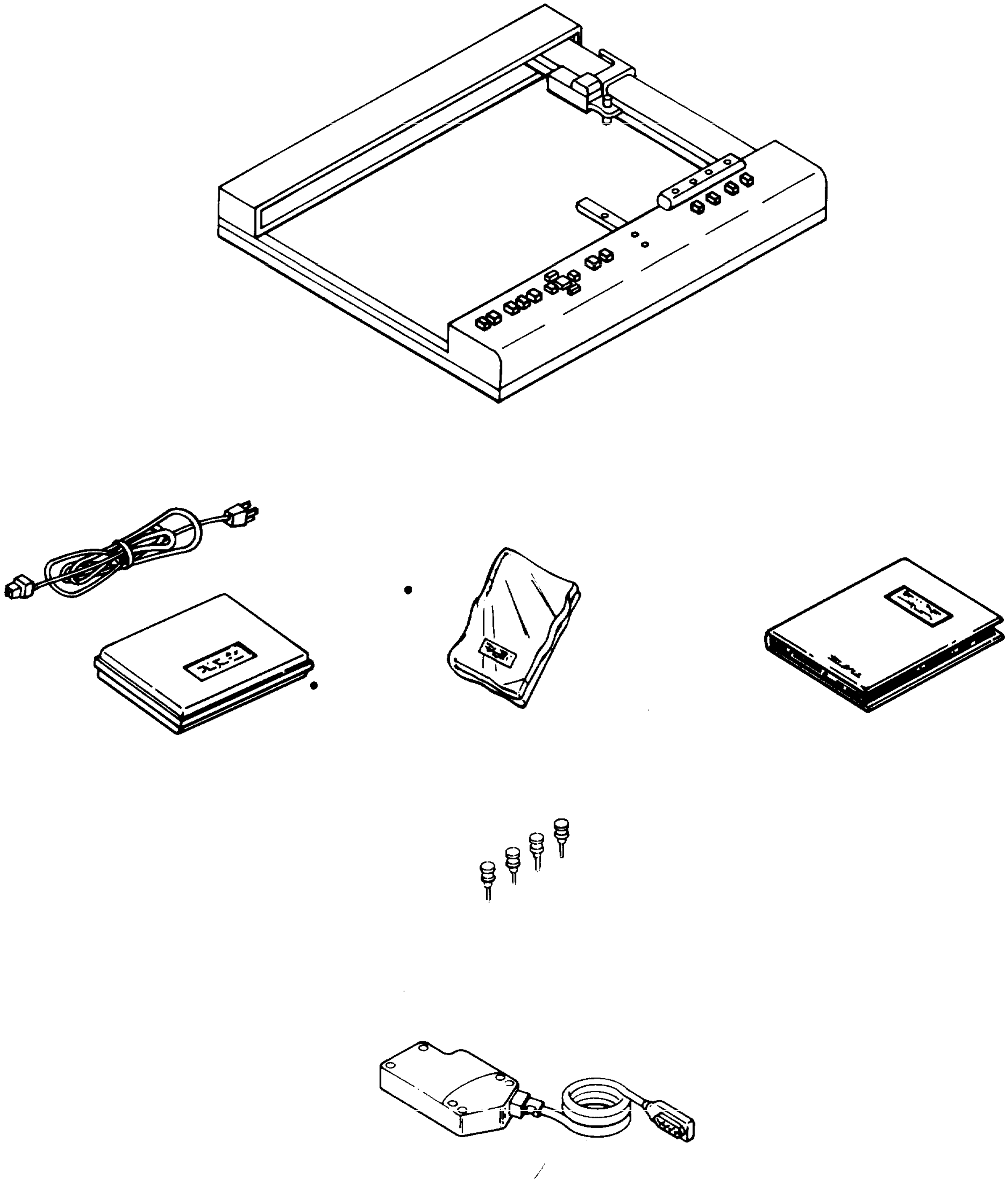
2-1.1 Scope.

a. Model Number and Equipment Name. Model AN/UYK-48, Analytical Photogrammetric Positioning System (APPS).

b. Purpose of Equipment. To accurately determine elevation and position of terrain features from a point-positioned data base.

2-1.2 Reference Information.

TM 5-1260-206-12, Operator and Organizational Maintenance Manual for Analytical Photogrammetric Positioning System (APPS) AN/UYK-48, and TM 5-1260-206-34, Direct and General Support Maintenance Manual for Analytical Photogrammetric Positioning System (APPS) AN/UYK-48, and TM 5-1260-206-24P, Organizational, Direct and General Support Maintenance Repair Parts and Special Tools List (RPSTL) (Including Depot Maintenance, Repair Parts and Special Tools) for Analytical, Photogrammetric Positioning System (APPS) AN/UYK-48, contain information applicable to this equipment.



CHAPTER 3

GRAPHICS PLOTTER

Section I INTRODUCTION

3-1. GENERAL INFORMATION.

3-1.1 Scope.

a. Model Number and Equipment Name. Model HP-9872B and HP-9872C X-Y Graphics Plotter.

(1) Operating instructions for the HP-9872B plotter are contained in paragraphs 3-2 through 3-10. For maintenance, contact closest vendor service center.

(2) Operating instructions for the HP-9872C plotter are contained in paragraph 3-11 through 3-16. If maintenance by vendor service personnel is not available, maintenance procedures for the plotter are found in paragraphs 3-17 through 3-29.

b. Purpose of Equipment. To produce data or instructions from a controlling computer in a permanent, multicolor, printed, or graphic form.

3-1.2 Glossary.

Default Condtions	Automatic parameters and conditions for program statements set by factory.
MOS	Metal-Oxide Semiconductor.
Program Statement	Programming command recognized by plotter's internal circuits.
ROM.	Read Only Memory. Cannot be changed by operator.
RAM	Reader Addressavle Memory. Can be changed by operator.
Statement Parameters	Functional limits of each plotter programming statement. Normally a set of tolerances.

TTL . . . . Transistor-Transistor Logic. IC chip contains linked transistors to accomplish logic functions.

3-2. EQUIPMENT DESCRIPTION.

3-2.1 Equipment Characteristics, Capabilities, and Features.

a. All major operations are controlled by the HP-9825A Desk-Top computer.

b. Programmable selection of four pens.

c. Selectable pen speed.

d. Point digitizing.

e. Electrostatic paper holding.

f. Five-character sets for labeling.

g. User-defined characters.

h. Dashed line fonts and selectable line types.

i. Built-in confidence and self-tests.

j. Error-free, off-scale data handling.

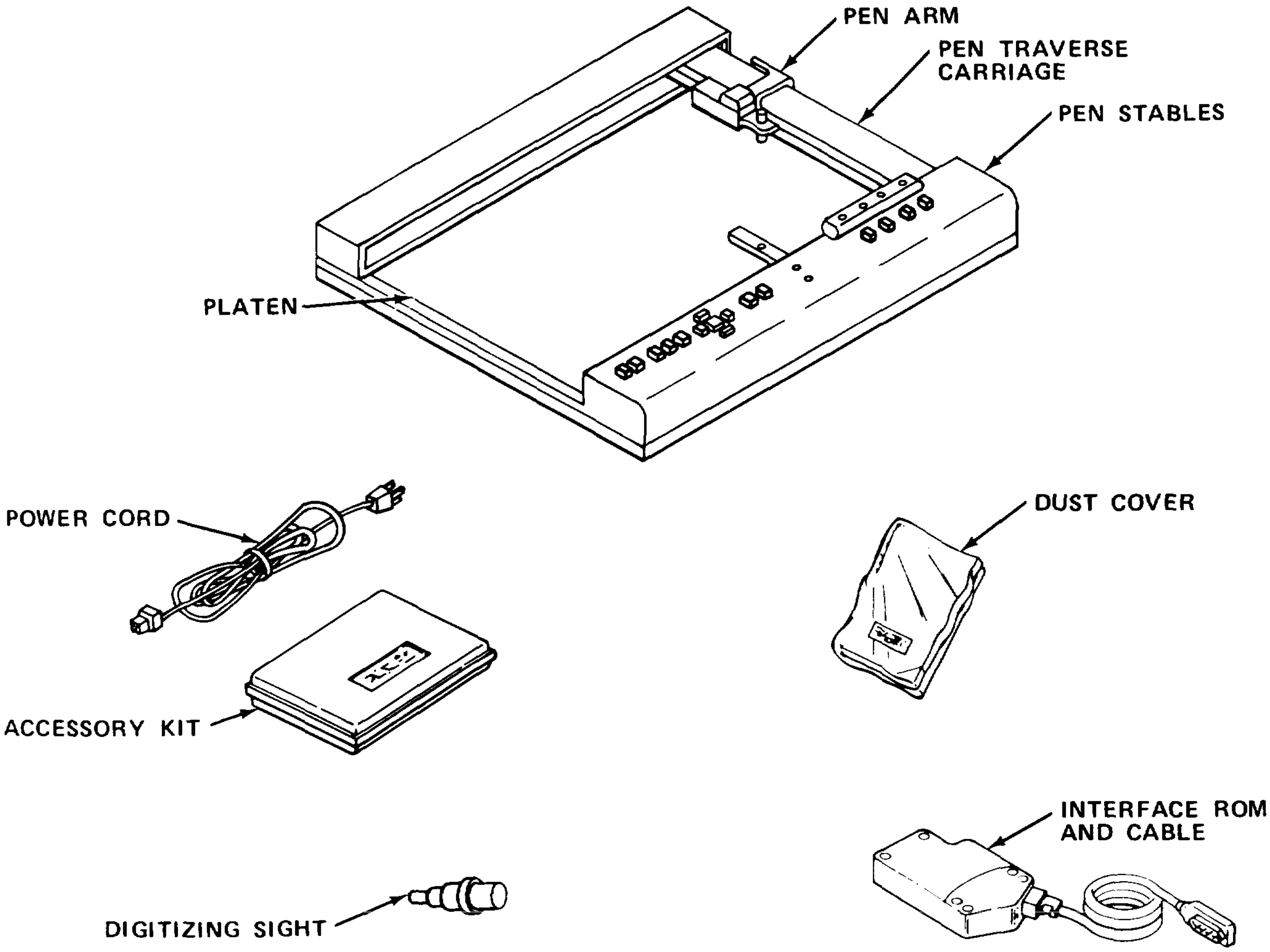
k. Symbol mode plotting.

l. Window plotting.

m. Local pen-positioning control.

n. Error indicators.

3-2.2 Location and Description of Major Components



DUST COVER. Cloth cover keeps dust off platen and internal components.

POWER CORD. Provides independent power to plotter.

HP-IB INTERFACE ROM WITH CABLE. Provides path for electronic signal transmission between plotter and controller.

PEN STABLES. Store pens.

PEN TRAVERSE CARRIAGE. Holds and moves pen arm.

PEN ARM. Holds pen in place and lifts or raises pen as ordered.

ACCESSORY KIT. Stores accessories, such as extra pens and digitizing sight.

PLATEN. Provides drawing surface for mounting paper.

DIGITIZING SIGHT. Used to visually position pen over point to be digitized.

3-2.3 Equipment Data.

Manufacturer	Hewlett-Packard
Weight	40 lbs (18.2 kg)
Power Requirements	120 V (108 V, Min; 126 V, Max), 48-66 Hz, 2.1 amps
Dimensions	
Width	19.5 in. (49.7 cm)
Depth	18 in. (45.5 cm)
Height	7.5 in. (18.9 cm)
Plotting Area	
Y-Axis	11 in. (28cm)
X-Axis	15.75 in. (40cm)
Plotting Accuracy	+0.2% deflection +0.008 in. (0.20 mm)
Repeatability	
Given Pen	0.002 in. (0.04 mm)
Pen-to-Pen	0.008 in. (0.20 mm)
Addressable Resolution	0.001 in. (0.025 mm) (Smallest addressable move)
Speed	
Either Axis	14 in./sec (36 cm/see), max
45° Angle	20 in./sec (50.9 cm/see), max
Adjustable Range	(Increments of 0.4 in./sec) 0.4 in./sec (10 mm/sec) to 14 in./sec (36 cm/see)
Plotting Speed	3 char/see

Environmental Range	
Temperature	32°F (0°C) to 131°F (55°C)
Humidity	5% to 95% relative

3-3. TECHNICAL PRINCIPLES OF OPERATION.

3-3.1 General.

a. The plotter has an internal microprocessor which interprets and responds to commands in the form of program statements from the HP-9825A Desk-Top Computer. It directs the plotter's internal circuits to perform the desired operation.

b. The plotter draws lines using vector data received from the computer in the form of a digital word. The plotter then translates the vector data into an analog signal which drives the chart pen.

c. The plotter can construct a plot by tracing a line from point to point in a series of data points, each point received as a digital word. If the sequence of data points is not continuous, an insertable ROM can calculate and provide the missing points.

d. The plotter can also send coordinate data back to the computer. Sending of plot data by plotter is called point digitizing. In digitizing, the digitizing sight is loaded like a regular pen and is manually positioned on a point using the local control push-button switches on the plotter's front panel. Pressing the ENTER key, with the sight in the pen down position, will send the coordinates of the pen's position to the computer.

e. The plotter is controlled and operated by programming statements sent from the computer. It can only be operated independently when performing self-tests, the confidence test and manually editing charts. The confidence test and self-tests are preprogrammed and, once initiated, are controlled internally by the microprocessor. Manual chart editing is accomplished using the front panel pen control buttons.

3-3.2 Detailed. The plotter can be separated into six functional areas:

98034A HP-IB Interface ROM with Cable

(Internal) Interface Circuits

Data Processing

Local Control Circuits

Pen Drive Circuits

Power Supply

a. All control, programming, and data signals are Inputted and outputted via the HP-IB interface cable. It acts as a traffic controller for signals and data, and commands input and output from the plotter.

b. Interface circuits perform internal interfacing functions for signals, data, and commands received into and outputted from the plotter. It transfers the data and commands the data processing.

c. Data processing acts as the brain of the computer. It interprets the commands and data, and implements the desired function by outputting signals to direct the front panel controls, X-Y pen drive motors and the pen up/down solenoid.

d. Local control circuits allow the operator to perform certain manual functions using the front panel controls. Signals produced by pressing the the controls are sent to data processing for implementation.

e. Pen drive circuits control the movement of the chart pen according to the instructions received from data processing.

f. Power supply provides regulated voltages to all the circuits in the plotter, It is turned on and off by a front panel control.

NOTE

In the following descriptions of the plotter's functional operation, all references to logic levels will follow the following convention:

(A) High = 1 = True
(B) Low = Ø = False

3-3.2.1 98034A HP-IB Interface ROM with Cable. Interfaces the computer and the plotter and contains the interface bus (16), used to send signal transmissions to and from the plotter, and the ROM that controls those signals.

NOTE

References to the plotter and the HP-16 in this description are synonymous, as the signal lines on the HP-16 come directly from the plotter.

a. The HP-16 interface performs four major functions:

(1) Monitoring signals from the HP-16 (from plotter) and computer.

(2) Transferring data bytes to the plotter.

(3) Transferring data bytes and information to the computer.

(4) Allowing communication between the computer and plotter.

b. The functions are accomplished by the following functional units:

Signal lines

Select code decoder circuit

I/O register decoder circuit

Computer command register circuit

I/O data register circuit

Computer interrupt logic circuit

Control logic circuit

Interrupt logic circuit

HP-IB transceiver circuit

HP-IB output data latch circuit

HP-IB address register circuit

HP-IB input multiplexer circuit

HP-IB control bus latch circuit

Parallel poll logic circuit

(1) Signal lines carry the data, information, and control signals between the HP-IB Interface ROM, the computer and the plotter (Tables 3-1 and 3-2). Signal lines can be grouped by function into four groups:

Data lines

Transfer lines

Control lines

I/O lines

(2) Data lines are found on both sides of the HP-IB Interface. They contain all the signals that communicate data, including input, output and program codes; address control; and status information. Transfer lines hold the signals that control the transfer of each byte of information between the plotter (via HP-IB) and the HP-IB Interface (either to or from). Signals on the control lines are primary control signals and govern the flow of information over both the transfer and data lines between the HP-IB Interface and the plotter. Signals on the I/O lines perform the same functions between the HP-IB Interface and computer, as those on the transfer and control lines do between the HP-IB Interface and the plotter.

(a) The operation of the HP-IB Interface ROM circuitry is dependent on the requirements of the computer or plotter as indicated by the status of signals on the signal lines. Direction of signal flow depends on which system (computer, HP-IB Interface, or plotter) is the active controller and, during an interchange, which device is talking (the active controller or the HP-IB Interface) and which is listening.

Table 3-1. SIGNAL LINES BETWEEN COMPUTER AND INTERFACE

Line*	Description	Function	Signal Direction (CMPTR INTFC)
		DATA LINES	
IODØ IOD7	Input/Output Data	Carries all data.	↔
$\overline{\text{PAØ}}$ thru PA3	Peripheral Address	Identifies peripheral device to be addressed.	→
		I/0 LINES	
IC1 thru IC2	Register Code	Latches inputs and outputs into register.	→
DOUT	Direction of Transfer (1 = Out)	Determines transfer direction.	→
$\overline{\text{10SB}}$	1/0 Strobe	Initiates transfer.	→
FLG	Interface Flag (1 = Ready)	Indicates HP-IB Interface readiness to computer.	←
STS	Interface Status (1 = Present)	Indicates HP-IB Interface presence to computer.	←
INIT	Calculator Initialize	Resets HP-IB Interface.	→
IRL	Interrupt Request Low (Ø-7)	Low priority request.	←
IRH	Interrupt Request High (8-15)	High priority request.	←
INT	Interrupt Poll	Demands response to poll.	→

* Bar over line designation stands for negative-true logic.

Table 3-2. SIGNAL LINES BETWEEN PLOTTER AND INTERFACE

Line	Description	Function	Signal Direction (CMPTR INTFC)
		DATA LINES	
DIO1-8	Data Input/Output	Carries I/O data, program codes, addresses and status.	
		CONTROL LINES	
ATN	Attention	Indicates data or address transmission.	↔
SRQ	Service Request (Low = Request)	Indicates service request.	→
IFC	Interface Clear (Low = Clear)	Disables HP-IB Interface for bus.	→
E01	End or Identify (Low = End)	Identifies end of data.	←
REN	Remote Enable	Enables remote control operation of plotter.	→
		TRANSFER LINES	
NRFD	Not Ready for Data (Low = Not Ready)	Indicates readiness to accept information.	
NDAC	Not, Data Accepted (Low = Not Ready)	Indicates receipt of information.	
DAC	Data Valid (Accepted) (Low = Data Valid)	Indicates information validity.	

NOTE

Operation of the HP-IB Interface ROM is explained in the following paragraphs in terms of the type of function being performed.

(b) Monitoring signal lines. In order to determine its mode of operation, the HP-IB Interface ROM has a processor in the control logic circuit that monitors the signal lines from the computer and the plotter.

(c) Monitoring of the computer is accomplished via a calculator flag (CFLAG) signal from the computer command register circuit. When the computer requests an input/output (I/O) operation from the HP-IB Interface, the CFLAG signal is sent true. A true CFLAG signal induces the processor in the control logic circuit to send instructions to other circuits to decode and execute the requested

(d) To monitor the plotter for an I/O operation request, the processor in the controlling logic circuit periodically samples signals on the control lines and transfer lines. If the state of these signals indicates an operation is requested, the proceesor issues appropriate instructions.

(3) Select code decoder circuit determines initially when the HP-IB Interface ROM is being addressed by the computer. A select code switch in the circuit establishes a unique select code for the HP-IB Interface ROM, which will only respond when an identical code is sent on peripheral address lines PA0 thru PA3. The circuit sends calculator flag (CFLAG) signal low to indicate its presence and readiness to the computer and sends status (STS) line low to tell the computer that no error conditions exist. The circuit responds to the receipt of a correct address code by looking for an I/O command via the 1/0 register decoder circuit.

(4) I/O register decoder circuit contains a set of gates that interpret an I/O command from the computer. A direction of transfer (DOUT) signal indicates to the circuit whether a transfer is an input or output operation from the computer, i.e., whether data will be transferred to or from the HP-IB Interface. If a data transfer to the HP-IB Interface is indicated, the circuit latches any data on the I/O data lines I0DØ thru IOD7 into the output register of the I/O data register circuit with an I/O strobe pulse (IOSB) signal. The IOSB signal also induces the latching of any coded signals on the DOUT, IC1, and IC2 lines into the computer command register circuit. If the HP-IB Interface ROM were transferring data to the computer (from the HP-IB Interface), the circuit would operate in the opposite direction upon receipt of the IOSB signal. Data would be latched onto the computer data lines IODØ thru IOD7.

NOTE

Data cannot be inputted to the computer when it is conducting an interrupt poll. The INT signal is low for an interrupt poll.

(a) A latch in the computer command register circuit holds an I/O register code signal (bits R4 thru R7). The I/O register code is composed of bits of the IC1 and IC2 signals and the transfer direction of transfer (DOUT) signal. One bit of the register code is buffered through a nand gate to become the calculator flag (CFLAG) signal sent to the processor in the control logic circuit. If the HP-IB Interface ROM is busy and cannot accomplish a transfer, CFLAG signal is sent true. CFLAG is sent to induce the interface flag (FLG) signal, sent to the computer by the select code decoder circuit, to go high indicating the not-ready state of the HP-IB Interface.

(b) When a transfer is first requested, the HP-IB Interface is not operating and the CFLAG signal is false, enabling a low FLG signal to be sent indicating readiness. As soon as the I/O strobe pulse (IOSB) strobes the data, DOUT, IC1 and IC2 signals into the HP-IB Interface, the computer command register circuit sends CFLAG signal true. The HP-IB Interface ROM now cannot accept a second set of data until the first is processed.

(c) Transferring to plotter. When coded signals and data have been latched into the HP-IB Interface ROM, transfer operations begin. A true CFLAG signal (same signal sent to the computer command register circuit) is sent to the processor in the control logic circuit, to tell it an I/O operation is commanded. The control logic circuit returns a read calculator command register (RCCR) signal that causes ICI, IC2, and DOUT signals to be gated onto the processor data bus.

NOTE

After an I/O operation (data transfer) is completed, processor outputs a clear calculator command register (CCCR) signal that clears circuits for another operation. Calculator flag (CFLAG) is sent false to indicate readiness.

(d) After the processor in the control logic circuit outputs the read calculator command register (RCCR) signal to computer command register circuit, it sends a read computer output data (RCOD) signal to I/O data register circuit. RCOD gates data from the computer onto the processor data bus.

(e) If data were being transferred to the computer instead of from, the processor would output a send computer input data (SCID) signal which would latch data on its data bus into the I/O data register circuit, where it would wait for an I/O strobe pulse to send it to the computer.

(f) The initialize circuit applies **+9 V** to the processor after all other supplies are stable. An initialize (INIT) signal is received from the computer when the proper power conditions have been reached. If the INIT signal is received and the HP-IB Interface is the active controller, the processor issues an abort signal (IFC) and sends a remote enable (REN) signal true. If the HP-IB Interface is not the controller, the processor clears all the HP-IB functions. The initialize circuit also provides a reset pulse for the HP-IB control bus latch circuit and power for the control logic circuit.

(g) The HP-IB address register circuit assigns five least significant bits of the HP-IB talk/listen address to data on the processor data bus and enables the HP-IB Interface to become the active controller, i.e., take over a transfer. Six switches in the circuit are used to set the HP-IB talk/listen address. When each switch is on, its corresponding bit is set to a logical Ø. Five of these switches are connected to the processor data bus bits DØ thru D4. One of the switches is the system controller switch which, when on, makes the HP-IB Interface the active controller for any data on the bus. The output of the system controller switch is connected to bit D5 of the processor data bus. The HP-IB talk/listen address bits and system controller bit are gated onto the bus during a transfer cycle when a read interface bus address (RIBA) is received from the control logic circuit.

(h) Data from the I/O data register circuit is transferred via the processor data bus to the HP-IB output latch circuit and to the ROM in the control logic circuit. The processor outputs a send interface bus data (SIBD) signal to enable transfer of the data to an eight-bit latch in the circuit. A five-bit pattern (HP-IB talk/listen address) that identifies the data is sent, with the send interface bus control (SIBC) signal, to the HP-IB control bus latch circuit.

(i) When the HP-IB control bus latch circuit receives an SIBC signal, the bit pattern on the processor is transferred to a five-bit latch. The outputs of this latch are five signals (IE01, IATH, IRSQ, IREH, and IIFC), which are routed to bus drivers in HP-IB transceiver circuit.

(5) The HP-IB transceiver circuit applies the identification bit pattern to the five control lines (E0I, ATN, SRQ, REN, and IFC) of the signal lines. The circuit has four bus transceiver modules, two for the data lines and two for the control and transfer lines. They allow bidirectional flow of data and control information via open collector drivers and receivers with hysteresis. When data and bit patterns are transferred, they are sent by circuit to the plotter via the HP-IB cable.

(a) Transferring to computer. When data signals and the accompanying control information is to be transferred from the plotter to the HP-IB Interface, signals are first input to the circuit transceivers of the HP-IB transceiver circuit.

(b) If a transfer from the plotter is processed, data and control bytes are routed by the HP-IB input multiplexer circuit. Outputs of the transceivers (data and control signals) are transferred through the circuit to the processor data bus. HP-IB transceiver circuit transfers a data byte (DI01-DI08) or a control byte (E0I, ATN, SRQ, REN, IFC, DAV, NRFD, and NDAC) to the bus, depending on which command signal it receives from control logic circuit. One of two possible signals are sent by the processor via its I/O register selector to HP-IB input multiplexer circuit. A data byte is transferred upon receipt of a read interface bus data (RIBD) command signal. A read interface bus control (RIBC) command signal implements a control byte transfer. When RIBD is received, a data byte is sent via the processor data bus to the I/O data register circuit and latched by a send interface bus data (SCIB) signal from processor for a transfer to the computer.

(c) A control byte is interpreted and implemented according to the instructions for the HP-IB functions stored in the 4096-bit ROM of the control logic circuit.

(6) The computer interrupt logic circuit allows the HP-IB Interface to request service, i.e., talk to the computer. Before it can transfer data to the computer, the HP-IB Interface must first notify the computer and request a transfer. This circuit has two interrupt request lines to the computer, IRL and IRH. When an interrupt is required, as when data from the HP-IB is to be processed, the processor in the control logic circuit outputs a computer interrupt request (CIRQ) instruction signal to the circuit. This signal induces the circuit logic to send an IRL or IRH signal low. Which signal goes low depends on which address the select code switch in the select code decoder circuit is set. If the switch is set between Ø and 7, IRL is sent low. If the switch is set between 8 and 15, IRH is sent low. When the computer senses an interrupt request, it will conduct an interrupt poll to determine which of its interfaces requires service. A peripheral address bit (PAØ thru PA3) will be received from the computer by the select code decoder circuit of the HP-IB Interface. If the bit matches the setting of the select code switch, then the transfer cycle previously described is initiated in reverse and data in the I/O data register circuit is transferred to the data lines. The computer interrupt logic circuit will also pull one of the I/O data lines low.

NOTE

For a select code switch setting of 7, data line I0D7 should be low. See Table 3-3 for a complete list of interrupt request bits.

Table 3-3. INTERRUPT REQUEST BITS

Select Code	Line Pulled Low
Ø or 8	IODØ
1 or 9	IOD1
2 or 1Ø	IOD2
3 or 11	IOD3
4 or 12	IOD4
5 or 13	IOD5
6 or 14	IOD6
7 or 15	IOD7

(7) Communication between computer and plotter. The computer interrupt logic circuit allows the plotter to become the active controller and interrupt operation of the processor in the control logic circuit. The interrupt logic is enabled by an interrupt enable (IENA) signal from the control logic circuit.

(a) When the plotter is the active controller and wishes to abort or clear the HP-IB Interface, it sends an IFC signal. The computer interrupt logic circuit initializes (clears) all the HP-IB Interface functions and circuits within the HP-IB Interface and generates a 100 microsecond pulse on the IFC line.

(b) If the computer is the active controller, the control logic circuit enables the computer interrupt logic circuit and sets the immediate control (IMD) signal true.

(c) If the plotter then sends an abort message (IFC), the circuit also initializes (resets) all the HP-IB Interface functions and circuits. If, in addition, the plotter sends an attention (ATN) true signal, indicating an expected transmission of data or information, the circuit readies the HP-IB Interface to receive data. Readiness is established by clearing HP-IB output data latch circuit, disabling HP-IB transceiver circuit transceivers and sending signals on the data-available (DAV), not-ready-for-data (NRFD), E0I, and not-data-available (NDAC) lines low.

(8) The parallel poll logic circuit allows the HP-IB Interface to respond to a parallel poll by the plotter. The plotter initiates a poll by sending ATN and E0I true signals. If the computer has requested service from the plotter, a service request (SRQ) signal is received from the HP-IB control bus latch circuit. The SRQ signal induces the parallel poll logic circuit to respond to the parallel poll by sending a status signal to the plotter via one of the data lines (DI01 thru DI08).

3-3.2.2 (Internal) Interface Circuits. The interface circuits allow transfer in and out of plotter of data and control information. The interface circuits consist of the following two printed boards:

Interconnect PCA Card A1
Internal Interface Bus PCA Card A2

Interconnect PCA card A1. Houses the connectors for the input/output cable, the ADDRESS switch S1 integrated module, CONFIDENCE TEST switch and LISTEN ONLY switch.

(1) The ADDRESS switch S1 integrated module provides an eight-bit address code to the address comparator in PCA A2. The module is set according to the operating instructions.

(2) All communications in and out of the plotter are done via the eight data lines and eight control lines that transverse PCA1.

(3) The CONFIDENCE TEST switch selects the plotter self-test.

b. Internal interface bus PCA card A2. Provides the communications interface by directing data flow. PCA A2 performs five major functions:

Address recognition. Recognizes that the plotter is being addressed.

Decoding. Decodes input instructions to mean (a) prepare to receive data (PRD) or (b) send data.

Service request. Requests service from the computer.

Polling. Answers polls from the computer.

Clear and self-test.

(1) Address recognition. Is accomplished through an address comparator (U20). The address comparator (U20) constantly compares bits 1-5 of the address switches of PCA A2 and data bits 1-5 received at the interface bus transceivers (U7 and U33). When two addresses are the same value, then the plotter is beinq addressed and-comparator U20 produces a my address signal. The my address signal is used to activate the talk and listen decoder circuits.

(2) Decoding. PCA A2 receives instructions to prepare for receiving data (PRD). When PCA A3 is available to accept data, it generates a ready signal which is the cue for the computer to send the first data word.

(a) The first data word received by the plotter is decoded by the PCA A2 circuits to determine if the plotter is the device actually being addressed. This first data word also tells the PCA A2 circuits to enter the acceptor handshake mode, which means data will be transmitted by the computer and "accepted" by the plotter.

(b) After the plotter has entered the acceptor handshake mode, the computer may send data directly to the processor via the HP-IB Interface until the mode has been terminated (Table 3-4).

(c) The plotter can send data via the talk logic circuitry on PCA A2. Talk logic circuitry is only enabled when the plotter is addressed by the computer. When the computer requests the plotter to send data, the plotter enters the talk handshake mode. The request is made via a data word. After entering the mode, the plotter may continue to send data until terminated (Table 3-5).

(3) Service request. The service request circuits in PCA A2 allow the plotter to request service from the computer. A request is initiated by a request for service (RSV) signal from PCA A3. Computer responds by initiating a serial poll on the data bus to determine which device is requesting service.

NOTE

The computer, upon detecting a service request, conducts a poll of all the devices on the bus that may have requested service. The following is the sequence of events performed by the PCA A2 circuitry for service request:

- The microprocessor generates an RSV signal and a clock pulse on the write interface bus.
- U9 transmits an RSV signal to service request latches U28 and U29.

Ž U9 generates an RSV true signal that is sent to the computer via IBT U8.

(4) Polling. Is directed by the computer as a response to a service request. There are two polling modes: serial poll mode and parallel poll mode. In the serial poll mode, the computer initiates a serial poll enable (SPE) signal and then sequentially commands each device on the interface bus to talk. The plotter responds by sending a BIT 7 true signal indicating that it is the device that has requested service.

NOTE

The followings the sequence of events for responding to a serial poll:

- The computer detects a service request and initiates a universal serial poll enable (SPE) by placing a data byte ØØ1ØØØ on the data bus.
- PCA A3 initiates a parallel poll enable (PPE) true signal.
- U32 receives EOI, attention (ATN) and PPE signals via U9 and addresses D and E via U5. Generates PPE signal to U21.
- U21 is enabled by PPE. This sets a data line equivalent to address ABC onto data bus to the computer.

(5) Clear and self-test. Clear and self-test circuitry of PCA A2 performs three operations:

Device Clear

Interface Clear

Self-Test

(a) Device clear. Sets the plotter to a preset condition. The computer initiates the device clear during a receive handshake mode by making the reset signal true. This causes the processor to position the plotter in a predefine state indicated by the data byte read into PCA A3 during the receive handshake mode operation.

(b) Interface clear. Is initiated by the computer. It clears the listen, talk, poll, and service request flip-flops.

(c) Self-test. Is used as an aid in locating a defective stage. Self-test is initiated and controlled by the microprocessor on PCA A3. Self-test for PCA A2 is accomplished by the microprocessor generating the following test functions:

Test Ready for Data

Test Data Accepted

Test Data Available

Test Data Enable

Test End or Identify

Test Attention

These functions, when applied in the appropriate sequence, will test all modes of PCA A2.

Table 3-4. PCA A2 ACCEPTOR HANDSHAKE MODE OPERATION

This functional operation is designed to assist in troubleshooting the plotter. All circuit references apply to PCA card A2.

Sequence Step	Circuit and Signal Operation
	INITIATION
1	Computer sends data available (DAV) and attention (ATN) true signals.
2	Control latch U19 generates ready signal indicated by microprocessor upon sensing DAV true signal.
3	Interface bus transceivers (IBT) U33 and U7 receive first data word from computer and transmit it to bit decode circuits.
4	Interface bus transceiver U34 receives ATN control work from computer and transmits it to bit decode circuits.
5	U6 receives ATN and READY signals and sets U19.
6	U19 receives ATN and READY signals and sets U8.
7	U8 transmits ready for data (RFD) true from U19 to computer. Transmits computer response, DAV true signal, to microprocessor via U22. DAV goes false.

Table 3-4. PCA A2 ACCEPTOR HANDSHAKE MODE OPERATION - Cont

Sequence Step	Circuit and Signal Operation
	INITIATION - Cont
8	U4 and U5 receive and decode bits 6 and 7 from U33. BIT 6 true and BIT 7 false signals decode as listen handshake mode, and listen decode clock pulse is sent to listen flip-flop U17A.
9	U16, U4, and U26 decode bits 1-5 to provide CLK input to listen flip-flop U17A. Any combination of data bits 1-5 will decode to produce true input to CLK, except bit 11111 which decodes as false.
10	Address comparator U20 compares bits 1-5 from computer to five bits from preset ADDRESS switch S1 on PCA A1. If bits are same, then U20 generates my address to indicate that plotter is being addressed.
11	Listen flip-flop U17A receives CLK input from decoded bits 1-5, receives input from my address and is clocked from decoded bits 6 and 7. This sets U17A which generates listen (LST) bit.
12	U19C is set by LST and generates receive handshake (RHS). RHS is sent to PCA A3 on bus 14 via microprocessor input gate U12. LST also sets data accepted (DAC) true and ready for data (RFD) false.
13	U8 receives DAC true and RFD false from U19 and transmits it to computer. Computer responds by sending data available (DAV) false to U8.
14	U8 transmits data available (DAV) false to microprocessor on PCA A3 via U22 and to U19 via U24. This removes receive handshake (RHS) input from microprocessor.
15	U6, U27, and U19 receive DAV false and set DAV false and ready for data (RFD) true.
	TRANSFER OF DATA
1	Computer places data byte on data bus via U33 and U7.
2	Computer sets DAV true at U8.
3	U6, U27, and U19 set RFD false.
4	Microprocessor on PCA A3 clocks microprocessor input gates U11 and U12 and accepts data on data bus.
5	U6, U27, and U19 set data accepted (DAC) true.

Table 3-4. PCA A2 ACCEPTOR HANDSHAKE MODE OPERATION - Cont

Sequence Step	Circuit and Signal Operation
	TRANSFER OF DATA - Cont
6	Computer sends DAV false.
7	U6, U27, and U19 set DAC false and RFD true.
8	Process is repeated until all data to be transferred from computer is transferred.
	TERMINATION
1	Computer initiates termination by placing a 11111 bit on data bits 1-5.
2	U16, U4, and U26 decode bits 1-5 and input CLK false to U17A.
3	U17A is clocked by decoded bits 6 and 7 and sets listen (LST) signal to false.
4	LST signal to U19 is removed and U10 stops generating receive handshake (RHS) signal.
5	Plotter has exited RHS mode.

Table 3-5. PCA A2 TALK HANDSHAKE MODE OPERATION

Sequence Step	Circuit and Signal Operation
	INITIATION
1	Interface bus transceivers U33 and U7 receive first data word from computer and transmit it to bit decode circuits.
2	U4 and U5 receive and decode bits 6 and 7 from U33. A BIT 7 true and BIT 6 false decodes a talk handshake (THS) mode and a talk decode clock pulse is sent to talk flip-flop U18B.
3	Address comparator U20 compares bits 1-5 from computer to the five bits from preset ADDRESS switch S1 on PCA A1. If bits are same, U20 generates my address indicating that plotter is being addressed.

Table 35. PCA A2 TALK HANDSHAKE MODE OPERATION - Cont

Sequence Step	Circuit and Signal Operation
	INITIATION - Cont
4	Talk flip-flop U18A receives input from my address and is clocked from decoded bits 6 and 7. This sets U18A which generates talk (TLK) true signal.
5	U27, set by TLK true signal, is sent false and. generates data enable (DEN) which is sent to interface bus transceiver (IBT).
6	U26 and U15 receive DEN from U27 and sets U17B to generate a THS true to U33.
7	U9 transmits new byte available (NBA) from microprocessor on PCA A3 to U26.
8	U26 receives inputs NBA true, serial poll mode select (SPMS) false and THS true. Provides true output to U25.
9	U8 receives ready for data (RFD) from computer and transmits RFD true to U25.
10	U25 receives RFD true, data enable (DEN) true, and new byte available/serial poll mode select (NBA/SPMS) true from U26. U25 latches, generating data available (DAV) true.
11	U26 is enabled by SPMS false and DEN true signals and sends serial poll mode active state (SPAS) false signal to enable latches U2 and U14.
12	U2 and U14 are enabled by a SPAS false signal and transmits a data byte from microprocessor on PCA A3 via data selectors U1 and U9 to interface bus transceivers (IBT's) U33 and U7. Write interface bus (WRIB) true signal, from microprocessor, gates data byte through U1 and U9.
13	U33 and U7 are enabled by DEN signal from U27 and transmit data byte received from U2 and U14 to computer.
14	U25, after data byte had been accepted by computer, generates data accepted (DAC) true signal. DAC true signal resets U25 via IBT U8.
15	U15 receives reset input from U17B and U25 and sets talk handshake (THS) to false.
16	Microprocessor on PCA A3 senses talk handshake (THS) false and sets new byte available (NBA) false signal.

Table 3-5. PCA A2 TALK HANDSHAKE MODE OPERATION - Cont

Sequence Step	Circuit and Signal Operation
	INITIATION - Cont
17	U9 receives NBA false signal and clears talk handshake flip-flop U17.
18	U15 sets THS true.
	DATA TRANSFER
1	Microprocessor on PCA A3 sends NBA true signal to talk handshake flip-flop U17.
2	Computer sends ready for data (RFD) true signal.
3	U25 sets data available (DAV) true and enables U15 to generate THS.
4	U2 and U14 transmit data byte from PCA A3 to IBTs U33 and U7.
5	U33 and U7 are enabled by U27 and transmit data byte to computer.
6	Microprocessor on PCA A3 sets NBA false, clearing talk handshake flip-flop U17.
7	Computer generates data accepted (DAC) true.
8	Microprocessor sets DAV false.
9	U15 sets talk handshake (THS) false, thus, indicating completion of transfer.
10	Microprocessor on PCA A3 sends new byte available (NBA) false, causing THS to go false.
11	Sequence is repeated until all data (data bytes) is transferred.
	TERMINATION
1	Termination can be initiated by microprocessor on PCA A3 by holding NBA false.
2	Active termination is initiated by computer when it places an address, other than plotter's preset address, on bits 1-5. This action will send my address false.

3-3.2.3 Data Processing, Is the “brain” of the plotter. All timing and control is initiated here and data is converted to a usable form for driving (controlling) the analog pen drive circuits.

Data processing consists of three PCA cards:

Processor PCA card A3

Memory PCA card A4

Internal I/O PCA card A5

Each of these circuit cards performs its own set of functional operations as part of the overall function of the data processing.

a. Processor PCA card A3. Provides the timing signals for all operations that occur in the plotter, synchronizing dependent events to a common clock. The processor also performs mathematical manipulation of the input data to convert it to plotter internal control language. PCA A3 consists of a microprocessor, local ROM, and support circuits. Each operation that the microprocessor performs is controlled by a program of instructions prestored in ROM on PCA A4.

PCA A3 performs three functions:

Timing. Controls timing for all plotter operations.

Information processing. Utilizes programmed instructions to request data, manipulate data and transmit data to appropriate circuits.

Self-test. Initiates and controls preprogrammed self-tests.

(1) Timing. Is controlled by the clock generator which establishes the time base. The clock generator consists of U27, crystal Y1, and associate passive elements. The clock frequency is divided in two by flip-flop U25. A 180 degree phase shift occurs here because the output comes from the Q+ and Q- outputs. The phase clock driver provides phase 1 and phase 2 clocks. Phase 1 clock is high when phase 2 clock is low. These two clocks provide for the synchronous operation of the plotter.

(2) Information processing. Establishes the movement of data within the plotter. The microprocessor controls the flow of data on PCA A2 and PCA A5. The processor receives vendor data from the computer via PCA A2, interprets it, and sends velocity commands to PCA A5 for positioning of the pen.

(a) In order for the microprocessor to perform these functions, it must be instructed in a step-by-step procedure for each different operation it performs. These sets of instructions are permanently stored in ROMs on PCA A4.

(b) The microprocessor reads instructions from ROM phases (U21 and U22) on PCA A3 and other ROM and RAM located on PCA A4. It also can write into RAM for temporary storage of data.

(c) Six clock periods are necessary for the microprocessor to accomplish a READ from memory, interpret and perform the instruction. Four more clock periods are required to complete a WRITE from the microprocessor to RAM on PCA A4 or a register on PCA A2 or A5.

NOTE

In order to troubleshoot hardware failures in the processing circuits, it is necessary to follow the function of the circuitry in terms of ROM phase timing when performing READ and WRITE operations. See Table 3-6 which relates the timing operation of the processing circuits.

Table 3-6. PROCESSING CIRCUITS FUNCTIONAL SEQUENCE OPERATION

Clock Period	Operation of Circuit
	WRITE OPERATION
t_1-t_6	Microprocessor tells RAM in which address to store data.
t_7-t_9	Data is transferred to be stored as follows:
	t_7 Microprocessor sets READ to low producing a high WRITE.
	t_8 start memory (STM) goes high which tells memory to stand by to receive data.
	t_9 extended synchronous memory complete (EXSMC) is generated. Directs microprocessor to place data on data bus.
	Microprocessor can also send data (write) to any of the following:
	Registers on I/O Interface PCA A2
	Registers on HP-IB PCA A2
	Self-test registers on PCA A3
	Interrupt registers on PCA A3
	Process of writing data to one of these other locations is accomplished in similar manner as described above. Correct register is deactivated by register decoder which decodes data bits Ø~-4.
	A5 card decoder is activated by I/O RAC, which is produced by register decoder.

Table 3-6. PROCESSING CIRCUITS' FUNCTIONAL SEQUENCE OPERATION - Cont

Clock Period	Operation of Circuit
	WRITE OPERATION - Cont
	NOTE Register 10 (U10 and Ull) latches (reads) last data bus word before interrupt occurs. Data word is latched until interrupt acknowledge is complete and then places data back into bus.
	READ OPERATION
t_1 and t_2	Microprocessor U23 sets SYNC high to initiate instruction fetch. Sets PDR high to indicate that it has placed address on data bus (IDA 0-15).
t_3	Microprocessor sets start memory (STM) and register access line (RAL) high. STM (high) enables interface bus drivers U30 and U31 to interface (internal) data bus with ROM phase inputs. Data bits 13 and 14 low are decoded by U19 to mean ROM phase read. (IFSTM is also generated but is only used by 1/0 to synchronize interrupt with beginning of instruction fetch.)
t_4 and t_5	Interface bus transceivers (IBT's) are selected to drive data bus from microprocessor direction. Chip select circuits are activated and data is transferred to microprocessor. These functions are accomplished by setting extended synchronous memory complete (EXSMC), PDR, and start memory (STM) high at ROM phase. (Note tha EXSMC is also used for timing of external memory access on PCA A4. Chip select enables ROM phase (U21 and U22) allowing it to place any instruction, that occupies addressed memory, onto data bus.

Table 3-6. PROCESSING CIRCUITS FUNCTIONAL SEQUENCE OPERATION - Cont

Clock Period	Operation of Circuit
	READ OPERATION - Cont
t_6 thru t_9	Microprocessor interprets instruction period and then exits mode by setting STM, synchronize (SYNC), and synchronous memory complete (SMC) to low. Microprocessor also reads data from any of the following: RAM and ROM on PCA A4 Registers on I/O interface PCA A5 Registers on HP-IB PCA A2 Self-test registers on PCA A3 Interrupt registers on PCA A3

NOTE

Process of reading data and instructions from any of these locations is accomplished in a similar manner as described above. However, register decoder circuits must be utilized to determine appropriate register to activate. First five data bits (IDA Ø-4) are decoded by register decoder circuits and activated register accepts instruction or data placed on data bus by microprocessor.

(3) Self-test. Is initiated by a self-test flag on PCA A3 (flag II), which originates at self-test switch S7. PCA A3 then performs self-test steps according to a program stored in ROM. Test results are displayed on self-test lamps when the microprocessor initiates a WRITE 13 (W13) and places the light sequence on the data bus.

If test selector 6 is selected to the on (2) position, an inhibit signal is generated which initiates the bidirectional interface buses (BIB's) and isolates the microprocessor from the data bus. Inhibit also sets U13 which places a preset address onto the microprocessor data bus.

b. Memory PCA card A4. Consists of two functional units: the BIB drivers and the memory.

The bidirectional interface bus (BIB) drivers provide interface between the TTL bus and the MOS memory bus. When memory 40, memory 44, or the RAM are accessed during a READ cycle, the BIB drives the TTL bus. During the WRITE cycle for the RAM or a READ cycle for the ROM, the BIB drives the MOS memory bus. The major control lines that determine direction of the BIB drivers are the read memory (RDMEM) and the HI PAGE lines.

The memory portion of PCA A4 includes the following:

Memory access decoding and address latching

Read only memories 40 and 44

Read/write memory

Read only memory 32 word constants

(1) Memory access decoding and address latching. Decodes signals from PCA A3 and the bus data to enable and access the memory location selected. A low BUS 14 indicates that a memory location on the memory PCA is to be addressed. When the HI PAGE line is made true by a low BUS 13 and BUS 14, the state of BUS 8 determines whether the RAM or the ROM 32 word constants are to be accessed, and the state of bus 11 determines whether memory 40 or memory 44 is to be enabled. The word in memory to be addressed is specified by decoding bus bits Ø-10. Although the plotter has a total of 5K of ROM, only 4K is located on the memory PCA. The remaining 1K of ROM is located on PCA A3 to allow the processor PCA to operate independently when in the self-test mode of operation from the system and, thus, simplify troubleshooting of the processor PCA.

Four control signals from PCA A3 determine when PCA A4 is to be accessed and the direction of the bus drive. They are: start memory (STM), extended synchronous memory complete (EXSMC), read memory (RDMEM), and synchronous memory complete (SMC). To select memory 40 (U15 and U17), a high BUS 11 is clocked through U2 by the leading edge of the STM signal. This causes ADR 11 to output a low enable signal to chip select (CS) pin 18 or both U15 and U17 (memory 40). Likewise, a low BUS 11 will make ADR 11 high and enable memory 44.

To summarize: BUS 11 = 1 = Selects Memory 40 (U15 and U17)
BUS 11 = Ø = Selects Memory 44 (U14 and U16)

However, during the READ cycle when memory 40 or 44 is to be addressed, U1 provides a low chip select to U15, U14, and U16. If address 11 is low, ROM 40 is selected (U15 and U17). If address 11 is high, ROM 44 is selected (U14 and U16).

(2) Read only memories 40 and 44. Consists of 4K memory blocks in which the instructions for the processor are stored. Each block (40 and 44) consists of two 2K x 8 memory chips: the first containing the eight least significant bits (LSB's) of a data word and the second containing the eight most significant bits (MSB's). (See table which follows.)

MEMORY BLOCK	ROM LSB	ROM MSB	OCTAL ADDRESSES
40	U15	U17	4Ø,ØØØ$_8$-43,777$_8$
44	U14	U16	44,ØØØ$_8$-57,777$_8$

(3) Read/Write memory. Consists of 256 words of memory used for temporary data storage by the processor. The octal addresses for the 256-word RAM chips are 774ØØ-77777. The bus bit pattern (inverted octal) for 774ØØ is ØØØ ØØØ Ø11 111 111, which is now used to trace the RAM enabling signal circuitry. (Table 3-7)

Table 3-7. RAM ENABLE SEQUENCE

Step	Circuit Operation
	INITIAL CYCLE
1	PCA A3 causes extended synchronous memory complete (EXSMC) to go high. First of three high (1) outputs input to nand gate U4A.
2	A low (Ø) BUS 8 is clocked through latch U2. U2 outputs second high to U4A.
3	A low BUS 13 and BUS 14 make U11 input a high to latch U2. High is clocked through U2 to produce third high input to U4A-13.
4	U4A outputs low enable signal to pin 13 of RAM chips U19, U12, and U13.
	DURING A READ CYCLE
5 5	U4 also outputs low to bidirectional interface bus (BIB) drivers U10 and U5. Contents of memory are transferred onto bus.
	DURING A WRITE CYCLE
6a	PCA A3 sends read memory (RDMEM) low, causing nand gate U4 to output high to U11 and BIB drivers U10 and U5.
6b	High input to U11 causes it to output low write enable signal to RAM chips U12, U13, U22, and U23.
6c	High input to BIB drivers U10 and U5 transfers write data from bus into memory (RAM chips U12, U13, U22, and U23).

(4) Read only memory 32 word constants. Contains octal addresses 77ØØØ-77Ø37. The 32 word constants are located in ROM's U7 and U6. The eight least significant bits (LSB's), bus 0 thru bus 7, are located in U7, and the eight most significant bits (MSB's), BUS 8 thru BUS 15, are located in U6. Address lines ADR Ø thru ADR 4 are used to address both ROM's.

The low enable chip select (CS) for the ROM's is derived from bus 8, bus 13, bus 14, read memory (rdmem), and synchronous memory complete (SMC) signal lines.

The criteria for selecting ROM 32 word constants is as follows:

Address 8 high

Address 13 low

Address 14 low

Read memory (RDMEM) high

Synchronous memory complete (SMC) high

These signals, inputted to U2, U11, and U4, decode as ROM 32 select. U4 provides a chip select to ROM'S U6 and U7 and disables bidirectional interface bus (BIB) drivers U5 and U10, leaving the bus lines clear for ROM output.

c. Internal I/O PCA card A5. Is functionally divided into two circuits:

I/O circuits

Interpolator circuits

(1) I/O circuits. Provide an interface between the front panel, interpolator circuits, and PCA A3. They perform two major functions:

Processor decoding

Processor interrupt

(a) Processor decoding. PCA A5 decodes a control data word from PCA A3. The microprocessor on PCA A3 sends the encoded control data word via lines $AØ_1$ thru $AØ_2$ and generates a start memory (STM) true signal which gates U22 on PCA A5. Data $AØ_1$ thru $AØ_2$ are gated to register decoder U23. An I/O register access line (RAC) false signal and synchronous memory complete (SMC) true signal from the microprocessor on PCA A3 allows the control data word to be decoded by U23. An output I/O RAL signal from U23 signifies a memory access to an I/O register. An SMC signal is a system timing signal which signifies data on the bus is true. The decoded word instructs PCA A5 to enter into one of four possible modes:

Front panel read RD17

Front panel write WR17

Pen stable read RD16

Interpolator write WR16

(b) If the encoded data word selects the front panel read (FPRD) mode RD17, decoder U23 allows the front panel switch data to be placed on the bus by enabling bidirectional interface bus (BIB) drivers U5, U8, and U13.

(c) If front panel write (FPWR) mode WR17 is selected (at U23-7), the status of the pen position and the four front panel indicators is stored in hex D-type flip-flop U7. The four front panel indicator lamps, LOAD, ENTER, WINDOW, and ERROR, are turned on by data signals from PCA A3. Decoder U23-7 clocks the appropriate low data bit from the bus through hex D-type flip-flop U7 to the selected lamp circuit turning on the associated lamp.

(d) In pen stable read mode RD16, buffer drivers U6 and U14 perform an interface function between PCA A7 and the bus. Selection of register 16 (RD16) pen stable read causes decoder U23 to output a low enable signal to buffer drivers U6 and U14 allowing pen select, pen armed, and stable status data to be driven onto the bus.

(e) Interpolator write mode WR16 is selected via write interpolator register 16. This causes decoder U23 to output a low enable signal to both data latch U9 and the power high flip-flop U19 in the interpolator section. For a detailed description of the interpolator write mode, see Table 3-8.

Table 3-8. PCA A5 INTERPOLATER WRITE MODE OPERATION SEQUENCE

Sequence Step	Circuit Operation
1	Read/Write register U9. When the interpolator write line of the control bus goes low, it enables the write function of registers U9-12. Data buses 12-15 are latched into one of four registers selected by two address bits on buses Ø and 1. At start of interpolator operating cycle, registers U9-RB and RA are low and four least significant bits (LSB's) of the X-axis instruction appear on both the output pins of register U9 and input pins of data selector U17.
2	Data selector U17. High input select signal from U17 transfers X-LSB to full adder U18.
3	Four-Bit and carry adder U18 and U19. Output of full adder U18 is the sum of X-LSB from previous instruction" stored in accumulator U27. The summation is then transferred to X-LSB register in accumulator U27.
4	Write enable decoder U10. The data transfer from full adder U18 to X-accumulator U27 is initiated by gating clock pulse through nand gate from U20 to U10. Write signal from ROM control gates clock pulse through nand gate U10. U10 goes low and enables write function of accumulator U27.
5	Accumulators U27 and U28. Having stored X-LSB in accumulator U27, X-MSB is now clocked through data latch U9 and data selector U17 to inputs of adder U18. At same time, MID-SB signal from accumulator U27 is clocked through data selector U26 to inputs of adder U18. Output of adder U18 is restored in MID-SB of accumulator U27.
6	With next clock pulse, output of register U9 remains same while select input to data selector U17 couples MSB sign bit (line 6) to inputs of adder U18. At same time, four MSB's are coupled from U28 through U26 to inputs of adder U18. Output of adder U18 is now latched into MSB of U28. This completes first subcycle, and output of accumulators U27 and U28 remains constant while data is being transferred into sine/cosine ROM's U29 and U30. Four LSB's and MSB's (sign bits) are discarded.
7	Sine and cosine only memories U29 and U30. Output function of sine/cosine ROM's U29 and U30 is selected by state of inputs from control ROM U20. Outputs from ROM U30 make up four LSB inputs to digital-to-analog converter (DAC) U12 while the outputs from ROM U29 provide four MSB inputs to DAC U12.

Table 3-8. PCA A5 INTERPOLATER WRITE MODE OPERATION SEQUENCE - Cont

Sequence Step	Circuit Operation
8	Digital-to-analog converter (DAC) U12. Eight-bit multiplying DAC U12 provides output current which is linear product of eight-bit digital input and analog input current. Reference current is provided by Q2 and determines full-scale output of DAC by setting current through resistor ladder network in DAC. Full-scale adjustment is provided by full-scale potentiometer R4. Current output (10) from pin 4 is controlled by the setting of offset potentiometer R8 via transistor Q3. The selected sine or cosine output from the DAC is coupled to waveform compensator U3 via operational amplifier U2.
9	Waveform compensators U1, U2, and U3. Waveform compensation is accomplished by varying amount of third harmonic input to summing junction at input of amplifier U2-2. Switch S1 in U3 is closed during part of ROM third harmonic output which allows C7 to store third harmonic.
10	Unity gain operational amplifier U1 couples third harmonic to X- and Y-axis potentiometers R15 and R16. R15 and R16 control amplitude to switches U3-S3 and U3-S4. Switch U3-S3 is closed when X-axis is selected, and closing switch U3-S2 during ROM fundamental output completes third harmonic feedback loop.
11	Output amplifier switching U4 and U21. Fundamental waveform compensated by third harmonic forms DAC output from operational amplifier U2. It is sent to the output analog switch U4. U4-S2 and U4-S4 are closed sequentially by switch decoder U11. Switch closure is timed to connect selected DAC output to its respective operational amplifier in motor phase amplifier U21.
12	Capacitors C8 thru C11 hold level of amplifier input signal during “switch open” times between subcycles. Field effect transistor Q4 ties analog common to digital common if pin 10 connector cable is unplugged at J3. Selected output of motor phase amplifier U21 is coupled to its respective motor winding through motor drive circuitry located on PCA A8 and PCA A12.
13	Timing circuits U15, U16, U31, U32, and U20. The 5 MHz PHI clock signal is coupled to input of dual 2- and 5-divider U16 through nand gate U15. Output of divider U16 is 250 kHz non-symmetrical clock which is used to clock two cascaded synchronous four-bit counters, U31 and U32. These counters effectively divide 250 kHz into 256 steps which are used as both input to control ROM U20 and as enable signals to synchronize switch decoder U11, waveform compensator U3 and ROM’s and U30. Carry-out pulse from U31 is used to set carry input to full adder U18 to Ø once every 16 clock pulses, at beginning of each X- or Y-subcycle.

Table 3-8. PCA A5 INTERPOLATER WRITE MODE OPERATION SEQUENCE - Cont

Sequence Step	Circuit Operation
14	Carry-out pulse from counter U32 occurs once every millisecond. It is used as interrupt request (IRQ) signal which is the enable signal for interrupt (Int) circuitry in I/O section of this PCA. Control ROM U20 decodes counter's output and provides control signals to switch decoder U11 and output analog switch U4, and also provides synchronizing signals to control flow of data through U3, U10, U19, U27, and U28.

b. Processor interrupt. An interrupt (INT) signal is generated by interrupt request circuitry of the I/O circuits. It synchronizes data requests from the interpolator circuits with the processor system. This INT signal causes PCA A3 to interrupt whatever it is processing, service the interpolator request for data, and then continue processing from the point at which it was interrupted. The interpolator section requests new velocity information for the motors every millisecond.

(1) The interrupt circuitry of the I/O circuits has two main stages:

Interrupt system enable latch circuit

Interrupt synchronizing (sync) circuit

(a) The interrupt system enable latch circuit consists of cross-coupled gates U24 and U15. When enabled, they cause PCA A3 to recognize an interrupt request. This latch, and the interrupt system, is disabled (inhibited) during power-up (PUP) or by a software command that is decoded by register decoder U23 as a read register 15 (RD15). The latch is enabled by a write register 15 (WR15) command being decoded by register decoder U23.

(b) The interrupt synchronizing (SYNC) circuit has an interrupt request flip-flop U25 which samples the state of interrupt enable latch U24 each time U25 is clocked by the leading edge of the interpolator interrupt request (IRQ) signal. If interrupt enable latch U24 is enabled, the Q-output of interrupt request flip-flop U25 will go high, signifying that a valid interrupt request is to be sent to PCA A3. The output of the interrupt request flip-flop U25 is clocked through the interrupt sync flip-flop by the leading edge of the instruction fetch start memory (IFSTM) to synchronize the interrupt request with the processor system timing. Nand gate U24A gates the IFSTM, the synchronized IRQ and the latched IRQ to provide the proper interrupt (INT) signal state to PCA A3. Interrupt request flip-flop U25 is preset during power-up (PUP) or when the processor generates an interrupt acknowledge (IAK) signal.

(2) Interpolator circuits. Are used to take digital data from PCA A3, integrate it, and convert it into analog data which is used to position the plotter pen.

(a) During a 1 msec operating cycle, motor position is advanced the desired amount for the 1 msec time period. This is accomplished by adding one-eighth of the input velocity vector data word to the position accumulator eight times. Control signals are developed from the system clock which allows time-sharing of most of the interpolator circuits. PCA A3 places six-bit data signals on IDA bus lines. BUS Ø and BUS 1 data bits specify the address and the axis part of the instruction. (See decoder circuits.) Buses 12 thru 15 contain one-half of an eight-bit X- or Y-axis velocity vector data word.

(b) Three clock periods are used to transfer a complete vector position, in one axis, to the analog circuits for pen motor control. During the first clock period, the least significant bits (LSB's) of the vector are transferred into the interpolator. During the second clock period, the most significant bits (MSB's) are transferred into the interpolator. The third clock period is used for manipulating the new vector data to determine a "difference" in previous pen position and the new pen position. The difference in value is used to drive the pen to the X- or Y-position dictated by the original data bytes from the processor.

3-3.2.4 Local Control Circuits. Are the controls and displays located on two printed card assemblies:

Front panel PCA A6

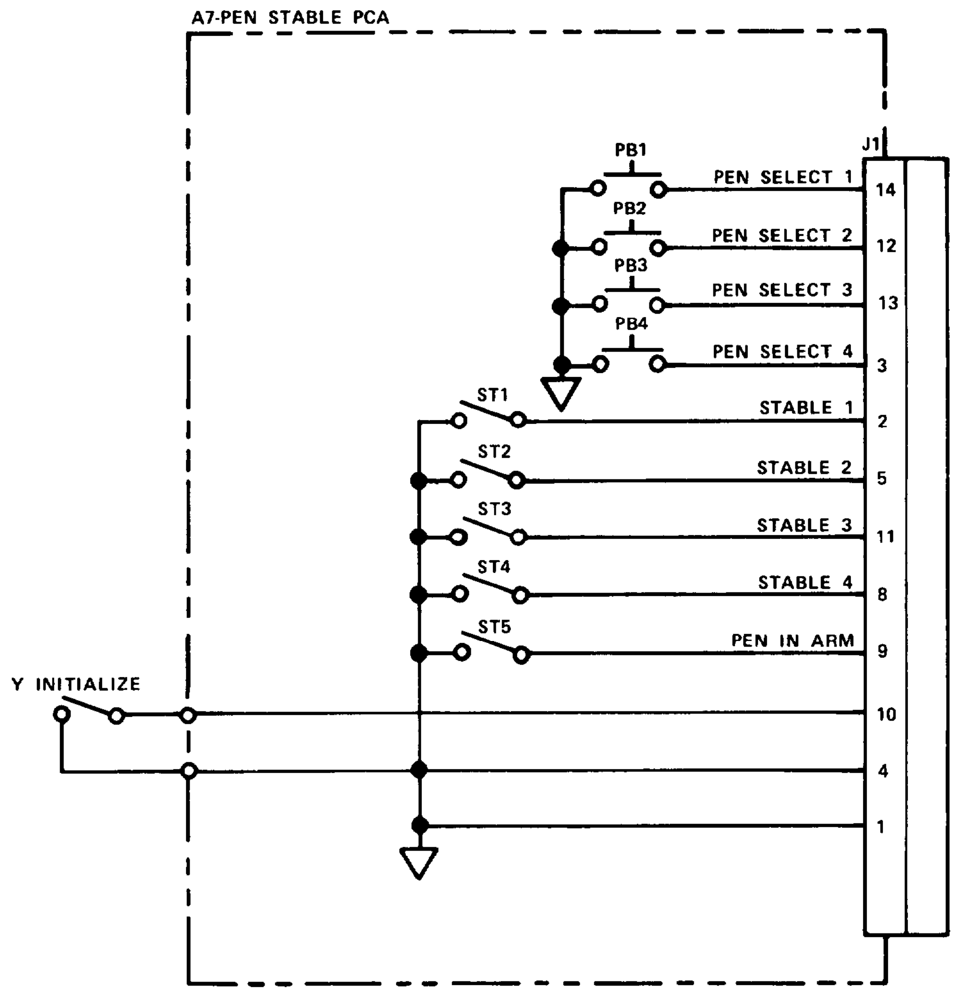
Pen stable PCA A7

a. Front panel PCA card A6. Provides the means of manually entering X- and Y-axis position data, pen control, and chart hold control to PCA A3. The status of the various plotter conditions is indicated by the front panel lamps.

(1) Information is manually inputted onto the IDA bus through push-button switches to display status information and to control the pen. The four indicator lamps, CHART LOAD, ENTER, ERROR, and OUT OF LIMIT, are driven directly by the front panel lamp latch located on PCA A5.

(2) With neither PEN UP nor PEN DOWN push-button switch depressed, pen control from PCA A3 is passed through internal I/O flip-flop U7 and through gates U1B and U1A to the pen solenoid. When either PEN UP or PEN DOWN push-button switches are depressed, their respective signals override PCA A3.

b. Pen stable PCA card A7. Provides a status indication of which pens are present in the stables to the processor. It houses the four manual pen select switches S1 thru S4 and the five pen stable switches. PCA A7 also connects the Y-initialize switch to PCA A6. Pen select switches S1 thru S4 provide a manual means of selecting a desired pen. Depressing one of the push-button pen select switches causes its appropriate input line to go low.



When a pen is installed in a pen stable, it causes the pen stable switch to close, which provides a low input signal to PCA A5 via PCA A6. This low signal indicates that there is a pen in that particular pen stable. Pen-in-arm switch indicates if there is a pen in the arm via a similar low signal.

3-3.2.5 Pen Drive Circuits. Accept pen position data from PCA A5 and drive the plotter chart pens along the X- and Y-axes. A series of drive wires are utilized to move the pens, controlled by the pen drive circuits.

The pen drive circuits include the following functional units:

Motor driver PCA A8

Pen solenoid

Transistor driver PCA A12

X- and Y-drive motors

a. Motor driver PCA A8. Houses the pen solenoid driver and the X/Y-drive amplifiers.

The motor driver PCA may be functionally divided into two circuit sections:

Current amplifier circuit for each of four motor phase drive signals (X-sine, X-cosine, Y-sine, and Y-cosine)

Pen relay drive amplifiers

NOTE

Except for the addition of a GAIN control to the X- and Y-sine amplifier circuit, the four amplifier circuits are identical. Consequently, only the X-sine amplifier will be described here.

(1) Current amplifier circuit. The selected output of the motor phase amplifier, located on PCA A5, is coupled into its respective amplifier circuit through connector J5. A separate mute switch is provided for each axis to disconnect the input to the amplifier to enable service and calibration. In each phase, the first amplifier stage (U1 and U2) functions as an active low pass filter with a cutoff point at 600 Hz. Assuming the sine amplifier has been selected, the motor drive signal is applied to the input of active filter U1. The setting of GAIN control R6 determines the amplitude of the input motor drive signal that is applied to the inverting input of operational amplifier (filter) U1. Offset control R8 determines the zero or reference level for the output of U1.

(2) Pen relay drive amplifiers. Produce bias voltages applied to pen power transistors and send power to drive pen solenoid. When the polarity of the output at U1 is positive, it causes transistors Q1 and Q3 to conduct, resulting in a proportional positive output through connector J1-6 to power transistors Q5 and Q6 located on PCA A12. Transistors Q5 and Q6 drive the X-motor sine winding. A fuse F1 is installed in series with the motor winding to protect it in the event that either power transistor Q5 or Q6 on PCA A12 should develop a short circuit condition. Resistor R11 acts as a motor current sense resistor.

NOTE

It is across this current sense resistor that the action of the circuit and the effect of the circuit control adjustments can be best measured.

When the polarity of the output of U1 is negative, it causes transistors Q2 and Q4 to conduct, resulting in a proportional negative output to connector J1-6 and the power transistors Q5 and Q6 on PCA A12. The motor sine winding is thus driven in the opposite direction (from when the polarity is positive).

The remaining three amplifier circuits (X-cosine, Y-sine, and Y-cosine) operate in an identical manner.

b. Pen solenoid. Controls the up/down position of each pen. The controlling signal to the pen solenoid may originate from either PCA A3 or PCA A5. The pen up or pen down signal from either the processor or the front panel is coupled through connector J5-7 to the base of input transistor Q17. A low (O V) pen down signal turns transistor Q17 causing a positive input to the inverting input of current amplifier U3-2. The negative output of U3-6 turns on transistors Q18 and Q19 via diode CR4. Conduction of Q18 provides a current path from the -12 V supply through connectors J1 and J2, pin 8, to energize the pen solenoid which is mounted on the plotter arm. From there, the current travels through the pen solenoid to connectors J1 and J2, pin 7, and then through transistor Q18 to common. Diode CR4 provides protection for transistors Q18 and Q19 when the pen is up. A positive pen up signal keeps transistors Q17 and Q18 in a nonconducting state, so the pen solenoid is not energized and the pen remains in an up position.

c. Transistor driver PCA Card A12. Boosts an analog position signal from interpolator to drive the X- and Y-drive motors. The analog position signal is interfaced by X14 drive amplifiers. PCA A12 is mounted adjacent to the stepping motors on the underside of the upper deck assembly and houses the eight motor drive power transistors. These eight motor drive power transistors provide current to the X- and Y-drive motor windings, utilizing the +26 V supply from the pen relay drive circuits. The eight transistors are in pairs, one NPN and one PNP, so each of the four motor phase windings has two transistors connected in a push-pull arrangement to provide its drive current.

d. X- and Y-axis drive motors. Drive and control the movement of the plotter arm and thus, the chart pen. The operation of both X- and Y-motors is identical. If the X-sine phase winding is activated, then PCA A8 outputs a signal through connector J1-6 which is coupled through connector J1-2 to common the bases of transistors Q5 and Q6. If the state of input signal is positive, transistor Q6 will conduct, energizing that motor winding which is in common with the emitter circuit. If the input signal is negative, then transistor Q5 will conduct, energizing the motor winding in a reverse direction. The stepping X- and Y-drive motors are identical. Each has 1.8-degree steps making 200 steps per 360-degree rotation. Motor rotation is translated into movement of plotter arm through the drive wire system.

3-3.2.6 Power Supply. Provides an electrostatic chart hold voltage and dc supply voltages as shown below:

For power supply control only: +8 V, +5 V, +12 V

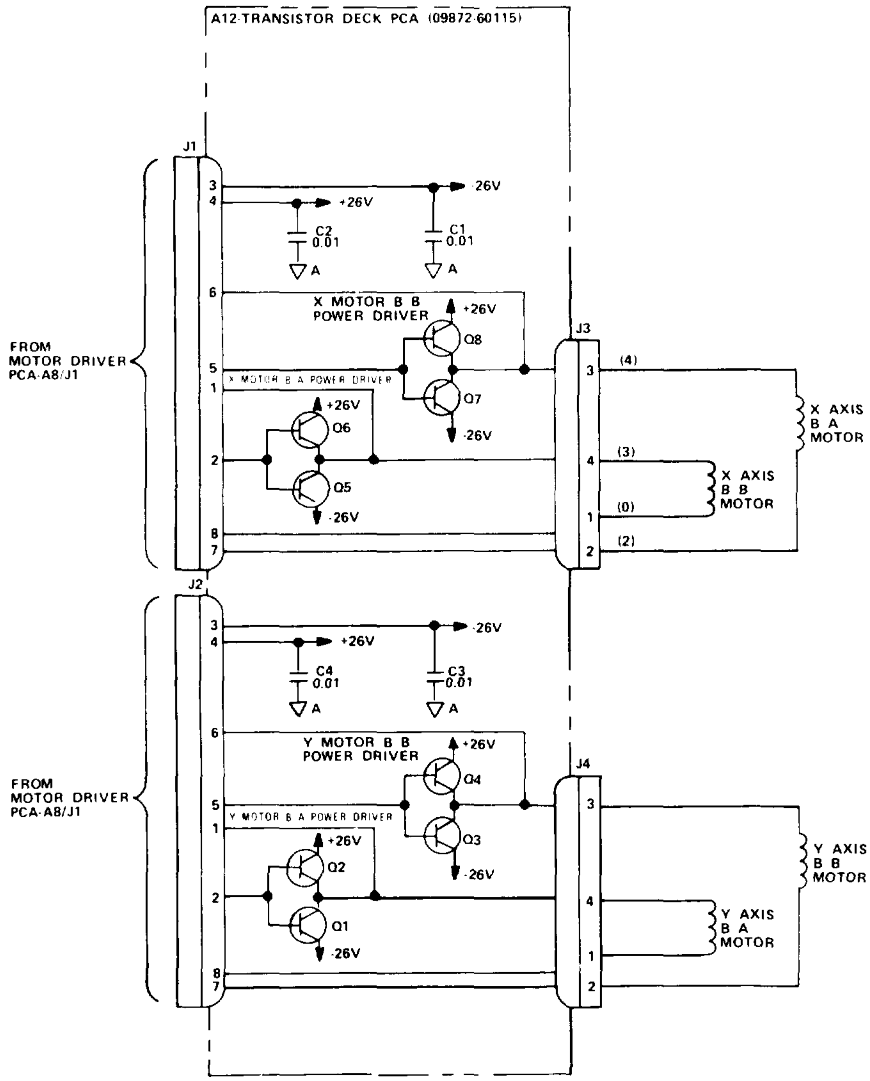
For plotter circuitry: +7 V, +5 V, +12 V, -12 V, +26 V, -26 V

The power supply consists of the following PCA cards:

Main power PCA card A9

Control PCA card A10

Power distribution PCA card A11



The circuits on these cards combine to act as units to perform the following three functions:

Power supply control circuit

Plotter power circuit

Autogrip power circuit

a. Power supply control circuit. Produces supply voltages of +15 V, +8 V, and +5 V, which are used as control voltages within the power supply assembly itself.

(1) Main ac power is input to PCA A9 via an ac receptacle, RF1 filter, line fuses and a set of line voltage selector switches. The main ac power source is switched into the primary windings of transformer T1 through the LINE power switch and the appropriate settings of the line voltage selector switches S2 and S3. Power transformer T1 provides the proper voltages to the full-wave rectifier diodes CR1 and CR2.

(2) The rectified output of CR1 and CR2 is filtered by capacitor C5 and applied to voltage regulator A9-U1 which provides the regulated +15 V supply. Capacitors A10-C3 and A10-C4 provide additional filtering and bypass for this supply.

(3) A second voltage regulator A9-U2 provides the +8 V supply using the regulated +15 V supply as an input. Capacitors A10-C5 and A10-C6 provide additional filtering and bypass for this supply. The +5 V (B) regulator A10-U2 functions in a similar manner by using the regulated +8 V supply as an input. Capacitor A10-C7 provides additional filtering for this supply.

(4) The +5 V, +8 V, and +15 V supply voltages are used only within the power supply assembly and are not outputted to other portions of the plotter.

b. Plotter power circuit. Produces the +7 V, +5 V (A), +26 V, -26 V, +12 V, and the -12 V supply voltages which are generated on PCA A9 card and regulated by circuitry on PCA A10 card. The plotter power voltages are generated and regulated by the following functional circuits:

Ac-to-dc conversion circuit

Square-wave conversion circuit

Voltage output smoothing circuit

Timing sawtooth waveform generation circuit

Voltage turn-on regulation circuit

Turn-on/off sequencing circuit

Power-on detection generation circuit

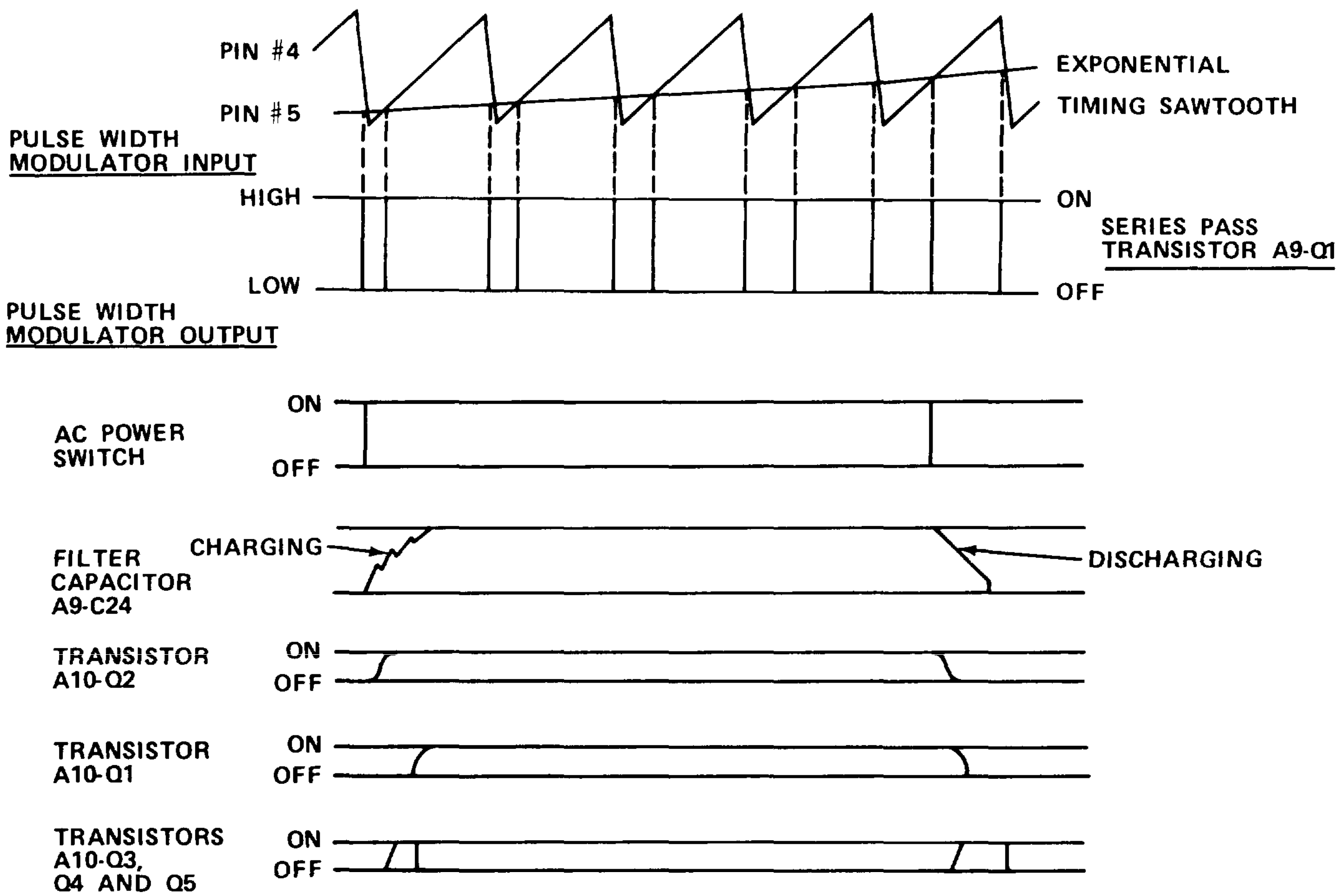
(1) Ac-to-dc conversion circuit. Converts the main plotter ac power to dc.

(a) The main ac power source is connected to a full-wave bridge rectifier CR6-CR9 through the LINE power switch and coil L1. Line voltage selector switch S4 setting determines the filter circuit configuration. For 100/120 V ac operation, line voltage selector switch S4 connects the junction of C6 and C7 to the junction of CR8 and CR9 which converts this filter network into a voltage doubler configuration.

(b) Filtered dc is applied to the series switch pass transistor A9-Q1. Drive circuitry for this transistor and the chopper stage that follows it is developed in PCA A10. These drive pulse signals are present in the switching section of the power supply assembly which is described next.

(2) Square-wave conversion circuit. Converts the input dc to a square-wave type of waveform.

(a) Applied dc is changed to a pulsed dc by pulsing the base of a series switch pass transistor at a kHz rate. A driving pulse train from PCA A10 (U3-6) turns on and off transistor A9-Q2. While A9-Q2 is turned on, series switch pass transistor A9-Q1 is reverse biased and, therefore, turned off. When A9-Q2 is turned off, series switch pass transistor A9-Q1 is turned on and provides dc voltage to energy storage inductor L2 which is connected to the chopper circuit.



(b) A chopper circuit is used to convert the pulsed dc to a square-wave type of waveform that is suitable as a transformer input to transformer T4. An 18 kHz chopper driving square-wave with a 50-percent duty cycle is supplied from PCA A10-Q6 and A10-Q7, which alternately turns on either chopper transistors Q5 and Q4 or A6 and Q3. The chopper driving square signal drives the primary windings of transformer T3 whose secondary windings cause proper switching of the two pairs of chopper transistors Q5 and Q4 or Q6 and Q3.

(3) Voltage output smoothing circuit. The voltage induced into the secondary windings of transformer T4 is rectified in a conventional manner.

(a) A+5 V (A) supply is the output of full-wave rectifiers CR26 and CR27 filtered by capacitor C24. A crowbar circuit provides over-voltage protection to the load by triggering SCR Q7 and clamping the +5 V (A) to common should an over-voltage condition occur. The +12 V and -12 V supply is the output of modular diode bridge CR22 which is connected across a center-tapped secondary winding of transfer-mer T4. Capacitor C19 provides filtering for the +12 V supply output and capacitor C20 provides filtering for the -12 V supply output. SCR's Q8 and Q9 provide over-voltage protection for the load in a similar manner to the +5 V (A) output. The +7 V supply is developed by tapping in the low (case) side of a 5 V regulator (U3) to a divider (R28 and R29), the junction of which is +2 V above common.

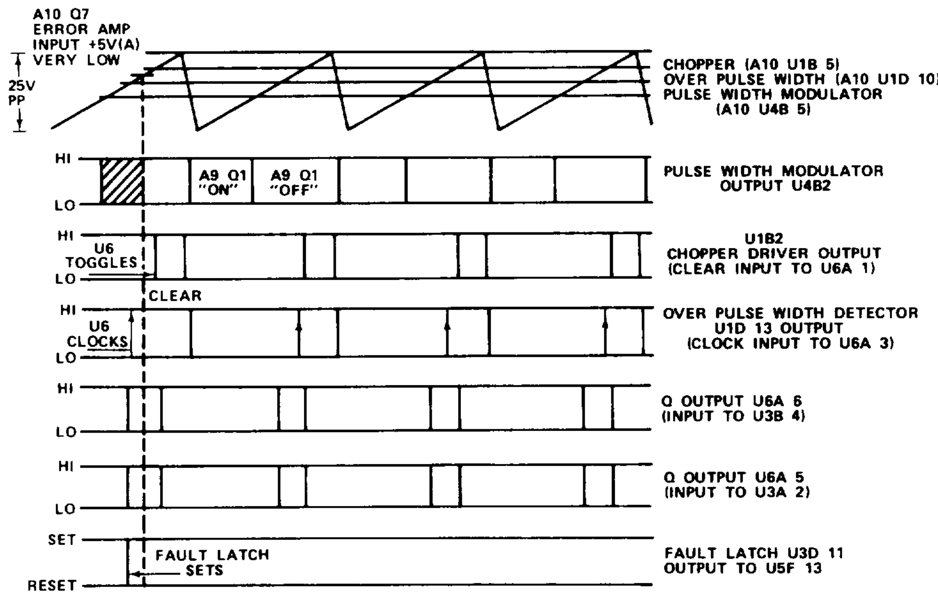
(b) The +26 V and -26 V supply signals are outputted from a full-wave bridge rectifier consisting of diodes CR18 thru CR21. Capacitors C17 and C18 pro-vide filtering for the +26 V and -26 V supplies respectively. The switched output voltages, +5 V (A), -12 V, +12 V, +7 V, +26 V, and -26 V, are connected to the plotter circuits through PCA A11. The circuits that generate the drive pulses for both A9-Q1 and the chopper circuits are located on PCA A10 and will be described next.

(4) Timing sawtooth waveform generation circuit. Generates a 36 kHz saw-tooth waveform as a timing signal for the power supply circuitry.

(a) Transistors A10-Q8 and Q9 form a complementary Darlington config-uration in which any base-to-emitter offset voltages generated as a function of temperature change are minimized. Transistor A10-Q9 is the current source for sawtooth-forming capacitor A10-C11. The rate of rise (ramp) in the collector cur-rent of Q9 determines the frequency of the generated sawtooth. Frequency adjustment potentiometer A10-R35 sets the bias level of A10-Q8 and Q9, thus, establishing a constant current through transistor A10-Q9.

(b) Reference voltage from the voltage divider circuit is provided by voltage comparator U1A. The normally high input to the fault latch is pulled low by open collector U1A-1 when an over-current condition is detected, thus, setting the fault latch and disabling the pulse width modulator A10-U4B output.

(5) Voltage turn-on regulation circuit. Controls voltage buildup in switched power circuits by regulating the initial turn-on drive pulse width to series pass transistor A9-Q1.



(a) When power is first applied to the plotter, transistor A10-Q5 in the turn-on/off sequence circuit is turned on, which provides a discharge path for any residual charge on C14 and forward biases transistor A10-Q10. Conduction of transistor A1-Q10 ties the output of error amplifier U7 to common and disables the pulse width modulator A10-U4B. As filter capacitor A9-C24 reaches a level which can allow proper operation of the rest of the power supply circuits, transistor A10-Q5 is turned off (by conduction of A10-Q1 and Q2) allowing capacitor A10-C14 to charge. As transistor A10-Q10 is turning off, the resultant exponential voltage rise forces the pulse width modulator to output (at start) small pulse widths. These pulse widths sequentially increase in width until the normal operating pulse width is reached.

(6) Turn-on/off sequence circuit. In conjunction with the fault latch and slow turn-on/off sequence circuitry, provides an orderly sequence to enable or disable the series switch transistor A9-Q1 and controls the charge or discharge of various circuits when the plotter is switched on or off. The turn-on/off sequence circuit is immune to at least 1-1/2 missing cycles and will continue to operate with power outages of less than 30 msec duration.

(a) Turn-on is initiated when power is first applied to the plotter, capacitor A9-C24 starts to charge and transistors A10-Q2, Q3, Q4, and Q5 start to turn on. Voltage comparator A10-U1C acts as a voltage comparator with hysteresis to prevent the power supply from shutting down during a momentary dropout of the main ac source and plotter.

(b) Conduction of transistor Q4 resets the output of fault latch U3C and U3D to its normal operational low state.

(c) Conduction of transistor Q5 provides a discharge path for capacitor A10-C14 and forward biases transistor A10-Q10 to disable pulse width modulator A10-U4.

(d) Conduction of transistor Q3 pulls the center tap of drive pulse transformer T1 to common which disables the series switch transistor A9-Q1. Conduction of transistor Q2 provides a current path for transistor Q1 which starts to conduct and cuts off transistors Q3, Q4, and Q5, allowing the slow turn-on/off sequence circuit to be activated.

(e) Conduction oftransistor Q1 occurs when the voltage of capacitor A9-C24 reaches a predetermined level and turns off transistors Q3, Q4, and Q5, signifying the start of operation of the power supply.

(f) Turn-off is initiated when the plotter is switched off. Transistor Q2 turns off, which turns transistor Q1 off and Q3, Q4, and Q5 on until capacitor A9-C24 discharges. The conduction of transistor Q3 during the off transient period inhibits transistor Q1 from turning on.

(7) Power-on detection generation circuit. Resets plotter for initialization.

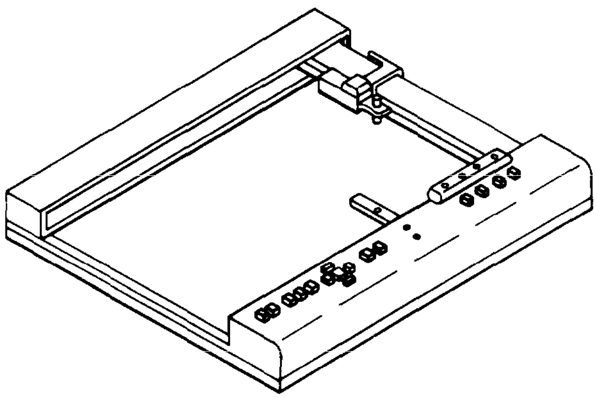
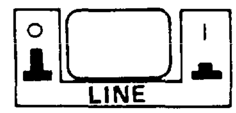
(a) A power on (PWR ON) signal is generated on PCA A10 which is used to set a power-up (PUP) driver on PCA A3. PUP clears or sets the plotter circuits to a known quiescent condition when the plotter is first switched on. This PUP signal is at a low logic level initially. Then it switches to a high state after the initial warm-up period and remains in a high state until the plotter is switched off.

(b) When the plotter is first switched on, the regulated +15 V supply from U1 on PCA A9 is outputted to the resistive divider consisting of A10-R54 and A10-R55. The output of this divider, which is approximately +2.26 V, is compared with the initially low +5 V (A) supply by voltage comparator A10-U4D which provides a low input to voltage comparator A10-U4C, causing its output to go high. This high output turns on transistor A10-Q11, which pulls the power on (PWR ON) output line low and activates the power-up (PUP) driver circuit on PCA A3. When the +5 V (A) supply output comes up to full voltage across voltage divider A10-R56 and R57, the output of divider (+2.5 V) is applied to the non-inverting side of voltage comparator A10-U4D causing its output to go high. This high output allows C19 to charge to +5 V through A10-R58. With a high input to U4C-8, its output goes low, cutting off transistor A10-Q1 and allowing the pwr on line to float up to the switched +5 V (A) level.

c. Autogrip power. Is supplied by the autogrip circuitry, which is in the power supply assembly and is part of PCA A10. A secondary winding of T4 supplies 110 V to generate the platen voltage. The 110 V is applied to a voltage multiplier (C201-204 and CR203-206) which boosts the voltage up to approximately 500 V. When the chart hold signal is low, transistor Q101 is turned off and relay K101 is normally closed. With relay K101 closed, the input to the voltage multiplier (at C201 and C204) is grounded through relay K101 and the platen voltage is 0.

Section II OPERATING INSTRUCTIONS

3-4. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS.

Control or Indicator	Function
	
LINE Power Switch Located on Front Base of Unit	Controls application of power to plotter. Power is on when depressed.

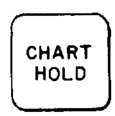



CHART HOLD Push Button	Activates electrostatic paper hold-down and turns off CHART LOAD lamp.

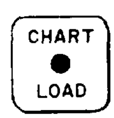
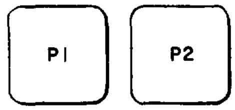
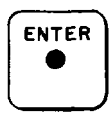
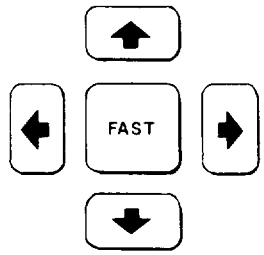



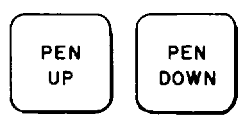
CHART LOAD Push Button	Pressing causes pen to move to upper right-hand corner of platen, turns on lamp, and deactivates paper hold-down.

Control or Indicator	Function
	
Scaling Point Control Push Buttons	Pressing either moves pen to corresponding physical point, P1 or P2, on platen. When the plotter is initialized, it sets P1 at lower left corner and P2 at upper right corner of platen. Pressing ENTER, P1, or P2 relocates that scaling point to current pen location.
	
ENTER Push Button	Multi-purpose button with lamp: Pushed before CHART HOLD, it initializes plotter. (lamp blinks.) Pushed before P1 or P2, it sets new scaling points. (lamp blinks.) Used to enter point in digitizing mode. (lamp is steady.) Used with pen select buttons to store pen in its stable. **NOTE** Pushing any of pen control arrows cancels ENTER lamp.

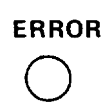
Control or Indicator	Function



Pen Direction Control Push Buttons	Moves pen at 4 mm/sec within plotting area in direction indicated. Pressing two adjacent buttons moves pen diagonally. Pressing arrow and FAST simultaneously increases pen speed to 60 mm/sec. **NOTE** Do not press during program execution.

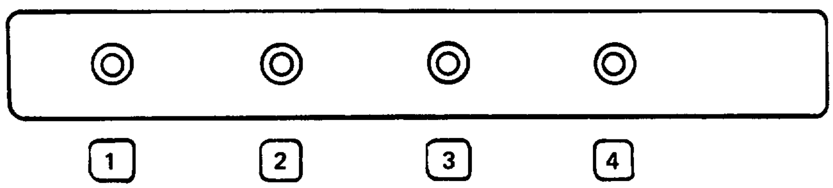


PEN UP/DOWN Control Push Button	Raises or lowers point of pen. When held down during a program execution, they override programmed pen control until released.



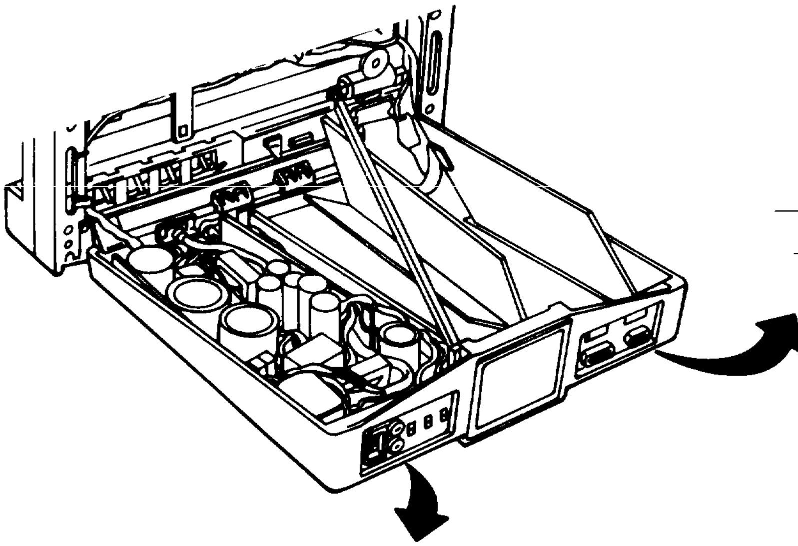
Error Light	Lights when an error occurs. Also lights at end of confidence test until CONFIDENCE TEST switch is turned off.

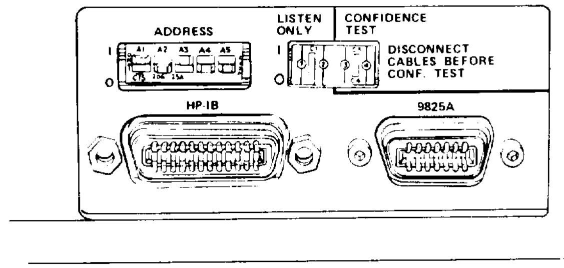
Control or Indicator	Function
OUT OF LIMIT Light	Lights when plotter is commanded to plot outside a window area or beyond limits of platen. Lamp blinks if commanded position puts plotter in "lost" state.

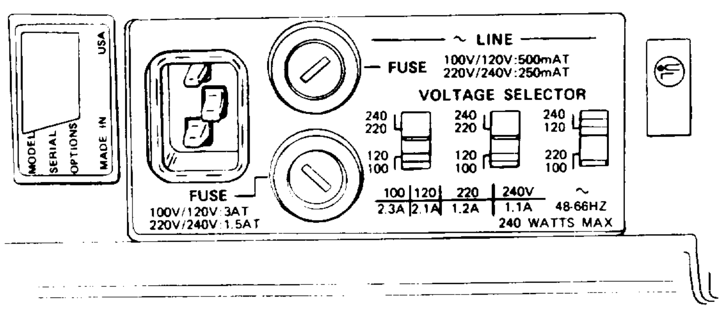


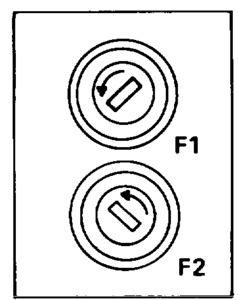
Control or Indicator	Function
Pen Select Buttons	Provides manual control of pen selection. Can be used to change pen selection during a program. **NOTE** Pen color is visible through holes above button.

Control or Indicator	Function

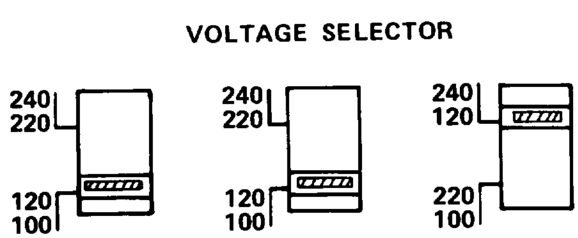




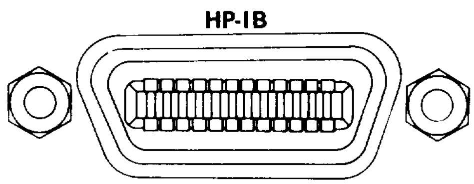
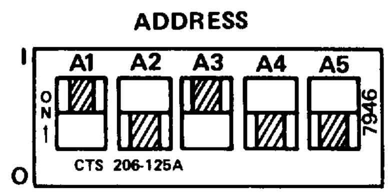
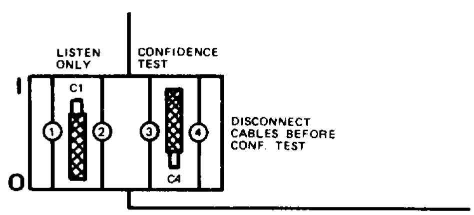




Fuse Holders — Hold fuses



Voltage Selector — Selects operating voltage of plotter. Set at factory to 120 V ac.

Control or Indicator	Function
	
HP-IB Cable Receptacle	HP-IB Interface cable 24-pin receptacle.
	
Logic Address Switches	Set address of plotter for controller. Set at factory to 5.
	
CONFIDENCE TEST/LISTEN ONLY Switch	When set to 0, LISTEN ONLY switch allows plotter to “talk” to controller and listen. Allows plotter to listen only when set to 1. Set to 0 for normal operation. CONFIDENCE TEST switch activates confidence test when set to 1.

Control or Indicator | Function

Illustration which follows lists the ADDRESS switch positions for each address value.

NOTE

Switches are in reverse order on the back panel of the plotter.

ADDRESS SWITCH POSITIONS

ADRESS RESTRICTED TO THESE CODES WHEN USING PARALLEL POLL CAPABILITY

Address Characters		Address Switch Settings					Address Codes	
Listen	Talk	A5	A4	A3	A2	A1	decimal	octal
SP	@	0	0	0	0	0	0	0
!	A	0	0	0	0	1	1	1
"	B	0	0	0	1	0	2	2
#	C	0	0	0	1	1	3	3
$	D	0	0	1	0	0	4	4
%	E	0	0	1	0	1	5	5 ← preset
&	F	0	0	1	1	0	6	6
'	G	0	0	1	1	1	7	7
(	H	0	1	0	0	0	8	10
)	I	0	1	0	0	1	9	11
*	J	0	1	0	1	0	10	12
+	K	0	1	0	1	1	11	13
,	L	0	1	1	0	0	12	14
–	M	0	1	1	0	1	13	15
.	N	0	1	1	1	0	14	16
/	O	0	1	1	1	1	15	17
0	P	1	0	0	0	0	16	20
1	Q	1	0	0	0	1	17	21
2	R	1	0	0	1	0	18	22
3	S	1	0	0	1	1	19	23
4	T	1	0	1	0	0	20	24
5	U	1	0	1	0	1	21	25
6	V	1	0	1	1	0	22	26
7	W	1	0	1	1	1	23	27
8	X	1	1	0	0	0	24	30
9	Y	1	1	0	0	1	25	31
:	Z	1	1	0	1	0	26	32
;	[	1	1	0	1	1	27	33
<	/	1	1	1	0	0	28	34
=	]	1	1	1	0	1	29	35
>	^	1	1	1	1	0	30	36

3-5. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES.

Before You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your before (B) PMCS.

b. While You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your during (D) PMCS.

c. After You Operate. Be sure to perform your after (A) PMCS.

d. If Your Equipment Fails to Operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA Pam 738-750.

3-5.1 PMCS Procedures.

a. PMCS are designed to keep the equipment in good working condition by performing periodic service tasks.

b. Service intervals provide you, the operator, with time schedules that determine when to perform specified service tasks.

c. The “Equipment is Not Ready/Available If” column is used for identification of conditions that make the equipment not ready/available for readiness reporting purposes or denies use of the equipment until corrective maintenance is performed.

d. If your equipment fails to operate after PMCS is performed, immediately report this condition to your supervisor.

e. Perform weekly as well as before operation if you are the assigned operator and have not operated the item since the last weekly or if you are operating the item for the first time.

f. Item number column. Item numbers are assigned in chronological ascending sequence regardless of interval designation. These numbers are used for your “TM Number” column on DA Form 2404, Equipment Inspection and Maintenance Worksheet in recording results of PMCS.

Interval columns. This column determines the time period designated to perform your PMCS.

h. Item to be inspected and procedures column. This column lists functional groups and their respective assemblies and subassemblies as shown in the Maintenance Allocation Chart (Appendix B). The appropriate check or service procedure follows the specific item to be inspected.

i. Equipment is not ready/available if: column. This column indicates the reason or cause why your equipment is not ready/available to perform its primary mission.

j. List of tools and materials required for PMCS is as follows:

Item	Quantity
Detergent, General Purpose (Item 9, Appendix E)	ar
Artist's Brush (5 in.)	1 ea
Cheesecloth (Item 7, Appendix E)	ar
Metric Scaler	1 ea
Optical Comparator	1 ea
System Test Tape (Electronic Data Tape, Item 31, Appendix E)	1 ea
H-P 9825A Desk-Top Computer	1 ea

Table 3-9, OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can safely be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

B - Before	W - Weekly	AN - Annually	(Number) - Hundreds of Hours
D - During	M - Monthly	S - Semiannually	
A - After	Q - Quarterly	BI - Biennially	

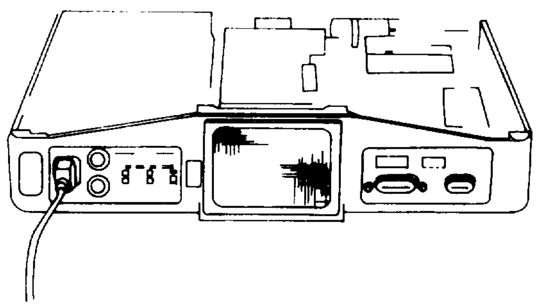
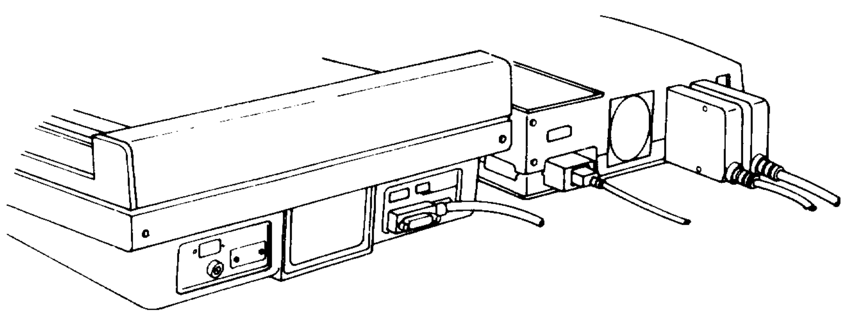
ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		GRAPHICS PLOTTER	
1	B	Inspect Plotter.   1. Check plotter and HP-IB Interface cable for visible damage.	Cable is cut or broken, or plotter has obvious visible mechanical damage.

Table 3-9. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

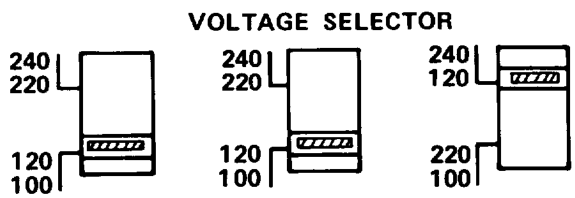
B - Before
D - During
A - After

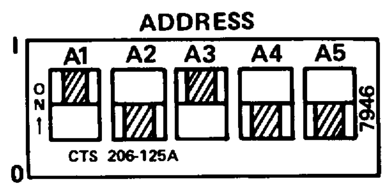
W - Weekly
M - Monthly
Q - Quarterly

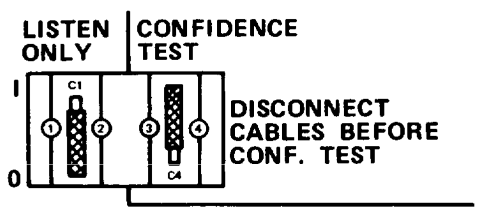
AN - Annually
S - Semiannually
BI - Biennially

(Numbed - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		<u>GRAPHICS PLOTTER - Cont</u>	
1	B	<u>Inspect Plotter - Cont</u>	
		2. Inspect to be sure HP-IB Interface connections at the computer and the plotter are firmly inserted and power cords for both units are tight. Tighten if required.	







		3. Check that switches on plotter rear panel are set correctly.	

Table 3-9. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannully
BI - Biennially

(Number) - Hundreds of Hours

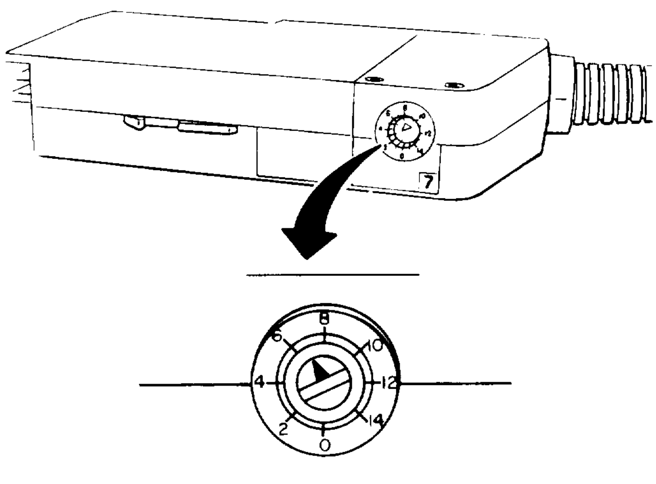
ITEM NO.	IN-TER.VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		<u>GRAPHICS PLOTTER - Cont</u>	
1	B	<u>Inspect Plotter - Cont</u>  4. Check that HP-IB Interface select code switch is set to position 7. 5. Inspect platen area for dust or foreign particles. Clean as required.	
2	W	<u>Clean.</u> 1. Check that LINE power switch is off (0) and remove power cord from wall outlet. 2. Remove dust accumulation from surfaces of plotter with soft-haired artist's brush. 3. Dampen cheesecloth with warm water and wring out excessive water. **WARNING** Death or serious injury may occur from electrical shock if plotter is energized with platen wet.	

Table 3-9. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-TER VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		<u>GRAPHICS PLOTTER - Cont</u>	
2	W	<u>Clean - Cont</u> 4. Apply cleaner (Hewlett-Packard or commercial cleaner) to cloth and wipe platen surface. 5. Wipe platen thoroughly with clean, damp cloth. 6. Wipe away any moisture from platen surface with dry cloth. Allow plotter to dry before use. 7. Remove fan filter by pulling gently from top two corners. Wash filter thoroughly with soapy water. Wring out all moisture and allow to dry before replacing.	
3	M	<u>Plotting Repeatability and Accuracy Test.</u> 1. Load plotter with blank chart paper. Place new pen in pen arm. 2. Enter program on illustration into calculator and run program.	

REPEATABILITY

```
0:  fxd 0
1:  wrt 705, "pu;
    vs;pa15000,1000
    0,5000,5500;"
2:  wrt 705, "vsl;
    pd;pr0,50]"
3:  wrt 705, 'pu;
    pa0,0,5000,6000
    "
4:  wrt 705, "pd;
    vsl; pr0,-250;
    vs;pu;pa0,0"
5:  wrt 705,"vs;
    pu;pa0,0,6000,
    5000;"
6:  wrt 705, "pd;
    vsl; pr500,0"
7:  wrt 705,"pu;
    pa15000,10000,
    6500,5000;"
8:  wrt 705,"pd;
    vsl;pr-250,0;
    vs;pu;pa0,0"
```

PLOTTING ACCURACY

```
9:  wrt 705, "tll"
    l;pu;pa0,1000"
10: for X=0 to
    15200 by 400
11: wrt 705, "pd;
    pa",X,",1000;
    xt"
12: next X
13: wrt 705,"pu;
    pa1000,0"
14: for Y=0 to
    10000 by 400
15: wrt 705, "pd;
    pa1000,",Y,";
    yt"
16: next Y
17: wrt 705,"pu;
    pal 5000,10000"
```

Table 3-9. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

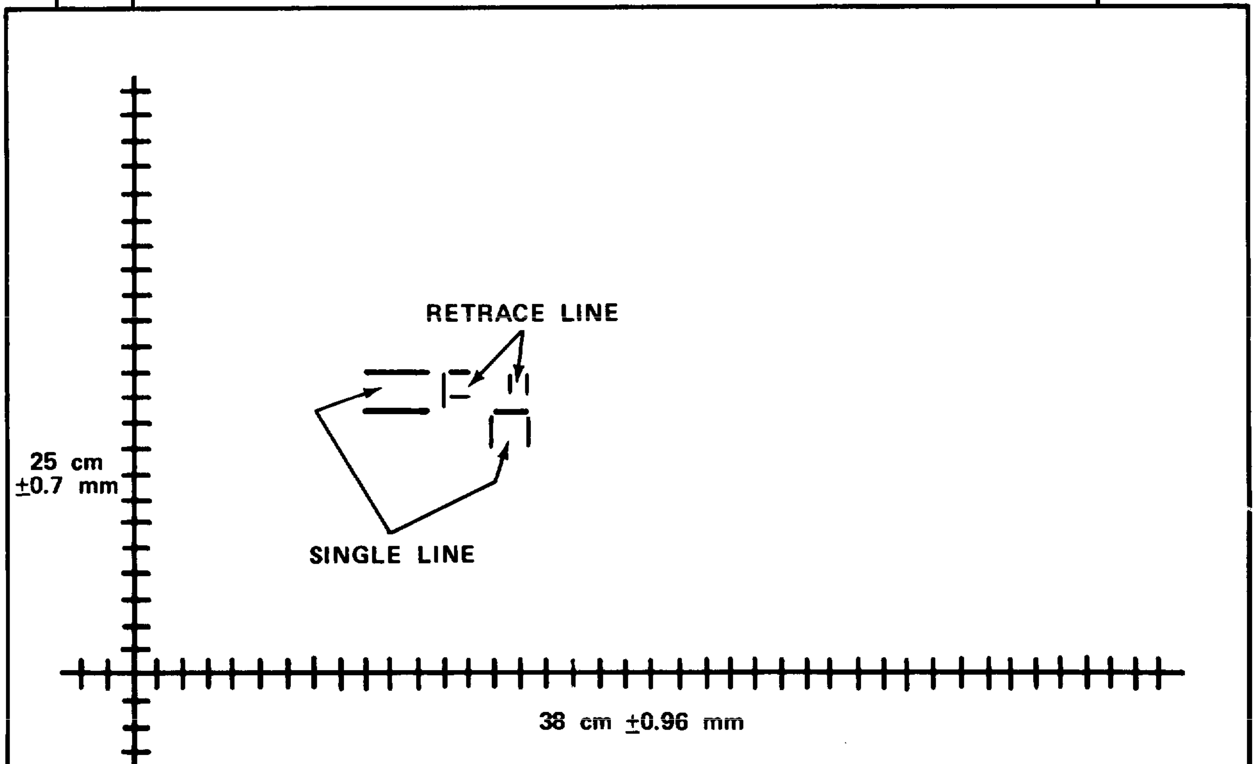
B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		GRAPHICS PLOTTER - Cont	
3	M	Plotting Repeatability and Accuracy Test - Cont 3. Use optical comparator to measure difference between full length of single line and retrace segment of that line. Repeatability should be within ±0.1 mm.	



		4. Using metric scaler, verify that plotting accuracy is within specifications shown on illustration.	

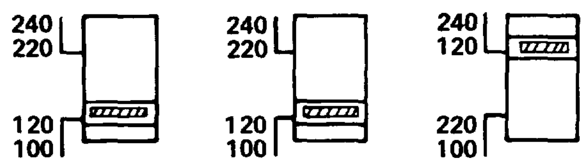
3-6. OPERATION UNDER USUAL CONDITIONS .

NOTE

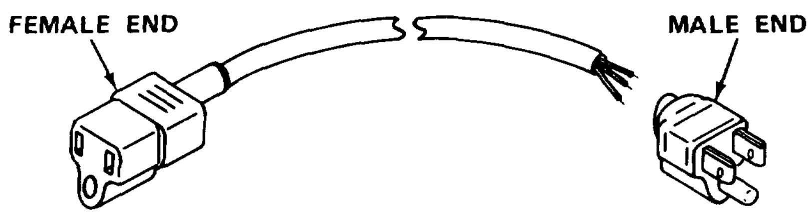
In general, independent operation of the plotter is confined to self-testing and editing charts. All other operating procedures use a computer to control the operation of the plotter, using programs written by the operator, and inputted through the computer.

3-6.1 Assembly and Preparation for Use.

VOLTAGE SELECTOR



a. Check that selector switches on rear panel are set at 120 V.



b. Plug female end of power cord into jack on rear panel of plotter.

WARNING

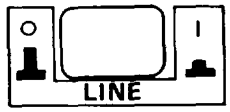
Death or serious injury may result from electrical shock. Plotter is equipped with three-conductor power cable which grounds plotter. Do not operate plotter from ac outlet that does not have connected ground pin.

CAUTION

Be sure power is off before plugging ROM's or HP-IB Interface cable into equipment, or damage to equipment will result.

c. Plug male end of power cord into grounded ac outlet.

d. Plug one end of HP-IB Interface in rear of computer. Connect other end of HP-IB Interface into jack on rear panel of plotter. Turn holding screws to fasten connection.



Press LINE power switch on front base of plotter. Plotter should respond as follows:

(1) Pen raises.

(2) Pen moves to lower right corner of platen.

3-6.2 Initial Adjustments, Daily Checks, and Self-Test.

a. Perform the operation confidence test as follows:

(1) Turn LINE power switch to off (0).

(2) Check that power cables are connected and voltage switches are set for 120 V ac operation,

(3) Check that HP-IB Interface is not connected.

(4) Turn LISTEN ONLY switch to 0.

(5) Turn CONFIDENCE TEST switch to 0.

(6) Check that logic ADDRESS switches are set to 1Ø1ØØ.

(7) Initialize plotter:

(a) Press LINE power switch.

(b) Press ENTER key.

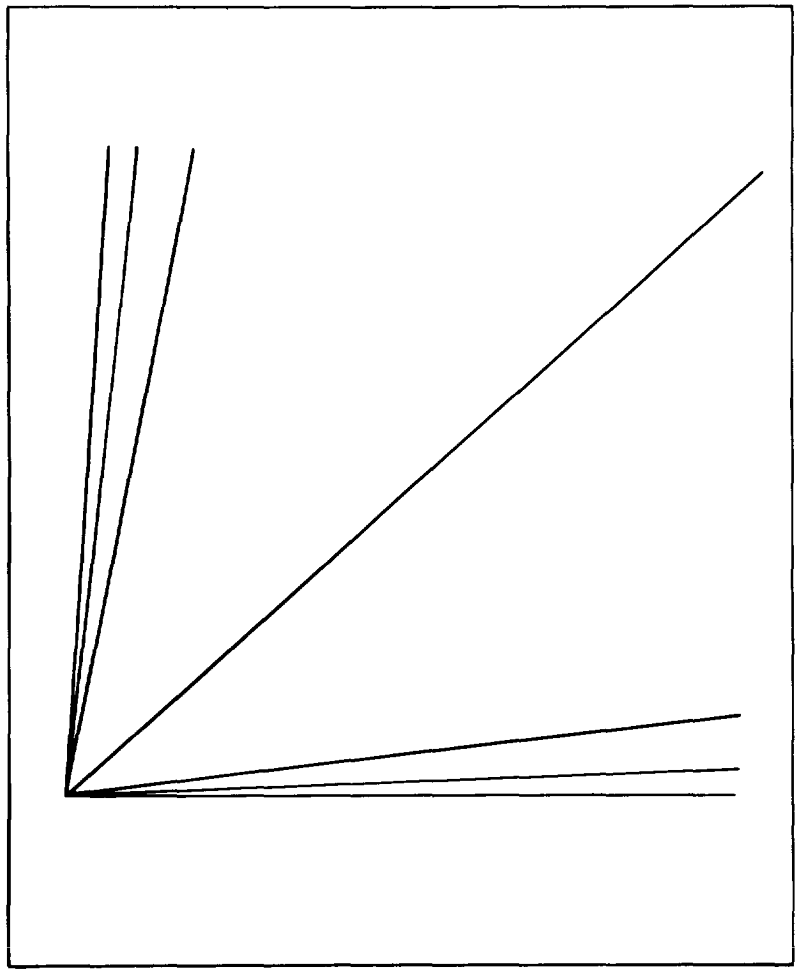
(c) Press CHART HOLD switch.

(8) Mount paper.

(9) Install pen in pen arm.

(10) Turn CONFIDENCE TEST switch to I. After completion of plot, pen should stop in lower left corner of platen, and all lamps on front panel should be turned on.

(11) Compare completed plot to illustration. If plot looks correct, turn CONFIDENCE TEST switch back to 0. (Pen should move to lower right corner.) If plot is not correct, notify your supervisor.



EXAMPLE OF CONFIDENCE TEST

b. Operational test one.

CAUTION

Removal or replacement of ROMs when power is supplied to computer will result in damage to computer.

(1) Check that required ROMs (three) are installed in the HP-9825A Desk Top Computer.

(a) String-advanced ROM.

(b) Matrix ROM.

(c) Extended I/O ROM.

(2) Install test tape cartridge into HP-9825A DeskTop Computer.

(3) Turn on power to computer and plotter.

(4) On computer, press:

STOP
ERASE
A
EXECUTE
RESET
L
D
B
3
EXECUTE

(5) Observe printer question on verification of ROMs.

(6) After ROM verification, observe display: ENTER MODEL # TO BE TESTED. On computer, press:

9
8
7
2
SHIFT
A
CONTINUE

(7) When display returns with ENTER SELECT CODE, enter plotter bus address and HP-IB interface code. Press.

7
0
5
CONTINUE

(8) Observe display: ENTER # OF TIMES TO RUN TEST.

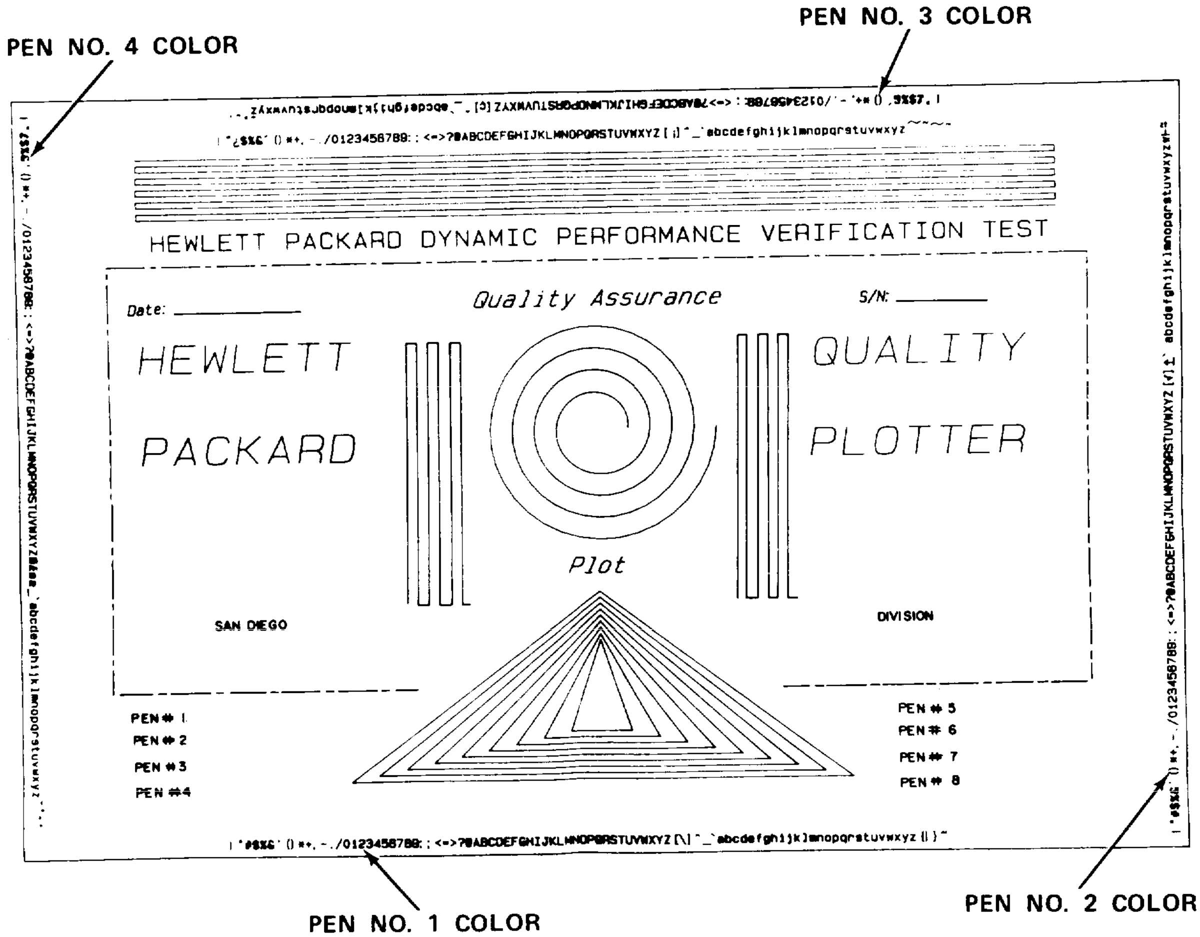
(9) Press 1 and CONTINUE.

(10) Observe display: LOAD PAPER AND THEN PRESS CONTINUE.

NOTE

Be sure plotter paper is loaded correctly.

(11) Press CONTINUE.



(12) Observe completed plot; computer prints: 9872B PLOT COMPLETE. Compare plot with above illustration. If plot is correct, computer and plotter interfaces are working properly.

(13) Enter: -5.

(14) Observe display: LOAD PAPER AND THEN PRESS CONTINUE. Press CONTINUE

(15) Observe printout 9872B DIGITIZE.

(16) Move pen on plotter using front panel plotting controls. When you reach any desired point, stop and press plotter ENTER key

(17) Repeat step (16) five times (equal to minus number entered in step (13)).

(18) Observe printout: DIGIT MODE COMPLETE.

(19) Failure to complete tests satisfactorily indicates malfunction requiring diagnosis/repair.

c. Operation test (four color plot).

WARNING

Death or serious injury may occur from electrical shock. Plotter is equipped with three-conductor power cable which grounds plotter. Do not operate plotter from ac outlet that does not have connected ground pin.

CAUTION

Be sure power is off before plugging HP-IB Interface to equipment, or damage to equipment will result.

(1) Turn off (0) LINE power switch.

(2) Check that voltage switches are set for 120 V ac.

(3) Turn LISTEN ONLY switch to 0.

(4) Turn CONFIDENCE TEST switch to I.

(5) Set logic ADDRESS switches to 5 (10100).

(6) Plug in power cable.

(7) Press LINE power switch to on.

(8) Initialize plotter.

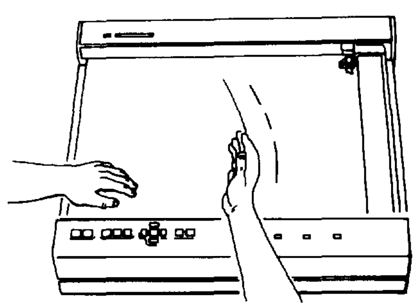
(a) Press ENTER key.

(b) Press CHART HOLD switch.

(9) Mount paper.

(a) Press CHART LOAD switch. (Pen should go to upper right corner).

(b) Raise paper stop by pressing down upper portion with screwdriver or other pointed object.



(c) Position paper squarely against ridge at bottom of platen and against paper stop on left side. Smooth paper with back of hand.

(d) Press CHART HOLD switch. (CHART LOAD should go off).

(10) Load pens.

WARNING

To avoid possible injury to fingers, always turn plotter off when directly storing pens.

(a) Turn off (0) LINE power switch.

(b) Remove cap from first pen.

(c) Place tip of pen in boot at base of stable.

(d) Gently press pen down and in until it snaps in place.

(e) Repeat for all four pens.

(11) Perform four-color dynamic test.

(a) Insert 9800 series test cartridge into computer.

(b) Load test cartridge by pressing STOP, ERASE, A, EXECUTE, RESET, lbd3, and EXECUTE.

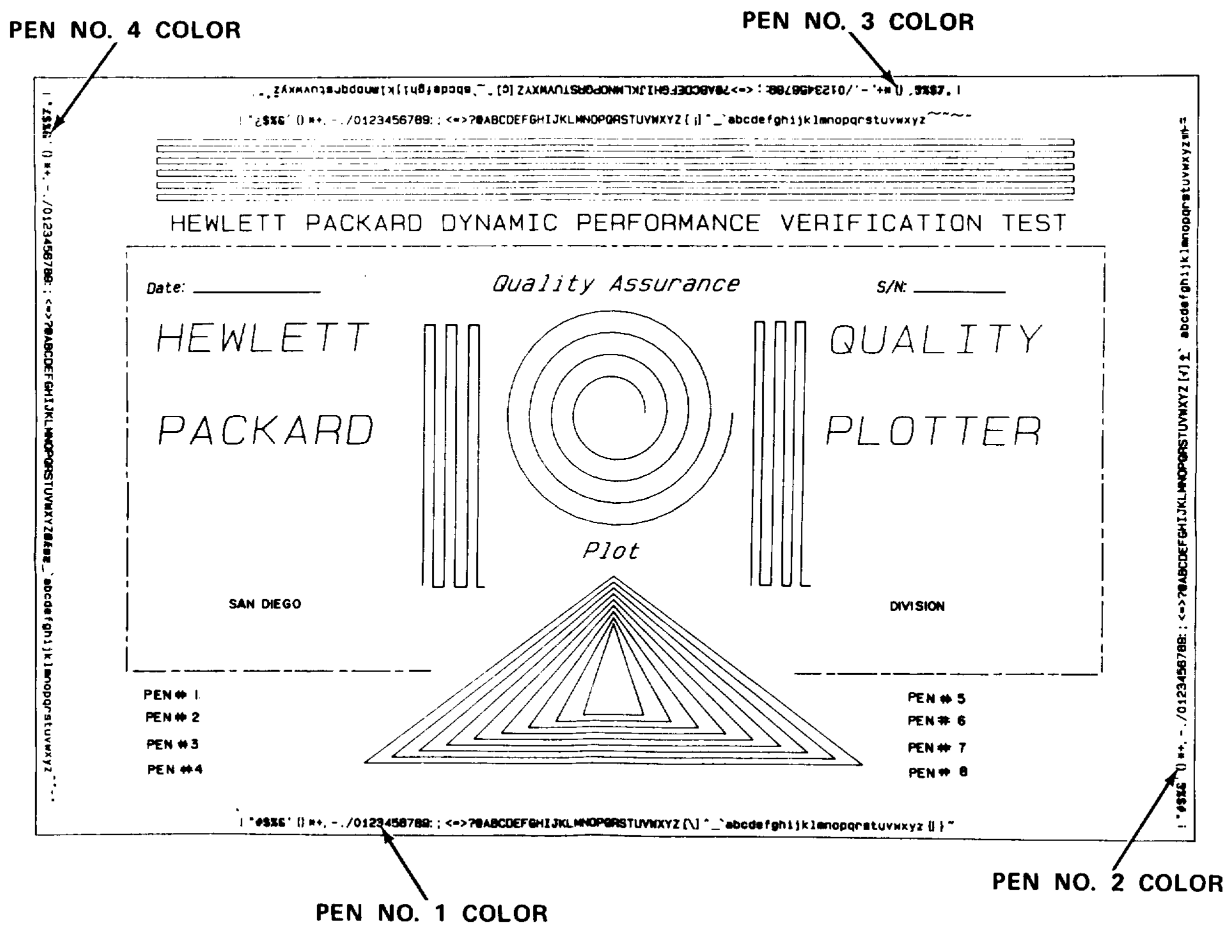
(c) When computer displays ENTER MODEL # TO BE TESTED, press 9872, SHIFT, A, and CONTINUE.

(d) When computer displays ENTER SELECT CODE . . . . . . press 705 and CONTINUE.

(e) When computer displays ENTER # OF TIMES TO RUN TEST . . . , press 1 and CONTINUE.

(f) When computer displays LOAD PAPER & THEN PRESS CONTINUE, check that paper is loaded and press CONTINUE.

(9) Printer should print 9872B PLOT COMPLETE in approximately 6 minutes. Compare plot produced.



(h) Repeat (a) through (d). When computer displays ENTER # OF TIMES TO RUN TEST . . ., press 2. Computer should print 9872B DIGITIZE.

(i) Press "↑" button on plotter until pen has moved approximately 1 in. Press plotter ENTER key. Computer should print DIGIT MODE COMPLETE.

(12) Press plotter ENTER key followed by CHART HOLD switch.

(13) Remove peripheral test tape. Insert scratch tape.

(14) Enter sample point program in computer:

(a) Press ERASE A.

(b) Press lbl "I AM A 9872 PLOTTER".

(c) Press STORE, LIST, and EXECUTE. Check printout of program.

(d) Press RUN.

(e) Check to see plotter draws I AM A 9872 PLOTTER.

d. HP-IB operational test.

WARNING

Death or serious injury may occur from electrical shock. Plotter is equipped with three-conductor power cable which grounds plotter. Do not operate plotter from AC outlet that does not have connected ground pin.

CAUTION

Be sure power is off before plugging HP-IB ROMs or HP-IB Interface cable into equipment or damage to equipment will result.

(1) Turn off computer power. Plug HP-IB card into I/O slot in back of computer.

(2) Plug plotter extended and general I/O ROM into slot in front of computer.

(3) Turn on computer. Verify lazy tee " (⊢) " display is on computer.

NOTE

If lazy tee does not appear, remove HP-IB Interface and press RESET. If it still does not appear, troubleshoot computer.

(4) Enter program line shown below.

PROGRAM LINE: rds (7,A,B,C)→D; dst A,B,C,D

DISPLAY	0.00	213.00	64.00	76.00

(5) Press EXECUTE and verify that display shown above appears.

(6) If display does not return after line is executed, press RESET and rotate HP-IB Interface select code switch to 0, then back to 7, carefully with a screwdriver.

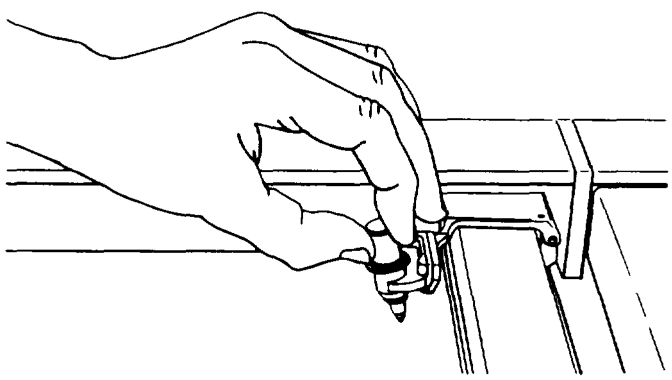
(7) Repeat step (4).

(8) If display does not return or display is incorrect, card is defective.

3-6.3 Operating Procedures.

INDEX

a. Loading pen in arm.



(1) Select color pen desired from accessory box.

(2) Remove cap from pen.

(3) As shown in illustration, gently push pen into pen holder so that thick ring around middle of pen lifts into slot in pen holder.

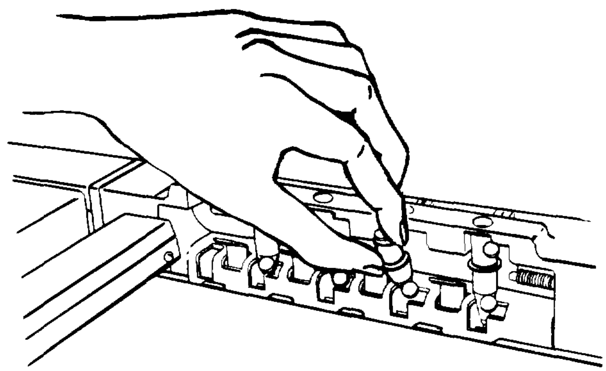
b. Direct pen storage.

WARNING

To avoid possible injury to fingers, always turn plotter off when directly storing pens.

(1) Turn off plotter.

(2) Select pen color to be placed in stable 1 and remove cap.



(3) Place pen tip into round boot at base of stable.

(4) Press pen down and in gently until holder snaps in place.

(5) Check that pen color shows through hole in front panel above pen.

(6) Repeat this procedure for remaining pens.

NOTE

Pens may be removed from stable by moving metal lever to right of pen with one hand, grasping pen between thumb and index finger of other hand, and pulling out and up.

(7) Turn on plotter.

c. Automatic pen storage.

(1) Select color pen desired for stable 1 and load in pen holder arm.

(2) Press ENTER followed by pen stable button 1.

(3) Repeat procedure for remaining three pens, changing to appropriate pen stable button each time.

NOTE

After depressing pen stable button, pen holder should place pen in the designated stable and return to its original position for loading of next pen.

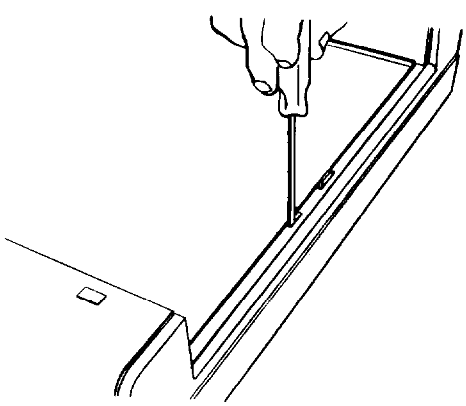
d. Loading paper.

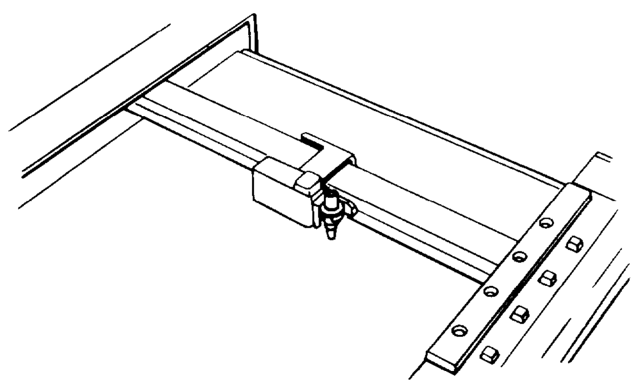
(1) Check that plotter is energized.

(2) Press CHART LOAD switch.

NOTE

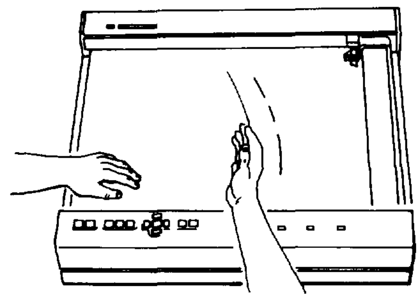
This releases electrostatic holding mechanism. Pen should move to upper right corner of platen.





(3) Raise paper stop by pressing down on upper portion with screwdriver or other pointed object.

(4) Position paper squarely against ridge at bottom of platen and against paper stop on left side.



(5) Press down on lower left corner of paper with left hand, and smooth paper by running back of other hand toward upper right corner.

NOTE

Paper is smoothed with back of hand so skin oils will not be deposited.

(6) Press CHART HOLD switch.

NOTE

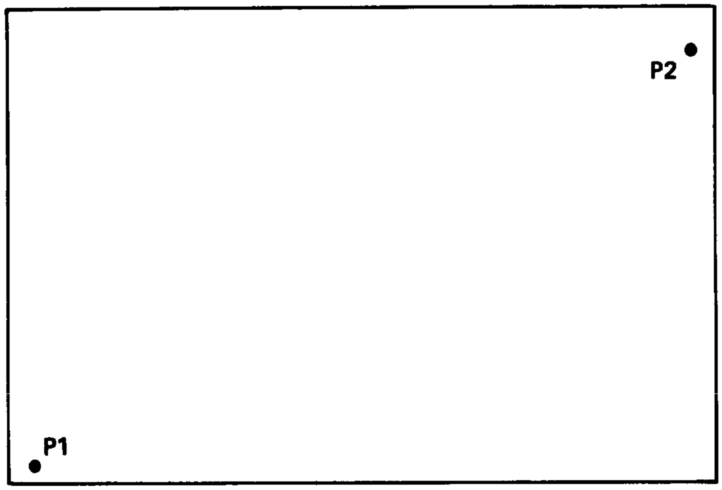
Lamp in CHART HOLD switch should go off.

(7) Smooth paper again with back of hand.

e. Setting scaling points.

NOTE

Scaling points P1 and P2 are used to establish scaled area for plot. When plotter is initialized, it sets P1 in lower left corner and P2 in upper right.



NOTE

Coordinate values of P1 and P2 in plotter units are:

P1 = 520, 380 (X, Y)

P2 = 15720, 10380

(8) The following procedure is used to relocate either or both of these points in order to expand or narrow field of plot:

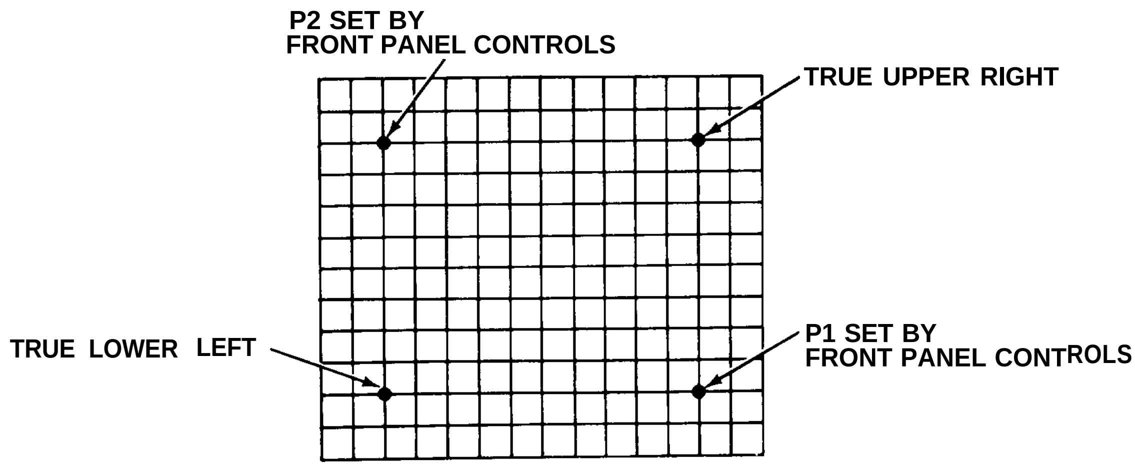
(a) Initialize plotter: Press LINE power switch, ENTER key, and CHART HOLD switch.

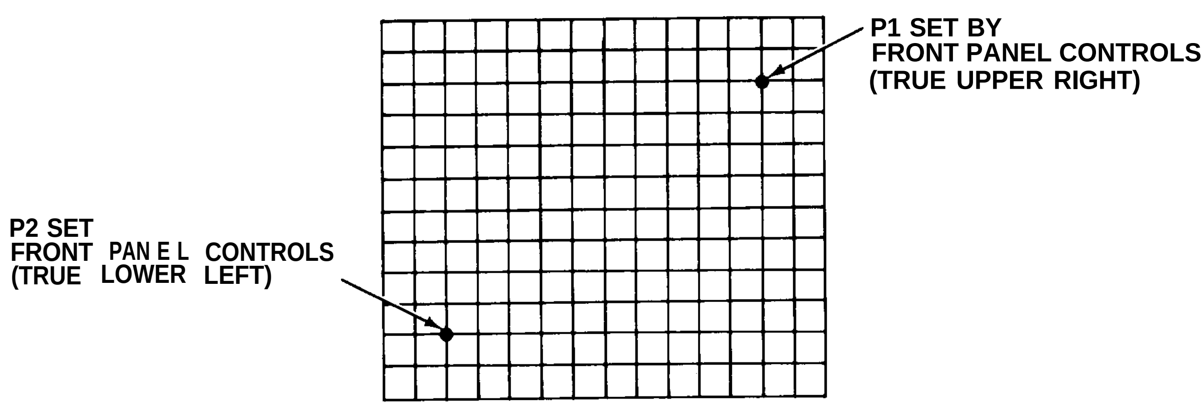
(b) Using pen controls on front panel, move pen to desired location for P1 or P2.

(c) When pen reaches location, set point by pressing ENTER key followed by pressing either P1 or P2, depending on which point is to be located there.

NOTE

P1 and P2 do not have to be set so that they are still in upper right/ lower left relationship. As shown in illustration, they can also be set in upper left/lower right relationship.





(d) Repeat, if necessary, for second point.

f. Plotting.

(1) Connect plotter to controlling computer and initialize. (When using 9825A computer, plotter is connected via HP-IB Interface.)

(2) Initialize computer and insert a blank scratch tape.

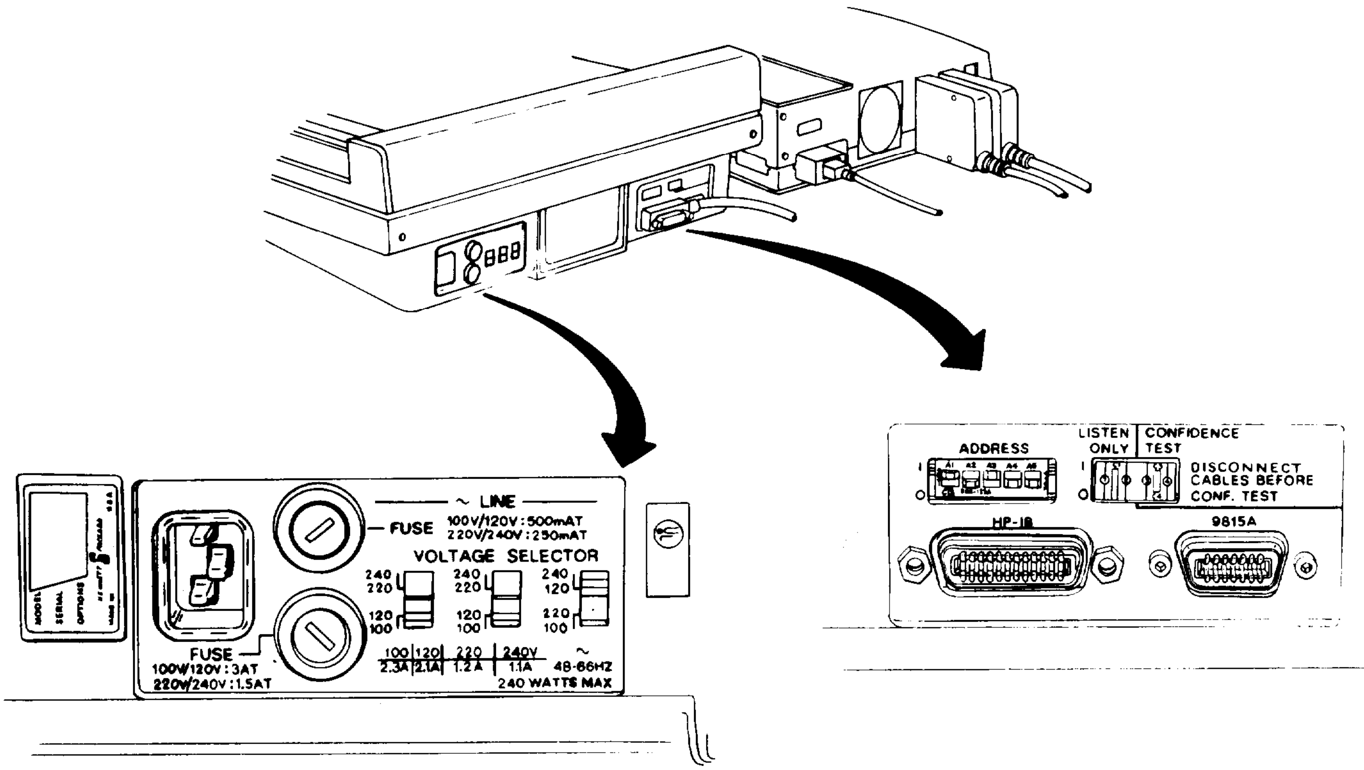
CAUTION

Be sure power to plotter is off before inserting ROMs or HP-IB Interface cable or damage to equipment will result.

(3) Insert plotter general and extended I/O ROM into computer.

NOTE

Before plotter can be programmed to operate, programming language of computer must be thoroughly understood.



(4) Check to see that all switches on plotter rear panel are set correctly and select code switch on HP-IB Interface is set on 7.

(5) Load paper and pens to be used.

(6) Determine what plotter is to draw. Construct program to accomplish this, using language of computer and plotter programming language statements listed in Table 3-10. If plot program is on prerecorded tape, load tape in computer and press RUN.

(7) Except when digitizing, program should contain a statement or statements that accomplish the following:

(a) Clear plotter.

(b) Set decimal place format for any numbers (floating, fixed to two significant digits, etc.).

(c) Establish character type (set) for any lettering.

(d) Set scale to which plot will be drawn.

(e) Select proper color pen.

(f) Tell what type or types of lines will be used for construction.

(g) Draw and label X- and Y-axes, if applicable.

(h) Describe plot itself and where it is to be drawn.

(i) Tell what and where to label and what label is to say (including symbols).

(j) Give any special directions, if needed.

(k) Instructions to change any of the above statements, if desired, and loop back to some point in program or continue.

(l) Statement to end program.

NOTE

Plotter can be cleared by inserting a **pclr** or **wrt 705 "IN"** command in program.

- Decimal place format is set using format commands of computer language.
- Character set is controlled using **lbl, csiz,** and **wrt 705 "CS", "CA", "SS", "SA", "SL", "SM",** or **"UC"** statements.
- Scale and plotting area are set using **scl** and line statements.
- Pen color is selected with **"pen #"** statement.
- Line type, such as solid, dash, etc., is set with a line statement.
- X- and Y-axes are drawn, tied and labeled using **xax, yax,** and **wrt 705 "TL"** statements.
- Plot on drawing is defined using **plt, ofs, iplit,** and **cplt** statements.
- Labeling is accomplished through **wrt 705 "SM", csiz, ptyp,** and **lbl** statements.
- Special instructions normally involve directions to pen, such as to raise its point on paper. Special instructions involve **pen** and **wrt 705, "AP", "PD", "VS", "VA",** or **"VN"** commands.
- Changes can be made to above statements in program by repeating statement with new parameters. Program continuation or looping is performed using statements from programming language of controller.

(8) After program is written, set computer in program mode and input each line of program and any data by keying in complete statement and then pressing **STORE**.

(9) When entire program is entered, place computer in run mode and press **RUN**.

NOTE

Certain programming practices will assure more effective use of plotter. Among these are:

- Select pen before first plot command to assure plot is actually recorded on paper.
- Lift pen before changing colors to avoid a dot of new color at termination of last vector.
- Store pens at completion of plot so pens do not dry out.
- When using A4 or 8-1/2 in. X 11 in. paper, reset P1 and P2 manually or programmatically to points inside paper area. Default P2 will scale plot beyond limits of 8-1/2 in. X 11 in. paper.

g. Chart editing.

(1) Initialize plotter.

(2) Load chart to be edited.

(3) Load pens of desired colors in their stalls.

(4) Straight lines can be added by moving pen with pen controls to start point. Press PEN-DOWN and move pen in direction desired with controls until line length desired is drawn.

(5) To add curved lines or labels, construct program to draw desired figure or label.

NOTE

Be sure to set scale of plotter to that of chart being edited, and instruct plotter exactly where change or addition is to be made.

h. Digitizing.

(1) Connect plotter to computer via HP-IB Interface.

NOTE

Special "sight pen" allows pen to be placed precisely over target point. Sighting is done by looking through it from above.

(2) Initialize plotter. Load digitizing sight pen.

(3) Place map, chart, plot, or drawing with points to be digitized on plotter, and make note of scale to which it is drawn.

(4) Determine how many points are to be digitized. Write small program for digitizing this number of points. Digitizing program should contain statements that accomplish the following:

(a) Clear plotter.

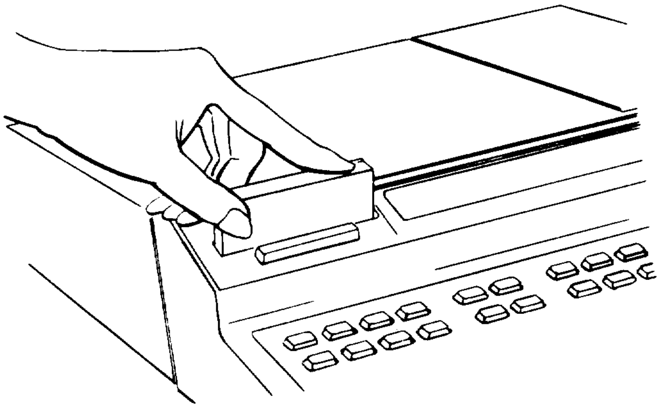
(b) Set decimal place format for numbers to be transferred.

(c) Set plotter scale to that identical to item being digitized.

(d) Statement to end program.

NOTE

- Plotter can be cleared with a **pclr** or **wrt 705 "IN"** statement.
- Decimal place format is set using format commands of computer language.
- Scale and digitizing are set with **scl** and **lim** statements.
- Digitizing is accomplished with **dig** statements. Looping is directed using computer language.



(5) Load blank scratch tape in computer and place it in PRINT ALL and program modes.

(6) Type in each line of program. After each is typed into display, press STORE to enter line.

(7) When program is entered, set computer in run mode and press EXECUTE.

(8) Using front panel controls, move pen to first point to be digitized. Press ENTER key on plotter front panel. Repeat until all points are digitized (transferred). Computer's printer should print X- and Y-coordinates of each point digitized in units of scale set.

SAMPLE PROGRAM

```
10 DIM X(4), Y(4), P (4)
20 FOR D=1 TO 4
30 PRINT USING “K”; “DP”
40 DISP “ENTER POINT’’ ;D; ”PLEASE"
50 COSUB 500
60 ENTER 7,5;X (D), Y(D), P(D)
70 NEXT D
80 FOR L=1 TO 4
90 DISP X(L);Y (L);P(L):
100 NEXT L
110 END
500 PRINT USING “K”; “OS”
510 ENTER 7,5;Status
520 Status=INT (Status/2)
530 Status=INT (Status/2)
540 Statue=Status MOD 2
550 IF Status=0 THEN 500
560 PRINT USING “K”; "OD"
570 RETURN !****
DITIZE****
```

Table 3-10. PLOTTER PROGRAMMING LANGUAGE

NOTE

In general, format of any plotter programming statement will be as follows:

plt	$X_{COORDINATE}$, $Y_{COORDINATE}$	[PEN CONTROL]
PROGRAM COMMAND STATEMENT	MANDATORY INPUT PARAMETERS	OPTIONAL INPUT PARAMETERS

Brackets are not entered as part of program. They only indicate which, if any, parameters in a statement are optional. Before attempting to write plotter program, you should be thoroughly familiar with programming language for computer.

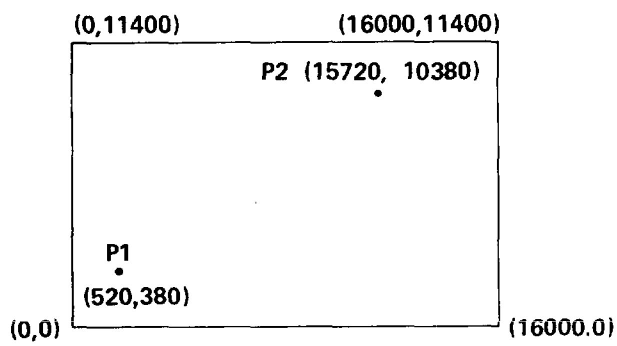
Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
scl	SCALE. Specifies scale units plot will be drawn in and locates origin (center point 0,0) for plot.

Syntax:

scl X_{P1}, X_{P2}, Y_{P1}, Y_{P2}

NOTE

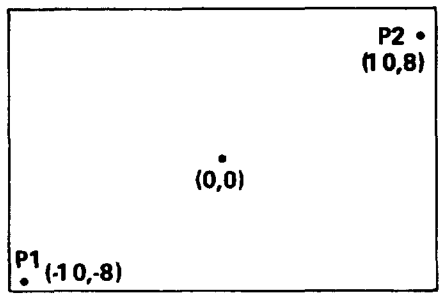
When plotter is initialized, two scaling points, P1 and P2, are automatically established in lower left and upper right corners of plot area. These are limiting reference points used to define actual physical area in which plot will fit.



ABSOLUTE PLATEN AREA SCALE
P1 AND P2 AT INITIALIZATION

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
scl - Cont	Scale statement parameters set scale for distance between scaling points P1 and P2. Parameter entries must be numeric. Each scaling point is assigned an X- and Y-coordinate. Plotter then automatically divides area between these points along each axis into units of length equal to distance between points.



Example:

Input of program statement

scl -10, 10, -8, 8

will set scaling points as shown in the illustration.

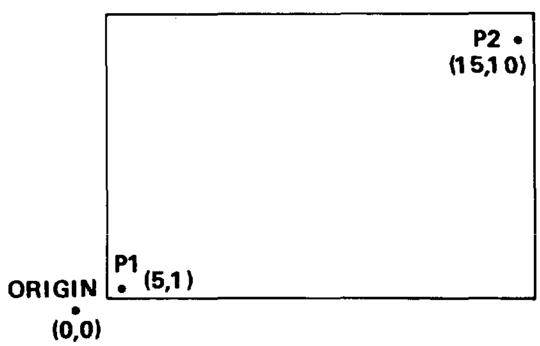
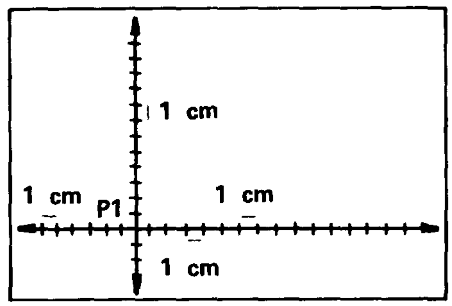


Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
scl - Cont	If scaling point P1 is assigned negative (-) coordinates and P2 is assigned positive coordinates, origin is automatically set at center of plot area. If both sets of coordinates for points are positive, origin will be off of paper in lower left corner as shown in illustration. For two negative sets of coordinates, origin is off of paper in upper right corner.



Scale is automatically set when plotter is initialized or **scl** statement without parameters is input. Origin is set at P1 and platen is divided into units 1 cm in length.

Coordinates of P1 and P2 in internal units of plotter are:

P1 (520, 380) and P2 (15720, 10380)

pclr — PLOTTER CLEAR. Sends all previous parameters sent in programming statement to their default values, with following exceptions:

scl and **psc** parameters

P1 and P2 remain unchanged.

Pen does not move but point raises.

Syntax:

pclr (No Parameters)

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
pclr - Cont	**NOTE** Plotter default conditions are listed in Table 3-11.
xax/yax	X- AND Y-AXES. Draws X- or Y-axis with or without tic marks or labels. <u>Syntax:</u> **xax** X-Offset [, Tic Interval [, Start Point [, End Point [, Number Tics/Label]]]] **yax** Y-Offset [, Tic Interval [, Start Point [, End Point [, Number Tics/Label]]]] X-Offset parameter specifies X-coordinate at which Y-axis will cross X-axis. Y-Offset parameter specifies Y-coordinate at which X-axis will cross Y-axis. Tic interval parameter specifies whether or not tic marks are to be drawn along axis. If tic marks are to be drawn, parameter value specifies spacing, in units of scale statement, between tics. Value of 0 results in no tic marks. If parameter is not specified, tic mark is drawn at each end of axis only. Sign of tic interval can result in either normal tic marks being drawn or tic mark drawn only at starting point of axis. Start point and end point parameters specify location of endpoints of axis. If end point is not specified, axis is drawn to P2 coordinate (i.e., XP2 for X-axis and YP2 for Y-axis). If both start point and end point parameters are not specified, axis is drawn from P1 coordinate value to P2 coordinate value, as specified by current scale statement (i.e., X_{P1} to X_{P2} for x-axis and Y_{P1} to Y_{P2} for Y-axis). The following relationship exists between start point and end point parameters and sign of tic interval parameter.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
xax/yax - Cont	Positive tic interval results in: Normal tic spacing if start point is less than end point. Tic mark drawn only at start point if start point is greater than end point. Negative tic interval results in: Normal tic spacing if start point is greater than end point. Tic mark drawn only at start point if start point is less than end point. Number tics/label parameter determines whether or not tic marks on axis will be labeled. Specifying either 0 or no parameter results in no labels. If labels are desired, parameter specifies number of tic marks between labels. Negative parameter will result in only labels being lettered without axis or tic marks being drawn. Labels will be lettered on an axis only if non-zero tic parameter is specified. All labels are lettered according to current character size **(csiz)** statement and in current number format (fixed or float statement). <u>Example</u>: **fxd** 0 **xax** 0, 1, -10, 2 **fxd** 1 **yax** 0, -.5, 8, -8, 1 Above program results in X- and Y-axes being drawn, crossing at center. X-axis goes from -10 to 10 with tic marks at every one unit and labeled every two units: -10, -8, -6, etc. Y-axis ranges from -8.0 to +8.0 with tic marks every half-unit. Every tic is labeled.
pen	PEN. Raises pen without moving it to a new location. <u>Syntax</u>: **pen** (No Parameters)

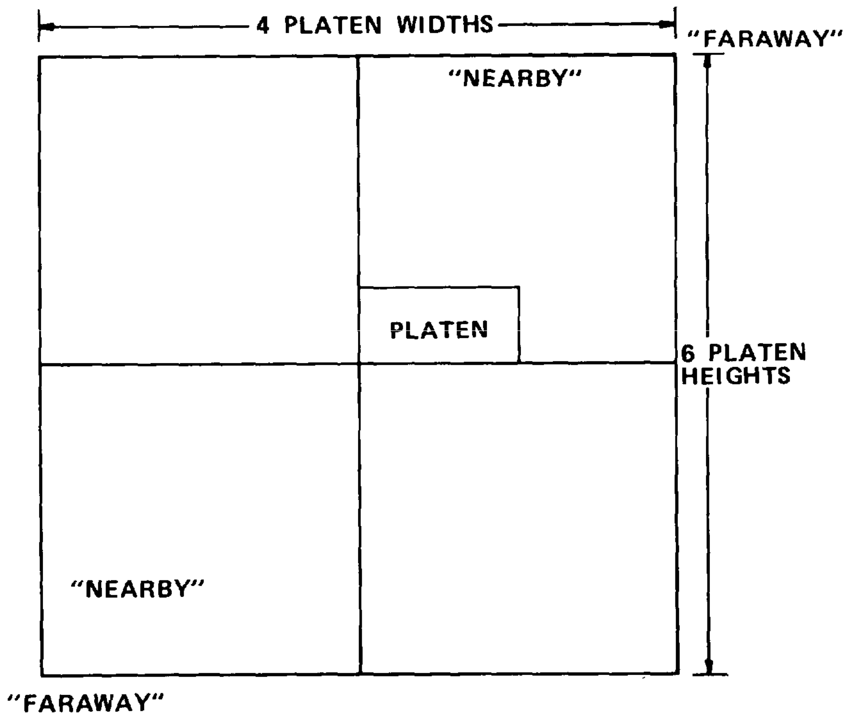
Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
plt	PLOT. Draws line by moving pen to point or points specified by X- and Y-coordinate parameters in statement. Syntax: **plt** $X_{Coordinate}$, $Y_{Coordinate}$ [, Pen Control] Optional pen control causes pen to raise or lower before or after moving. If point specified by plot statement lies off of platen surface, line is drawn to platen limit and then pen is raised. Pen remains raised until point on platen is specified. Optional pen control parameter can be any integer in range - 32768 thru 32767. Odd, Positive Integer = Pen lifts before moving. Odd, Negative Integer = Pen lifts after moving. Even, Positive Integer = Pen lowers before moving. Even, Negative Integer = Pen lowers after moving. 0 = No change. No parameters = Pen remains in its present position, moves to point specified, and lowers or remains down. If point lies off platen but is within "nearby" area (as shown), OUT OF LIMIT lamp will turn on. If point lies in "faraway" area, OUT OF LIMIT lamp will blink.

Table 310. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions

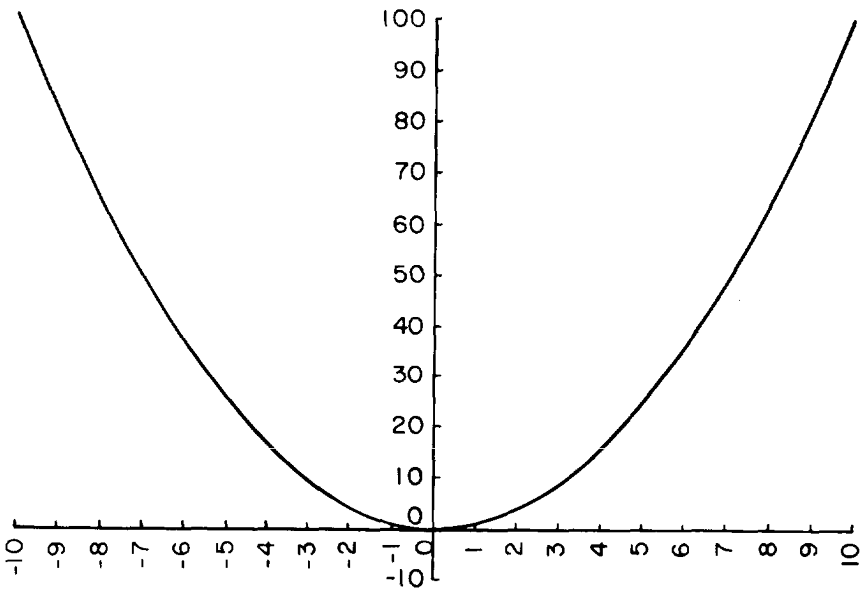
plt - Cont



"PLATEN AREA"

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
plt - Cont	Following example program plots values of function $Y = X^2$.



PLOT OF Y = X²

```
0:  pclr
1:  scl -10, 10, -10, 100
2:  fxd 0
3:  xax 0, 1, -10, 10, 1
4:  yax 0, 10, -10, 100, 1
5:  -10-X
6:  plt X,X 2; if
    (X + 1 → X ) <=10;
    jmp 0
7:  pen
8:  end
```

pen #	PEN. Allows selections of desired pen colors via program.

Syntax:

pen # (Pen front panel stall no.)

When **pen #** statement is executed, pen arm raises pen it is currently holding (if any) and returns it to empty pen storage position. If a valid pen position number is specified (1-4), pen in that position is taken and pen arm returns to its last location on platen.

Parameter value of 0 or no parameter directs pen arm to return pen it is currently using to empty storage position without taking new pen.

If specified pen position is empty or if all of pen positions are full and there is pen in arm, then no operation occurs.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
ofs	OFFSET. Moves origin (point 0,0) of plot from its present location to new position specified by X- and Y-increment values in statement. Syntax: **ofs** $X_{Increment}$, $Y_{Increment}$ X-Increment specifies number of horizontal scale statement units that origin is to be moved. Y-Increment specifies number of vertical scale statement units that origin is to be moved. Signs of increment parameters specify direction that origin moves, as follows: Positive parameter moves origin in positive direction as defined by current scale statement. Negative parameter moves origin in negative direction as defined by current scale statement.
iplt	INCREMENTAL PLOT. Moves pen from its current location to new location specified by X- and Y-parameters. Syntax: **iplt** $X_{Increment}$, $Y_{Increment}$ [, Pen Control] X-Increment parameter specifies number of scale statement units that pen is to move horizontally. Y-Increment parameter specifies numbers of scale statement units that pen is to move vertically. Signs of increment parameters determine relative direction that pen moves, as follows: Positive value moves pen in positive direction as defined by current scale statement. Negative value moves pen in negative direction.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
iplt - Cont	Optional pen control parameter is same as that used with plot statement. Odd, Positive Integer = Pen lifts before moving. Odd, Negative Integer = Pen lifts after moving. Even, Positive Integer = Pen lowers before moving. Even, Negative Integer = Pen lowers after moving. 0 = No change. No Parameters = Pen remains in its present position, moves to point specified, and lowers or remains down. If **iplt** statement specifies point off of platen, pen draws line to limit of platen and stops. If point lies off of platen in "nearby" area (shown next), OUT OF LIMIT lamp turns on. Plotter recognizes **iplt** statements in this area. If point specified lies in "faraway" area, OUT OF LIMIT lamp flashes and plotter does not recognize **iplt** statements. Regular plot **(plt)** statement must be used to specify point that is either on platen or in nearby area before any further **iplt** statements are recognized by plotter.

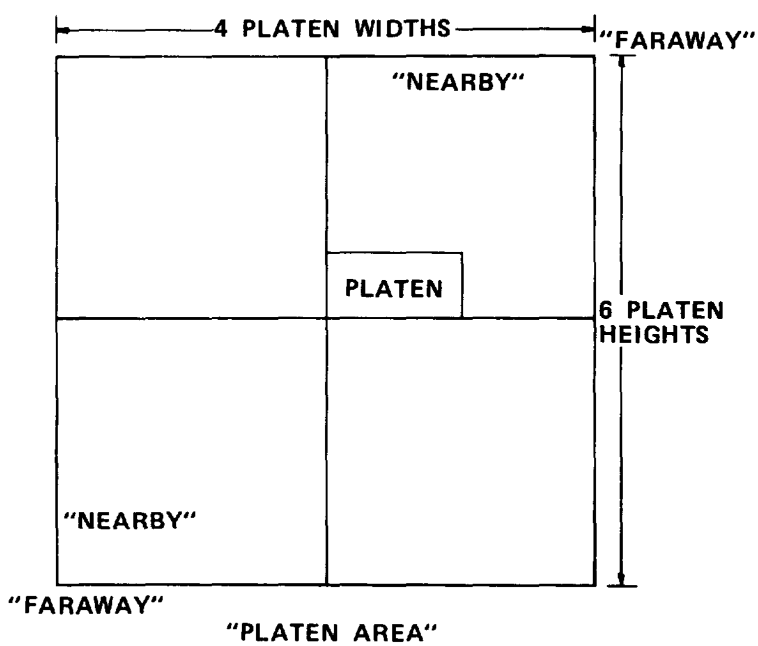


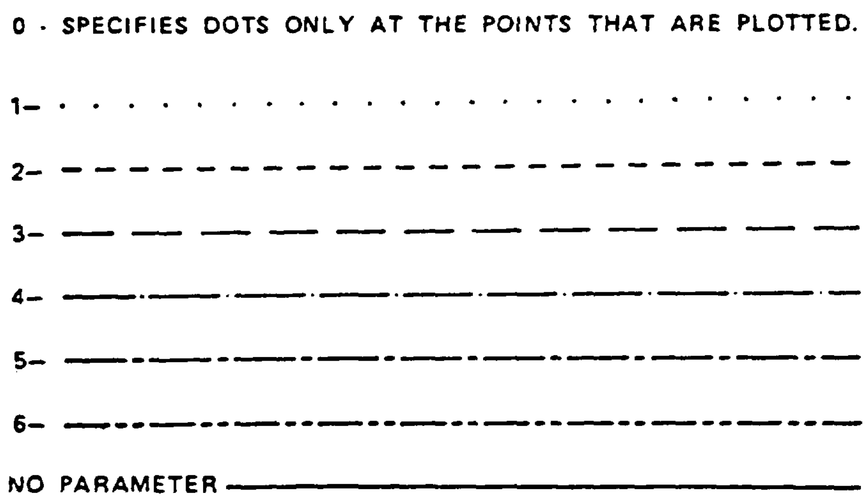
Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
line	LINE TYPE. Specifies type of line plotter is to use when implementing **plt, iplt, xax,** and **yax** statements.

Syntax:

line [pattern no. [, pattern length]]

See illustration for line patterns available and their code numbers.



Shaded portion of each of line pattern above is one complete segment of pattern.

Optional pattern length parameter specifies length of one complete segment of pattern and is expressed as percentage of diagonal distance between scaling points P1 and P2. If pattern length parameter is not specified, a length of 4-percent is used. Range of pattern length parameter is from 0 thru 127.9994999.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

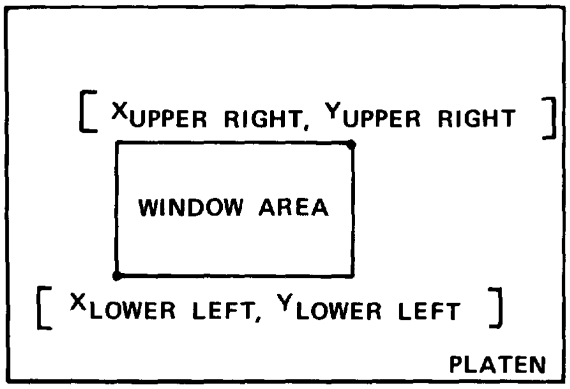
Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
lim	LIMIT. Restricts programmed pen motion to specific rectangular area on platen within area defined by scaling points. Can be used to emphasize specific portion of larger plot. <u>Syntax</u>: **lim** $X_{\text{Lower Left}}$, $X_{\text{Upper Right}}$, $Y_{\text{Lower Left}}$, $Y_{\text{Upper Right}}$ Four parameters specify, in current scale statement units, X- and Y-coordinates of lower left and upper right corners of a window area, as shown below.  If limit statement is not executed or if limit statement without parameters is executed, window is automatically set at mechanical limits of plotter.
lbl	LABEL. Allows you to letter characters, expressions and test or string variables. <u>Syntax</u>: **lbl** Any Combination of “Text,” Expressions or String Variables Example of Text Statement: **lbl "9872A Plotter"** Example of Expression Label: **lbl X, X+1, X+2**

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

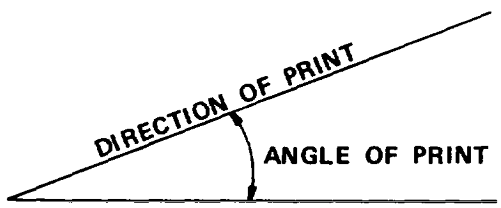
Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
lbl - Cont	Value assigned to X will be lettered in current number format (fixed or float). Value resulting from expression X+1 is lettered next, followed by value resulting from expression X+2. Digits in these expressions are lettered as string of characters. This requires you to add any spaces needed to fit numbers into context of item being lettered. For example, the following statement letters same expressions as example above, with four spaces between each value. **lbl X, " ", X+1, " ", X+2, "** " The following example letters characters contained in string variable A$. (String variable ROM is required.) **lbl A$** Before using label statement, pen should be moved to location where labeling is to begin by using one of plot statements **(cplt, iplt,** or **plt)** or by using four direction controls on plotter front panel. This point will become lower left corner of first character. After lettering character, pen stops at lower left corner of next character space.
csiz	CHARACTER SIZE. Specifies size and shape of characters and symbols and direction they are to be lettered. Syntax: **csiz** [Height [, Aspect Ratio [, Paper Ratio [, Angle of Rotation]]]] Statement can specify up to four parameters. If any of parameters are omitted, specific default value for parameter is assumed. Note that when parameter is omitted, parameter listed immediately to its right must be omitted as well. Here is description of each of four parameters: Height parameter specifies height of characters as percent of scale height defined by scaling points P1 and P2. Must be within range of 0 thru 127.9994999.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
csiz - Cont	Aspect ratio parameter specifies ratio of height of character to its width. For example, an aspect ratio of 2 specifies characters that are twice as high as they are wide. An aspect ratio of 1 specifies square characters.

Paper ratio parameter specifies ratio of height of scaling area to its width. Scaling area is defined by scaling points P1 and P2. For example, 10 in. high X 15 in. wide scaling area has paper ratio of 10:15 or 2:3.

Angle of rotation parameter specifies direction in which characters are printed. Direction is expressed as angle (measured left) between line of print and X-axis, as shown below.



Parameter is expressed in current angular units (degrees, radians, or grads).

Default values for four parameters are as follows:

Height	1.5%
Aspect Ratio	2
Paper Ratio	1
Angle of Rotation	0

Executing **csiz** statement without parameters sets default values. These values are also set when plotter is initialized or cleared **(pclr).**

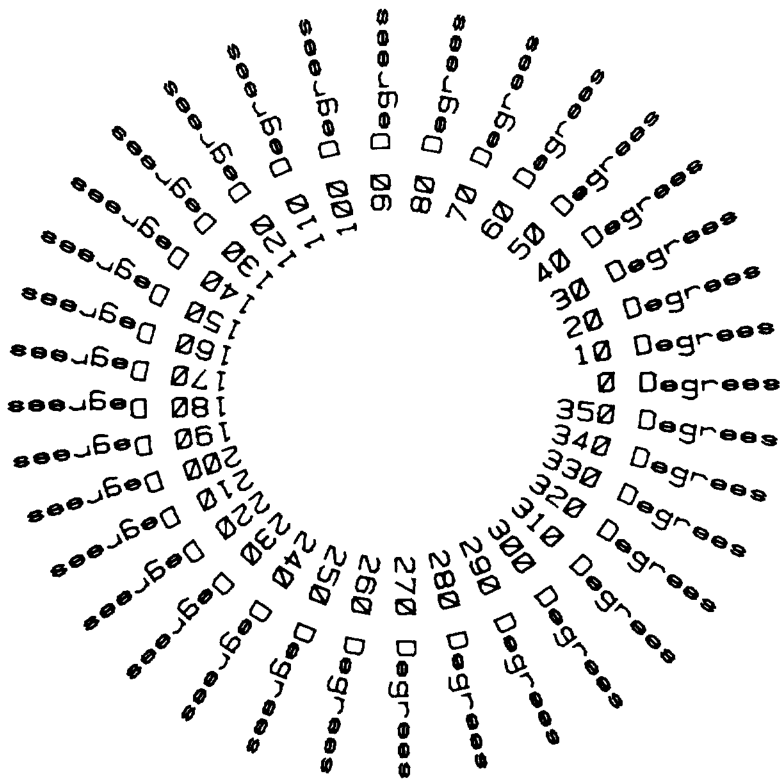
The following example program uses **csiz** instruction (line 3) to specify character dimensions and shape and rotate lettering direction through entire circle in 10-degree intervals. Plot statement (line 2) centers pen for each printing sequence.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
csiz - Cont	Lines 4 and 5 add extra spaces (if needed) to right justify values that precede “DEGREES.” This example assumes that scaling area is set for 8 in. high X 10 in. wide paper.

PROGRAM

```
0: pclr:0 → R → X deg:fxd 0
1:  scl 0, 30, 0, 24
2:  csiz 2, 1.5, 8/10, R
3:  plt 15, 12, 1
4:  if R<10;lbl “ “
5:  if R<99;lbl “ “
6:  lbl “ “, R, “ Degrees”
7:  if (R+10 → R) <360; jmp -5
8:  plt 30, 20, 1
9:  end
```



ANGLE OF ROTATION PLOT

In diagram, you can see relative position of character, in this case M, within character space field. Character space field is set indirectly by **csiz** statement, since character space height is twice the character’s height and character space width is 1-1/2 times the character’s width. Spaces above and below character become spacing between lines and characters.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

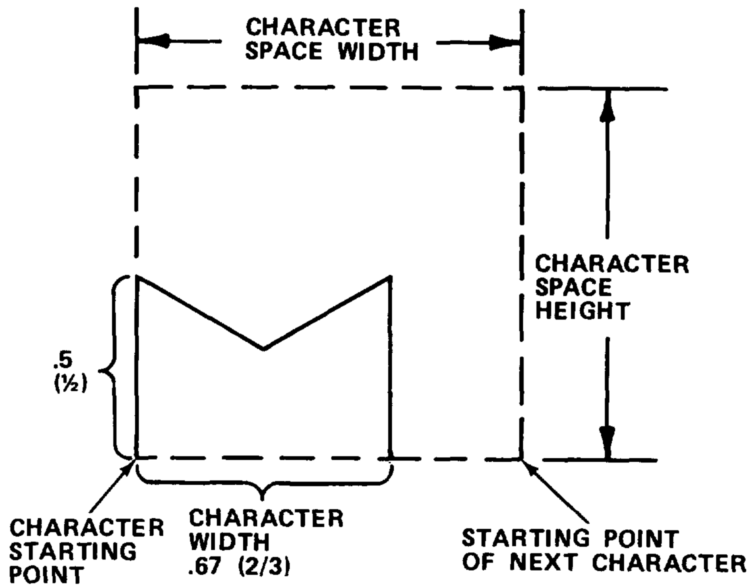
Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
	
	When you specify height of character in **csiz** statement, you should specify character height and not height of character space field.
cplt	CHARACTER PLOT. Moves pen a specified number of character space fields. <u>Syntax:</u> **cplt** [Number of Character Space Widths, Number of Character Space Heights] If no parameters are specified, **cplt** statement performs carriage return and line feed operation by moving one character space height down and returning to margin defined by last point that pen was sent to by either plot statement, **iplt** statement, or the plotter front panel controls. If **csiz** statement is executed after pen is positioned by plot, **iplt,** or front panel controls, location of pen when **csiz** statement is executed becomes that margin pen returns to when **cplt** is executed without parameters.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
cplt - Cont	When parameters are specified, **cplt** statement moves pen specified number of character space widths to right (positive value) or to left (negative value) and number of character space-heights up (positive value) or down (negative value). Pen position (raised or lowered) does not change when **cplt** statement is executed. Parameters must be within range of ±127.9994999.

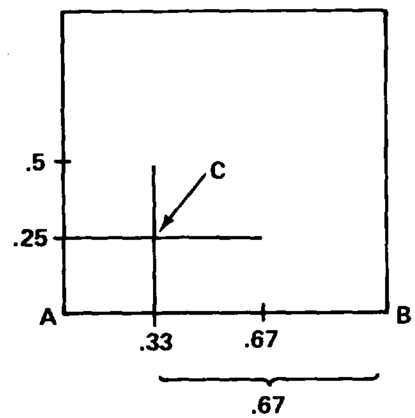


Diagram above shows character spacing around symbol +. Pen begins to draw symbol at point A and ends at point B, ready to draw another character.

To center symbol on point C, which represents plotted point, pen must be moved to point A. This can be done by executing **cplt** statement specifying parameters -.33, -.25. After symbol is drawn, pen must be returned from point B to point C to continue plotting next point. This can be done by executing a **cplt** statement specifying parameters -.67, .25.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
ptyp	PLOTTER TYPEWRITER. Sets plotter in manual typewriter lettering mode. Syntax: **ptyp** (No parameter inserted) After **ptyp** statement is executed (either in program, in live keyboard mode or from keyboard), you type desired characters on computer keyboard, and they are lettered by plotter. To end **ptyp** mode, press STOP key once. Pen can be positioned by **plt, iplt,** or **cplt** statements before **ptyp** mode is established. Once **ptyp** mode is established, four computer display keys or four pen movement keys on plotter front panel can be used to position pen for lettering. Following keys perform these functions while in **ptyp** mode: Space → Backspace ← Line Feed ↓ Inverse Line Feed ↑ Carriage Return STORE
dig	DIGITIZE. Sends coordinates of point where pen is located to computer. Syntax: **dig** Variable 1, Variable 2 [, Pen Status] Digitize statement enables digitizer mode. When digitizer mode is set, ENTER lamp on plotter is lit. You can-use plotter pen movement controls to position pen at point on platen. After positioning pen, pressing ENTER on plotter front panel sends its coordinates, in scale statement units, to computer.

Table 3-10. PLOTTER PROGRAMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
dig - Cont	Coordinate values are assigned to variables specified by digitize statement in following order: **NOTE** Select code for plotter is set at factory to 705. X-Coordinate Value — Variable 1 Y-Coordinate Value — Variable 2 Pen Status (0 = Up, 1 = Down) — Parameter (If Specified) To cancel digitize statement without entering values, press STOP key. If digitize statement is executed from program, STOP key will also stop program at end of line containing digitize statement. Special digitizing sight is provided with plotter which allows you to visually position pen directly over point to be digitized. Sight is loaded and stored like pen. **NOTE** If more than one point is to be digitized, then program must contain looping statements to return to and repeat program step containing digitize command or contain several digitize commands. Plotter can only digitize one point each time digitize command is encountered.
wrt	WRITE. Identifies additional plotter control commands. Syntax: **wrt 705,** "Command Code" **NOTE** Select code for plotter, set at factory, is 705.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
wrt - Cont	Syntax and function of control commands are as follows: **wrt 705, "AP"** Automatic pen pickup command, **"AP",** causes plotter to automatically raise pen whenever it has been down without motion for 65 seconds. This condition is set automatically when plotter is initialized. Sending, characters **"APO"** to plotter will disable automatic pen pickup. **wrt 705, "PD"** Pen down command, **PD,** lowers pen to paper. **wrt 705, "VS** 1 thru 36 [, Pen No.]" Select pen velocity command specifies pen speed, in cm/see, for plotting and lettering operations. Velocity can be any value between 1 and 36. If optional pen no. (1-4) is specified, speed will apply only to that pen. If pen no. is not specified, speed applies to all pens. Whenever plotter is initialized, pen velocity is set to 36 cm/sec. **wrt 705, "VA"** Sets plotter to adaptive pen velocity mode. Plotter will adapt pen speed, automatically, to approximate rate that computer sends coordinate data to plotter. This mode provides smoother plot than normal velocity mode for plotting coordinates that are generated by a relatively slow program routine (fewer than 15 coordinates/sec). **wrt 705, "VN"** Normal velocity command, **"VN",** cancels adaptive velocity mode. Pen speed is now controlled by current pen velocity command.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
wrt - Cont	**wrt 705, "SM** Character"

Symbol mode command, **"SM",** sets symbol mode for use with **plt, iplt, XAX,** and **YAX** statements. These statements function as described in this table except that specified character is drawn centered on each plotted point or tic mark. Character is drawn according to currently selected character set. If character is not specified, symbol mode is cancelled. All ASCII characters from decimal 35 thru 122 can be specified except the following:

ASCII Character	Decimal Value
%	37
&	38
'	39
(	40
)	41
/	47
:	58
;	59
<	60
=	61
>	62
?	63
@	64
[	91
\	92
[	93
∩	94
-	95
\	96

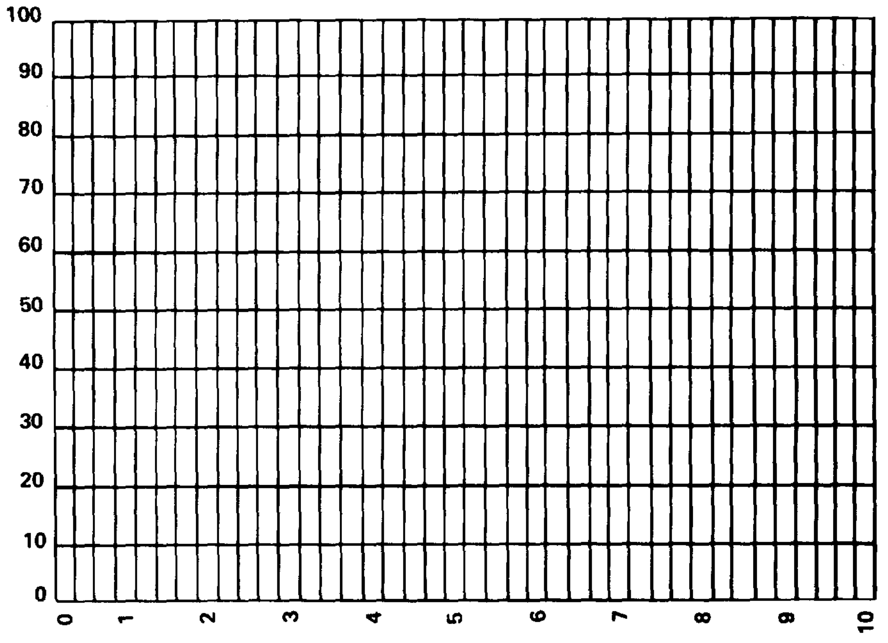
Characters shown above are from set 0. Characters in other character sets that replace any of these are also not usable with symbol mode.

wrt 705, "TL [Up and Right Tic Length [, Down and Left Tic Length]]"

Tic length command, **"TL",** specifies length of tic marks drawn by axis statements. Tic lengths are specified as percentage of horizontal and vertical distances between scaling points P1 and P2.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
wrt - Cont	Up and right tic length determines length of upward portion of tic marks to be drawn along X-axis and right side portion of tic marks to be drawn along Y-axis. This value is specified percentage of vertical scale length, $Y_{P2} - Y_{P1}$. Down and left tic length determines length of downward portions of tic marks to be drawn along X-axis and left side portion of tic marks to be drawn along Y-axis. Value is specified as percentage of horizontal scale length $X_{P2} - X_{P1}$. Plotter, when initialized, automatically sets tic length values to 0.5% of scaling lengths ($Y_{P2} - Y_{P1}$ and $X_{P2} - X_{P1}$). Program shown below uses tic length command to draw a grid within plotting area of plot. Note that only up and right length parameter is specified, since only area above X-axis and to right of Y-axis is being used. Since down and left tic length is not specified, plotter uses length of 0 (no tic marks).



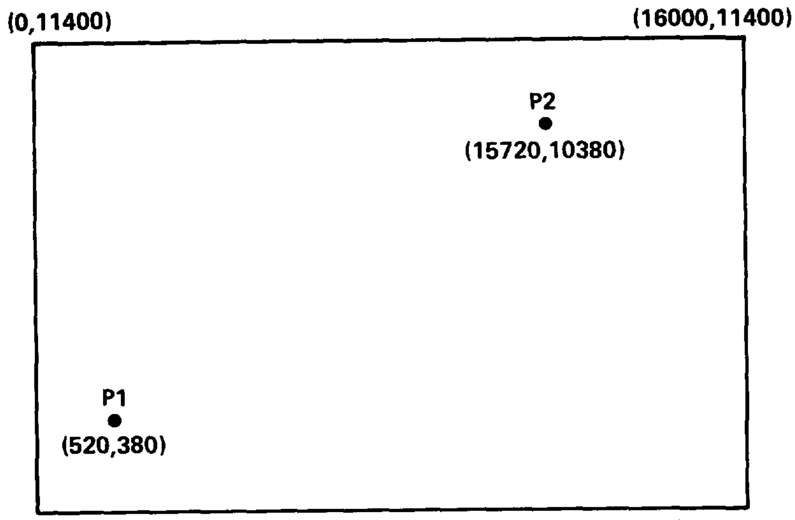
TIC LENGTH EXAMPLE

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
wrt - Cont	**wrt 705, "IP** $X_{P1}, Y_{P1}, X_{P2}, Y_{P2}$ "

Used to relocate scaling points P1 and P2. New coordinates of P1 and P2 are specified in order shown above. These coordinates must be in absolute plotter scale units.

Default coordinates of P1 and P2 are specified in absolute plotter scale units. Illustration below shows location of P1 and P2 at initialization in these units:

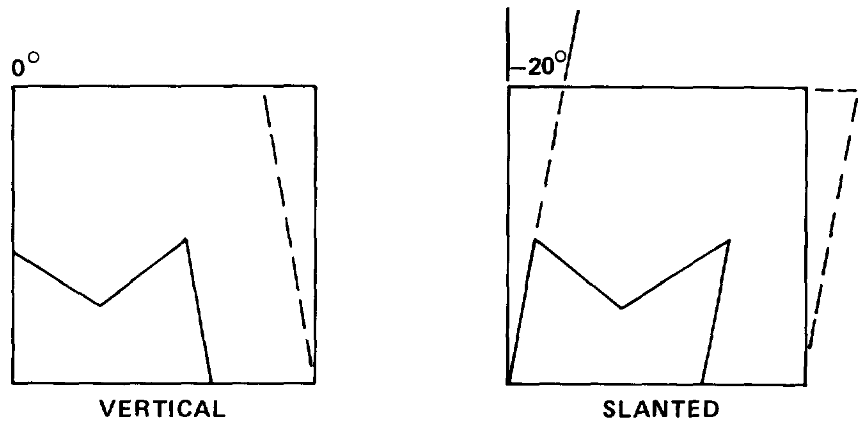


ABSOLUTE PLATEN AREA SCALE
P1 AND P2 AT INITIALIZATION

wrt 705, "SL", Tan θ

Character slant command specifies slant with which characters are lettered. Angle θ specifies slant as shown:

Table 310. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
wrt - Cont	

Sending **"SL"** or **"SLO"** to plotter defaults character slant to vertical or 0°.

wrt 705, "CS (Ø-4)"

Character sets command designates one of five sets (Ø-4) as standard character set. This character set will be used for all labeling and lettering operations. Character Set Ø is automatically set whenever plotter is initialized.

NOTE

Plotter, when initialized, automatically specifies ANSI-ASCII character set (set Ø) as both "standard" and "alternate" sets. The **pclr** statement, however, designates 9825 character set (set 1) as standard set and set Ø as alternate set. Following keys are used to switch from standard character set to alternate set and back:

Select Standard Set = SHIFT F_2

Select Alternate Set = SHIFT F_3

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
wrt - Cont	Shown below are characters contained in set 1. These characters correspond to those on computer keyboard. They are shown in order (from left to right) of decimal-equivalent value of their ASCII codes (32-126).

Character Set1

! "#$%&'()*+,-./Ø123456789:;<=>?

@ABCDEFGHIJKLMNOPQRSTUVWXYZ[√]↑

_`abcdefghijklmnopqrstuvwxyzπ⊢→~

Shown next are symbols in various character sets that are changed from set 1. An asterisk (*) beside symbol indicates that plotter will perform automatic backspace when that symbol is drawn.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions

wrt - Cont

Decimal Value	Set 0 Standard ASCII	Set 1 9825 ASCII	Set 2 French/German ASCII	Set 3 Scandinavian ASCII	Set 4 Spanish/Latin American ASCII
35	#	#	£	£	¿
39	'	'	´	'	´
91	[	[	[	Ø	[
92	\	√	ç	Æ	¡
93	]	]	]	ø	]
94	^	↑	^	æ	^
95	_	←	_	_	_
96	`	`	`	`	`
123	{	π	[illegible]	[illegible]	~
124	¦	⊢	[illegible]	[illegible]	[illegible]
125	}	→	[illegible]	[illegible]	~
126	~	~	'	[illegible]	[illegible]

wrt 705, "CA (0-4)"

Alternate character command specifies alternate character set. Any of five character sets (0-4) can be specified. Character Set 0 is automatically specified as alternate character set whenever plotter is initialized.

wrt 705, "SS"

Standard set command selects standard set as character set to be used for all labeling statements **(lbl, ptyp, xax,** and **yax).**

Standard set is selected automatically when plotter is first switched on, initialized, or cleared.

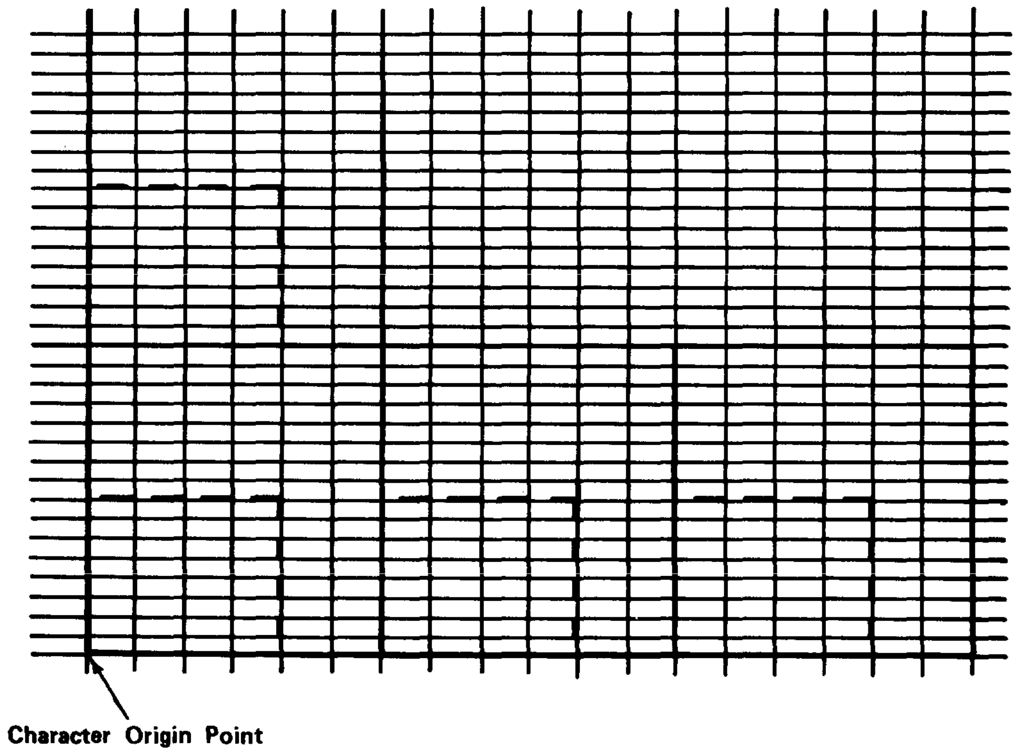
Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement Syntax, Explanation, and Input Instructions
wrt - Cont	**wrt 705, "SA"** Set alternate command selects normal alternate set as character set to be used for all labeling statements **(lbl, ptyp, xax,** and **yax).** This command should be executed prior to executing labeling statement whenever alternate character set is to be used. **wrt 705, "UC,** Pen Control Parameter, X-Increment, Y-Increment, Pen Control Parameter, X-Increment, Y-Increment, . . ." User-defined character command is used to draw characters of your own design. Each segment of character is drawn according to three parameter values as follows: Pen Control Parameter +99 = Pen Down Pen Control Parameter -99 = Pen Up X-Increment specifies number of character grid units that pen will move horizontally. Positive value moves pen to right and negative value moves it to left. Increment value can range from -98 thru +98 grid units. Y-Increment specifies number of character grid units that pen will move vertically. Positive value moves pen up and negative value moves it down. Increment value can range from -98 thru +98 grid units. Character grid units are scaled by current size statement as shown on the following page. Each character block contains 6 horizontal grid units and 16 vertical grid units. Each character starts from character block origin point. When character is completed, "LF" is sent automatically by WRITE statement at end of string of characters, returns pen to next character block origin (six grid units from initial starting point). **NOTE** This may not be a valid starting point if new character was larger than normal character. A **plt, iplot** or **cplot** statement may be needed to properly position pen for next character, if any, to be lettered.

Table 3-10. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use / Statement Syntax, Explanation, and Input Instructions

wrt - Cont



User-defined character is drawn with the current character slant.

wrt 705, "IN"

Initialize command is equivalent of switching plotter off and then on again or initializing it from front panel. Sets plotter to same conditions as **pclr** command and sets these additional conditions:

Pen is moved to lower right corner of platen.

Scaling points P1 and P2 are set to points P1 (520,380) and P2 (15720,10380).

Table 3-11. PLOTTER DEFAULT CONDITIONS

Statement, Parameter, or Condition	Changed To:
psc	705 (Not changed with **pclr** or **"DF")**
scl	cm unit of measure from P1 (Not changed with **pclr** or **"DF")**
line	Solid line
Line Pattern Length	4% of distance from P1 to P2
lim	Total platen area
csiz	1.5, 2, 1, 0
Automatic Pen Pickup	On
Pen Velocity	36 cm/sec
Adaptive Pen Velocity	Off
Symbol	Off
Tic Length	5% of P1-P2 length for each half
Standard Character Set	Set 0 (Set 1 for **pclr)**
Alternate Character Set	Set 0
Character Slant	0
Mask Value	223, 0, 0

P1 and P2 are changed only with initialize, **"IN",** command. They are not affected by **pclr** and default, **"DF",** command.

Pen is raised by **pclr.**

Current pen location is moved to lower right corner with **"IN"** command but is unaffected by **pclr** and **"DF"** command.

Table 3-12. PLOTTER OPERATION AND PROGRAM ERRORS

Error No. Displayed	Error Explanation
	PLOTTER ERRORS
p1	INSTRUCTION NOT RECOGNIZED Plotter has received illegal character sequence.
p2	WRONG NUMBER OF PARAMETERS Too many or too few parameters have been sent with instruction.
p3	BAD PARAMETER Parameters sent to plotter with instruction are out of range for that instruction.
p4	ILLEGAL CHARACTER Character specified as parameter is not in allowable set for that instruction.
p5	UNKNOWN CHARACTER SET Character set out of range 0-4 has been designated as either standard or alternate character set.
p6	POSITION OVERFLOW Attempt has been made to draw character or perform CP that is located outside of plotter's numeric limit of -32768 to +32767 .
p7	(Not Used)
p8	OUT OF PAPER Either advance option is off when an **"AH"** or **"AF"** is attempted or out-of-paper sensor indicates no paper after advance.

Table 3-12. PLOTTER OPERATION AND PROGRAM ERRORS - Cont

Error No. Displayed	Error Explanation
	PLOTTER ROM ERRORS
P1	ATTEMPT TO STORE INTO CONSTANT Occurs when one or more parameters in dig instruction are constants rather than variables.
P2	WRONG NUMBER OF PARAMETERS Occurs on instructions with numeric only parameter lists **(scl, ofs, plt, iplt, cplt, xax, yax, lim, dig, csiz, line, pen #,** and **psc).** In certain unusual cases where parameter list contains user level function calls, instruction having incorrect number of parameters may be executed. For example, **scl funct** is executed as **scl** Function call **funct** is ignored.
P3	WRONG TYPE OF PARAMETER OR ILLEGAL PARAMETER VALUE Examples: **lbl A *** **psc 31**
P4	NO HP-IB DEVICE NUMBER SPECIFIED Occurs on **psc** instruction when parameter is between 0 and 14, inclusive, and HP-IB card is at corresponding select code.
P5	PEN CONTROL VALUE NOT IN -32768 THRU +32767 RANGE Occurs on **plt** and **iplt.** May also occur if hardware transmission error occurs between plotter and computer.
P6	NO HP-IB CARD AT SPECIFIED SELECT CODE Occurs on **psc** instruction when HP-IB card set to specified select code is not HP-IB card.
P7	**axe, ltr** INSTRUCTIONS EXECUTED Occurs on **axe** and **ltr** instructions because ROM recognizes these instructions but cannot execute them. This error flags all **axe** and **ltr** instructions for purpose of converting 9825/9862 programs.

Table 3-12. PLOTTER OPERATION AND PROGRAM ERRORS - Cont

Error No. Displayed	Error Explanation
	PLOTTER ROM ERRORS - Cont
P8	CALCULATOR STOP KEY CANCELLED OPERATION Occurs on any instruction when plotter fails to respond for 3 sec after STOP key has been pressed. This error is most likely to occur when pen is traveling slowly.
p0	TRANSMISSION ERROR Computer has received an illegal ASCII input from plotter.
p1	INSTRUCTION NOT RECOGNIZED Plotter has received illegal character sequence.
p2	WRONG NUMBER OF PARAMETERS Too many or too few parameters have been sent with instruction.
p3	BAD PARAMETER Parameters sent to plotter with instruction are out of range for that instruction.
p4	ILLEGAL CHARACTER Character specified as parameter is not in allowable set for that instruction.
p5	UNKNOWN CHARACTER SET Character set out of range 0-4 has been designated as either standard or alternate character set.
p6	POSITION OVERFLOW Attempt has been made to draw character or perform CP that is located outside of plotter's numeric limit of -32768 to +32767.
	Error messages generated by WRITE **(wrt)** and READ **(red)** statements will typically be displayed as error in next executed plotter ROM statement. This can be avoided by using output error command **(wrt** select code **"OE")** followed by a READ statement **(red** select code, variable) to check for errors after READ or WRITE statements that address plotter.

Section III OPERATOR MAINTENANCE

3-8. LUBRICATION INSTRUCTIONS. This equipment does not require lubrication.

3-9. TROUBLESHOOTING PROCEDURES .

a. The table lists the common malfunctions which you may find during operation or maintenance of the X-Y graphics plotter or its components. You should perform the test/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all test or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Before proceeding:

(1) Check that power cable is connected.

(2) Check that all switches are in proper positions for normal operation.

(3) Check that HP-18 Interface and computer are connected.

(4) Check that computer has power.

(5) Place pens in each of four stalls.

d. Before referring to Table 3-13, perform Confidence Test as follows:

WARNING

To prevent serious injury to personnel or equipment, when performing next step, be sure that fingers and clothing (especially ties) are away from plotting arm and pen stable.

(1) Remove HP-IB Interface from plotter.

(2) Turn LINE power switch to on (1).

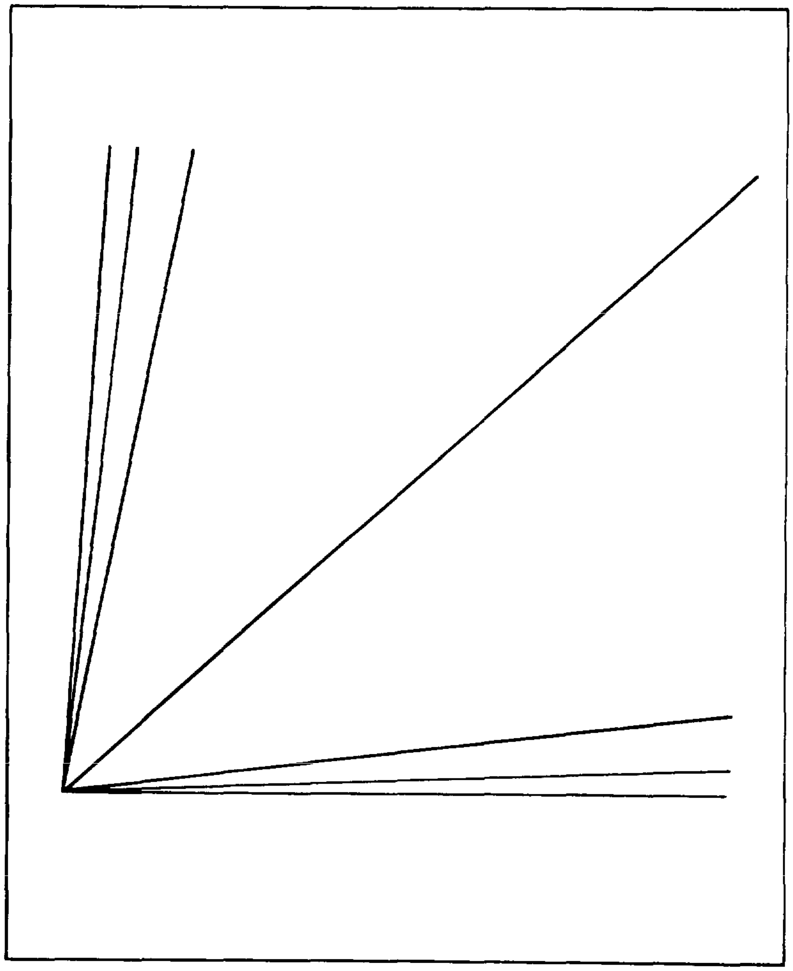
[3) Load sheet of chart paper on platen.

(4) Load pen in pen holder.

(5) Place CONFIDENCE TEST switch in I position. Confidence test begins immediately and runs automatically to completion without operator intervention. Leave CONFIDENCE TEST switch in I position throughout test.

e. Observe that following functions are performed:

(1) Pen is raised and moved to lower left corner of chart.



SAMPLE CONFIDENCE TEST

(2) Confidence plot shown above is plotted.

(3) All front panel lights are turned on.

f. After completion of confidence test, return CONFIDENCE TEST switch to 0 position. Plotter will reinitialize.

Note any observations of incorrect or inadequate performance by plotter. Refer to Table 3-13 to match failure indication.

Table 3-13. TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. PLOTTER IS TOTALLY INOPERATIVE. NO INDICATORS ARE LIT.

Step 1. Check to see if ac power plug is plugged into wall outlet.

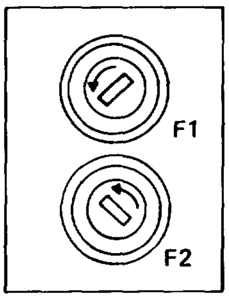
(a) If plotter is plugged in, proceed to step 2.

(b) Insert plug into grounded ac outlet.

Step 2. Check that electrical outlet is operative.

(a) Insert plug into different outlet or reset circuit breaker.

(b) If malfunction is not corrected, proceed to step 3.



Step 3. Visually check for blown fuses.

Insert new fuse.

2. PLOTTER STOPS. COMPUTER DISPLAYS ERROR MESSAGE.

Refer to Table 3-12, Plotter Operation and Program Errors.

Correct program or repeat key sequence correctly.

3. COOLING FAN RUNS. EVERTHING ELSE IS INOPERATIVE.

Press LINE power switch to off (0) and then to on (1).

Table 313. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

3. COOLING FAN RUNS . EVERYTHING ELSE IS INOPERATIVE - Cont

NOTE

This action resets power supply if fault was caused by momentary low line voltage.

4. PLATEN DOES NOT HOLD PAPER WHEN "CHART HOLD' IS ACTIVATED.

Check that paper is not wet and platen is clean.

(1) Clean platen if necessary.

(2) Replace paper.

5. NO RESPONSE TO PROGRAMMED COMMANDS.

Step 1. Check to see if front panel ERROR lamp is lit.

(a) If lamp is not lit, proceed to step 2.

(b) If lamp is on, correct improper program command.

Step 2. Check that HP-IB Interface is connected and tight.

(a) If HP-IB Interface is properly connected, proceed to step 3.

(b) Connect and tighten HP-IB Interface.

Step 3. Check that HP-IB Interface select code switch is set to 7.

(a) If code switch is properly set, proceed to step 4.

(b) Turn off controller's power.

(c) Set switch to 7.

(d) Re-energize controller.

Step 4. Perform operator's HP-IB operational test (paragraph 3-6.2d).

Refer HP-IB to vendor for servicing.

Table 3-13. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

6. PLOTTER DOES NOT DRAW EXPECTED PLOT OR PLOT APPEARS INACCURATE.

Step 1. Check program for incorrect or misplaced syntax.

(a) If program is correct, proceed to step 2.

(b) Correct program.

Step 2. Perform Operator's HP-IB operational test (paragraph 3-6.2d).

Refer to vendor for servicing.

7. PLOTTER WILL NOT RESPOND TO DIGITIZE COMMAND OR TRANSFER COORDINATES.

Step 1. Check that LISTEN ONLY switch is set to 0 (talk and listen).

(a) If LISTEN ONLY switch is properly positioned, proceed to step 2.

(b) Set LISTEN ONLY switch to 0.

Step 2. Check to see if ERROR or OUT OF LIMIT lamp on front panel is lit.

(a) If neither lamp is lit, proceed to step 3.

(b) Correct error in program syntax.

Step 3. Perform Operator's HP-IB operational test. (3-6.2d)

Refer equipment to vendor for servicing.

3-10. MAINTENANCE PROCEDURES. There are no operator maintenance procedures assigned for this equipment.

Section IV ORGANIZATIONAL MAINTENANCE

There are no organizational maintenance procedures assigned for this equipment.

Section V DIRECT/GENERAL SUPPORT MAINTENANCE

There are no direct/general support maintenance procedures assigned for this equipment.

GRAPHICS PLOTTER (9872C)

Section VI INTRODUCTION

3-11. EQUIPMENT DESCRIPTION.

3-11.1 Equipment Characteristics, Capabilities, and Features.

a. All major operations are controlled by the HP-9825A Desk-Top Computer.

b. Programmable selection of eight pens.

c. Selectable pen speed.

d. Point digitizing.

e. Electrostatic paper holding.

f. Five-character sets for labeling.

g. User-defined characters.

h. Dashed line fonts and selectable line types.

i. Built-in confidence and self-tests.

j. Error-free, off-scale data handling.

k. Symbol mode plotting.

l. Window plotting.

m. Local pen-positioning control.

n. Error indicators.

3-11.2 Location and Description of Major Components.

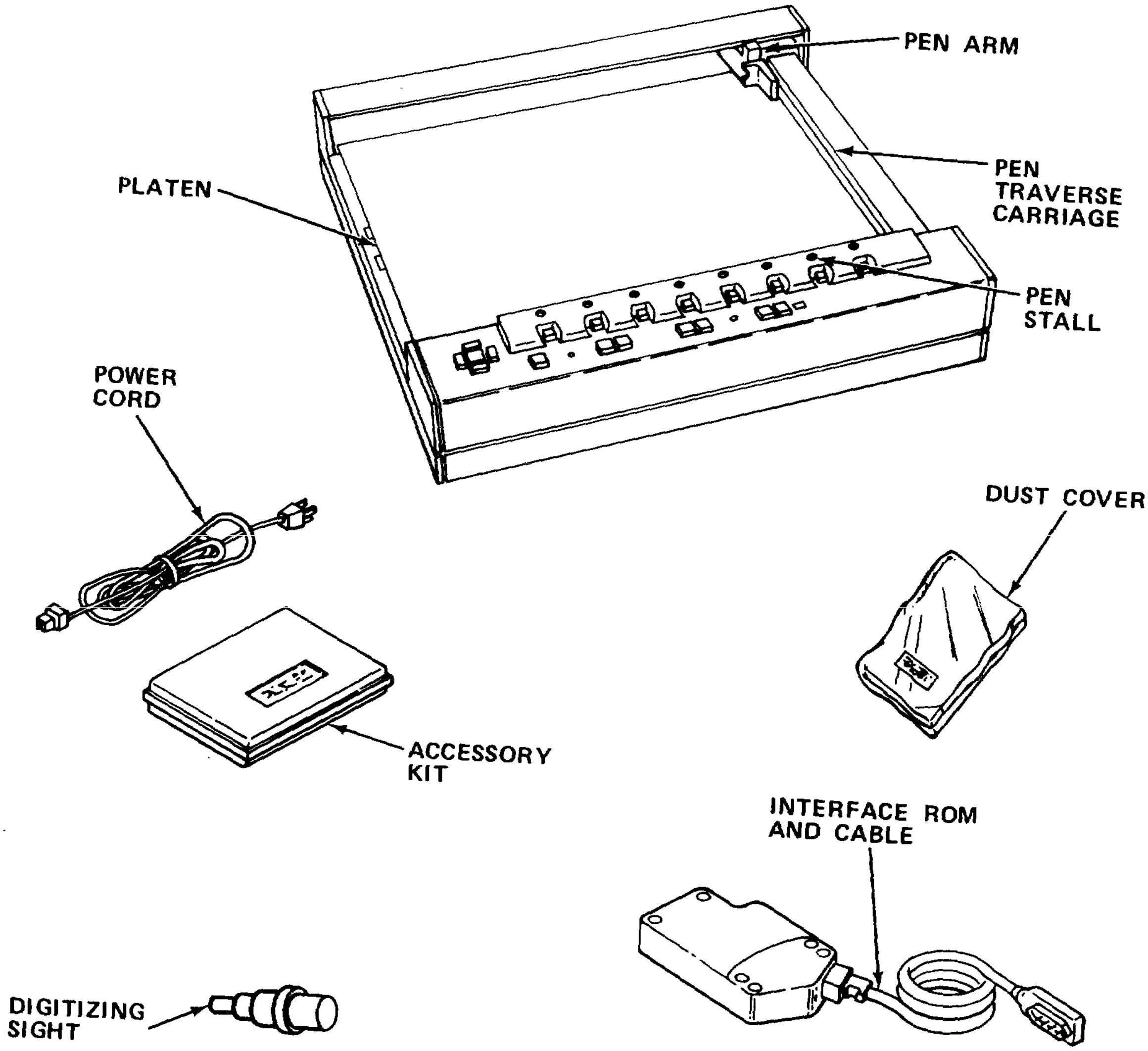
DUST COVER. Cloth cover keeps dust off platen and internal components.

POWER CORD. Provides independent power to plotter.

HP-IB INTERFACE ROM WITH CABLE. Provides path for electronic signal transmission between plotter and controller.

PEN STALLS. Store pens.

PEN TRAVERSE CARRIAGE. Holds and moves pen arm.



PEN ARM. Holds pen in place and lifts or raises pen as ordered.

ACCESSORY KIT. Stores accessories, such as extra pens and digitizing sight.

PLATEN. Provides drawing surface for mounting paper.

DIGITIZING SIGHT. Used to visually position pen over point to be digitized.

3-11.3 Equipment Data.

Manufacturer	Hewlett-Packard
Weight	40 lbs (18.2 kg)
Power Requirements	120 V (100 V, Min; 240 V, Max), 48-66 Hz, 2.1 amps
Dimensions	
Width	19.5 in. (49.7 cm)
Depth	18.75 in. (47.7 cm)
Height	7.5 in. (18.9 cm)
Plotting Area	
Y-Axis	11 in. (28.0 cm)
X-Axis	15.75 in. (40.0 cm)
Plotting Accuracy	±0.2% deflection ±0.008 in. (0.2 mm)
Repeatability	
Given Pen	±0.004 in. (0.1 mm)
Pen-to-Pen	±0.008 in. (0.2 mm)
Addressable Resolution	0.001 in. (0.025 mm) (smallest addressable move)
Speed	
Either Axis	14 in./sec (35.6 cm/sec), max
45° Angle	20 in./sec (50.8 cm/sec), max
Adjustable Range	(Increments of 0.4 in./sec) 0.4 in./sec (10 mm/see) to 14 in./sec (36 cm/sec)
Plotting Speed	2 char/sec

Environmental Range

Temperature	32°F (0°C) to 131°F (55°C)
Humidity	5% to 95% relative

3-12. TECHNICAL PRINCIPLES OF OPERATION.

3-12.1 General.

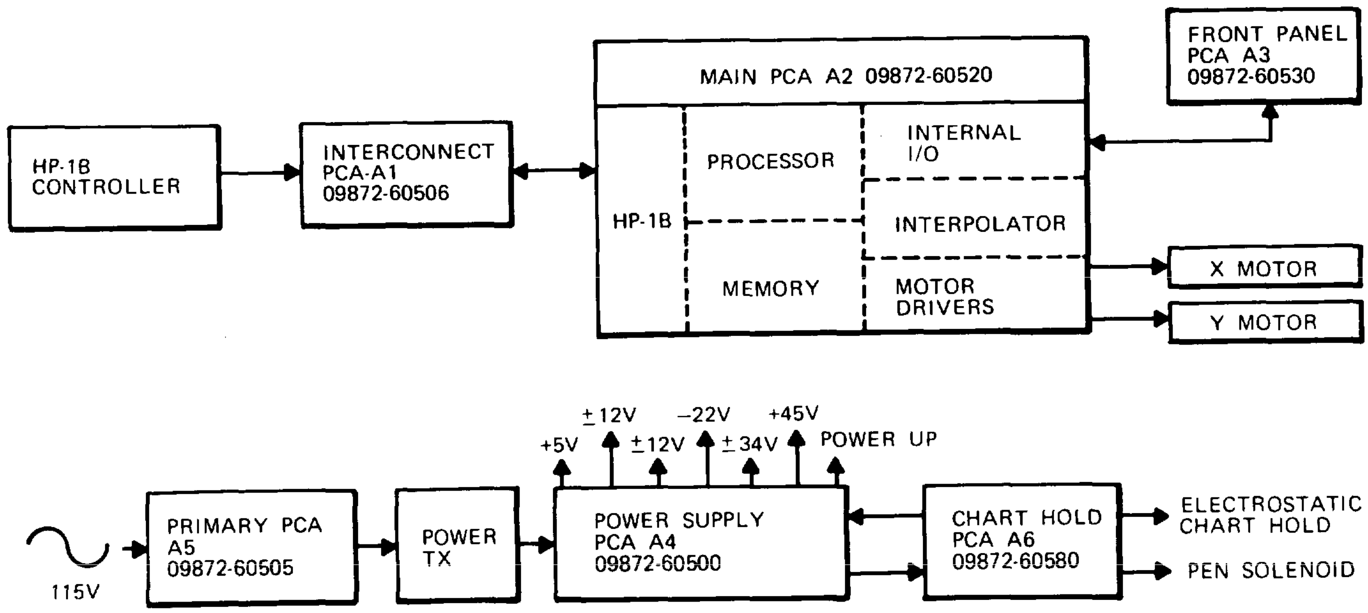
a. The plotter has an internal microprocessor which interprets and responds to commands in the form of program statements from the HP-9825A Desk-Top Computer. It directs the plotter's internal circuits to perform the desired operation.

b. The plotter draws lines using vector data received from the computer in the form of a digital word. The plotter then translates the vector data into an analog signal which drives the chart pen.

c. The plotter can construct a plot by tracing a line from point to point in a series of data points, each point received as a digital word. If the sequence of data points is not continuous, an insertable ROM can calculate and provide the missing points.

d. The plotter can also send coordinate data back to the computer. Sending of plot data by plotter is called point digitizing. In digitizing, the digitizing sight is loaded like a regular pen and is manually positioned on a point using the local control push-button switches on the plotter's front panel. Pressing the ENTER key, with the sight in the pen down position, will send the coordinates of the pen's position to the computer.

e. The plotter is controlled and operated by programming statements sent from the computer. It can only be operated independently when performing self-tests, the confidence test and manually editing charts. The confidence test and self-tests are preprogrammed and, once initiated, are controlled internally by the microprocessor. Manual chart editing is accomplished using the front panel pen control buttons.



f. The general theory of operation is provided as an introduction to the plotter system at a simplified block diagram level. Input to the plotter is from a desktop computer through an HP-IB Interface bus. The ADDRESS switch setting on the interconnect PCA determines the bus address that the plotter will respond to. When addressed to transfer data or status, the HP-IB circuitry sets up the data transfer and provides the interface between the plotter microprocessor and the controller.

(1) Data transfer is controlled by the processor circuitry which generates the appropriate timing signals to properly sequence the processing of data and instructions on the plotter bus.

(2) In the memory circuitry, the read only memories (ROMs) store the instructions and data constants which the processor accesses and interprets. The random access memories (RAMs) are used for temporary storage of microprocessor calculations and for input/output data.

(3) The internal I/O circuitry provides an interface between the front panel PCA circuitry and the plotter bus and also passes velocity information from the microprocessor to the motor drive circuitry.

(4) The interpolator circuits accept velocity information generated in the processor and convert this information from digital format to the analog waveforms required by the motor drivers for the X- and Y-axis motors.

(5) The motor drivers provide both voltage and power amplifications for the analog signals generated by the interpolator circuits. These signals drive the X- and Y-axis plotter motors.

(6) The front panel circuits provide a means of manually entering X- and Y-position data, reset, pen control, and chart hold data to the microprocessor. The front panel indicators make certain status information available to the operator. Switches mounted in the pen stalls provide information to the microprocessor as to which stalls contain pens and if a pen is present in the plotter arm pen holder. The X- and Y-initialize switches are also interfaced through the front panel PCA.

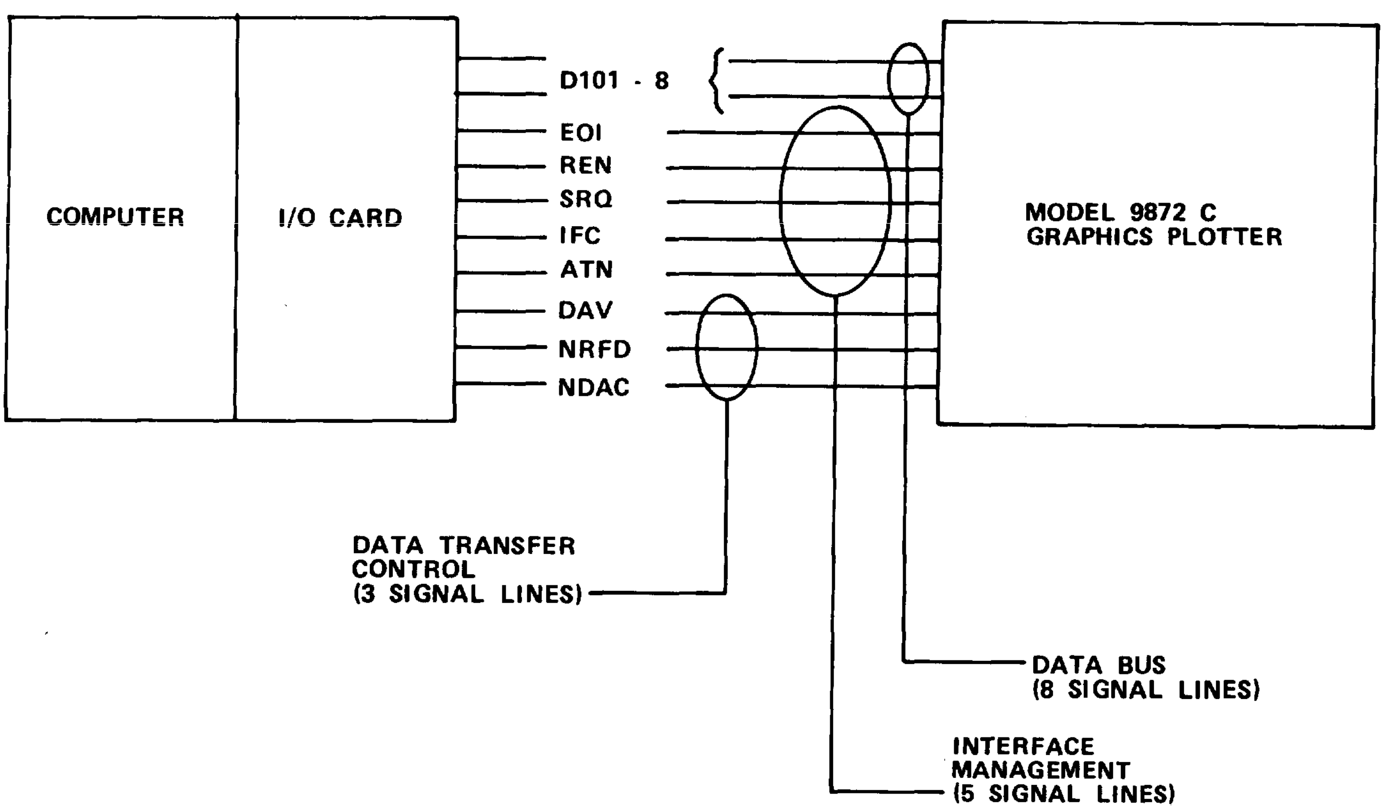
(7) The power supply converts the input ac line voltage into the necessary de voltages to operate the plotter. The power supply also contains the circuitry for the reset pulse and for the electrostatic paper hold down circuits.

3-12.2 Detailed. The detailed theory of operation is a block diagram description which includes a functional description of each block of the diagram.

a. Interconnect PCA A1 theory of operation. The interconnect PCA A1 houses the 24-pin connector for the input/output cable which connects the plotter with the external controller on the HP-IB interface system.

b. The interconnect PCA A1 also houses the CONFIDENCE TEST switch, LISTEN ONLY switch, and the ADDRESS switch. The CONFIDENCE TEST switch causes the plotter to perform a check of the plotter electronics, plot seven vectors, and light the front panel LEDs. The LISTEN ONLY switch, when activated, disables the talk and serial poll flip-flops. The ADDRESS switch module contains five slide switches wired as five single-pole double-throw switches. Each switch will input either a low in the 0 position or a high in the I position to the address comparator circuits of the main PCA A2.

c. Main PCA A2 HP-IB circuits. A 16-line bus is used to carry data and control information between the interconnected devices and is divided into three sets of lines:



(1) data bus - 8 signal lines - DI01 through DI08,

(2) data transfer control - 3 signal lines - (Handshake),

(3) interface management - 5 signal lines.

d. The data bus transfers 8-bit data or control words between the controller and the plotter. The words are in bit-parallel byte-serial form. The words are transferred bidirectionally. The three data transfer control lines, or handshake lines, are used to control the transfer of information on the data bus. These lines are identified as follows:

(1) Data valid (DAV) - used to indicate that valid information is available on the data lines.

(2) Not ready for data (NRFD) - used to indicate the readiness of the plotter to accept information.

(3) Not data accepted (NDAC) - used to indicate the acceptance of information by the plotter.

e. The five interface management lines are used to provide an orderly flow of information across the interface bus. In the operation of the 9872C plotter on the interface bus, the remote enable (REN) is not used. The five interface management lines are identified as follows:

(1) Attention (ATN) - used by the controller to specify how data on the 010 signal lines are to be interpreted (command, data, or parallel poll response), and which devices on the bus must respond to the data.

(2) Service request (SRQ) - used to indicate that the plotter needs attention and to request an interruption of the current sequence of events.

(3) Interface clear (IFC) - used by the controller to place the bus in a known quiescent condition.

(4) End or identify (EOI) - used by a talker to indicate the end of a multipie-byte transfer sequence or, in conjunction with ATN, to execute a polling sequence.

(5) Remote enable (REN) - not used.

f. Positive true logic is used within the plotter circuitry. A capital letter N before a mnemonic, such as NRFD, shows an inversion for that line.

Power up. When power is applied to the plotter, a $\overline{\text{reset}}$ signal is generated in the power supply. This reset pulse is used to clear flip-flops thus setting the plotter to a known condition. The NDAC and NRFD lines to the controller are set passive true indicating this idle condition. The reset pulse can also be generated by pressing the RESET switch S5 on the main PCA A2.

h. My address. The address comparator U235 compares the logic levels of the address switch settings with the first five data bits coupled through the bus receivers U231 and U233 from the data input/output (010) lines DI01 through 0105. If a valid address is on the bus, the logic levels of the two inputs will be equal, and the address comparator output will be true. This output is the my address (MA) signal which is used as an input to the talk U213A and listen U219B flip-flops. Having received a valid address, the plotter has to decode the data bits on DI06 and DI07 to determine if it is being addressed as an acceptor and set up its listen logic, or as a source and set up its talk logic circuits. If the LISTEN ONLY switch is in the listen only position, the talk circuits will be disabled regardless of the data bits on DI06 and DI07.

i. Acceptor (Listen) handshake sequence. When the controller is ready to transfer a control word on the data bus, it sends ATN true and EOI false. Control words are accepted by the plotter without microprocessor intervention. When the plotter receives the above two signals, it starts the handshake sequence:

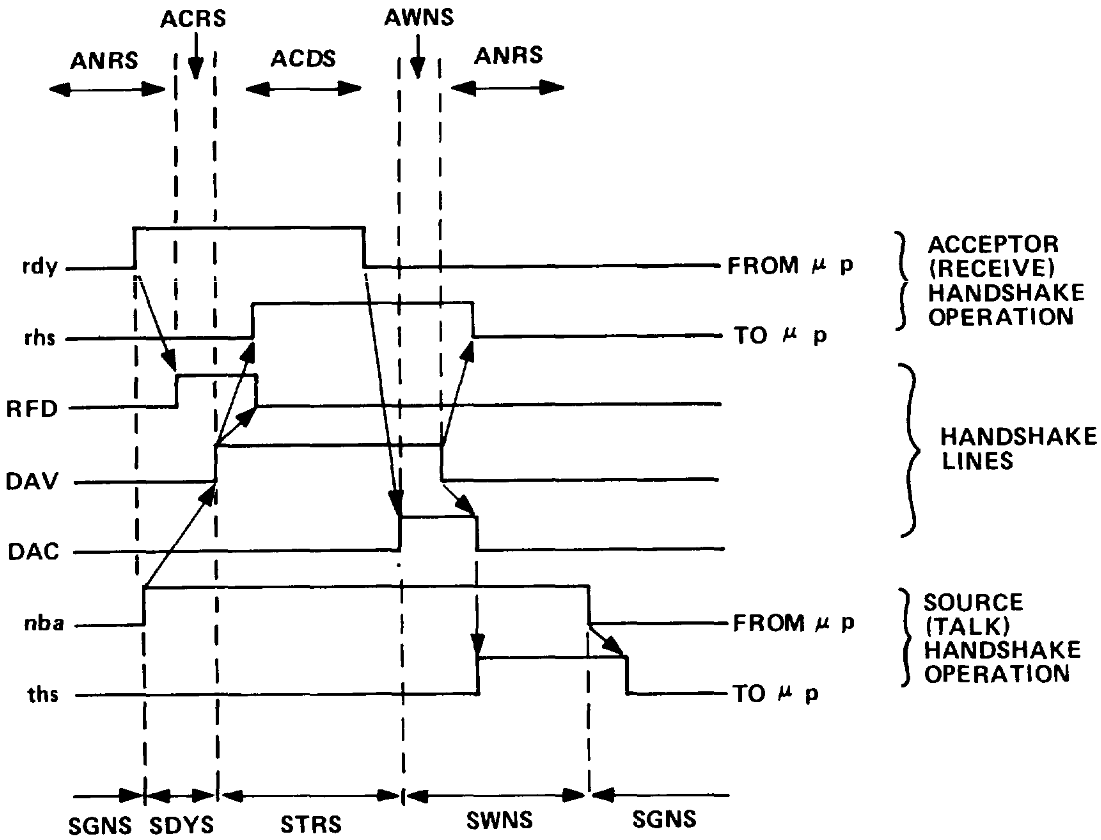
(1) The plotter indicates that it is ready to accept data by setting RFD true and DAC false.

(2) After RFD has gone true, the controller places a data byte on the eight data lines and sets the DAV true line.

(3) After the DAV line has gone true, the plotter sets the RFD false, accepts the data, and sets DAC true.

(4) After the DAC line has gone true, the controller can set DAV false again and take the data off the line. When DAV goes false, the plotter sets DAC back to false, and the sequence is ready to repeat the handshake sequence.

j. When the controller sends a valid address with DI06 true and DI07 false, the plotter is being addressed as a listener. Bit decoder logic gates U221D and U215C decode the true bit 6 and false bit 7 to provide a clock pulse; U235 provides the MA input; and gates U221A, U222B, and U212D decode bits 1 through 5 to provide unlisten command to the K input of the listen flip-flop U219B. The Q output of the listen flip-flop provides one input to the receive handshake gate U202A whose output is read into the microprocessor through the gate U208 during an HP-IB read cycle. A ready (rdy) signal from the microprocessor and the levels of the DAV and ATN and the Q output of the listen flip-flop U219B are decoded by U201A-D, U202A-C, U203F, and U226B. The decoded logic levels enable the bus handshake lines in the timing sequence shown.



HANDSHAKE TIMING

ALL SIGNALS SHOWN POSITIVE TRUE LOGIC.

k. Unlike control words, data transfer requires intervention by the microprocessor to complete the transaction. This occurs when the ATN line is false and the microprocessor generated signals ready (rdy), receive handshake (rhs), new byte available (nba), and talk handshake (ths) are used to complete the transfer.

l. Source (Talk) handshake sequence. The talk logic circuitry of the HP-IB provides the plotter with the capability to send data over the interface to the controller. This talk function is only enabled when the plotter is addressed to talk by the controller. After being addressed, the HP-IB address comparator generates a my address signal and, with the decoded bits 6 and 7, which determine the talk address, activates the talk logic circuits. The plotter talk function is deactivated whenever the controller puts any other talk address on the bus lines. When the controller sends a valid address with DI06 false and DI07 true, the plotter is being addressed as a talker. Bit decoder U215B and U221B decode bits 6 and 7 to provide a pulse to clock talk flip-flop U213A. The low Q output (talk) from U213A with the low attention (ATN) enable the nor gate U226D to provide a data enable (den) pulse to the bus transmitters U228 and U232 through nor gate U226A.

m. The microprocessor sends a new byte available (nba) which is gated through U220B and U220C and with data enable (den) and ready for data (RFD) sets the data available (DAV) latch U205 output true. The output of the serial poll flip-flop U213B and (den) set the nand gate U204C to output a false serial poll active state (spas) signal. This signal enables the data selectors U218 and U224 to select and couple the output of the transmit latches U217 and U223 through the transmitters U228 and U232 to the HP-IB lines. If the LISTEN ONLY switch is set for listen only, a low will be input to the clear and preset of the talk and serial poll flip-flops disabling them. This prevents the (den) signal from being generated, and the bus transmitters will not be enabled.

n. Service request. The service request (SRQ) allows the plotter to asynchronously request service from its controller. A service request is initiated when the plotter microprocessor generates a request for service (rsv) which causes the HP-IB service request logic circuit to set the SRQ line true. This true SRQ state indicates over the interface that the plotter is requesting service. The controller, upon detecting a service request, conducts a serial poll of all devices on the bus that may have requested service. To initiate the serial poll, the controller transmits the universal command SPE (serial poll enable), then sequentially commands each device on the HP-IB to talk.

o. The serial poll enable (SPE) command sets the serial poll mode flip-flop when the controller sets the plotter as a talker. The plotter indicates it has requested service by sending the status byte. The controller has the option of determining when and if the request will be granted.

p. Parallel poll mode. Parallel polling permits the controller to simultaneously check the status of up to eight devices on the HP-IB. The operator assigns each device a data line which the device will pull low during the parallel poll routine if it is requesting service. The parallel poll function requires that the controller periodically poll the instruments connected to the bus. The controller interrogates the instruments by sending EOI and ATN true. The plotter HP-IB circuitry decodes these messages with the parallel poll enable (ppe) signal from the microprocessor circuitry and activates the parallel poll driver circuit U236. This pulls the selected DIO line low indicating that the plotter is requesting service. The parallel poll address for the plotter is selected by the ADDRESS switch on the interconnect PCA A1.

q. Device clear (DCL) and selected device clear (SDC) function. The controller can set all devices on the HP-IB system to a predefined or initialized state by sending the universal command device clear (DCL). The controller can also set selected devices to this state by sending selected device clear (SDC). Upon receiving either command, the plotter decodes the data lines and sets the respective gates. The output of the enabled gate sets a DCL latch which requests that the microprocessor go to an initialized state. The microprocessor receives the request during its read interface (RDIB) cycle and determines when the request will be granted. The microprocessor next causes the HP-IB control gate to output a clear knowledge (cla) pulse to reset the data clear latch when the next write interface bus (WRIB) cycle occurs.

r. Main PCA A2 processor circuitry. The plotter microprocessor is a 16-bit word controller which essentially accesses and processes instructions from memory. It also performs mathematical operations and controls the flow of data on the plotter bus. The microprocessor circuitry also contains a clock generator, memory timing and decoding circuits, bidirectional drivers, register decoders, and interrupt and self test registers. Refer to Table 3-14 for microprocessor definitions.

Table 3-14. MICROPROCESSOR DEFINITIONS

Mnemonic	Name	Definition
SYNC	SYNCHRONOUS	A synchronizing signal generated by the microprocessor denotes when microprocessor is in an instruction fetch cycle.
$\overline{\text{STM}}$	$\overline{\text{START MEMORY}}$	A signal generated by the microprocessor which is essentially the system timing signal. The signal's leading edge indicates that there is a stable address on the bus. When the signal is true, it indicates a memory reference is in process.
$\overline{\text{UMC}}$	$\overline{\text{UNSYNCHRONOUS MEMORY COMPLETE}}$	A handshake signal indicating that a memory or a register is ready to process data.
SMC	SYNCHRONOUS MEMORY COMPLETE	A signal generated by the microprocessor when data, or an instruction, is on the bus. The trailing edge indicates that the microprocessor has accepted data. UMC must be present for the microprocessor to generate SMC.
$\overline{\text{PDR}}$	$\overline{\text{PROCESSOR DRIVING}}$	A signal generated by the microprocessor denotes when the microprocessor is driving the MOS bus.
RD	READ	A microprocessor generated signal indicating when memory is in a READ/WRITE state.
RAL	REGISTER ACCESS LINE	A microprocessor generated signal to decode registers 20-27.
$\overline{\text{PON}}$	$\overline{\text{POWER ON}}$	A power-up signal to the microprocessor. Begins program execution at 40_8.
$\overline{\text{INT}}$	$\overline{\text{INTERRUPT}}$	A signal from the interpolator section signifying it is ready to receive new velocity data. The INT signal forces the microprocessor to execute "JSM10,I" instruction.

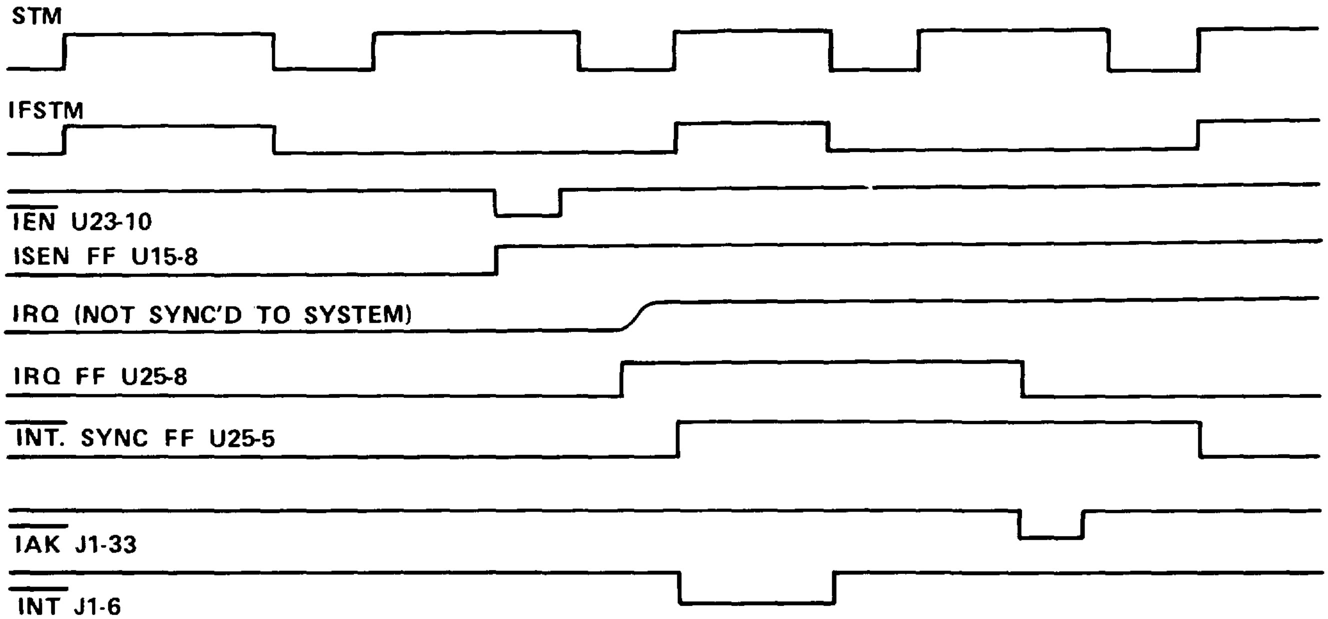
Table 3-14. MICROPROCESSOR DEFINITIONS - Cont

Mnemonic	Name	Definition
$\overline{\mathrm{FLG}}$	$\overline{\mathrm{FLAG}}$	A self-test switch input which, when actuated, causes system to go to the next step.
$\overline{\mathrm{STS}}$	$\overline{\mathrm{STATUS}}$	Indicates on power-up whether the system is in normal operation or self-test.
IFSTM	INSTRUCTION FETCH START MEMORY	A signal where the rising edge denotes address of an instruction.
$\overline{\mathrm{IAK}}$	$\overline{\mathrm{INTERRUPT\ (READ\ 10)}}$ ACKNOWLEDGE	Acknowledges that an interrupt has been accepted.
XSMC	EXTENDED SYNCHRONOUS MEMORY COMPLETE	Extends the SMC to allow time needed by MOS memories to stabilize data.

s. Clock generator. The output of the crystal controlled 10 MHz oscillator provides the clock input for the divide by two flip-flop U60A which in turn provides two 5 MHz pulsed inputs to the clock driver circuit. The clock driver U63 outputs are MOS level non-overlapping clock pulses referred to as phase 1 (PH1) and phase 2 (PH2). These two signals provide all timing for the plotter and the clock drive to the microprocessor.

t. Microprocessor. Using the clock input, the microprocessor issues the appropriate timing signals to initiate and maintain the proper sequence of events required for processing data and instructions. The activities of the microprocessor are cyclical; fetching an instruction, performing the required operations, and then fetching the next instruction in an orderly, timed sequence.

(1) The main timing signal from the microprocessor is start memory ($\overline{\mathrm{STM}}$), indicating the start of a memory read cycle. The falling edge of STM is used to latch the memory address into the 3-state address latches U52 and U53. The rising edge of synchronous memory complete (SMC) indicates the end of memory access cycle, with the data being latched into either the microprocessor (READ cycle) or into RAM (WRITE cycle). In order to satisfy the access time requirements of RAM and some of the internal I/O circuitry, SMC is extended by the use of unsynchronous memory complete UMC to generate extended synchronous memory complete (XSMC). The microprocessor bus is buffered by the use of bidirectional drivers U46 and U47. The MOS (memory) bus is further isolated from the TTL bus by the use of bidirectional drivers U49 and U50.



INTERRUPT REQUEST TIMING

(2) The microprocessor uses a single level of interrupt to update the interpolator section. This interrupt request is synchronized to the microprocessor instruction fetch cycle by the latch U60B, gate U31A, and latch U28B.

u. Self-test circuitry. The built-in self-test provides a means of locating a defective stage or component and is an aid in performing certain alinements. The circuitry consists of the CONTINUE switch S3, the self-test switch S4-2, RESET switch S5, U68, and the self test LEDs.

v. Register decoders. Register selection is determined by the data bits A0-A4 and the states of the register access line (RAL), synchronous memory complete (SMC), extended synchronous memory complete (XSMC), and read lines from the microprocessor, The functions of the register lines are listed in Table 3-15.

Table 3-15. REGISTER FUNCTIONS

Register	Operation	Function
20	R	Read Self-Test
	W	Write Self-Test
21	R	Read Confidence Test
	W	Write to HP-IB Interface
22	R	Read HP-IB
	W	Write HP-IB
23	R	Read Front Panel & Paper Advance
	W	Write to Paper Advance
24	R	Not Used
	W	
25	R	Inhibit Interrupt
	W	Enable Interrupt
26	R	Read Front Panel
	W	Write Front Panel
27	R	Read Front Panel
	W	Write Front Panel

w. MOS and TTL bus drivers. The MOS and TTL bus drivers are 3-state bidirectional bus drivers (BIBs) which provide a two-way data transmission between the microprocessor and the various circuits of the plotter. BIBs U46 and U47 buffer the microprocessor bus from the MOS bus which interfaces with the memory circuits and the TTL BIBs. These BIBs are enabled by delayed extended synchronous memory complete (DXSMC). The direction that these BIBs are driving is controlled by the microprocessor generated processor driving (PDR). When PDR is low, the BIBs drive out to the bus, and with PDR high, the BIBs drive toward the microprocessor. Further buffering is provided for the HP-IB circuitry and the front panel by the BIBs U49 and U50. Direction control for these BIBs also comes from PDR, while the enable signal is generated in the memory timing circuits.

x. Memory timing. The memory timing generates the necessary waveforms from the microprocessor control signals to insure proper timing for the memory and I/O data transfers. A typical READ cycle begins when the microprocessor places an address on the bus. One clock period later, STM goes true indicating that the address is valid and that the address latches should store the information. One clock period after receipt of STM, the memory timing sends back UMC. At this time, the microprocessor removes the address from the bus. One-half clock period later, XSMC goes high which allows the memory output drivers to be enabled. At the trailing edge of SMC, data must be stable in order for the microprocessor to store the data in its accumulator register. At the same time, the output drivers are disabled.

y. Main PCA A2 internal I/O circuitry. The internal I/O circuitry provides buffered interconnection between the Front Panel PCA A3 and the processor circuits. A front panel READ will put the status of the front panel switches on the plotter TTL bus. A front panel WRITE causes the selected front panel LEDs to light up. READ registers 23, 26, and 27 are used to put front panel PCA data on the TTL bus, while WRITE registers 21, 23 ,, and 27 are used to enable the LEDs on the front panel assembly. These registers are stored in memory locations 20_8 through 27_8 and are decoded in the microprocessor circuitry by U33 and U38 using READ, RAL, and addresses A0-A2.

z. Front panel PCA A3. The front panel PCA A3 provides a means for the operator to set CHART HOLD or CHART LOAD, and to manually select a pen, control pen up or down, and to enter certain position data to the plotter. The operator may also receive status information concerning the plotter operation from the LEDs on the front panel. The front panel PCA circuits interface with the main PCA A2 through the internal I/O circuitry. The front panel PCA houses switches which indicate to the plotter which pen stalls are loaded with pens, or if a pen is presently in the pen arm. The PCA also provides an interconnection for the X- and Y-limit switches.

aa. Main PCA A2 memory circuit. The memory capacity of the plotter is 9k sixteen-bit words. The memory includes the following:

(1) Read only memory (ROM)
8192 words of ROM. (8k x 16)

(2) Read/Write random access memory (RAM)
1024 words of RAM. (1k x 16)

ab. Read only memory. The ROM consists of two 8-bit wide mask programmable ROMs configured as 8k of 16-bit wide memory. ROMs U55 and U56 are 8k devices, and they represent memory locations 00000_8 through 17777_8. These ROMs contain the firmware instructions to drive the plotter and communicate with the HP-IB controller through the I/O. Program execution begins at memory location 40_8 after the microprocessor receives the power-on pulse.

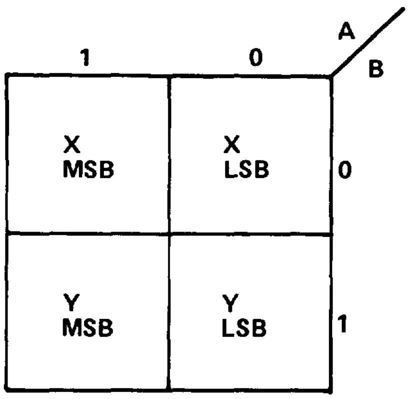
Random access memory. The RAM consists of four 1k by 4 Read/Write Memories U64, U65, U66, and U67 configured as 1k by 16. The RAM is used as temporary storage for various plotter operations and as a buffer for incoming data. The RAM occupies memory locations 76000_8 through 77777_8.

ad. Memory control logic. The 15-bit memory address register consists of two 8-bit bistable latches, U52 and U53, which latch the address off the plotter bus on the rising edge of STM. The first 13 outputs are supplied to the 8k ROMs to select specific memory locations. The ROMs are enabled by addresses 13 and 14 along with STM, READ, and R10 + RAL. The RAM address locations are accessed by the first 10 outputs of the address register. The devices are enabled by addresses 10 and 14 along with XSMC. The READ line determines if a READ or WRITE function is occurring.

ac. Main PCA A2 interpolator circuitry. The interpolator circuitry of the main PCA receives the X- and Y-velocity data from the processor, integrates, and converts the data into analog signals for the motor driver circuits.

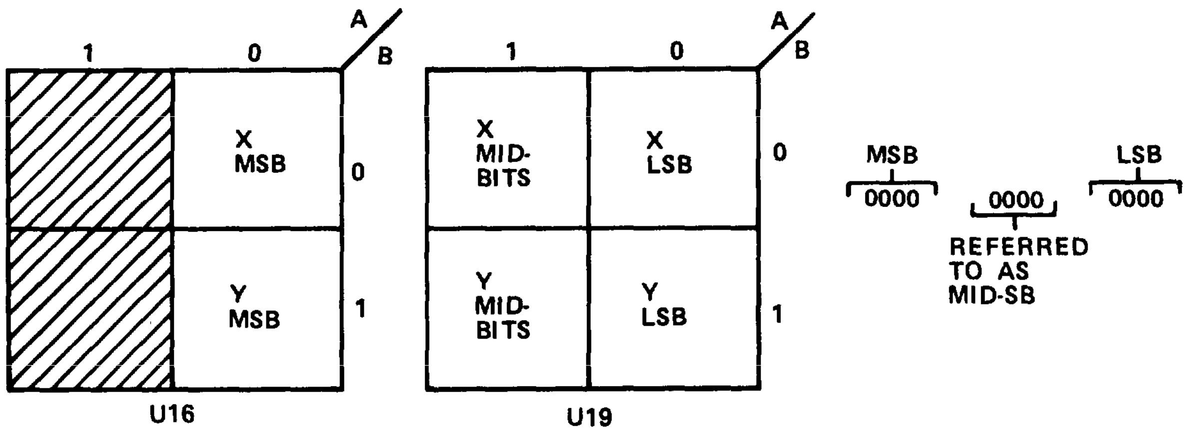
During the 1024 microsecond operating cycle, the motor position is updated eight times. This is accomplished by adding 1/8 of the input velocity word, which is an 8-bit, signed two's complement, with a maximum value of plus or minus decimal 90, to the position accumulator during each of the eight subcycles. The velocity word is added in these small increments to provide a smoother motor operation.

af. Operating cycle. The interpolator operating cycle is begun with the positive transition of the interrupt request (IRQ) from U22. The microprocessor responds and the interpolator write (W26) latches the first half of the velocity word (bus 12-15) into one of four registers of the input data register U25 as selected by the address bits (bus 0-1).



REGISTER SELECTION ADDRESSING

(1) The latching of data into U25 is accomplished during the Y-axis portion of the eighth subcycle of the previous interpolator cycle. The-first subcycle places the four least significant bits (LSB) of the X-axis instruction on the inputs of the data selector U26. The data selector couples the X LSB to the Y inputs of the adder U24. At this time, the Z inputs are the four LSBs from the previous subcycle, input through U21. The output of U24 is the sum of the Y and Z inputs and the carry input (X) from the carry adder U27. If a carry-out from the previous summation in U24 exists, it is clocked through U27 and becomes a carry-in to U24 for the present subcycle. The carry input to U24 is set low every 16 clock pulses to assure that the carry is clear at the beginning of each new cycle.



SIMPLIFIED ACCUMULATOR STORAGE LOCATION

(2) The output from U24 is loaded into the four LSB registers of the X accumulator U19. The data transfer to U19 is accomplished when U19 is enabled by the write enable decoder U10. The decoder is enabled by the clock signal and a write signal from control ROM U20.

(3) Having stored the X-axis LSB in U19, the X-axis most significant bits (MSB) are loaded into the adder U24. These are summed with the X MID SB from the preceding subcycle and stored in the MID SB register of U19. With the next clock pulse, the output of the data register remains constant. The data selector U26 couples the sign bit of the MSB to the Y input of the adder U24, while the MSB from the previous subcycle is coupled to the Z input. These bits and the sign bit are summed and latched into the MSB register of U16 by the write enable decoder U10C. This completes the updating of the X-axis accumulator for this subcycle.

(4) The output of the accumulators is used to address the sine/cosine ROMs U9 and U15. The four LSBs and the sign bit of the MSB are not used to address the ROMs, but are retained for use in further computation. The output function of the ROMs is controlled by the inputs to pins 14 and 15. See Table 3-16. ROM U9 generates the four LSB inputs to the digital to analog converter (DAC) U7, while U15 outputs the four MSBs to U7.

Table 3-16. ROM FUNCTIONS

PIN 14	PIN 15	ROM OUTPUT
Low	Low	Cosine, 3rd Harmonic
High	Low	Cosine Fundamental
Low	High	Sine, 3rd Harmonic
High	High	Sine Fundamental

ag. Digital to analog converter. The DAC U7 produces differential output currents which are linear products of the digital input and the dc current reference at pin 14. The op. amp. U3 converts the differential currents to a voltage source for the analog switches U2 and U4. If the plotter motors are stationary, the power control U27 turns the transistor Q2 on, shunting the reference circuit, reducing the output current from U7.

ah. Interpolator output. During each subcycle, U3 must output four discrete signals in each axis. These are:

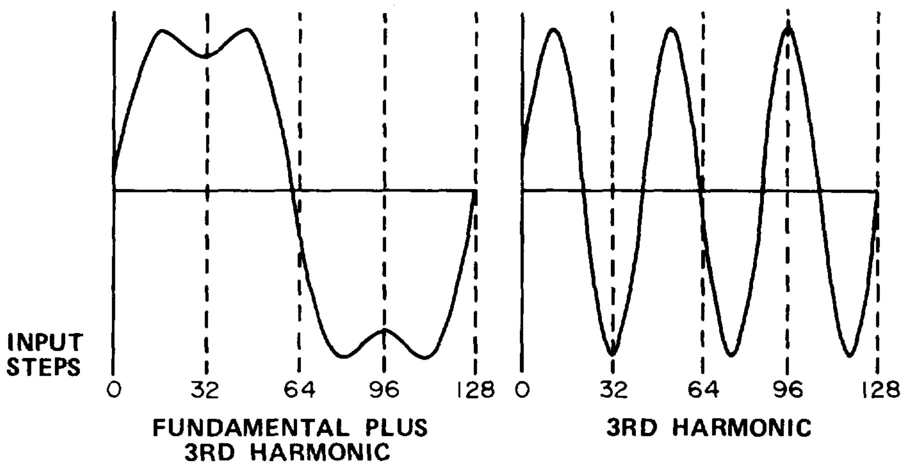
cosine 3rd harmonic,

cosine fundamental plus 3d harmonic,

sine 3rd harmonic,

sine fundamental plus 3rd harmonic.

(1) Demultiplexers, in the form of analog switches U2 and U4 with their associated buffers U1 and U8, combine the fundamental and harmonic pairs and then separate these pairs into the four analog signals for the motor drivers.



SINE/COSINE ROM VALUES

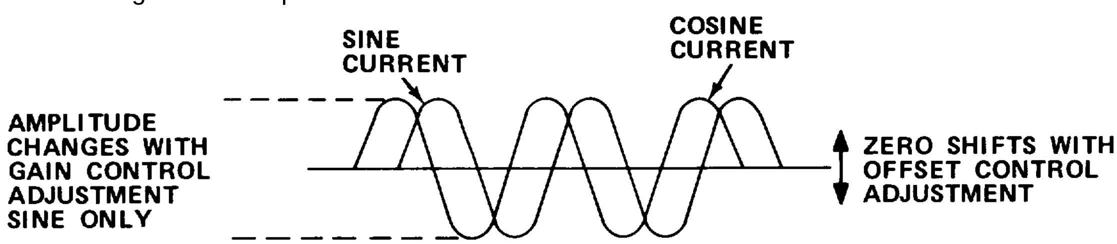
The fundamental plus 3rd harmonic consists of the fundamental frequency plus an in-phase quarter amplitude 3rd harmonic.

(2) At the start of each subcycle, the X cosine 3rd harmonic is output by U7. U4-S1 is closed, and the value of the harmonic is stored on C34 and buffered by U8A to the X and Y 3rd harmonic adjustment potentiometers R38 and R39. At this time, the X cosine fundamental plus 3rd harmonic is output from U7. The analog switch U4-S2 and U4-S4 are closed, as is U2-S4. A portion of the 3rd harmonic, selected by the setting of R38, is subtracted from the fundamental in U3. The result is stored in C8, buffered by U1C, and applied to the X phase-B motor driver. The same sequence is followed for the X sine, Y sine, and Y cosine in order.

ai. Main PCA A2 motor driver circuitry. The motor driver circuitry provides amplification of the interpolator outputs required to drive the X- and Y-axis stepper motors and the paper advance motor, if installed.

(1) Following the path of the X cosine signal, from the buffer U1C, the signal passes through the mute switch S1. This switch allows for muting of the X-axis motor during servicing or alinement procedures.

(2) The first stage of the X cosine motor driver is U5 which functions as a high gain integrator to the signal. The 10 kHz oscillator signal from the power supply is also input at this stage to develop the required triangular switching signal. Feedback from the motor is also sensed here for precision current control. The offset potentiometer is used to establish the baseline reference for the drive signal. In the X- and Y-phase A amplifiers, the gain potentiometers allow matching of-the relative gains of phases A and B.



DRIVE CURRENT WAVESHAPES

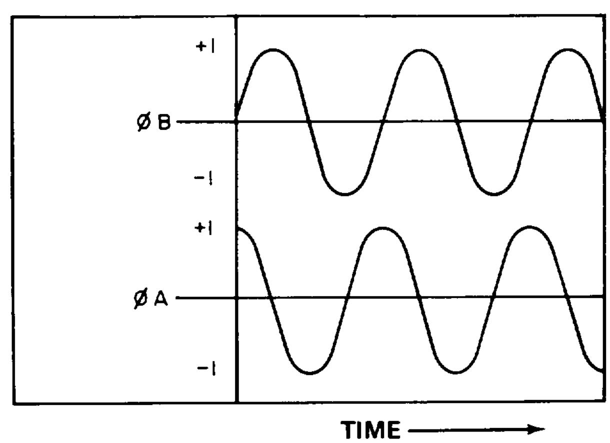
(3) The triangular output of U5, plus the signal, is applied to the comparator U11 along with a feedback signal from-the motor. The resulting squarewave output has an amplitude of approximately 25 volts.

(4) During power-up and the paper advance switching sequence, the U11 output is disabled by the conduction of transistor Q5. The ZPWR signal is used to turn on Q5. The resistor R23 in the feedback path acts as a current sensing resistor. This provides a convenient location for testing circuit action.

COUNTERCLOCKWISE		CLOCKWISE*	
MOTOR WINDING PHASE			
ØA	ØB	ØA	ØB
+I	+I	+I	+I
+I	-I	-I	+I
-I	-I	-I	-I
-I	+I	+I	-I
+I	+I	+I	+I

*WHEN VIEWED FROM THE MOUNTING END OF MOTOR

+1 DEFINED AS CURRENT FLOW FROM BLACK TO ORANGE LEADS OF MOTOR (PHASE A) AND FROM RED TO YELLOW LEADS OF MOTOR (PHASE B)



MOTOR WINDING DRIVE CURRENT FOR CLOCKWISE ROTATION

MOTOR DRIVE CURRENT AND SEQUENCING

(5) The squarewave output of U11 drives the ground-based transistor pair Q9 on the positive half-cycle and Q13 on the negative half-cycle. The transistor Q17 provides the necessary current gain to gate the FET Q25. The transistor Q18 provides inversion as well as gain for the FET Q26. The FET switching action provides the current required to microstep the plotter motor.

aj. Power supply assembly, The power supply consists of three PCAs, a rear panel, and the power transformer, which is mounted in the lower case assembly.

ak. Primary Circuits. The ac line input connection is through the receptacle mounted on the rear panel. The ac line fuse holder is also mounted here. From the rear panel, the ac input is wired to the primary PCA A5. Mounted on this PCA are the broad band line filters L1 and L2, the LINE switch S1, and the voltage selection jumpers W1-W3. These jumpers are inserted in sockets to match the plotter primary circuits to one of four ac line voltages. Jack J1 connects the primary PCA with the primary side of the power transformer T1. The secondary of the transformer is connected through J5 to the filter and rectifier circuits of the power supply PCA A4. This rectifier circuit supplies the plus and minus 34 volts which supplies the main power supply and the X- and Y-motors.

Table 3-17. POWER SUPPLY OUTPUTS

Supply	Type	Use
±34 V	Zener regulated and balanced	Motor driver and power supply circuits
+5 V ref	Zener regulated	Power supply reference, reset, and chart hold
+12 V aux	Zener regulated	Power supply operation
+5 V	Regulated switching supply	Plotter operating voltage
+12 V	Regulated switching supply	Plotter operating voltage
+46 V	Zener regulated	+FET gate supply
-22 V	Zener regulated	-FET gate supply
-12 V	Zener regulated	Plotter operating voltage
±12 V	Interlocked	Motor driver and balance circuit shutdown

al. Reference supply. The +34 volt main power is the source for the reference supply which controls all other power supply voltages. This Zener-regulated supply produces a +5 volt reference and a +12 volt auxiliary supply. These voltages come up first and are used to control the switching supplies, balance circuit, and the 20 kHz oscillator circuit.

am. Voltage balance circuit. The X- and Y-plotter motors form inductive loads across the ±34 volt supplies. With the switching action of the motor drivers, it is possible to generate counter-induced voltages which would drive one or the other of the 34 volt supplies to a high level. To prevent the possibility of this happening, a balance circuit has been provided for the ±34 volt supplies. Any imbalance created by the counter-induced voltages is sensed at the junction of resistors R66 and R74 in the balance circuit. With a balanced condition, this point is maintained at zero volts.

(1) Any voltage at the tie point is sensed at the inverting input of the comparator US along with the integrated signal from the 20 kHz oscillator. With the +34 volts high, during the negative half-cycle output from U5, transistor Q27 will be conducting. This turns on transistor Q18, which in turn gates the FET Q20 on, drawing current from the +34 volt supply. The FET Q20 will pump current into inductor L3. During the positive half-cycle out of U5, transistors Q26 and Q21 will be turned on, gating the FET Q22 on. The current established in L3 continues to flow during this half-cycle through FET Q22, acting as a diode, in a direction opposite the normal flow. This current charges the -34 volt supply, and this action, combined with the loading of the +34 volt supply, brings the two supplies into balance. When the supplies are in balance, a null will again exist at the tie point of the resistors R66 and R74.

(2) The comparator U4 and its associated components acts as a safety system by sensing the average current through the inductor L3 and the resistor R61. If this current tries to exceed 3 amps, Q24 and Q25 feed back a signal to limit the current at 3 amps to prevent circuit damage.

(3) During power-up or reset, the balance circuit is disabled by transistor Q28. This disabling action prevents any attempt at a balancing action before all voltages have had time to stabilize.

an. Positive 5 volt switching supply. Switching circuitry is used to develop a regulated +5 volts from the unregulated +34 volt supply. The +34 volts is applied to the FET Q15. When the FET is conducting, a ramp of current is developed in the inductor L2, which charges the capacitor C15 to the output voltage of +5 volts. The 20 kHz oscillator output is integrated, and the sawtooth is applied to the comparator along with the 5 volt reference from the reference supply, and the +5 volt sense, which is the +5 volt output from the power supply. The output of U3 switches according to the relationship between the two 5 volt levels. If the +5 volt sense is low, the on time of the FET Q15 will increase, increasing the current flow in L2, thus increasing the charge on C15. If the +5 volt sense is high in comparison with the reference, the on time of Q15 will be reduced, allowing the charge on C15 to bleed down to the proper level.

ao. Positive 12 volt switching supply. The functioning of the +12 volt switching supply is essentially identical to that of the +5 volt switching supply. The resistors R14 and R16 at the non-inverting input of U3 form a voltage divider. This divider drops the feedback voltage from the +12 volt output of the supply allowing the use of the +5 volt reference voltage as the reference in this supply as it is in the 5 volt switching supply.

ap. Negative 12 volt supply. The -12 volt supply is a low current, Zener-regulated emitter-follower circuit. The thyristor Q32 has been included for circuit overload protection.

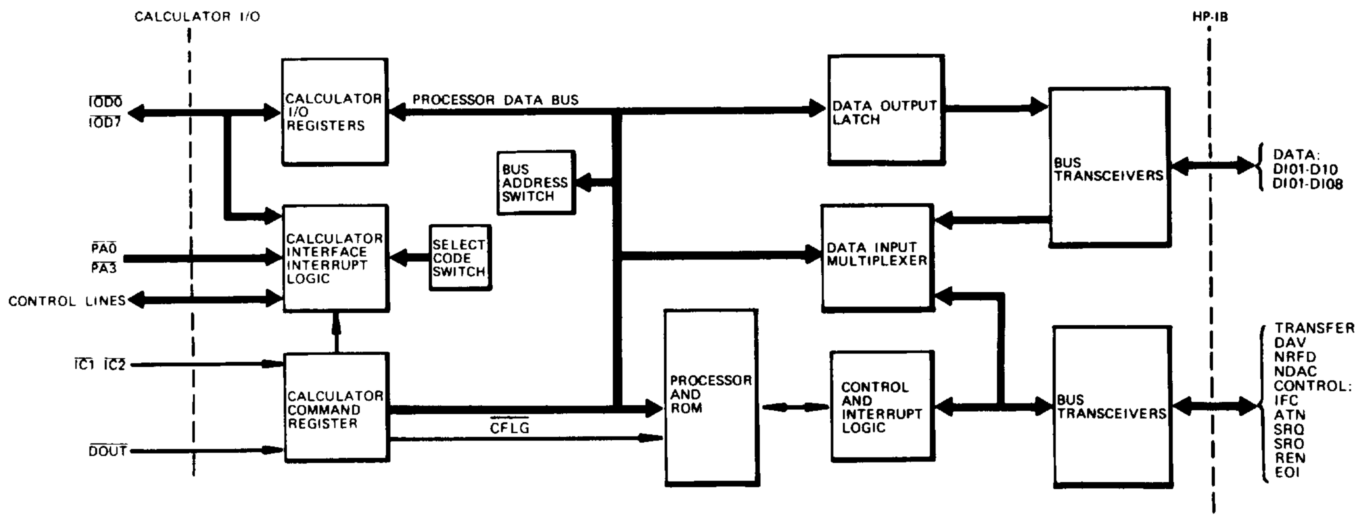
aq. FET gate supplies. The positive FET gate supply is a doubler and regulator, producing an output which is maintained at a level 12 volts more positive than the +34 volt main supply. The nominal level is +46 volts. The negative FET gate supply is a Zener-regulated supply producing a voltage which is 12 volts less negative than the -34 volt supply. The nominal level is -22 volts.

ar. Power-Up reset circuit. The reset circuit on the chart hold PCA A6 provides a negative pulse 70 milliseconds in duration at power-up. This pulse disables the balance circuits, motor drive circuits, and provides a reset pulse to the microprocessor circuits.

as. Electrostatic power supply. The electrostatic power supply on PCA A6 develops a high voltage at a very low current to hold the chart against the platen. This is a ringing circuit charging two parallel capacitor networks. Transistor Q101 is switched on and off by the 20 kHz oscillator signal. The transistor base voltage is controlled by U102 and Q102, while the emitter current is limited by resistor R114. While Q101 is switched on, a ramp of current is created in the inductor L101. When the transistor is turned off, current continues to flow, charging stray capacitance to a high level. When the charge on the inductor is greater than the charge on the capacitors C102 and C103, the diodes CR102 and CR103 conduct, charging these capacitors. Resistors R102, 103, 105, and 106 current limit the high voltage to the platen. The open circuit voltage to the platen is approximately 900 volts.

at. Pen lift drive. The pen lift drive is a switched current source providing approximately 250 mA to the pen solenoid. When Q10 is switched on, the voltage is applied to the solenoid, lowering the pen to the paper. When the transistor is switched off, the pen is raised by spring action.

3-3.3 HP-IB Interface. The interface performs four major functions: interpreting control bytes from the calculator, transferring data bytes from the calculator to the HP-IB, transferring data bytes from the HP-IB to the calculator, and transferring status information to the calculator. The processor monitors the status of both the calculator I/O and the HP-IB. It determines if the calculator is requesting an I/O operation by monitoring the CFLG (Calculator Flag) line from the calculator command register. If this signal is true, the processor issues the appropriate instructions to the other modules to decode and execute the requested I/O operation. The processor monitors the status of the HP-IB by periodically sampling its control lines (ATN, SRQ, REN, IFC, and EOI) and its transfer lines (DAV, NRFD, and NDAC) via the data input multiplexer. If a condition is detected that requires action (for example, a require service message) the processor issues the appropriate instructions to complete the operation requested.



a. Select code decoder and switch. The function of the select code decoder is to determine when the interface is addressed by the calculator. The interface responds only when the code on the peripheral address lines, PAØ through PA3, matches the select code set on the select code switch. Receiving the preset code enables the interface to look for an I/O command from the calculator. When the interface is ready for an I/O operation, the interface indicates its presence to the calculator by setting the flag line (FLG) low and setting the status line (STS) low when no error conditions exist on the interface.

b. I/O register decoder and calculator command register.

(1) The I/O register decoder is a network of gates which interprets the type of I/O operation being requested by the calculator. It determines whether the transfer is an input or output operation by looking at the DOUT line. For an output operation, the data on the calculator input/output data lines (IODØ through IOD7) is latched into the calculator output data register when the I/O strobe pulse (IOSB) occurs. For an input operation when the calculator is not conducting an interrupt poll (INT), the data in the calculator input data register is placed on the calculator data lines. For both input and output, the code on the DOUT, IC1, and IC2 lines is latched into the calculator command register when the I/O strobe pulse (IOSB) occurs.

(2) The calculator command register consists of a 4-bit latch and four open-collector nand gates. The latch holds the I/O register code (R4 through R7) determined by IC1 and IC2 and the direction of the I/O transfer determined by DOUT. In addition, one bit of the latch is always set when the calculator requests an I/O operation. This bit is buffered through one of the nand gates and becomes the calculator flag line (CFLG). Setting this line true causes the flag line (FLG) to go high, indicating that the interface is busy. The other three nand gates are used to gate the DOUT, IC1, and IC2 signals onto the processor's data bus when it issues a read calculator command register (RCCR) instruction. When the processor has executed the requested I/O operation and is ready for another I/O operation, it issues a clear calculator command register (CCCR) instruction, which clears the calculator command register and readies the interface for another I/O operation.

c. Calculator I/O data registers. The calculator output data register consists of two 4-bit latches and eight open-collector nand gates. This register holds the data to be transferred from the calculator to the interface. The data contained in the latches is gated onto the processor data bus when the processor issues a read calculator output data (RCOD) instruction.

The calculator input data register consists of two 4-bit latches and eight open-collector nand gates. The data on the processor data bus is latched into the two 4-bit latches when the processor issued the send calculator input data (SCID) command. The data in this register is transferred to the calculator input/output data lines when the calculator requests an input operation.

d. Calculator interrupt logic. The calculator interrupt logic allows the interface to request service from the calculator. The calculator interrupt logic is a network of gates and a one-of-eight decoder. This logic pulls the appropriate interrupt request line (IRL or IRH) low when the processor issues a calculator interrupt request (CIRQ) instruction and the calculator is not conducting an interrupt poll (INT). IRL is pulled low when the select code switch is set to an address between 0 and 7, and IRH is pulled low when the switch is set between 8 and 15. When the calculator senses a service request, it conducts an interrupt poll to determine when interface requires service. A poll is conducted when INT is low. When the most-significant address bit from the select code switch, the calculator interrupt logic pulls one of the calculator input/output data lines low. The setting of the select code switch determines which line is pulled low, as shown.

Interrupt Request Bits

Select Code	Line Pulled Low
0 or 8	IODØ
1 or 9	IOD1
2 or 10	IOD2
3 or 11	IOD3
4 or 12	IOD4
5 or 13	IOD5
6 or 14	IOD6
7 or 15	IOD7

e. Control logic. The processor, ROM I/O register selector, and oscillator form the control logic portion of this interface. The processor controls all interface operations by issuing instructions via seven control lines, the 8-bit processor data bus, and selecting I/O registers via the I/O register selector. The algorithms for interface control and the implementation of the HP-IB interface functions are contained in the 4096-bit ROM. The oscillator generates a 2 MHz (approx.) asymmetrical waveform which is used as the main clock for the processor and as the enable signal for the I/O register selector.

f. Processor interrupt logic. The processor interrupt logic is a network of gates that provides the ability to interrupt the processor for either of two conditions: when an abort message (IFC) is received from the HP-IB, or when the control line ATN is set true by the controller in charge.

(1) An interrupt occurs for the second condition only when the calculator is not the active controller.

(2) The processor enables the interrupt logic via the interrupt enable (IENA) line. When an abort message is received via the HP-IB, the interrupt causes the processor to generate a 100 microsecond pulse on the IFC line and then initializes all of the HP-IB interface functions within the interface. The IFC line was previously set true as the result of an I/O operation from the calculator.

(3) When the interface is not the active controller, the processor not only enables the interrupt logic via the interrupt enable line, but also sets the immediate control line (IMD) true. When an abort message is received, the interrupt logic generates a vectored interrupt to the algorithm which initializes all of the HP-IB interface functions. In addition, when the controller in charge of the HP-IB sets the ATN line true, the interrupt logic immediately clears the HP-IB output data latch and disables the HP-IB transceivers for the HP-IB data lines (DI01 through DI08), the DAV line, the NRFD line, and the EOI line; then the NDAC line is set low. This leaves the interface ready to receive data from the controller. A vectored interrupt is also generated to the algorithm which controls the acceptance and analysis of the data sent by the controller.

g. HP-IB output data and control bus latches.

(1) The HP-IB output data latch consists of two 4-bit latches. Data is transferred from the processor data bus into this 8-bit latch when the processor issues the send interface bus data (SIBD) command. The outputs of this latch are routed to the HP-IB data lines via the drivers contained in the HP-IB transceivers.

(2) The HP-IB control bus latch is a 5-bit latch which holds the bit pattern to be applied to the HP-IB control lines (EOI, ATN, SRQ, REN, and IFC). The appropriate bit pattern is transferred from the processor data bus into this latch when the processor issues the send interface bus control (SIBC) command. This latch consists of one 4-bit latch and one D flip-flop. The outputs of this latch are routed to the bus drivers contained in the HP-IB transceivers.

h. HP-IB address register. The HP-IB address register consists of a hex, tri-state buffer and six switches. Five of the switches are used to set the five least-significant bits of the HP-IB talk/listen address. When each switch is off, its corresponding bit is set to a logical 1. The HP-IB address switches are connected to the five least-significant bits of the processor data bus (DØ through D4). In addition to the HP-IB address switches, this module also contains the system controller switch. When this switch is on, the interface assumes the role of system controller. This switch is connected to bit D5 of the processor data bus. The contents of this register are gated onto the processor data bus when the processor issues a read interface bus address (RIBA) instruction.

i. Data input multiplexer. The function of the data input multiplexer is to route either a data byte (DIO1 through DI08) or a control byte (EOI, ATN, SRQ, REN, IFC, DAV, NRFD, and NDAC) from the HP-IB transceivers to the processor data bus. The processor selects the data byte by issuing the read interface bus data (RIBD) command. The control byte is selected when the processor issues the read interface bus control (RIBC) command.

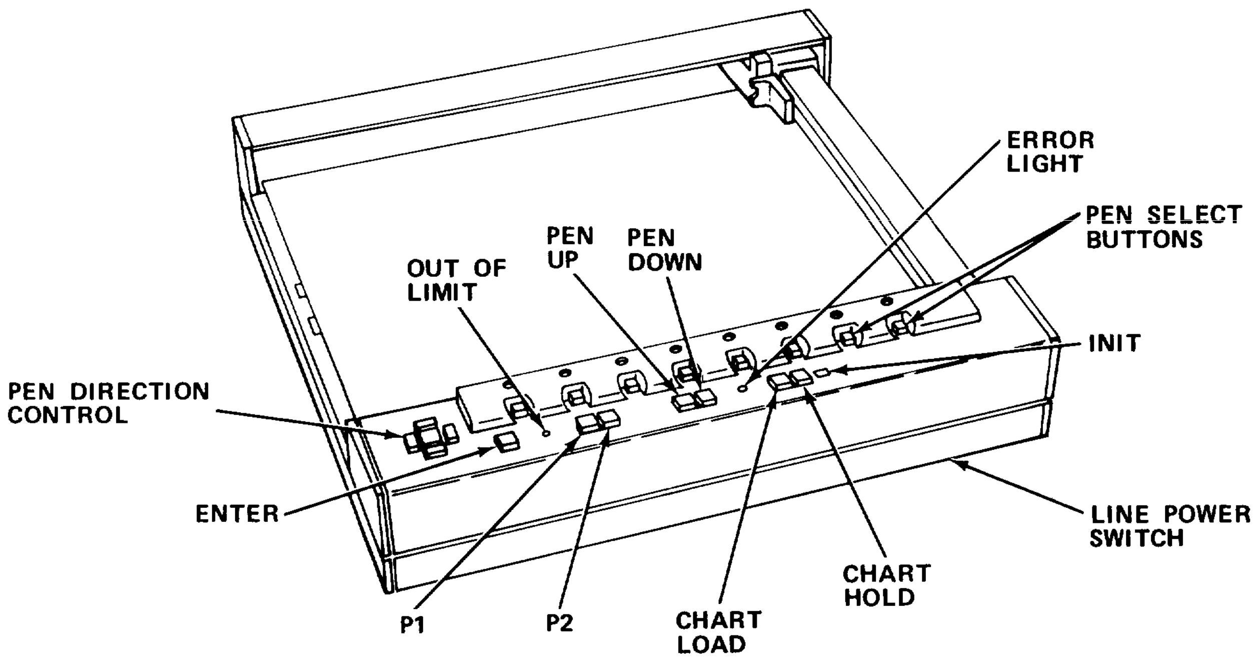
j. HP-IB transceivers. The interface uses four bus transceiver modules. Two are used for the HP-IB data lines (DIO1 through DI08) and two are used for the HP-IB control lines (EOI, ATN, SRQ, REN, IFC, DAV, NRFD and NDOC). These transceivers allow bidirectional flow of data and control information between the interface and the HP-IB. Each transceiver provides four open-collector drivers and four receivers with hysteresis.

k. Parallel poll logic. The parallel poll logic provides the capability to respond to a parallel poll conducted by the controller in charge of the HP-IB. When the controller initiates a parallel poll (ATN and EOI true) and the calculator has requested service from the controller via the SRQ line, the parallel poll logic sends one bit of status to the controller via one data line (DIO1 through DI08).

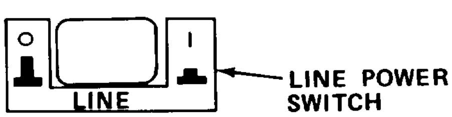
l. Initialize circuit. The initialize circuit applies +9 V to the processor after all other power supplies are stable. This condition is indicated by the initialize signal (INIT) from the calculator, and causes the processor to execute an initialize algorithm. If the interface is the system controller, this algorithm issues the abort message (IFC) and sets the REN line true. If the interface is not the system controller, this algorithm clears all HP-IB Interface functions. This circuit also provides a reset pulse to the HP-IB control bus latch.

Section VII OPERATING INSTRUCTIONS

3-13. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS.



Control or Indicator	Function
	Control Panel



LINE Power Switch (Switch located on front base of unit)	Controls application of power to plotter. Power is on when depressed.

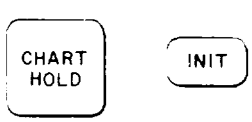


CHART HOLD Push Button	Activates electrostatic paper hold-down and turns off CHART LOAD lamp. When pressed after enter, plotter is initialized.

Control or Indicator	Function

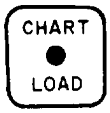
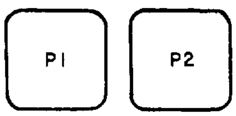


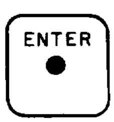
CHART LOAD Push Button

Pressing causes pen to move to upper right-hand corner of platen, turns on lamp, and deactivates paper hold-down.



Scaling Point Control Push Buttons

Pressing either button moves pen to corresponding physical point, P1 or P2, on platen. When the plotter is initialized, it sets P1 at lower left corner and P2 at upper right corner of platen. Pressing ENTER, P1, or P2 relocates that scaling point to current pen location.

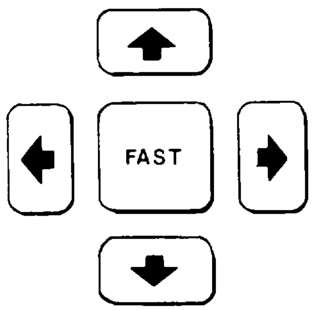


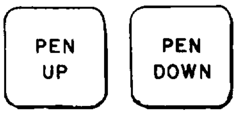
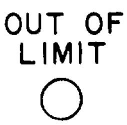
ENTER Push Button

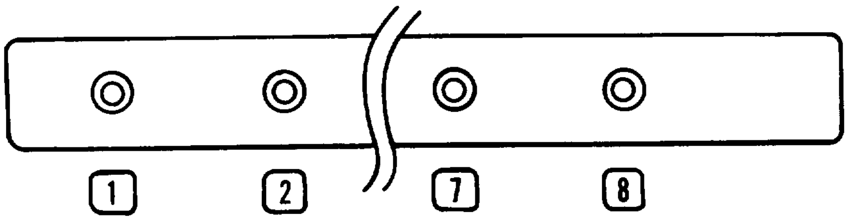
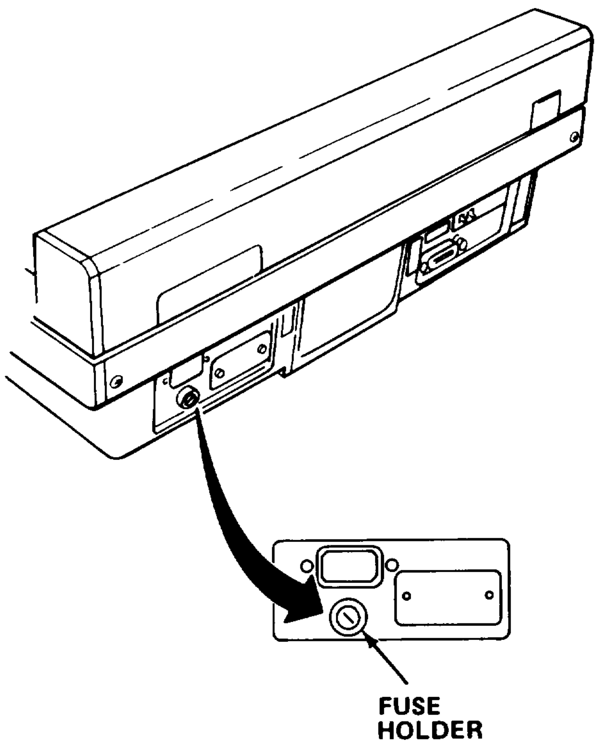
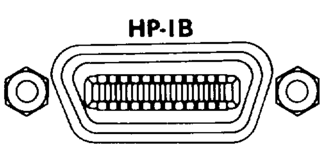
Multi-purpose button with lamp:

Pushed before CHART HOLD, it initializes plotter. (Lamp blinks.)

Pushed before P1 or P2, it sets new scaling points. (Lamp blinks.)

Control or Indicator	Function
ENTER Push Button - Cont	Used to enter point in digitizing mode. (Lamp is steady.) Used with pen select buttons to store pen in its stall. **NOTE** • Pushing any of pen control arrows cancels ENTER lamp. • Do not press during program execution.
 Pen Direction Control Push Buttons	Moves pen at 4 mm/sec within plotting area in direction indicated. Pressing two adjacent buttons moves pen diagonally. Pressing arrow and FAST simultaneously increases pen speed to 60 mm/sec.

Control or Indicator	Function
	
PEN UP/DOWN Control Push Buttons	Raises or lowers point of pen. When held down during a program execution, they override programmed pen control until released.
	
ERROR Light	Lights when an error occurs. Also lights at end of confidence test until CONFIDENCE TEST switch is turned off.
	
OUT OF LIMIT Light	Lights when plotter is commanded to plot outside a window area or beyond limits of platen. Lamp blinks if commanded position puts plotter in "lost" state.

Control or Indicator	Function
 Pen Select Buttons	Provides manual control of pen selection. Can be used to change pen selection during a program. **NOTE** Pen color is visible through holes above button.
 Fuse Holder	Holds fuses, 250 V, 1.5 amp.
 HP-IB Cable Receptacle	HP-IB interface cable 24-pin receptacle.

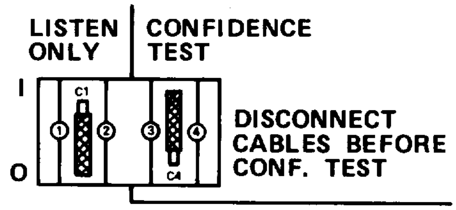
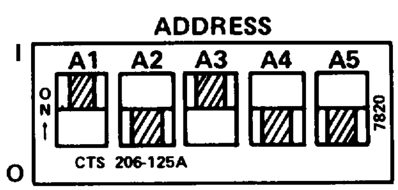
Control or Indicator	Function
 CONFIDENCE TEST/LISTEN ONLY Switch	When set to 0, LISTEN ONLY switch allows plotter to “talk” to controller and listen. Allows plotter to listen only when set to I. Set to 0 for normal operation. CONFIDENCE TEST switch activates confidence test when set to I. Set to 0 for normal operation.
 Logic Address Switches	Set address of plotter for controller. Set at factory to 5. See Table 3-18. **NOTE** Shading denotes switch position.

Table 3-18. LOGIC ADDRESS SWITCH POSITIONS

ADDRESS SWITCH POSITIONS

ADDRESS RESTRICTED TO THESE CODES WHEN USING PARALLEL POLL CAPABILITY

RESERVED FOR HP DESK TOP COMPUTER ADDRESS

RESERVED FOR UNIVERSAL UNLISTEN COMMAND

Address Characters		Address Switch Settings					Address Codes	
Listen	Talk	A5	A4	A3	A2	A1	decimal	octal
SP	@	0	0	0	0	0	0	0
!	A	0	0	0	0	1	1	1
"	B	0	0	0	1	0	2	2
#	C	0	0	0	1	1	3	3
$	D	0	0	1	0	0	4	4
%	E	0	0	1	0	1	5	5 ← preset
&	F	0	0	1	1	0	6	6
'	G	0	0	1	1	1	7	7
(	H	0	1	0	0	0	8	10
)	I	0	1	0	0	1	9	11
*	J	0	1	0	1	0	10	12
+	K	0	1	0	1	1	11	13
,	L	0	1	1	0	0	12	14
–	M	0	1	1	0	1	13	15
.	N	0	1	1	1	0	14	16
/	O	0	1	1	1	1	15	17
0	P	1	0	0	0	0	16	20
1	Q	1	0	0	0	1	17	21
2	R	1	0	0	1	0	18	22
3	S	1	0	0	1	1	19	23
4	T	1	0	1	0	0	20	24
5	U	1	0	1	0	1	21	25
6	V	1	0	1	1	0	22	26
7	W	1	0	1	1	1	23	27
8	X	1	1	0	0	0	24	30
9	Y	1	1	0	0	1	25	31
:	Z	1	1	0	1	0	26	32
;	[	1	1	0	1	1	27	33
<	/	1	1	1	0	0	28	34
=	]	1	1	1	0	1	29	35
>	^	1	1	1	1	0	30	36
?		1	1	1	1	1	31	37

3-14. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES.

a. Before You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your before (B) PMCS.

b. While You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your during (D) PMCS.

c. After You Operate. Be sure to perform your after (A) PMCS.

d. If Your Equipment Fails to Operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA Pam 738-750.

3-14.1 PMCS Procedures.

a. PMCS are designed to keep the equipment in good working condition by performing periodic service tasks.

b. Service intervals provide you, the operator, with time schedules that determine when to perform specified service tasks.

c. The “Equipment is Not Ready/Available If” column is used for identification of conditions that make the equipment not ready/available for readiness reporting purposes or denies use of the equipment until corrective maintenance is performed.

d. If your equipment fails to operate after PMCS is performed, immediately report this condition to your supervisor.

e. Perform weekly as well as before operation if you are the assigned operator and have not operated the item since the last weekly or if you are operating the item for the first time.

f. Item number column. Item numbers are assigned in chronological ascending sequence regardless of interval designation. These numbers are used for your “TM Number” column on DA Form 2404, Equipment Inspection and Maintenance Worksheet in recording results of PMCS.

g. Interval columns. This column determines the time period designated to perform your PMCS.

h. Item to be inspected and procedures column. This column lists functional groups and their respective assemblies and subassemblies as shown in the Maintenance Allocation Chart (Appendix B). The appropriate check or service procedure follows the specific item to be inspected.

i. Equipment is not ready/available if: column. This column indicates the reason or cause why your equipment is not ready/available to perform its primary mission.

j. List of tools and materials required for PMCS is as follows:

Item	Quantity
Metric Scaler	1 ea
Optical Comparator	1 ea
System Test Tape (Electronic Data Tape, Item 31, Appendix E)	1 ea
HP 9825A Desk-Top Computer	1 ea
Artist's Brush (5 in.)	1 ea
Cheesecloth (Item 5, Appendix E)	ar
Detergent (Item 6, Appendix E)	ar
Chart Paper	ar
Denatured Alcohol (Item 3, Appendix E)	ar

Table 3-19. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can safely be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

B - Before | W - Weekly | AN - Annually | (Number) - Hundreds of Hours
D - During | M - Monthly | S - Semiannually
A After | Q - Quarterly | BI - Biennially

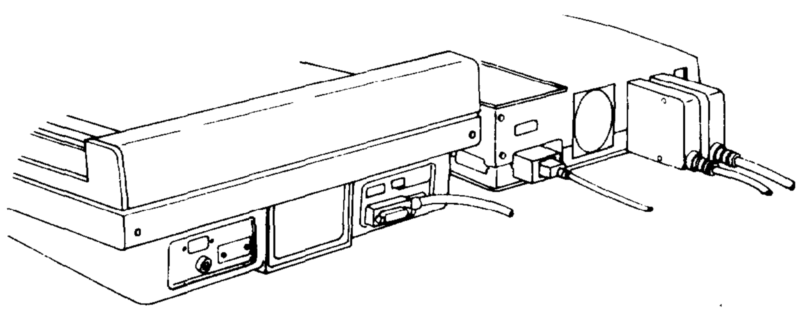
ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment is Not Ready/ Available If:
		GRAPHICS PLOTTER	
1	B	Inspect Plotter. 	
		1. Check plotter interface cable for visible damage.	Cable is cut or broken, or plotter has obvious visible mechanical damage.
		2. Check that interface connections at the computer and the plotter are firmly inserted and power cords for both units are tight. Tighten if required.	

Table 3-19. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN . Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

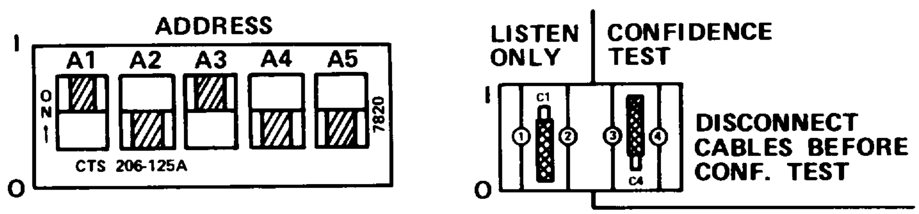
ITEM NO,	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment is Not Ready/ Available If:
		GRAPHICS PLOTTER - Cont	
1	B	Inspect Plotter - Cont  3. Check that switches on plotter rear panel are set correctly (refer to paragraph 3-13 and Table 3-18).	

Table 3-19. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

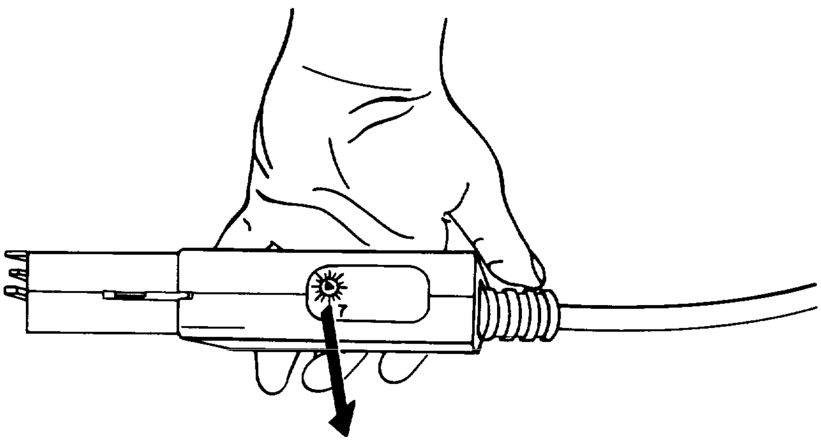
B - Before
D - During
A - After

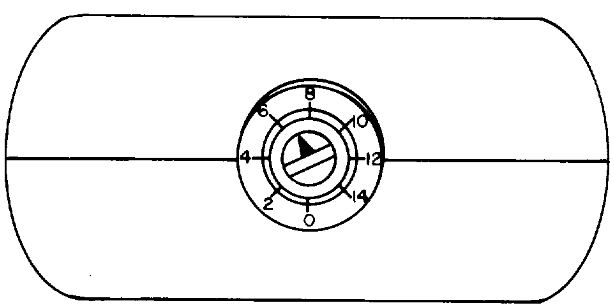
W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		GRAPHICS PLOTTER - Cont	
1	B	Inspect Plotter - Cont	





4. Set interface select code switch to position 7.

5. Inspect platen area for dust or foreign particles. Clean as required.

Table 3-19. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

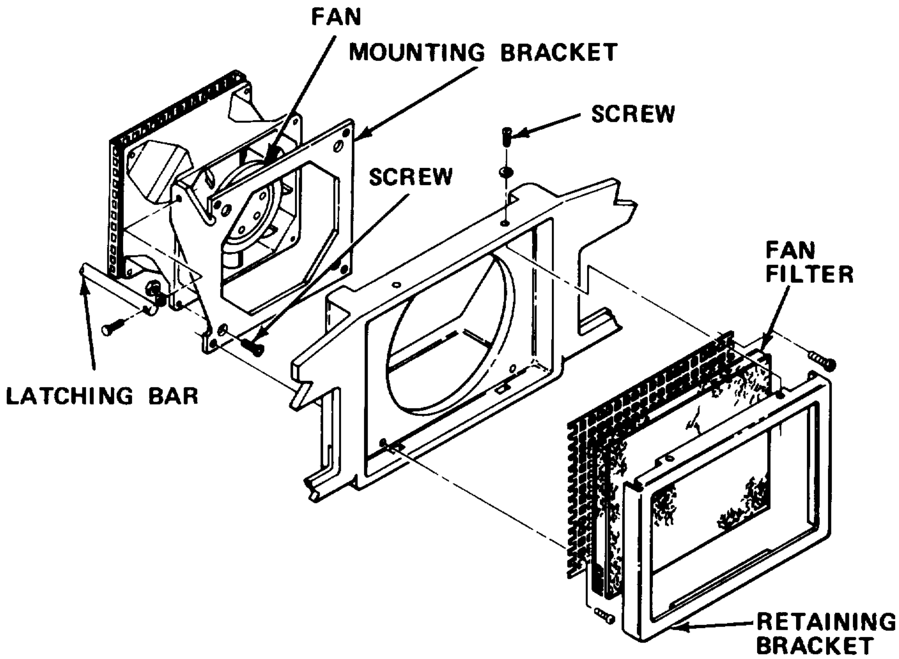
(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		GRAPHICS PLOTTER - Cont	
2	W	Clean Plotter. 1. Turn LINE power switch off (0) and remove power cord from wall outlet. 2. Remove dust accumulation from surfaces of plotter with soft-haired artist's brush. 3. Dampen cheesecloth with a 50-50 solution of denatured alcohol and water. Wring out excess. **WARNING** Death or serious injury may occur from electrical shock if plotter is energized with platen wet. 4. Clean platen thoroughly with clean, damp cloth. 5. Wipe away any moisture from platen surface with dry cloth. Allow plotter to dry before use.	

Table 3-19. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before	W - Weekly	AN - Annually	(Number) - Hundreds of Hours
D - During	M - Monthly	S - Semiannually	
A - After	Q - Quarterly	BI - Biennially	

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		GRAPHICS PLOTTER - Cont	
2	W	Clean Plotter - Cont	



6. Remove fan filter by pulling gently from top two corners of retaining bracket. Wash filter thoroughly with soapy water. Wring out all moisture and allow to dry before reinstalling into bracket.

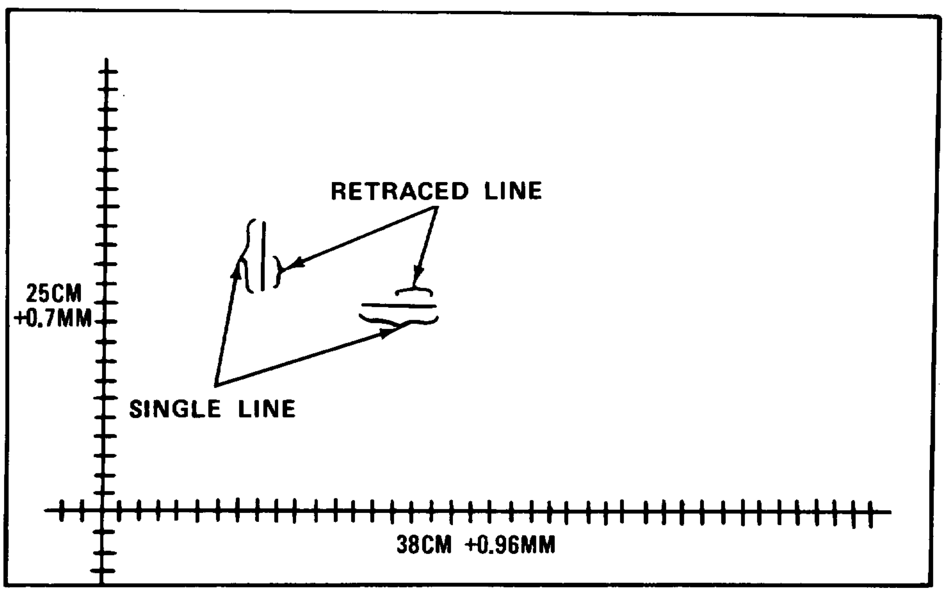
Table 3-19. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before, D - During, A After | W - Weekly, M - Monthly, Q - Quarterly | AN - Annually, S - Semiannally, BI - Biennially | (Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED / PROCEDURE	For Reediness Reporting, Equipment Is Not Ready/ Available If:
		GRAPHICS PLOTTER - Cont	
3	M	Plotting Repeatability and Accuracy Test. 1. Load plotter with blank chart paper. Place new pen in pen arm. 2. Enter program below into calculator and run program. Record program on tape for future use. 0: fxd 0 1: wrt 705, "pu; vs; pa 15000, 10000, 5000, 6000;" 2: wrt 705, "vs1; pd; pr0,-500" 3: wrt 705, "pu; pa0, 0, 5000, 5500;" 4: wrt 705, 'pd; vs1; pr0, 250; vs; pu; pa0, 0" 5: wrt 705, "vs; pu; pa0, 0, 6000, 5000;" 6: wrt 705, "pd; vs1; pr500, 0" 7. wrt 705, "pu; pa 15000, 10000, 6500, 5000" 8: wrt 705, "pd; vs1; pr-250, 0; vs; pu; pa0, 0" 9: wrt 705, "t 11, 1; pu; pa0, 1000" 10: for X=0 to 15200 by 400 11: wrt 705, "pd; pa", X,",1000; xt 12: next X 13: wrt 705, "pu; pa 1000, 0" 14: for Y=0 to 10000 by 400	

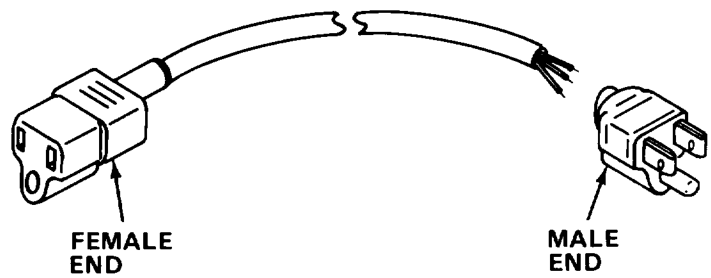
Table 3-19. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before W - Weekly AN - Annually (Number) - Hundreds of Hours
D - During M - Monthly S - Semiannually
A - After Q - Quarterly BI - Biennially

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED / PROCEDURE	For Reediness Reporting, Equipment Is Not Ready/ Available If:
		GRAPHICS PLOTTER - Cont	
3	M	Plotting Repeatability and Accuracy Test - Cont	
		15: wrt 705, "pd; pa 1000, , Y, "; yt"	
		16: next Y	
		17: wrt 705, "pu; pa 15000, 10000"	
			
		3. Using an optical comparator, measure the difference in width between the single line segment and the retraced portion of the line segment. The difference should be within ±0.1 mm.	Difference is greater than 0.1 mm.
		4. Using a metric scale, verify that the horizontal line measures 38 cm ±0.96 mm and that the vertical line measures 25 cm to ±0.7 mm.	Difference is greater than 0.7 mm.

3-15. OPERATION UNDER USUAL CONDITIONS. In general, independent operation of the plotter is confined to self testing and editing charts. All other operating procedures use a computer to control the operation of the plotter, using programs written by the operator and inputted through the computer.

3-15.1 Assembly and Preparation for Use.



a. Plug female end of power cord into jack on rear panel of plotter.

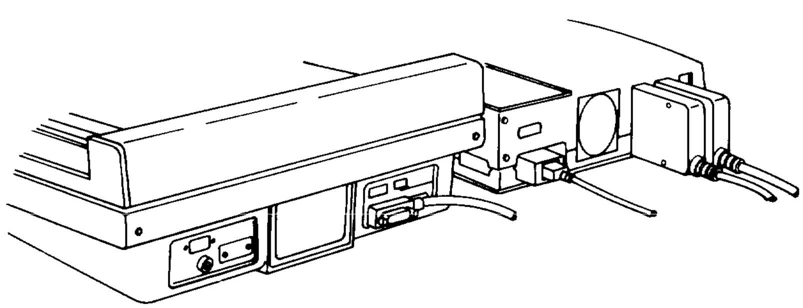
WARNING

Death or serious injury may occur from electrical shock. Plotter is equipped with three-conductor power cable which grounds plotter. Do not operate plotter from ac outlet that does not have connected ground pin.

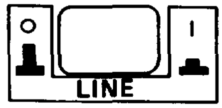
CAUTION

Be sure power is off before plugging ROM's or interface cable into equipment, or damage to equipment will result.

b. Plug male end of power cord into grounded ac outlet.



c. Plug one end of interface ROM in rear of computer. Connect other end of interface into jack on rear panel of plotter. Tighten knurled screws to fasten connection.



d. Press LINE power switch on front base of plotter. Plotter should respond as follows:

(1) Pen raises.

(2) Pen moves to lower right corner of platen.

3-15.2 Initial Adjustments, Daily Checks, and Self Test.

a. Confidence test.

(1) Turn LINE power switch off (0).

(2) Connect power cables.

(3) Disconnect interface cable at plotter.

(4) Flip LISTEN ONLY switch to 0.

(5) Flip CONFIDENCE TEST switch to 0.

(6) Set Logic ADDRESS switches to I0I00.

(7) Initialize plotter:

(a) Press LINE power switch on.

(b) Press CHART LOAD button.

(c) Press ENTER button.

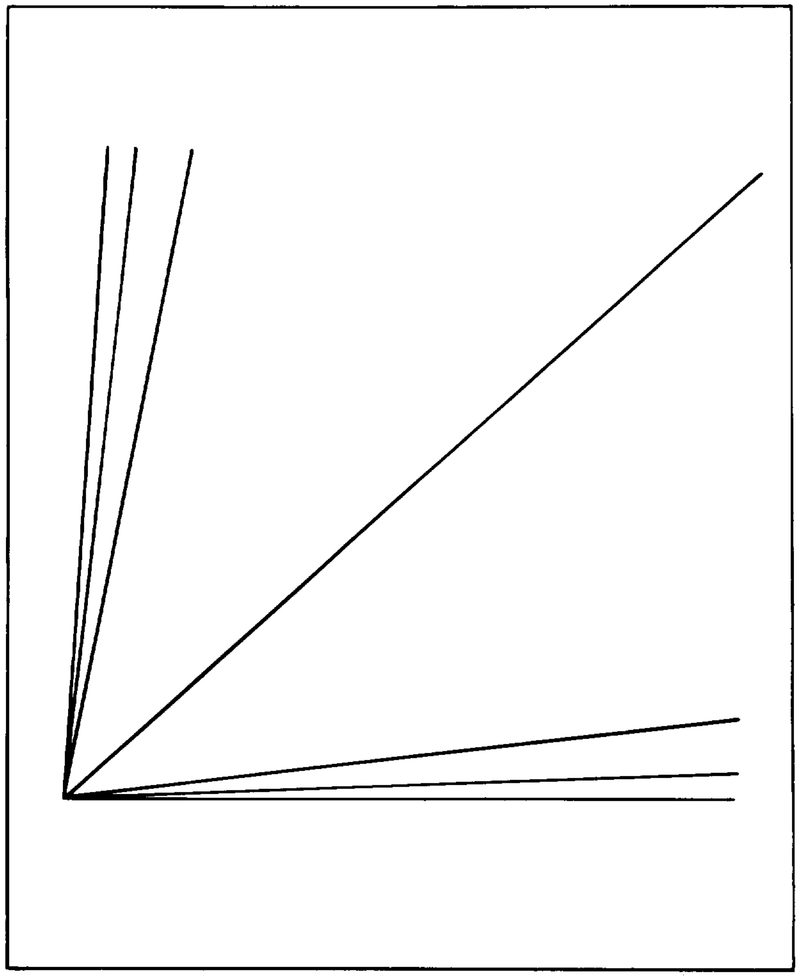
(d) Place paper on platen.

(e) Press CHART HOLD button.

(8) Install pen in pen arm.

(9) Turn CONFIDENCE test switch to I. After completion of plot, pen should stop in lower left corner of platen and all lamps on front panel should be turned on.

(10) Press PEN UP button. Remove pen.



EXAMPLE OF CONFIDENCE TEST

(11) Push CONFIDENCE TEST switch to 0. Lights will turn off and pen arm will move to lower right hand corner.

(12) Compare completed plot to example. If plot is not correct, notify your supervisor.

(13) Turn off LINE power switch.

(14) Reconnect interface cable to plotter.

(15) Unplug power cord.

b. Operational Test One.

CAUTION

Removal or replacement of ROM'S when power is supplied to computer will result in damage to computer.

NOTE

- The program will test pens 1-4. If it is desired to test all 8 pens, modify the test program, lines 60 and 63.

- This program is in file 14.

From: 60: plt 29,6,1;pen #4;lbl "DIVISION"
To: 60: plt 29,6,6;pen #4;lbl "DIVISION"; gto 81

From: 63: prt "9872A PLOT''," COMPLETE"; spc 2;wrt S,''DF'';end
To: 63: prt "9872A PLOT",''COMPLETE"

- Add the following lines at the end of the test program:

```
plt 4,3,1;pen #1;lbl "PEN#1"

plt 4,2,1;pen #2;lbl "PEN #2"

plt 4,1,1;pen #3;lbl "PEN #3"

plt 4,0,1;pen #4;lbl "PEN #4"

plt 29,3,1;pen #5;lbl "PEN #5"

plt 29,2,1;pen #6;lbl "PEN #6"

plt 29,1,1;pen #7;lbl "PEN #7"

plt 29,0,1;pen #8;lbl "PEN #8"

gto 69
```

Ž It is recommended that this modified program be stored on a blank tape for future use.

NOTE

- Be sure required ROM's (three) are installed in the desk-top computer:

  String-Advanced ROM

  Matrix ROM

  Extended I/O ROM

- String-advanced ROM and Extended I/O ROM are permanently installed on the HP-9825B.

(1) Install test tape cartridge into desk-top computer.

(2) Turn on power to computer and plotter.

(3) On computer, press:

STOP
erase
a
EXECUTE
RESET
I
d
b
3
EXECUTE

(4) Observe printer question on verification of ROM's.

(5) After ROM verification, observe display: ENTER MODEL # TO BE TESTED. On computer, press:

9
8
7
2
SHIFT
A
CONTINUE

(6) When display returns with ENTER SELECT CODE, enter plotter bus address and HP-IB Interface code. Press:

7
Ø
5
CONTINUE

(7) Observe display: ENTER # OF TIMES TO RUN TEST.

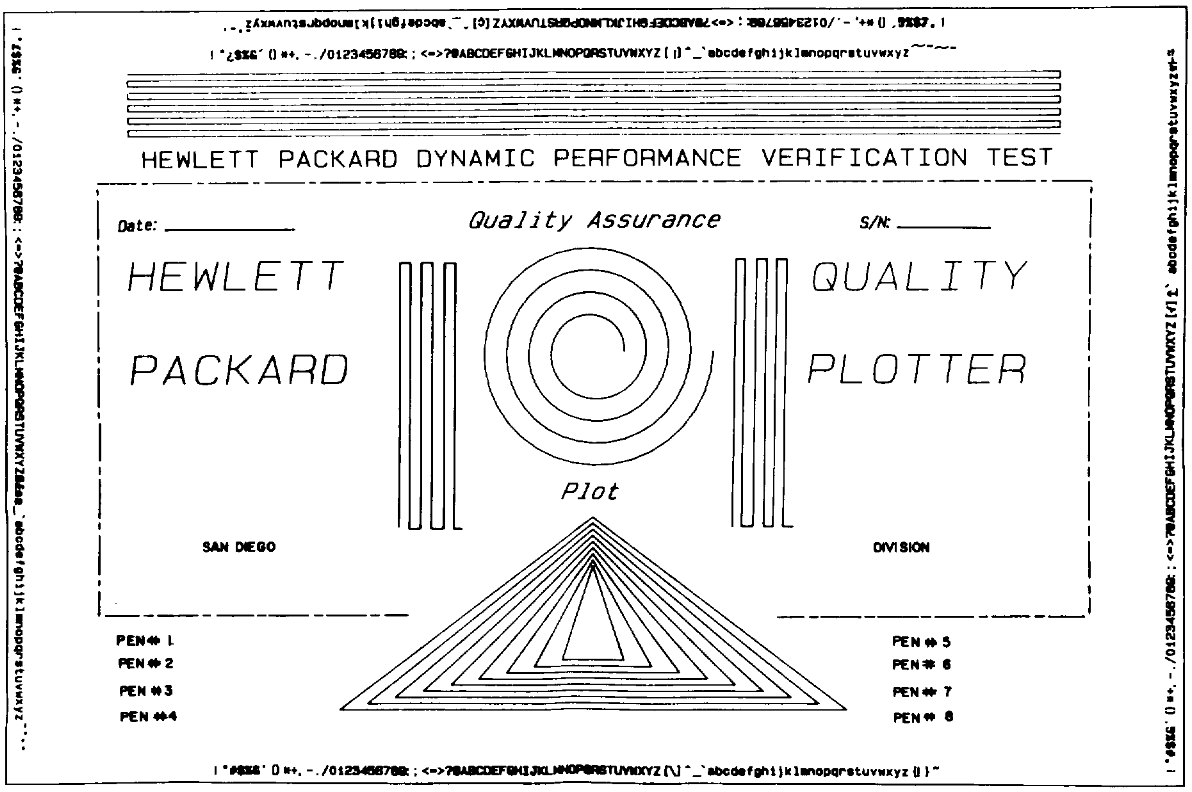
(8) Press 1 and CONTINUE.

(9) Observe display: LOAD PAPER AND THEN PRESS CONTINUE.

NOTE

Be sure plotter paper is loaded correctly.

(10) Press CONTINUE.



(11) Observe completed plot; computer prints: 9872A PLOT COMPLETE. Compare plot with above illustration. If plot is correct, computer and plotter interfaces are working properly.

(12) Enter: - 5.

(13) Observe display: LOAD PAPER AND THEN PRESS CONTINUE. Press CONTINUE.

(14) Observe printout: 9872A DIGITIZE.

(15) Move pen on plotter using front panel plotting controls. When you reach any desired point, stop and press plotter ENTER key.

(16) Repeat step (15) five times (equal to minus number entered in step (12).

(17) Observe printout: DIGIT MODE COMPLETE.

NOTE

Failure to complete tests satisfactorily indicates malfunction requiring repair/ diagnosis at direct support level.

c. Operational test two.

WARNING

Death or serious injury may occur from electrical shock. Plotter is equipped with three-conductor cable which grounds plotter. Do not operate plotter from ac outlet that does not have connected ground pin.

CAUTION

Be sure power is off before plugging ROM's or HP-IB interface cable into equipment. Damage to equipment will result.

NOTE

- The program will test pens one through four. If it is desired to test all eight pens, modify the test program lines 60 and 63, as follows:

  From: 60: plt 29,6,1;pen #4;lbl “DIVISION”
  To: 60: plt 29,6;pen #4;lbl “DIVISION”; gto 81

  From: 63: prt "9872A PLOT", ’’COMPLETE”; spc 2;wrt S,’’DF’’;end
  To: 63: prt “9872A PLOT’’,’’COMPLETE”

- Add the following lines at the end of the test program:

  plt 4,3,1;pen #1;lbl “PEN #1”

  plt 4,2,1;pen #2;lbl “PEN #2”

  plt 4,1,1;pen #3;lbl “PEN #3”

  plt 4,0,1;pen #4;lbl “PEN #4”

  plt 29,3,1;pen #5;lbl “PEN #5”

  plt 29,2,1;pen #6;lbl “PEN #6”

  plt 29,1,1;pen #7;lbl “PEN #7”

  plt 29,0,1;pen #8;lbl “PEN #8”

  gto 69

- To make above change 1df14, make changes to lines 60 and 63, and add additional lines to rcf 14 program.

(1) Check that LINE power switch is set to off (0).

(2) Check that voltage switches are set for 120 V ac.

(3) Flip LISTEN ONLY switch to 0 and CONFIDENCE TEST switch to I.

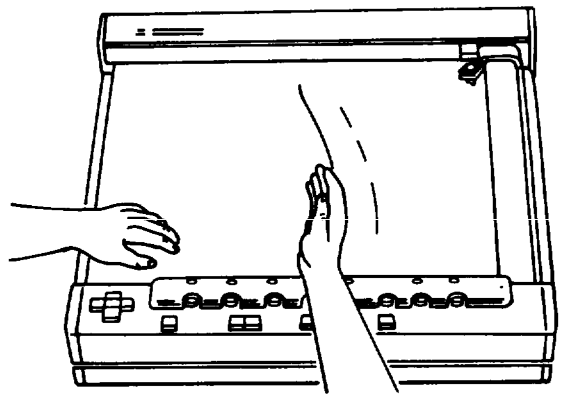
(4) Check that logic ADDRESS switches are set to 5 (10100).

(5) Plug in power cable. Press LINE power switch on (0).

(6) Mount paper:

(a) Press CHART LOAD switch. (Pen should go to upper right corner.)

(b) Raise paper stop by pressing down upper portion with screwdriver or other pointed object.



(c) Position paper squarely against ridge at bottom of platen and against paper stop on left side. Smooth paper with back of hand.

(d) Press CHART HOLD switch. (CHART LOAD lamp should go off.)

(7) Load pens:

WARNING

To avoid possible injury to fingers, always turn plotter off when directly storing pens.

(a) Turn LINE power switch to off (0).

(b) Remove cap from first pen.

(c) Place tip of pen in boot at base of stall.

(d) Gently press pen down and in until it snaps in place.

(e) Repeat for all pens.

(8) Connect HP-IB Interface bus to rear of plotter. Controller Rom should be plugged into computer (HP9825A only). Turn LINE power switch to on (l).

(9) Perform dynamic test:

(a) Insert 9800 series test cartridge into computer.

(b) Load test cartridge by pressing STOP, ERASE a, EXECUTE, RESET, lbd3, and EXECUTE.

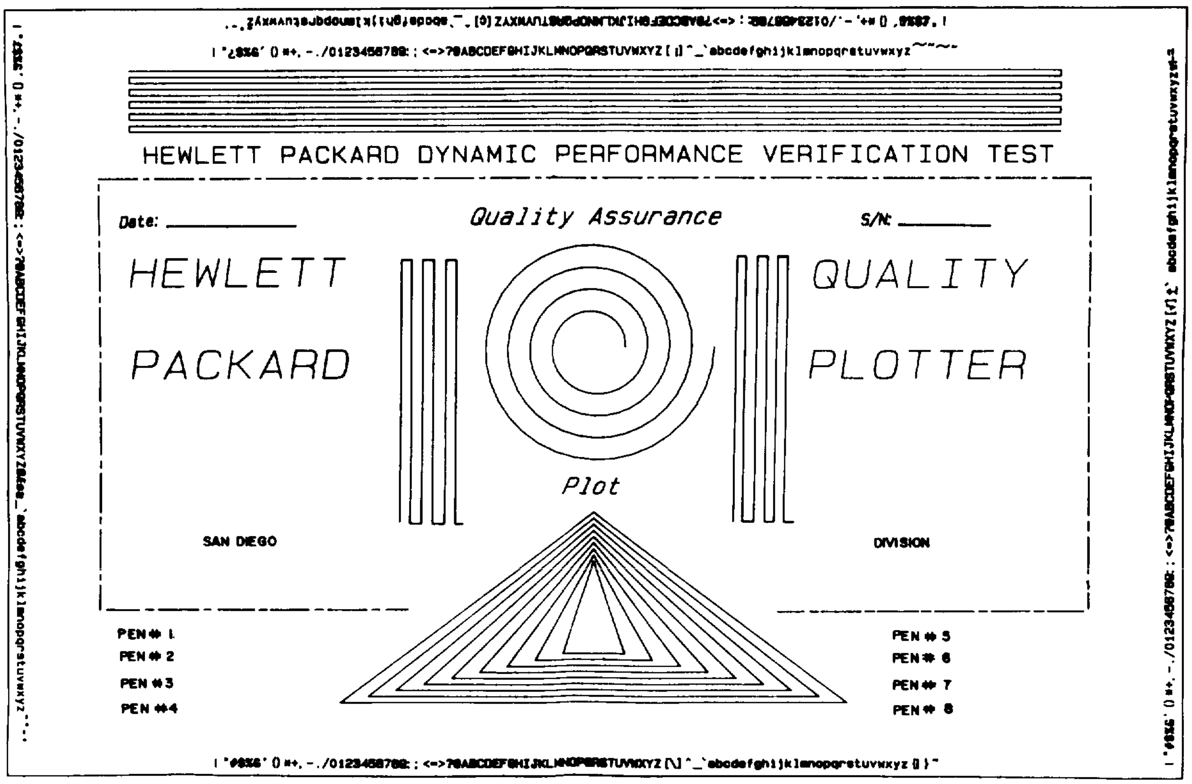
(c) When computer displays ENTER MODEL # TO BE TESTED, press 9872, SHIFT, A, and CONTINUE.

(d) When computer displays ENTER SELECT CODE . . ., press 705 and CONTINUE.

(e) When computer displays ENTER # OF TIMES TO RUN TEST..., press 1 and CONTINUE.

(f) When computer displays LOAD PAPER and THEN PRESS CONTINUE, check that paper is loaded and then press CONTINUE.

(9) printer should print 9872A PLOT COMPLETE in approximately six minutes. Compare plot produced.



(h) Repeat (a) thru (d) of (9). When computer displays ENTER # of TIMES TO RUN TEST. . . . press -2. Computer should print 9872A DIGITIZE.

(i) Press " ↑ " button on plotter until pen has moved approximately 1 in. (25.4 mm). Press plotter ENTER key.

(j) Press " ↑ " button until pen moves approximately 1 in. (25.4 mm). Press plotter ENTER key. Computer should print DIGIT MODE COMPLETE.

(10) Press plotter ENTER key followed by CHART HOLD switch.

(11) Remove peripheral test tape. Insert scratch tape.

(12) Enter sample print program in computer.

(a) Press ERASE A.

(b) Press lbl "I AM A 9872 PLOTTER".

(c) Press STORE, LIST, and EXECUTE. Check printout of program.

(d) Press RUN.

(e) Check to see plotter draws "I AM A 9872 PLOTTER."

d. HP-IB Operational Test.

WARNING

Death or serious injury may occur from electrical shock. Plotter is equipped with a three-conductor power cable which grounds plotter. Do not operate plotter from an ac outlet that does not have connected ground pin.

CAUTION

Be sure power is off before plugging ROM's or HP-IB Interface cable into equipment. Damage to equipment will result.

(1) Check that computer power is off. Plug HP-IB cable into I/O slot in back of computer.

(2) Plug ROM into slot in front of computer.

(3) Turn on computer. Verify lazy "T" (⊢) is on computer.

NOTE

If lazy "T" does not appear, remove HP-IB Interface and press RESET. If it still does not appear, refer to direct/general support maintenance.

(4) Enter program line shown below.

PROGRAM LINE: rds (7, A, B, C) → D; dsp A, B, C, D

DISPLAY:				
	0.00	213.00	64.00	76.00

(5) Press EXECUTE and verify that display shown above appears.

(6) If display does not return after line is executed, press RESET and rotate HP-IB interface select code switch to 0, then back to 7 carefully with the flat tip screwdriver.

(7) Repeat step (4).

(8) If display does not return or display is incorrect, card is defective. Refer unit to direct/general support maintenance.

e. Self-test.

NOTE

- Plotter can be tested using preprogrammed self-test procedure that is controlled by self-test selector switches located on PCA A2. Failures can usually be isolated to single PCA or even a group of components on PCA.
- The self-test is controlled by three switches at the rear of the main PCA A2. Switch S4-2 is used to select the self-test. The CONTINUE switch S3 (green) is used to continue the test after any error or halt. The RESET switch S5 (red) sets the plotter to the same state as a power-up sequence.
- Self-test indications are obtained from the four light emitting diodes (LEDs) beside the test switches. These indicate the binary number of the failed test step. The steps are as follows:

LED check - The self-test LEDs flash sequentially.

ROM LSB - A2U56

ROM MSB - A2U55

RAM - A2U67, U66, U65, U64

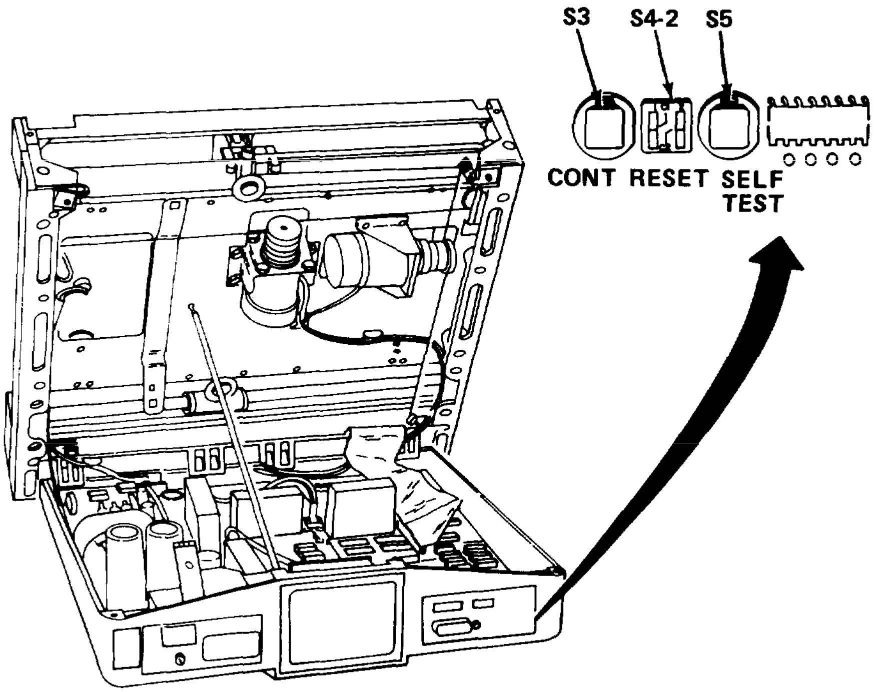
Interrupt 1 - interrupt request logic, subroutine, and stack pointer.

Interrupt 2 - interrupt subroutine and return to normal.

HP-IB - HP-IB circuits.

Front Panel - operator interactive test of the front panel switches.

Motor Vectors - operator interactive plotting test.



(1) Remove power from the plotter.

(2) Remove all interface cables.

(3) Open the plotter.

(4) Apply power to the plotter.

(5) Set the SELF TEST switch S4-2 to the on position.

(6) Press the RESET switch S5 pushbutton (red).

(7) The self-test LEDs will flash sequentially as a lamp test.

(8) Press the CONTINUE switch S3 pushbutton (green).

(9) The test will run to the end of the automatic tests or to a fault indication. To continue after any error, press the CONTINUE push-button S3 (green).

(10) The self-test LEDs will flash in unison when the automatic tests are complete or indicate the binary number of the failed step if one is found.

(11) To perform the front panel interactive tests, after completing self-test:

(a) Mute the X-motor at S1 on the main PCA A2, and move the plotter arm to the left end of the platen (nearest pen stall #1). Turn S1 on.

(b) Remove all pens from the front panel.

(c) Press the pen select pushbutton #8.

(d) The self-test LEDs will indicate 1011 and all front panel LEDs will be on for a lamp test.

(e) Press CONTINUE (green). All front panel indicators except ERROR will be off.

(f) Press the front panel switches in the order given on self-test chart.

(g) As each switch closes, the ERROR LED will go off and the OUT OF LIMIT LED will turn on momentarily. Go to the next switch when the ERROR LED comes on.

(h) Upon completion of the front panel test, the self-test LEDs will flash sequentially.

(12) To perform the motor vector tests, proceed as follows:

(a) Press CONTINUE (S3).

(b) Press pen select pushbutton #1. The plotter arm and pen holder will begin a diagonal move. All self-test LEDs will be off. An error is indicated by failure of the plotter to make the move.

(c) Press and hold pen select pushbutton #2 until the arm movement stops . Release the pushbutton, and the plotter will begin the second vector. Repeat with pen select pushbuttons 3 through 6. Each button initiates a new vector.

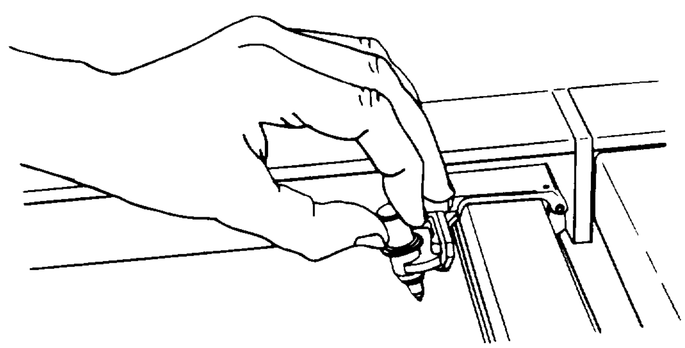
(d) Upon completion of the vector test, set the SELF TEST switch S4-2 to the off position, and press the RESET switch S5 pushbutton (red). The plotter will complete a power-up initialization.

(e) Turn off the plotter, remove the power cord, and close the plotter. Secure the upper deck locking screws and replace the rear hood.

3-15.3 Operating Procedures.

INDEX

a. Loading pen in arm.



(1) Select color pen desired from accessory container.

(2) Remove cap from pen.

(3) As shown in illustration, gently push pen into pen holder so that thick ring around middle of pen fits into slot in pen arm.

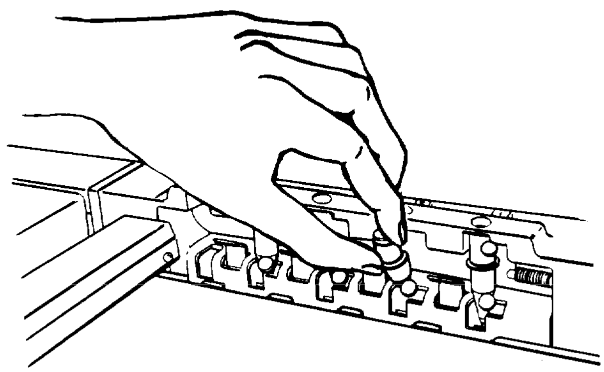
b. Direct pen storage.

(1) Turn off plotter.

(2) Select pen color to be placed in stall 1 and remove cap.

WARNING

To avoid possible injury to fingers, always turn plotter off when directly storing pens.



(3) Place pen tip into round boot at base of stall.

(4) Press pen down and in gently until holder snaps in place.

(5) Check that pen color shows through hole in front panel above pen.

(6) Repeat this procedure for remaining pens.

NOTE

Pens may be removed from stalls by moving metal lever to right of pen with one hand, grasping pen between thumb and index finger of other hand, and pulling out and up.

(7) Turn LINE power switch on.

c. Automatic pen storage.

(1) Select color pen desired for stall 1 and load in pen holder arm.

(2) Press ENTER followed by pen stall button 1.

(3) Repeat procedure for remaining seven pens, changing to appropriate pen stall button each time.

NOTE

After depressing pen stall button, pen holder should place pen in the designated stall and return to its original position for loading of next pen.

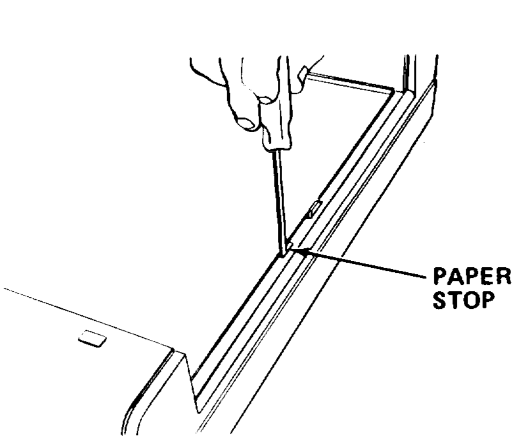
d. Loading paper.

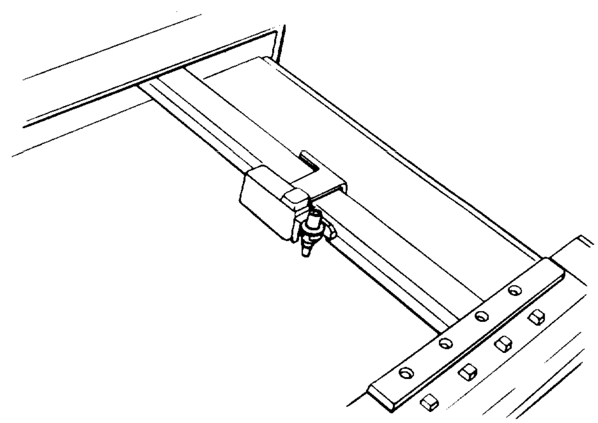
(1) Check that plotter is on.

(2) Press CHART LOAD switch.

NOTE

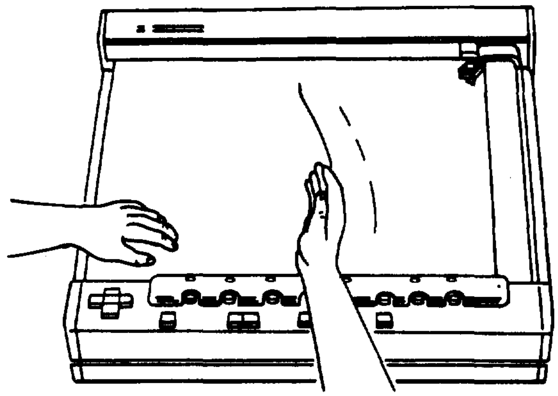
This releases electrostatic holding mechanism. Pen should move to upper right corner of platen.





(3) Raise paper stop by pressing down on upper portion with screwdriver or other pointed object.

(4) Position paper squarely against ridge at bottom of platen and against paper stop on left side.



(5) Press down on lower left corner of paper with left hand, and smooth paper by running back of other hand toward upper right corner.

NOTE

Paper is smoothed with back of hand so skin oils will not be deposited.

(6) Press CHART HOLD switch.

NOTE

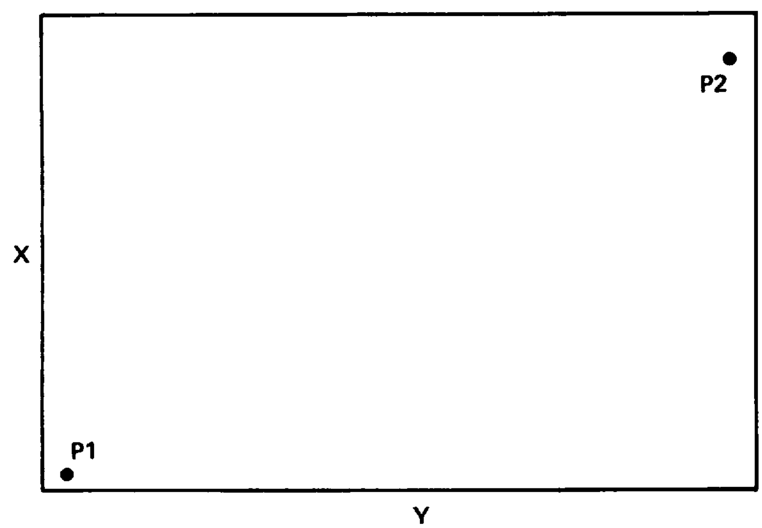
Lamp in CHART LOAD switch should go off.

(7) Smooth paper again with back of hand.

e. Setting scaling points.

NOTE

Scaling points P1 and P2 are used to establish scaled area for plot. When plotter is initialized, it sets P1 in lower left corner and P2 in upper right corner.



NOTE

Initial values of P1 and P2 in plotter units are:

P1 = 520, 380 (X, Y)

P2 = 15720, 10380 (X, Y)

The following procedure is used to relocate either or both of these points in order to expand or narrow field of plot:

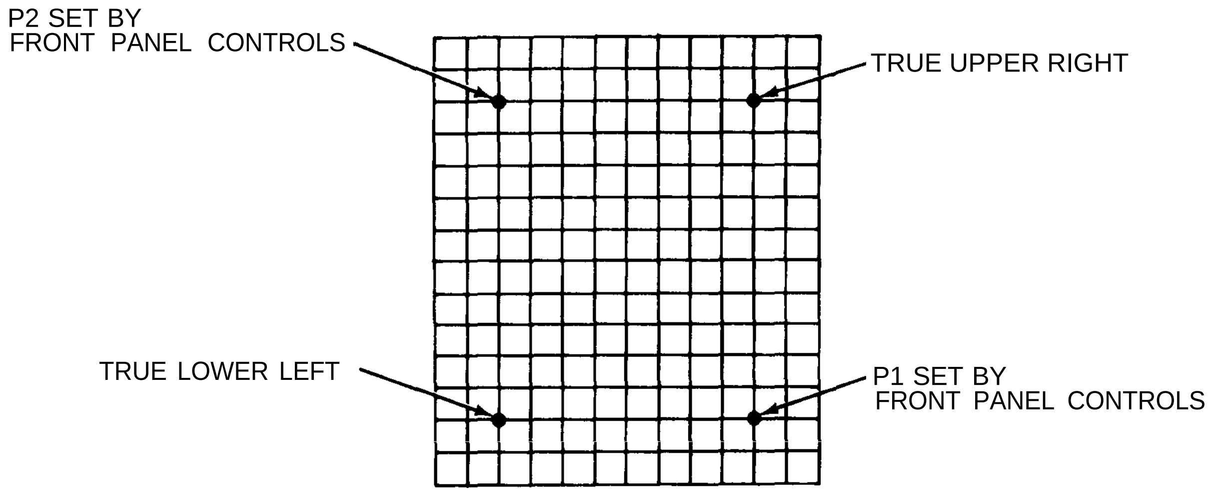
(1) Initialize plotter: Press LINE power switch on, then press ENTER and CHART HOLD buttons.

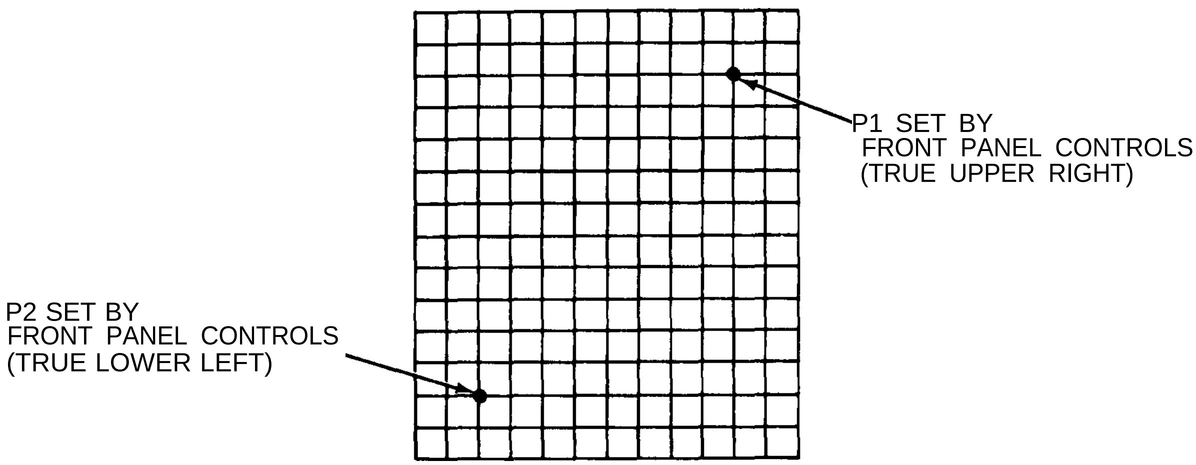
(2) Using pen controls on front panel, move pen to desired location for P1 or P2.

(3) When pen reaches location, set point by pressing ENTER followed by pressing either P1 or P2, depending on which point is to be located.

NOTE

P1 and P2 do not have to be set so that they are still in initial relationship. As shown in illustration, they can also be set in lower right/upper left relationship.





(4) Repeat, if necessary, for second point.

(5) Confirmation of new P1 and P2 1 locations may be accomplished by pressing P1 and P2 buttons to note new positions of pen locations.

f. Plotting.

(1) Connect plotter to controlling computer.

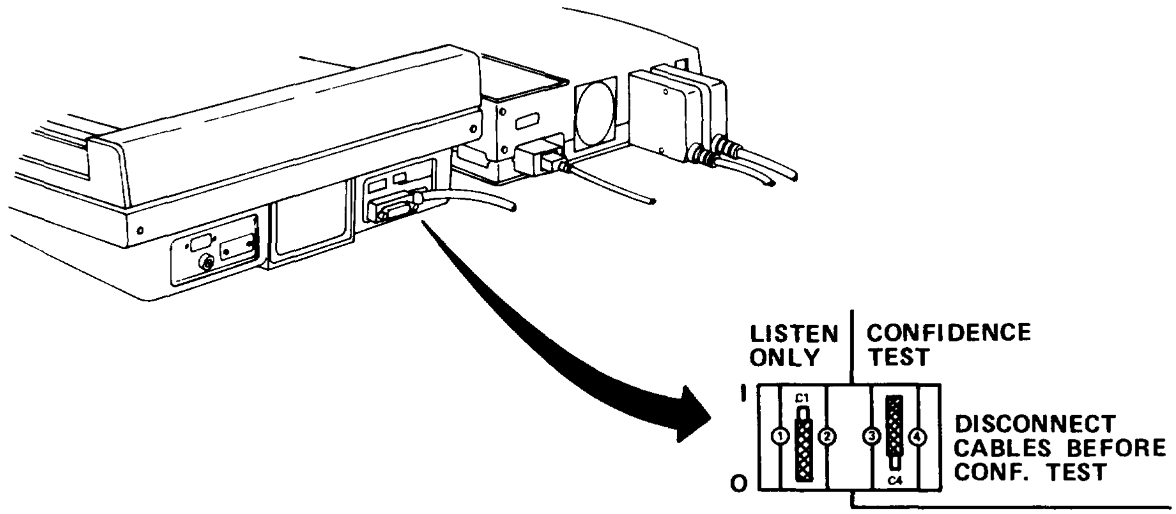
(2) Initialize computer.

CAUTION

Be sure power to plotter is off before inserting ROM's or interface cable. Damage to equipment will result.

NOTE

String advanced ROM and extended I/O ROM are permanently installed on the HP9825B. Before plotter can be programmed to operate, programming language of computer must be thoroughly understood.



(3) Check to see that all switches on plotter rear panel are set correctly and select code switch on interface.

(4) Load paper and pens to be used.

(5) Determine what plotter is to draw. Construct program to accomplish this, using language of computer and plotter programming language statements listed in Table 3-20. If plot program is on prerecorded tape, load tape in computer and press RUN.

(6) Except when digitizing, program should contain a statement or statements that accomplish the following:

(a) Clear plotter.

(b) Set decimal place format for any numbers (floating, fixed to two significant digits, etc.).

(c) Establish character type (set) for any lettering.

(d) Set scale to which plot will be drawn.

(e) Select proper color pen.

(f) Tell what type or types of lines will be used for construction.

(g) Draw and label X- and Y-axes, if applicable.

(h) Describe plot itself and where it is to be drawn.

(i) Tell what and where to label and what label is to state (including symbols).

(j) Give any special directions, if needed.

(k) Instructions to change any of the above statements, if desired, and loop back to some point in program or continue.

(l) Statement to END program.

NOTE

- Plotter can be cleared by inserting a **pclr** or **wrt 705 "IN"** command in program.
- Decimal place format is set using format commands of computer language.
- Character set is controlled using **lbl, csiz,** and **wrt 705 "CS", "CA", "SS", "SA", "SL", "SM",** or **"UC"** statements.
- Scale and plotting area are set using **scl** and **line** statements.
- Pen color is selected with **"pen #"** statement.
- Line type, such as solid, dash, etc., is set with a line statement.
- X- and Y-axes are drawn, tied and labeled using **xax, yax,** and **wrt 705 "TL"** statements.
- Plot on drawing is defined using **plt, ofs, iplt,** and **cplt** statements.
- Labeling is accomplished through **wrt 705 "SM", csiz, ptyp,** and **lbl** statements.
- Special instructions normally involve directions to pen, such as to raise its point on paper. Special instructions involve pen and **wrt 705, "AP", "PD", "VS", "VA",** or **"VN"** commands.
- Changes can be made to above statements in program by repeating statement with-new parameters. Program continuation or looping is-performed using statements from programming language of controller.

(7) After program is written, input each line of program and any data by keying in complete statement and then pressing STORE.

(8) When entire program is entered, press LIST and EXECUTE to receive tape to verify that correct program is entered. Press RUN to execute program.

NOTE

Certain programming practices will assure more effective use of plotter. Among these are:

- Select pen before first plot command to assure plot is actually recorded on paper.
- Lift pen before changing colors to avoid a dot of new color at termination of last vector.
- Store pens at completion of plot so pens do not dry out.
- When using A4 or 8.5 in. (21.59 cm) X 11 in. (27.94 cm) paper, reset P1 and P2 manually or programmatically to points inside paper area. Default P2 will scale plot beyond limits of 8.5 in. (21.59 cm) X 11 in. (27.94 cm) paper.

g. Map/chart editing.

(1) Initialize plotter.

(2) Load map/chart to be edited.

(3) Load pens of desired colors in their stalls.

(4) Straight lines can be added by moving pen with pen controls to start point. Press PEN DOWN and move pen in direction desired with controls until line length desired is drawn.

(5) To add curved lines or labels, construct program to draw desired figure or label.

NOTE

Be sure to set limits of plotter to that of map/chart being edited, and instruct plotter exactly where change or addition is to be made.

h. Digitizing.

(1) Connect plotter to computer via interface.

NOTE

Special sight pen allows pen to be placed precisely over target point. Placement is done by looking through sight pen from above.

(2) Initialize plotter. Load digitizing sight pen.

(3) Place map, chart, plot, or drawing with points to be digitized on plotter, and make note of scale to which it is drawn.

(4) Determine how many points are to be digitized. Write small program for digitizing this number of points. Digitizing program should contain statements that accomplish the following:

(a) Clear plotter.

(b) Set decimal place format for numbers to be transferred.

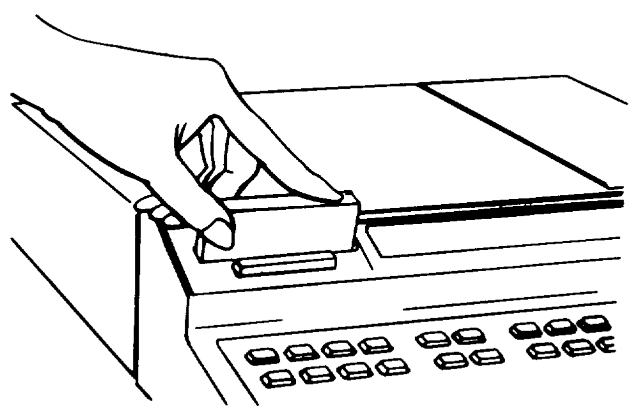
(c) Set plotter scale to that identical to item being digitized.

(d) Statement to end progam.

NOTE

- Plotter can be cleared with a **pclr** or **wrt 705 "IN"** statement.
- Decimal place format is set using format commands of computer language.
- Scale and digitizing are set with **scl** and lim statements.
- Digitizing is accomplished with **dig** statements. Looping is directed using computer language.

```
0:  prt  "****DIGI
 TIZE****"
1:  fxd 0
2:  pclr:ent  "Ent
 er # of Points
 & Continue",I
3:  for N=1 to I
4:  dig A,B,C
5:  dsp A,B,C
6:  prt "X=  ",A
7:  prt "Y-  ",B
8:  prt "P=  ",C
9:  spc
10:  next N
11:  prt  "Complet
 e"
*22857
```



(5) Load blank scratch tape in computer and press PRINT ALL and program modes.

(6) Type in each line of program. After each is typed into display, press STORE to enter line into computer's memory.

(7) When program is entered, press LIST and EXECUTE to obtain a program tape.

(8) Using front panel controls, move sight pen to first point to be digitized. Press ENTER key on plotter front panel. Repeat until all points are digitized (transferred). Computer's printer should print X- and Y-coordinates of each point digitized in units of scale set.

(9) Record program into designated file on blank tape.

(10) Press LOAD (appropriate file number) and EXECUTE to load program into computer's memory.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE

NOTE

In general, format of any plotter programming statement will be as follows:

plt	X-COORDINATE	Y-COORDINATE	[PEN CONTROL]
PROGRAM COMMAND STATEMENT	MANDATORY INPUT PARAMETERS		OPTIONAL INPUT PARAMETERS

Brackets are not entered as part of program. They only indicate which, if any, parameters in a statement are optional. Before attempting to write plotter program, you should be thoroughly familiar with programming language for computer.

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
scl	SCALE. Specifies scale units plot will be drawn in and locates origin (center point 0,0) for plot.

Syntax:

scl [X_{P1}, X_{P2}, Y_{P1}, Y_{P2}]

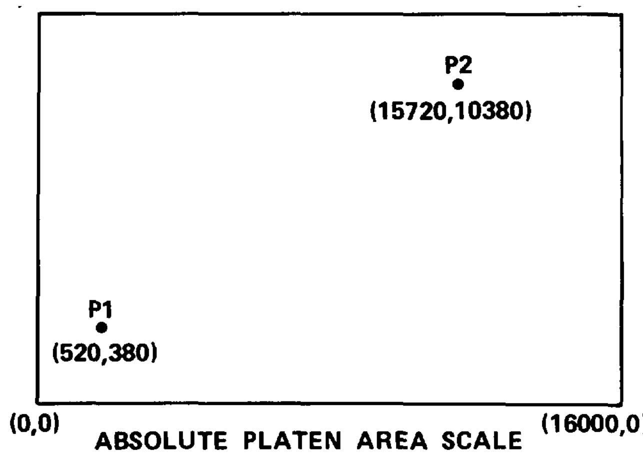
NOTE

When plotter is initialized, two scaling points, P1 and P2, are automatically established in lower left and upper right corners of plot area. These are limiting reference points used to define actual physical area in which plot will fit.

Scale statement parameters set scale for distance between scaling points P1 and P2. Parameter entries must be numeric. Each scaling point is assigned an X- and Y-coordinate.

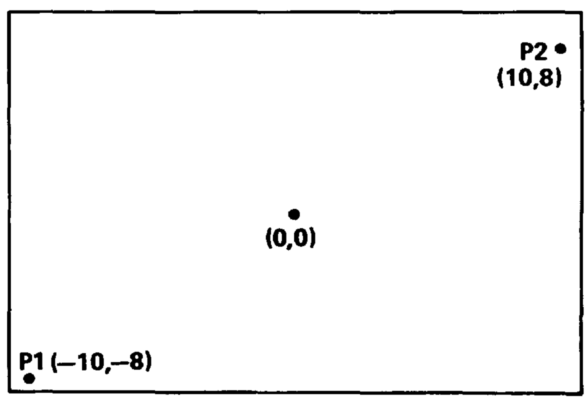
Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
scl - **Cont**	



ABSOLUTE PLATEN AREA SCALE
P1 AND P2 AT INITIALIZATION

Plotter then automatically divides area between these points along each axis into units of length equal to distance between points.



Example:

Input of program statement

scl -10, 10, -8, 8

will set scaling points as shown in the illustration.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

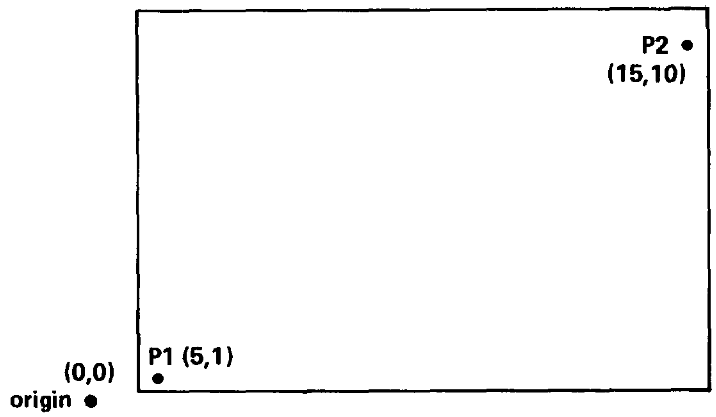
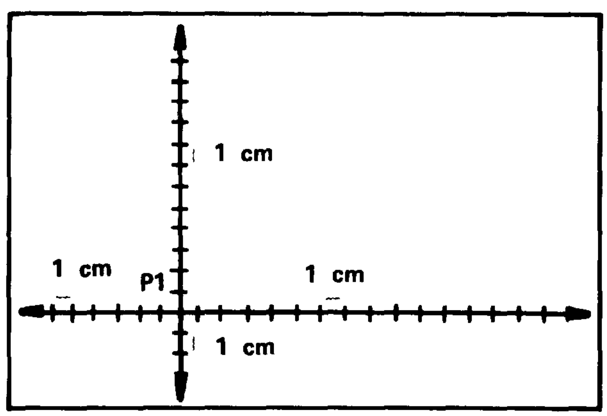
Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
scl - Cont	 If scaling point P1 is assigned negative (-) coordinates and P2 is assigned positive coordinates, origin is automatically set at center of plot area. If both sets of coordinates for points are positive, origin will be off paper in lower left corner as shown in illustration. For two negative sets of coordinates, origin is off paper in upper right corner.  Scale is automatically set when Plotter is initialized or scl statement without parameters is input. Origin is set at P1 and platen is divided into units 1 cm in length. Coordinates of P1 and P2 in internal units of plotter are: P1 (520, 380) and P2 (15720, 10380)

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
pclr	PLOTTER CLEAR. Sends all previous parameters sent in programming statement to their default values, with the following exceptions: **scl** and **psc** parameters P1 and P2 remain unchanged. Pen does not move but point raises. Syntax: **pclr** (No Parameters) **NOTE** Plotter default conditions are listed in this table.
xax/yax	X- AND Y-AXES. Draws X- or Y-axis with or without tic marks or labels. Syntax: **xax** X-offset, tic interval, start point, end point, number tics/label **yax** Y-offset, tic interval, start point, end point, number tics/label X-Offset parameter specifies X-coordinate at which Y-axis will cross X-axis. Y-Offset parameter specifies Y-coordinate at which X-axis will cross Y-axis. Tic interval parameter specifies whether or not tic marks are to be drawn along axis. If tic marks are to be drawn, parameter value specifies spacing, in units of scale statement, between tics. Value of 0 results in no tic marks. If parameter is not specified, tic mark is drawn at each end of axis only. Sign of tic interval can result in either normal tic marks being drawn or tic mark drawn only at starting point of axis.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
xax/yax - Cont	Start point and end point parameters specify location of endpoints of axis. If end point is not specified, axis is drawn to P2 coordinate (i.e., XP2 for X-axis and YP2 for Y-axis). If both start point and end point parameters are not specified, axis is drawn from P1 coordinate value to P2 coordinate value, as specified by current scale statement (i.e., X_{P1} to X_{P2} for X-axis and Y_{P1} to Y_{P2} for Y-axis). The following relationship exists between start point and end point parameters and sign of tic interval parameter. Positive tic interval results in: Normal tic spacing if start point is less than end point. Tic mark drawn only at start point if start point is greater than end point. Negative tic interval results in: Normal tic spacing if start point is greater than end point. Tic mark drawn only at start point if start point is less than end point. Number tics/label parameter determines whether or not tic marks on axis will be labeled. Specifying either 0 or no parameter results in no labels. If labels are desired, parameter specifies number of tic marks between labels. Negative parameter will result in only labels being lettered without axis or tic marks being drawn. Labels will be lettered on an axis only if non-zero tic parameter is specified. All labels are lettered according to current character size **(csiz)** statement and in current number format (fixed or float statement).

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

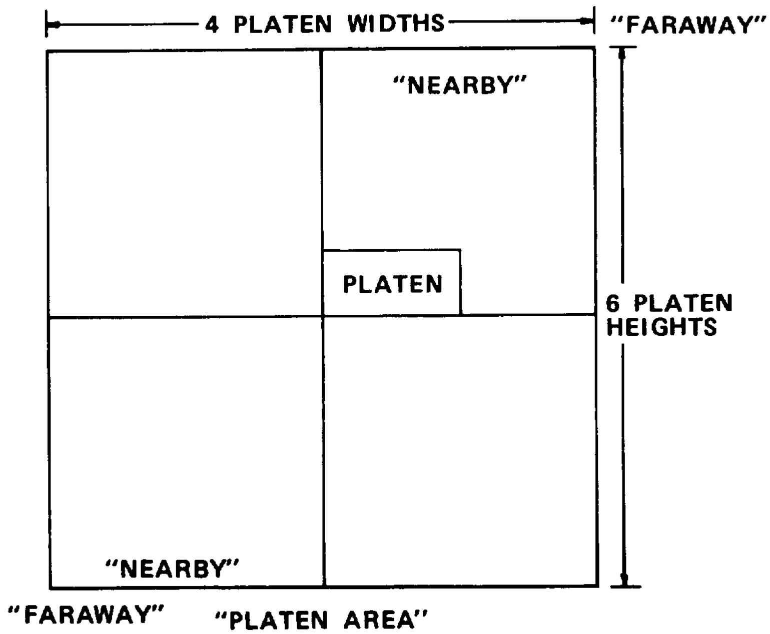
Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
xax/yax - Cont	Example: **scl** -10, 10, -8, 8 **fxd** 0 **xax** 0, 1, -10, 10, 2 **fxd** 1 **yax** 0, -.5, -8, 8, 1 Above program results in X- and Y-axes being drawn, crossing at center. X-axis goes from -10 to 10 with tic marks at every one unit and labeled every two units: -10, -8, -6, etc. Y-axis ranges from -8.0 to +8.0 with tic marks every half-unit. Every tic is labeled.
pen	NUMBER PEN. Raises pen without moving it to a new location. Syntax: **pen** (No Parameters)
pen #	PEN NUMBER. Allows selection of desired pen colors via program. Syntax: **pen #** (Pen front panel stall number) When **pen #** statement is executed, pen arm raises pen it is currently holding (if any) and returns it to empty pen storage position. If a valid pen position number is specified (1-8), pen in that position is taken and pen arm returns to its last location on platen. Parameter value of 0 or no parameter directs pen arm to return pen it is currently using to empty storage position without taking new pen. If specified pen position is empty or if all of pen positions are full and there is pen in arm, then no operation occurs.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
plt	PLOT. Draws line by moving pen to point or points specified by X- and Y-coordinate parameters in statement. Syntax: **plt** $X_{Coordinate}$, $Y_{Coordinate}$,[Pen Control] Optional pen control causes pen to raise or lower before or after moving. If point specified by plot statement lies off platen surface, line is drawn to platen limit and then pen is raised. Pen remains raised until point on platen is specified. Optional pen control parameter can be any integer in range -32768 thru 32767. Odd, positive integer = Pen lifts before moving. Odd, negative integer = Pen lifts after moving. Even, positive integer = Pen lowers before moving. Even, negative integer = Pen lowers after moving. 0 = No change. No Parameters = Pen remains in its present position, moves to point specified, and lowers or remains down. If point lies off platen but is within "nearby" area (shown below), OUT OF LIMIT lamp will turn on. If point lies in "faraway" area, OUT OF LIMIT lamp will blink. If point lies off platen but is within "nearby" area (as shown), OUT OF LIMIT lamp will turn on. If point lies in "faraway" area, OUT OF LIMIT lamp will blink.

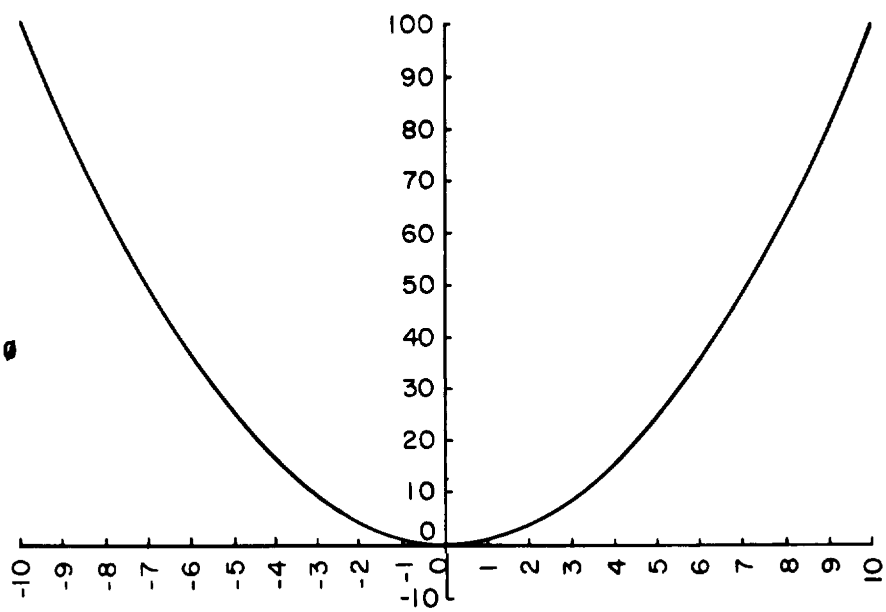
Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
plt - Cont	



Following example program plots values of function Y = X^2.

```
O: pclr
1: scl -10, 10, -10, 100
2: fxd 0
3: xax 0, 1, -10, 10, 1
4: yax 0, 10, -10, 100, 1
5: -10→X
6: plt x, x↑2; if (x+1→x)<=10; jmp Ø
7: pen
8: and
```



PLOT OF Y = X^2

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
ofs	OFFSET. Moves origin (point 0,0) of plot from its present location to new position specified by X- and Y-increment values in statement. Syntax: **ofs** ^{X}Increment' ^{Y}Increment X-Increment specifies number of horizontal scale statement units that origin is to be moved. Y-Increment specifies number of vertical scale statement units that origin is to be moved. Signs of increment parameters specify direction that origin moves, as follows: Positive parameter moves origin in positive direction as defined by current scale statement. Negative parameter moves origin in negative direction as defined by current scale statement.
iplt	INCREMENTAL PLOT. Moves pen from its current location to new location specified by X- and Y-parameters. Syntax: **iplt** ^{X}Increment.' ^{Y}Increment , [Pen Control] X-Increment parameter specifies number of scale statement units that pen is to move horizontally. Y-Increment parameter specifies numbers of scale statement units that pen is to move vertically. Signs of increment parameters determine relative direction that pen moves, as follows: Positive value moves pen in positive direction as defined by current scale statement. Negative value moves pen in negative direction.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
iplt - Cont	Optional pen control parameter is same as that used with plot statement.
	Odd, positive integer = Pen lifts before moving.
	Odd, negative integer = Pen lifts after moving.
	Even, positive integer = Pen lowers before moving.
	Even, negative integer = Pen lowers after moving.
	0 = No change.
	No parameters = Pen remains in its present position, moves to point specified, and lowers or remains down.
	If **iplt** statement specifies point off platen, pen draws line to limit of platen and stops. If point lies off platen in "nearby" area (shown next), OUT OF LIMIT lamp turns on. Plotter recognizes **iplt** statements in this area. If point specified lies in "faraway" area, OUT OF LIMIT lamp flashes and plotter does not recognize **iplt** statements. Regular plot **(plt)** statement must be used to specify point that is either on platen or in nearby area before any further **iplt** statements are recognized by plotter.

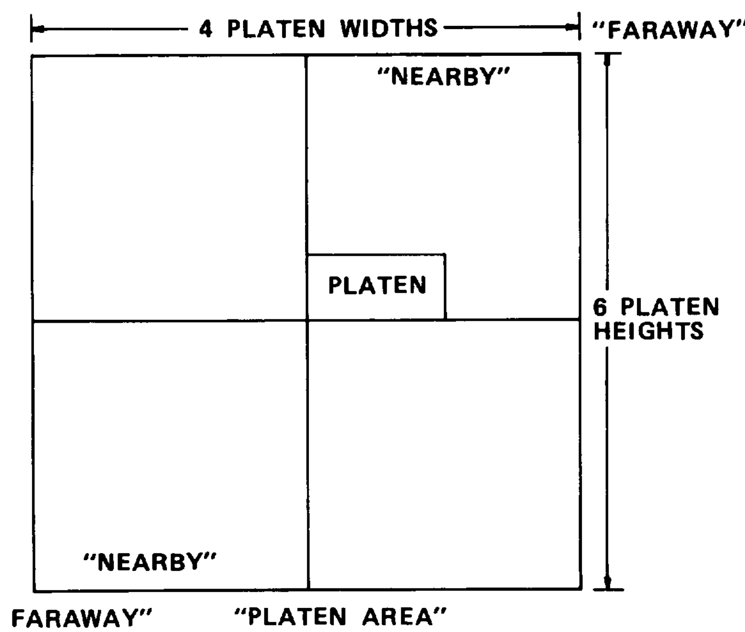


Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
line	LINE TYPE. Specifies type of line plotter is to use when implementing **plt, iplt, xax,** and **yax** statements.

Syntax:

line [pattern no. [, pattern length]]

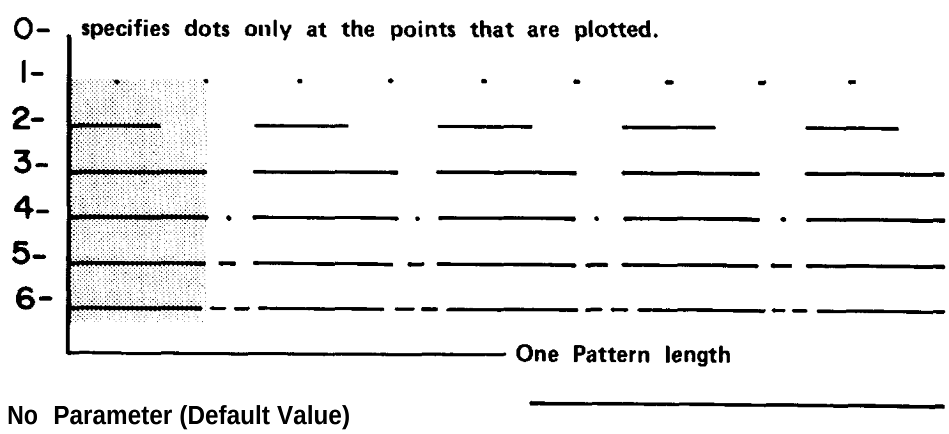
See illustration below for line patterns available and their code numbers.

The line type "line" statement specifies the type of line that will be used with **plt, iplt, xax** and **yax** statements.

Syntax:

line [pattern no. [, pattern length]]

Shown below are the line patterns and their pattern numbers.



Shaded portion of each of line pattern above is one complete segment of pattern.

Optional pattern length parameter specifies length of one complete segment of pattern and is expressed as percentage of diagonal distance between scaling points P1 and P2. If pattern length parameter is not specified, a length of 4 percent is used. Range of pattern length parameter is from 0 thru 127.9994999.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions

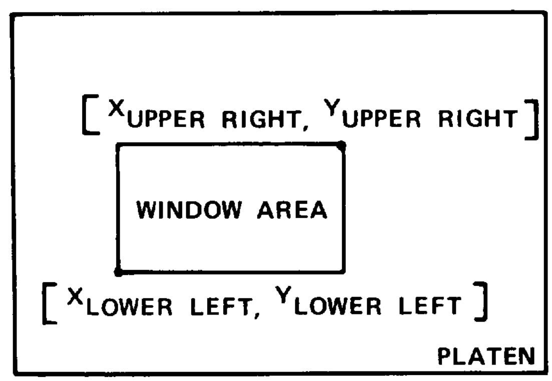
lim

LIMIT. Restricts programmed pen motion to specific rectangular area on platen within area defined by scaling points. Can be used to emphasize specific portion of larger plot.

Syntax:

lim [$X_{\text{Lower Left}}$, $X_{\text{Upper Right}}$, $Y_{\text{Lower Left}}$, $Y_{\text{Upper Right}}$]

Four parameters specify, in current scale statement units, X- and Y-coordinates of lower left and upper right corners of a window area, as shown below.



If limit statement is not executed or if limit statement without parameters is executed, window is automatically set at mechanical limits of plotter.

lbl

LABEL. Allows you to letter characters, expressions and test or string variables.

Syntax:

lbl Any combination of “text”, expressions or string variables.

Example of text statement:

lbl “9872C Plotter”

Example of expression label:

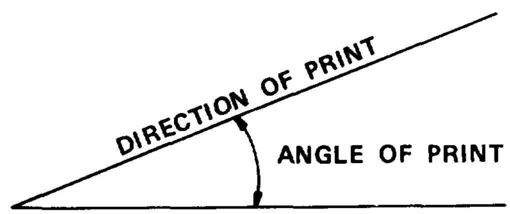
lbl X, X+1, X+2

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
lbl - Cont	Value assigned to X will be lettered in current number format (fixed or float). Value resulting from expression X+1 is lettered next, followed by value resulting from expression X+2. Digits in these expressions are lettered as string of characters. This requires you to add any spaces needed to fit numbers into context of item being lettered. For example, the following statement letters same expressions as example above, with four spaces between each value. **lbl X, " ", X+1, " ", X+2, " "** The following example letters characters contained in string variable AS. (String variable ROM is required.) **lbl A$** Before using label statement, pen should be moved to location where labeling is to begin by using one of plot statements **(cplt, iplt,** or **plt)** or by using four direction controls on plotter front panel. This point will become lower left corner of first character. After lettering character, pen stops at lower left corner of next character space.
csiz	CHARACTER SIZE. Specifies size and shape of characters and symbols and direction they are to be lettered. Syntax: **csiz** [height [, aspect ratio [, paper ratio [, angle of rotation]]]] Statement can specify up to four parameters. If any of parameters are omitted, specific default value for parameter is assumed. Note that when parameter is omitted, parameter listed immediately to its right must be omitted as well. Here is description of each of four parameters: Height parameter specifies height of characters as percent of scale height defined by scaling points P1 and P2. Must be within range of 0 thru 127.9994999.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
csiz - Cont	Aspect ratio parameter specifies ratio of height of character to its width. For example, an aspect ratio of 2 specifies characters that are twice as high as they are wide. An aspect ratio of 1 specifies square characters.
	Paper ratio parameter specifies ratio of height of scaling area to its width. Scaling area is defined by scaling points P1 and P2. For example, 10 in. (25.4 cm) high X 15 in. (38.1 cm) wide scaling area has paper ratio of 10:15 or 2:3.
	Angle of rotation parameter specifies direction in which characters are printed. Direction is expressed as angle (measured left) between line of print and X-axis, as shown below.



	Parameter is expressed in current angular units (degrees, radians, or grads).
	Default values for four parameters are as follows:

Parameter	Default
Height	1.5%
Aspect ratio	2
Paper ratio	1
Angle of rotation	0

Executing **csiz** statement without parameters sets default values. These values are also set when plotter is initialized or cleared **(pclr).**

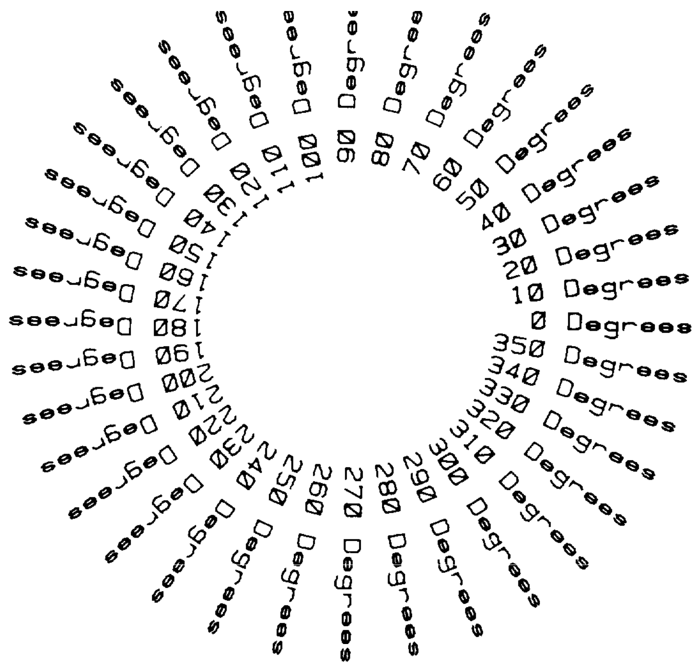
The following example program uses **csiz** instruction (line 3) to specify character dimensions and shape and rotate lettering direction through entire circle in 10-degree intervals. Plot statement (line 2) centers pen for each printing sequence.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
csiz - Cont	Lines 4 and 5 add extra spaces (if needed) to right justify values that precede "DEGREES." This example assumes that scaling area is set for 8 in. (20.32 cm) high X 10 in. (25.4 cm) wide paper.

PROGRAM

```
0: pclr:0→R→X deg:fxd 0
1: scl 0,30,0,24
2: csiz 2, 1.5, 8/10, R
3: plt 15, 12, 1
4: if R<10;lbl "   "
5: if R<99;lbl "   "
6: lbl "   ", R, " Degrees"
7: if (R+10→R) <360; jmp -5
8: plt 30,20,1
9: end
```



ANGLE OF ROTATION PLOT

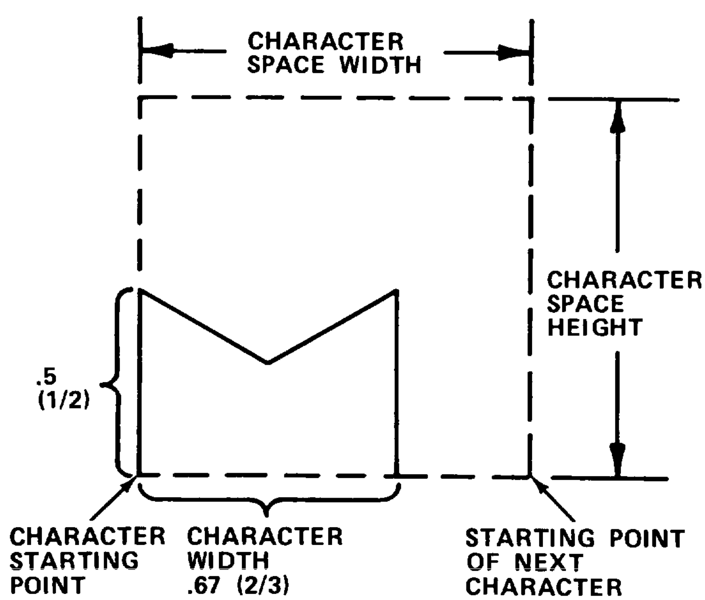


Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
csiz - Cont	In diagram, you can see relative position of character, in this case M, within character space field. Character space field is set indirectly by **csiz** statement, since character space height is twice the character's height and character space width is 1-1/2 times the character's width. Spaces above and below character become spacing between lines and characters. When you specify height of character in **csiz** statement, you should specify character height and not height of character space field.
cplt	CHARACTER PLOT. Moves pen a specified number of character space fields. Syntax: **cplt** Number of character space widths, number of character space heights If no parameters are specified, **cplt** statement performs carriage return and line feed operation by moving one character space height down and returning to margin defined by last point that pen was sent to by either plot statemet, **iplt** statement, or the plotter front panel controls. If **csiz** statement is executed after pen is positioned by plot, **iplt,** or front panel controls, location of pen when **csiz** statement is executed becomes that margin pen returns to when **cplt** is executed without parameters. When parameters are specified, **cplt** statement moves pen specified number of character space widths to right (positive value) or to left (negative value) and number of character space heights up (positive value) or down (negative value). Pen position (raised or lowered) does not change when **cplt** statement is executed. Parameters must be within range of ±127.9994999.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

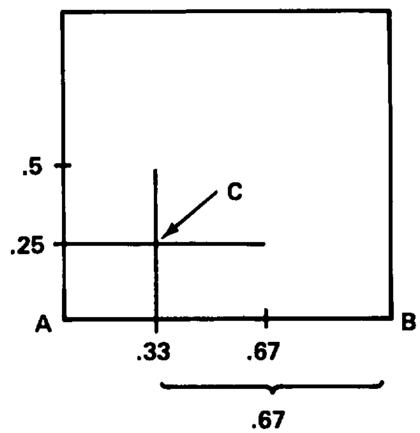
Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
cplt - Cont	 Diagram above shows character spacing around symbol +. Pen begins to draw symbol at point A and ends at point B, ready to draw another character. To center symbol on point C, which represents plotted point, pen must be moved to point A. This can be done by executing **cplt** statement specifying parameters .33, -.25. After symbol is drawn, pen must be returned from point B to point C to continue plotting next point. This can be done by executing a **cplt** statement specifying parameters -.67, .25.
ptyp	PLOTTER TYPEWRITER. Sets plotter in manual typewriter lettering mode. Syntax: **ptyp** (No parameter inserted) After **ptyp** statement is executed (either in program, in live keyboard mode or from keyboard), you type desired characters on computer keyboard, and they are lettered by plotter. To end **ptyp** mode, press STOP key once.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
ptyp - **Cont**	Pen can be positioned by **plt, iplt,** or **cplt** statements before **ptyp** mode is established. Once **ptyp** mode is established, four computer display keys or eight pen movement keys on plotter front panel can be used to position pen for lettering. Following keys perform these functions while in **ptyp** mode: Space → Backspace ← Line Feed ↓ Inverse Line Feed ↑ Carriage Return STORE
dig	DIGITIZE. Sends coordinates of point where pen is located to computer. Syntax: **dig** variable 1, variable 2, pen status Digitize statement enables digitizer mode. When digitizer mode is set, ENTER lamp on plotter is lit. You can use plotter pen movement controls to position pen at point on platen After positioning pen, pressing ENTER on plotter front panel sends its coordinates, in scale statement units, to computer Coordinate values are assigned to variables specified by digitize statement in following order:

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
dig - Cont	**NOTE** Select code for plotter is set at factory to 705. X-coordinate value — variable 1 Y-coordinate value — variable 2 pen status (0 = Up, 1 = Down) — parameter (If Specified) To cancel digitize statement without entering values, press STOP key. If digitize statement is executed from program, STOP key will also stop program at end of line containing digitize statement. Special digitizing sight is provided with plotter. This allows you to visually position pen directly over point to be digitized. Sight is loaded and stored like pen. **NOTE** If more than one point is to be digitized, then program must contain looping statements to return to and repeat program step containing digitize command or contain several digitize commands. Plotter can only digitize one point each time digitize command is encountered.
wrt	WRITE. Identifies additional plotter control commands. Syntax: **wrt 705,** command code **NOTE** Select code for plotter, set at factory, is 705. Syntax and function of control commands on next page.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	User-defined character is drawn with the current character slant. **wrt 705, "IN"** Initialize command is equivalent of switching plotter off and then on again or initializing it from front panel. Sets plotter to same conditions as **pclr** command and sets these additional conditions: Pen is moved to lower right corner of platen. Scaling points P1 and P2 are set to points P1 (520,380) and P2 (15720,10380).

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Plotter Default Conditions

Condition	Set To:
Relative Character Direction	Horizontal (DR1,0)
Line Type	Solid line
Line Pattern Length	4% of the distance from P1 to P2
Input Window	Mechanical limits of plotter
Relative Character Size	(SR.75, 1.5) width = 0.75% of $1P2_x - P1_x1$ height = 1.5% of $1P2_Y - P1_y1$
Scale	Off
Symbol Mode	Off
Tic Length (on either side of axis)	0.5% of $1P1_x - P2_x1$ or $1P1 - P2_y1$ for tp or tn
Standard Character Set	Set 0
Alternate Character Set	Set 0
Character Slant	0
Mask Value	223,0,0
Digitize Clear	On
Automatic Pen Pickup	On
Pen Velocity	36 cm/sec
Adaptive Pen Velocity	off

P1 and P2 are changed only with initialize command (IN). They are not affected by the default command (DF) or the bus command, device clear.

The current pen location is moved to the lower right corner with the initialize command (IN), but is unaffected by the default command (DF) or the bus command, device clear.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	**wrt 705, "AP"**

Automatic pen pickup command, **"AP",** causes plotter to automatically raise pen whenever it has been down without motion for 65 seconds. This condition is set automatically when plotter is initialized.

Sending characters **"APO"** to plotter will disable automatic pen pickup.

wrt 705, "PD"

Pen down command, **PD,** lowers pen to paper.

wrt 705, 'VS 1 thru 36 [, Pen No.]"

Select pen velocity command specifies pen speed, in cm/sec, for plotting and lettering operations. Velocity can be any value between 1 and 36. If optional pen no. (1-8) is specified, speed will apply only to that pen. If pen no. is not specified, speed applies to all pens.

Whenever plotter is initialized, pen velocity is set to 36 cm/sec.

wrt 705, 'VA"

Sets plotter to adaptive pen velocity mode. Plotter will adapt pen speed, automatically, to approximate rate that computer sends coordinate data to plotter. This mode provides smoother plot than normal velocity mode for plotting coordinates that are generated by a relatively slow program routine (fewer than 15 coordinates/sec).

wrt 705, 'VN"

Normal velocity command, **'VN",** cancels adaptive velocity mode. Pen speed is now controlled by current pen velocity command.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	**wrt 705, "SM** character"

NOTE

Some symbols in the following text are not elsewhere defined in this manual. Refer to Hewlett-Packard operating manuals for complete symbol definitions.

Symbol mode command, "SM", is used with PA and PR commands and provides the means to draw a symbol at the end of each vector. Symbol is limited to a single character and may be any printing character except: (ASCII 59). PA and PR commands function as usual, except that the specified character is drawn at the end of each vector and is centered on the plotted point. Character will be drawn at the end of the vector whether the pen is up or down. Character is drawn according to the character set currently selected when the SM instruction is executed. Once selected, the character is independent of character set changes later in the program and can only be changed by a new SM command. If a character is not specified the symbol mode is cancelled. If a non-printing or control character is specified, error 3 is set and the symbol mode is cancelled. The size (SI and SR), slant (SL), and direction (DI and DR) commands affect the character drawn. An SM command remains in effect until another SM command is executed or the plotter is initialized or set to default conditions. Since symbol mode can only be used with a single symbol, whenever a label requires more than one symbol, CP instructions must be used.

wrt 705, "TL [Up and right tic length
[, down and left tic length]]"

Tic length command, **"TL",** specifies length of tic marks drawn by axis statements. Tic lengths are specified as percentage of horizontal and vertical distances between scaling points P1 and P2.

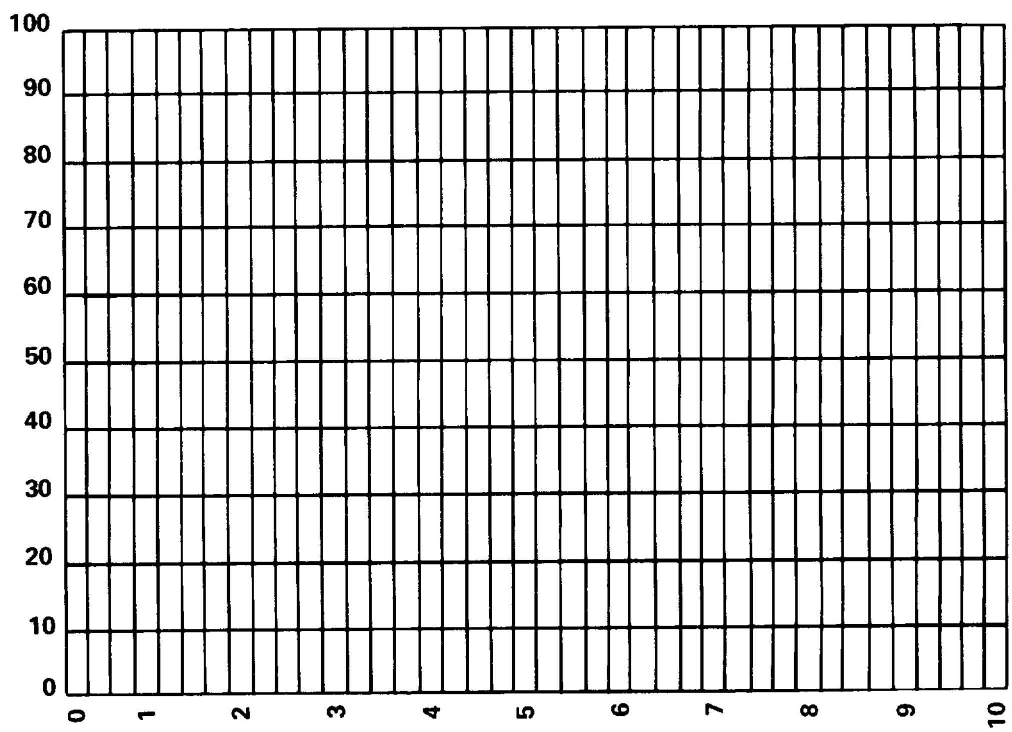
Up and right tic length determines length of upward portion of tic marks to be drawn along X-axis and right side portion of tic marks to be drawn along Y-axis. This value is specified as percentage of vertical scale length, $P1_y - P2_y$.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	Down and left tic length determines length of downward portions of tic marks to be drawn along X-axis and left side portion of tic marks to be drawn along Y-axis. Value is specified as percentage of horizontal scale length $P1_x - P2_x$. Plotter, when initialized, automatically sets tic length values to 0.5% of scaling lengths ($P1_y - P2_Y$ and $P1_x - P2_x$). Program shown below uses tic length command to draw a grid within plotting area of plot. Note that only UP and right length parameter is specified, since only area above X-axis and to right of Y-axis is being used. Since down and left tic length is not specified, plotter uses length of 0 (no tic marks).

PROGRAM

```
0:  pclr:scl 0,
 10,0,100
1:  wrt 705,"TL10
 0"
2:  fxd 0:xax 0,
  .25,0,10,4
3:  yax 0,10,0,
 100,1
```



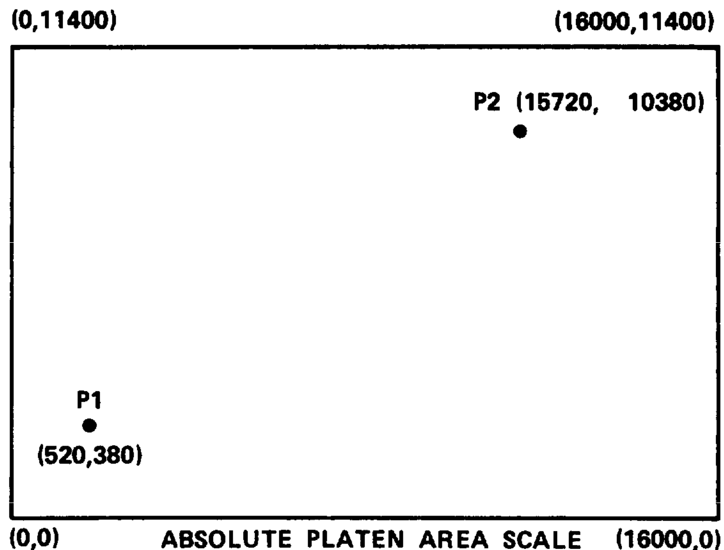
TIC LENGTH EXAMPLE

wrt 705, "IP X_{p1}, Y_{p1}, X_{P2}, Y_{P2}"

Used to relocate scaling points P1 and P2. New coordinates of P1 and P2 are specified-in order shown above. These coordinates must be in absolute plotter scale units.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

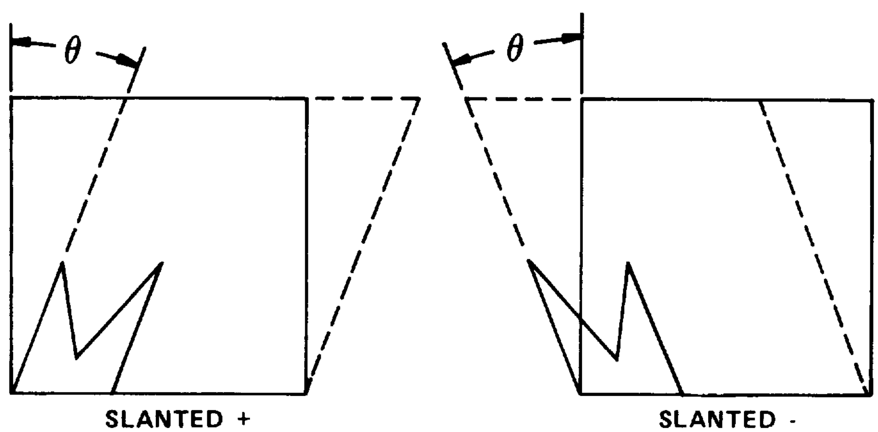
Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	Default coordinates of P1 and P2 are specified in absolute plotter scale units. Illustration below shows location of P1 and P2 at initialization in these units:



ABSOLUTE PLATEN AREA SCALE
P1 AND P2 AT INITIALIZATION

wrt 705, "SL", tan θ

Character slant command specifies slant with which characters are lettered. Angle θ specifies slant as shown below:



Sending **"SL"** or **"SLO"** to plotter defaults character slant to vertical or 0.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	**wrt 705, "CS (Ø-4)"**

Character sets command designates one of five sets (Ø-4) as standard character set. This character set will be used for all labeling and lettering operations. Character set Ø is automatically set whenever plotter is initialized.

NOTE

Plotter, when initialized, automatically specifies ANSI-ASCII character set (set Ø) as both "standard" and "alternate" sets. The **pclr** statement, however, designates 9825 character set (set 1) as standard set and set Ø as alternate set. Following keys are used to switch from standard character set to alternate set and back:

Select standard set = SHIFT F_2

Select alternate set = SHIFT F_3

Shown below are characters contained in set Ø. These characters correspond to those on computer keyboard. They are shown in order (from left to right) of decimal-equivalent value of their ASCII codes (32-126).

CHARACTER SET Ø

! "#$%&' () *+, -. /0123456789: ; <=>?@
ABCDEFGHIJKLMNOPQRSTUVWXYZ [\] ^ _ `
abcdefghijklmnopqrrstuvwxyz {| } ~

Shown next are symbols in various character sets that are changed from set Ø. The plotter will perform an automatic backspace before drawing any of the shaded symbols.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions

wrt - Cont

Decimal Value	Set 0 Standard ASCII	Set 1 9825 ASCII	Set 2 French/German ASCII	Set 3 Scandinavian ASCII	Set 4 Spanish/Latin American ASCII
35	#	#	£	£	¿
39	'	'	´	'	´
91	[	[	[	Ø	[
92	\	√	Ç	Æ	¡
93	]	]	]	ø	]
94	^	↑	[illegible]	æ	^
95	_	_	_	_	_
96	`	`	`	`	`
123	{	π	[illegible]	[illegible]	~
124	|	⊢	[illegible]	[illegible]	[illegible]
125	}	→	[illegible]	[illegible]	~
126	~	~	'	[illegible]	[illegible]

wrt 705, "CA (Ø-4)"

Alternate character command specifies alternate character set Any of five character sets (Ø~4) can be specified. Character Set Ø is automatically specified as alternate character set whenever plotter is initialized.

wrt 705, "SS"

Standard set command selects standard set as character set to be used for all labeling statements **(lbl, ptyp, xax,** and **yax).**

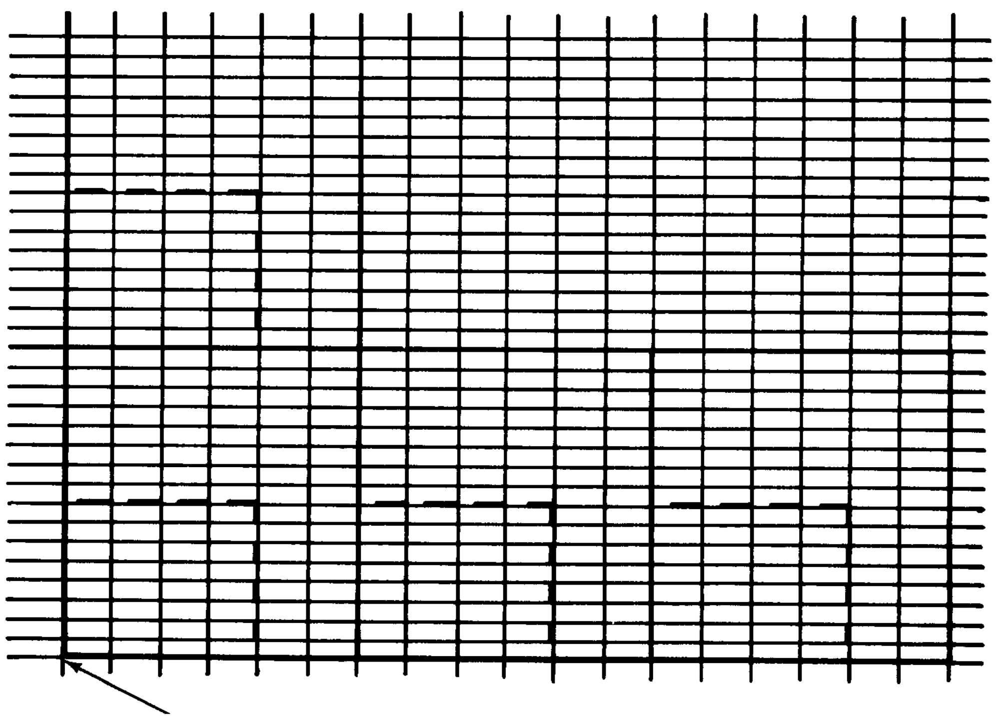
Standard set is selected automatically when plotter is first switched on, initialized, or cleared.

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	**wrt 705, "SA"** Set alternate command selects normal alternate set as character set to be used for all labeling statements **(lbl, ptyp, xax,** and **yax).** This command should be executed prior to executing labeling statement whenever alternate character set is to be used. **wrt 705, "UC,** Pen Control Parameter, X-Increment, Y-Increment, Pen Control Parameter, X-Increment, Y-Increment, ..." User-defined character command is used to draw characters of your own design. Each segment of character is drawn according to three parameter values as follows: Pen control parameter +99 = pen down Pen control parameter -99 = pen up X-Increment specifies number of character grid units that pen will move horizontally. Positive value moves pen to right and negative value moves it to left. Increment value can range from -98 thru +98 grid units. Y-Increment specifies number of character grid units that pen will move vertically. Positive value moves pen up and negative value moves it down. Increment value can range from -98 thru +98 grid units. Character grid units are scaled by current size statement. Each character block contains 6 horizontal grid units and 16 vertical grid units. Each character starts from character block origin point. When character is completed, **"LF"** is sent automatically by WRITE statement at end of string of characters, returns pen to next character block origin (six grid units from initial starting point).

Table 3-20. PLOTTER PROGRAMMING LANGUAGE - Cont

Program Statement	Statement Identification and Use Statement, Syntax, Explanation, and Input Instructions
wrt - Cont	**NOTE** This may not be a valid starting point if new character was larger than normal character. A **plt, iplt** or **cplt** statement may be needed to properly position pen for next character.



CHARACTER-ORIGIN POINT

User-defined character is drawn with the current character slant.

Table 3-21. PLOTTER OPERATION AND PROGRAM ERRORS

Error No. Displayed	Error Explanation
	PLOTTER ROM ERRORS
P1	ATTEMPT TO STORE INTO CONSTANT Occurs when one or more parameters in **dig** instruction are constants rather than variables.
P2	WRONG NUMBER OF PARAMETERS Occurs on instructions with numeric only parameter lists **(scl, ofs, plt, iplt, cplt, xax, yax, lim, dig, csiz, line, pen #,** and **psc).** In certain unusual cases where parameter list contains user level function calls, instruction having incorrect number of parameters may be executed. For example, **scl funct** is executed as **scl.** Function call **funct** is ignored.
P3	WRONG TYPE OF PARAMETER OR ILLEGAL PARAMETER VALUE Examples: **lbl A *** **psc 31**
P4	NO HP-16 DEVICE NUMBER SPECIFIED Occurs on **psc** instruction when parameter is between 0 and 14, inclusive, and HP-IB card is at corresponding select code.
P5	PEN CONTROL VALUE NOT IN -32768 THRU +32767 RANGE Occurs on **plt** and **iplt.** May also occur if hardware transmission error occurs between plotter and computer.
P6	NO HP-IB CARD AT SPECIFIED SELECT CODE Occurs on **psc** instruction when HP-IB card set to specified select code is not HP-IB card.

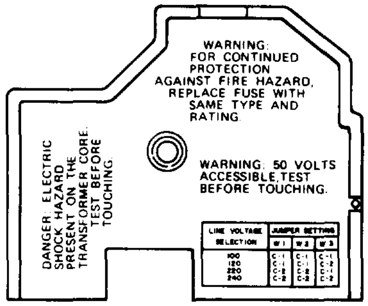
Table 3-21. PLOTTER OPERATION AND PROGRAM ERRORS - Cont

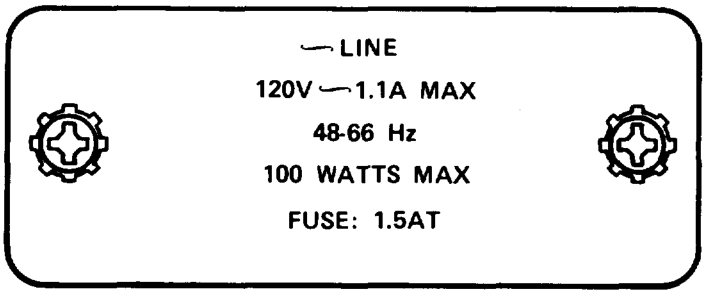
Error No. Displayed	Error Explanation
	PLOTTER ROM ERRORS - Cont
P7	**axe, ltr** INSTRUCTIONS EXECUTED Occurs on **axe** and **ltr** instructions because ROM recognizes these instructions but cannot execute them. This error flags all **axe** and **ltr** instructions for purpose of converting 9825 programs.
P8	CALCULATOR STOP KEY CANCELLED OPERATION Occurs on any instruction when plotter fails to respond for three seconds after STOP key has been pressed. This error is most likely to occur when pen is traveling slowly.
pO	TRANSMISSION ERROR Computer has received an illegal ASCII input from plotter.
p1	INSTRUCTION NOT RECOGNIZED Plotter has received illegal character sequence.
p2	WRONG NUMBER OF PARAMETERS Too many or too few parameters have been sent with instruction.
p3	BAD PARAMETER Parameters sent to plotter with instruction are out of range for that instruction.
p4	ILLEGAL CHARACTER Character specified as parameter is not in allowable set for that instruction.

Table 3-21. PLOTTER OPERATION AND PROGRAM ERRORS - Cont

Error No. Displayed	Error Explanation
	PLOTTER ROM ERRORS - Cont
p5	UNKNOWN CHARACTER SET Character set out of range 0-4 has been designated as either standard or alternate character set.
P6	POSITION OVERFLOW Attempt has been made to draw character or perform CP that is located outside of plotter's numeric limit of -32768 to +32767 .
	Error messages generated by WRITE **(wrt)** and READ **(red)** statements will typically be displayed as error in next executed plotter ROM statement. This can be avoided by using output error command **(wrt** select code **"OE")** followed by a READ statement (red select code, variable) to check for errors after READ or WRITE statements that address plotter.

3-15.4 Operating Instructions on Decals and Instruction Plates.





3-16. OPERATION UNDER UNUSUAL CONDITIONS. This equipment is designed for operation only in a controlled environment.

Section VIII OPERATOR MAINTENANCE

3-17. LUBRICATION INSTRUCTIONS. This equipment does not require lubrication.

3-18. TROUBLESHOOTING PROCEDURES.

a. The table lists the common malfunctions which you may find during operation or maintenance of the X-Y graphics plotter, or its components. You should perform the test/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all test or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Prior to proceeding with equipment troubleshooting perform the following steps:

(1) Check that power cable is connected.

(2) Check that all switches are in proper positions for normal operation.

(3) Check that interface and computer are connected.

(4) Check that computer has power.

(5) Place pens in each of eight stalls.

(6) Before referring to Table 3-22, perform confidence test as follows:

WARNING

To prevent serious injury to personnel or equipment, when performing next step, be sure that fingers and clothing (especially ties) are away from plotting arm and pen stable.

(a) Remove interface from plotter.

(b) Turn LINE power switch to on (I).

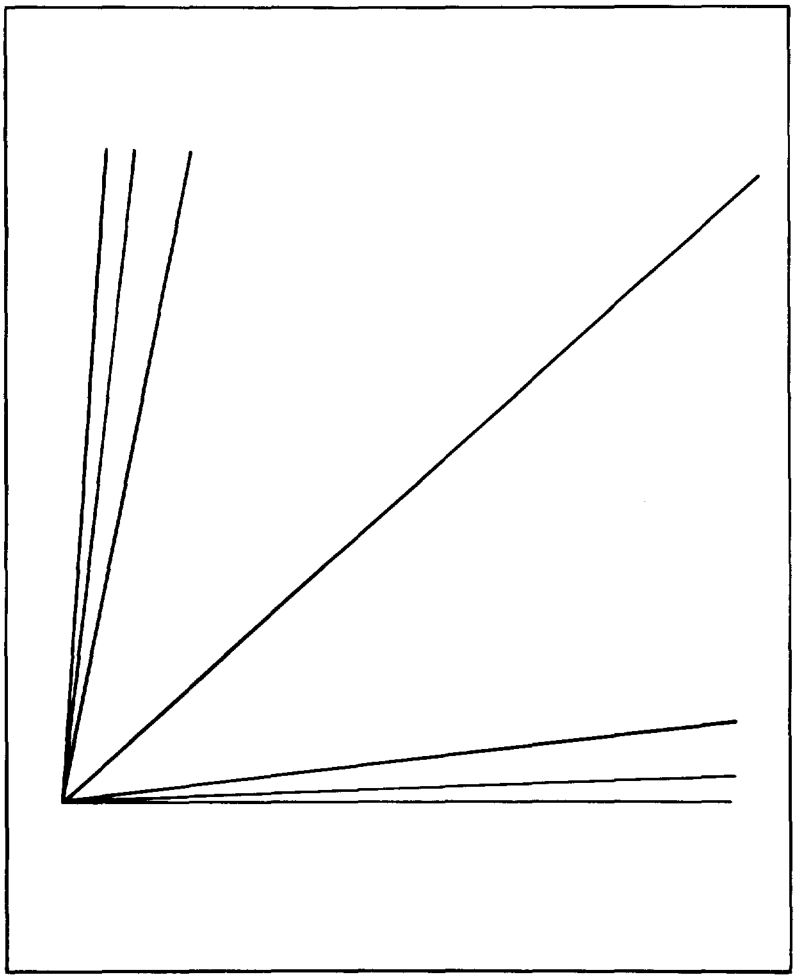
(c) Load sheet of chart paper on platen.

(d) Load pen in pen holder.

(e) Place CONFIDENCE TEST switch in I position. Confidence test begins immediately and runs automatically to completion without operator intervention. Leave CONFIDENCE TEST switch in I position throughout test.

(f) Observe that following functions are performed:

1. Pen is raised and moved to lower left corner of chart.



SAMPLE CONFIDENCE TEST

2. Confidence plot shown above is plotted.

3. All front panel lights are on.

(g) After completion of confidence test, return CONFIDENCE TEST switch to 0 position. Plotter will reinitialize.

(7) Turn LINE power switch to off (0). Plug in interface cable.

(8) Note any observations of incorrect or inadequate performance by plotter. Refer to Table 3-21 to match failure indication.

Table 3-22. TROUBLESHOOTING

NOTE

Each MALFUNCTION leads to one or more TEST OR INSPECTIONS. Each TEST OR INSPECTION leads to CORRECTIVE ACTION. Perform CORRECTIVE ACTION necessary to correct failure. If beyond scope of Operator CORRECTIVE ACTION, refer to higher level maintenance.

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

---

1. PLOTTER IS TOTALLY INOPERATIVE. NO INDICATORS ARE LIT.

Step 1. Check to see if ac power plug is plugged into wall outlet.

(a) If power cord is plugged in proceed to step 2.

(b) Plug in power cord.

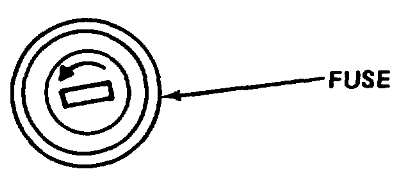
Step 2. Check that electrical outlet is operable.

(a) If power is present at the receptacle, proceed to step 3.

(b) If no power is present, refer to organizational maintenance.

Step 3. Visually check for blown fuse on plotter.

(a) Remove power cord from outlet.



(b) Remove fuse and correct by installing a new fuse. If problem persists, refer to direct/general support maintenance.

Table 3-22. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

2. PLOTTER STOPS . COMPUTER DISPLAYS ERROR MESSAGE.

Refer to Table 3-21, Plotter Operation and Program Errors, for corrective procedure.

(a) Re-enter program using correct key sequence.

(b) If problem persists, refer to direct/general support maintenance.

3. COOLING FAN RUNS. EVERYTHING ELSE IS INOPERATIVE.

Press LINE power switch to off (0) and then to on (I).

NOTE

This action resets power supply if fault was caused by momentary low line voltage.

If problem persists, refer to direct/general support maintenance.

4. PLATEN DOES NOT HOLD PAPER WHEN “CHART HOLD” IS ACTIVATED.

Step 1. Check that paper is not wet and platen is clean.

(a) If paper is not wet and platen is clean, proceed to Step 2.

(b) Clean platen if necessary.

(c) Replace paper.

Step 2. Press LINE power switch to off (0) and then to on (I).

If problem persists, refer to direct/general support maintenance.

Table 3-22. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

5. NO RESPONSE TO PROGRAMMED COMMANDS.

Step 1. Check to see if front panel ERROR lamp is lit.

(a) If lamp is on, re-enter program code correctly.

(b) If problem persists, proceed to step 2.

Step 2. Check that interface is connected and tight.

(a) Connect and tighten interface.

(b) If problem persists, proceed to step 3.

Step 3. Check that interface select code switch is set to seven using the following sequence:

(a) Turn off controller's power.

(b) Set switch to seven.

(c) Re-energize controller.

Step 4. Perform operator's HP-IB operational test (paragraph 3-14.2).

If problem persists, refer HP-IB to direct/general support troubleshooting.

6. PEN ARM PRODUCES EXCESSIVE NOISE WHEN RUNNING ALONG X-AXIS.

Problem is not operator correctable. Refer plotter to direct/general support troubleshooting.

7. NO MOVEMENT IN "X" DIRECTION.

Problem is not operator correctable. Refer plotter to direct/general support troubleshooting.

Table 3-22. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

8. NO MOVEMENT IN “Y” DIRECTION.

Problem is not operator correctable. Refer plotter to direct/general support troubleshooting.

9. PLOTTER INITIALIZES, THEN CONTINUES TO DRIVE, WHILE IN (LOWER RIGHT) STOPS.

Problem is not operator correctable. Refer plotter to direct/general support troubleshooting.

10. PEN SKIPS WHILE PLOTTING.

Problem is not operator correctable. Refer to direct/general support troubleshooting.

11. PLOTTER PERFORMS ABNORMALLY OR ERRATICALLY.

Problem is not operator correctable. Refer to direct/general support troubleshooting.

12. PLOTTER DOES NOT DRAW EXPECTED PLOT OR PLOT APPEARS INACCURATE.

Step 1. Check program for incorrect or misplaced syntax.

(a) If program is correct, proceed to step 2.

(b) Re-enter correct program sequence.

Step 2. Perform operator’s HP-IB operational test (paragraph 3-14.2).

If problem persists, refer plotter to direct/general support troubleshooting.

Table 3-22. TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

13. PLOTTER WILL NOT RESPOND TO DIGITIZE COMMAND OR TRANSFER COORDINATES.

Step 1. Check that LISTEN ONLY switch is set to 0 (talk and listen) mode.

(a) If not, set LISTEN ONLY switch to 0.

(b) If correct, proceed to step 2.

Step 2. Check to see if ERROR or OUT OF LIMIT lamp on front panel is lit.

(a) If lit, enter correct error in program syntax.

(b) If problem persists, proceed to step 3.

Step 3. Perform operator's HP-IB operational test (paragraph 3-14.2).

If problem persists, refer equipment to direct/general support troubleshooting.

3-19. MAINTENANCE PROCEDURES. There are no operator maintenance procedures assigned for this equipment.

Section IX ORGANIZATIONAL MAINTENANCE

3-20. LUBRICATION INSTRUCTIONS. This equipment does not require lubrication.

3-21. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT. These items are not required at this level of maintenance.

3-22. SERVICE UPON RECEIPT.

3-22.1 Checking Unpacked Equipment.

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6, Packing Improvement Report.

b. Check the equipment against the packing list to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Check to see whether the equipment has been modified.

3-23. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES.

a. PMCS are designed to keep the equipment in good working condition by performing certain tests, inspections, and services. The intervals provide you, the organizational technician, with time schedules that determine when to perform specified tasks.

b. Item number column. Item numbers are assigned in chronological ascending sequence regardless of interval designation. These numbers are used for your "TM Number" column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording the results of PMCS.

c. Interval columns. This column determines the time period designated to perform your PMCS.

d. Item to be inspected and procedures column. This column lists functional groups and their respective assemblies and subassemblies as shown in the Maintenance Allocation Chart (Appendix B). The appropriate check or service procedure follows the specific item to be inspected.

e. List of tools and materials required for PMCS is as follows:

Item	Quantity
Jeweler's Screwdriver (0.25 in.)	1 ea
Cross Tip Screwdriver	1 ea
Chart Paper	ar

Table 3-23. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can safely be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

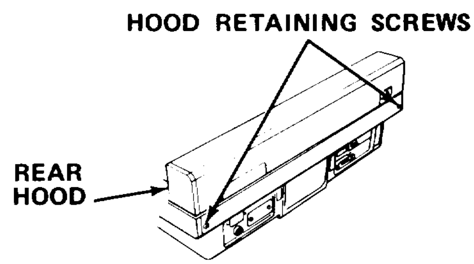
B - Before
D - During
A - After

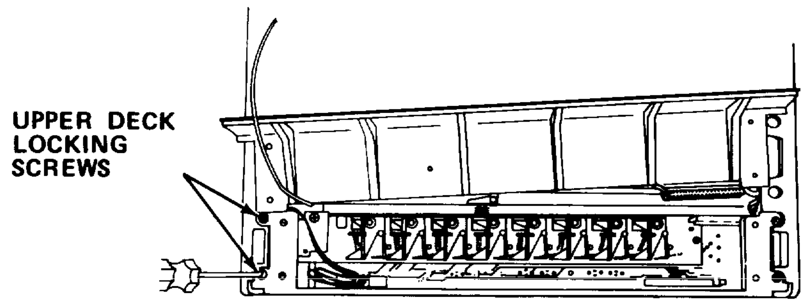
W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE
		GRAPHICS PLOTTER
1	B	Voltage Selector Jumpers.





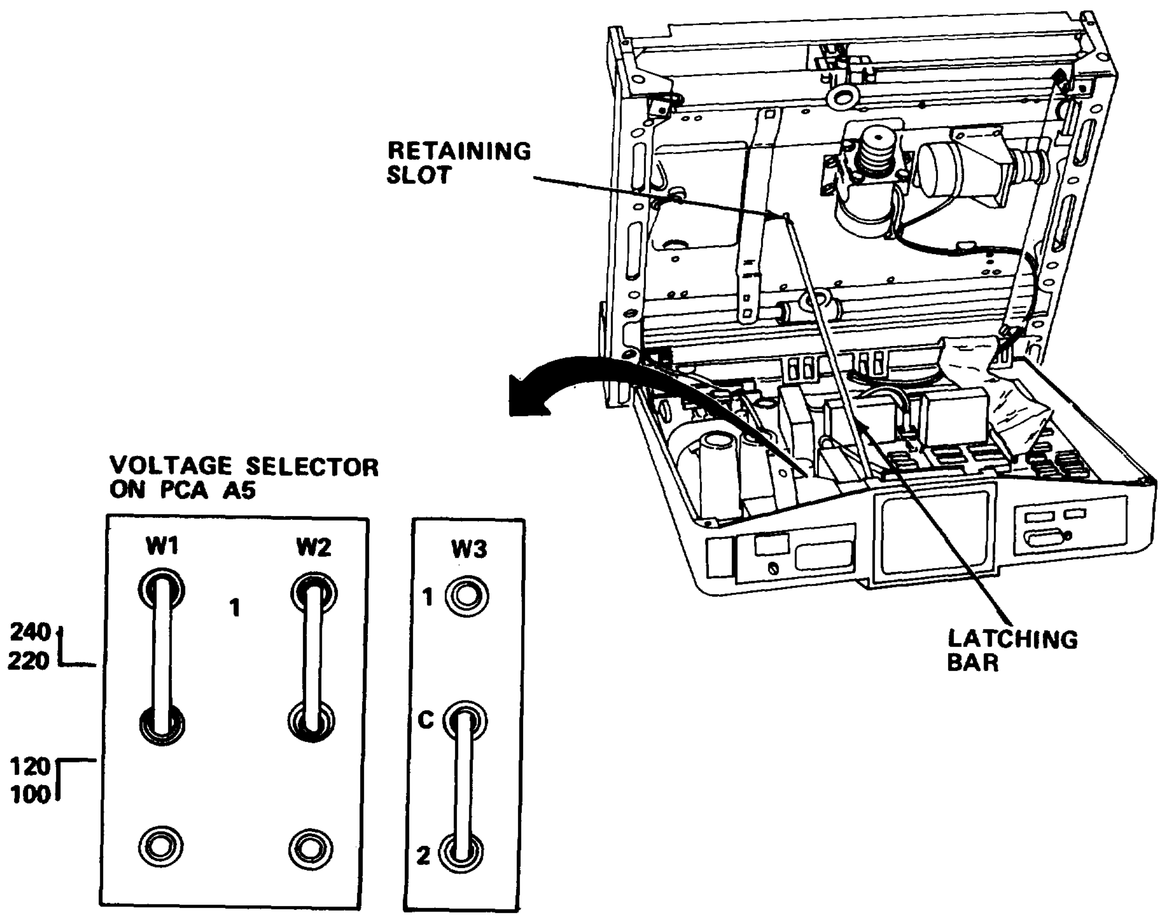
1. Unscrew hood retaining screws and remove rear hood.

2. Center plotter arm on platen and unscrew upper deck locking screws.

Table 3-23. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before	W - Weekly	AN - Annually	(Number) - Hundreds of Hours
D - During	M - Monthly	S - Semiannually	
A - After	Q - Quarterly	BI - Biennially	

ITEM NO	IN-TER-VAL	ITEM TO BE INSPECTED / PROCEDURE
		GRAPHICS PLOTTER - Cont
1	B	Voltage Selector Jumpers - Cont



3. Raise upper deck. Swing latching bar up and secure in retaining slot.

4. Remove two screws and grounding spring.

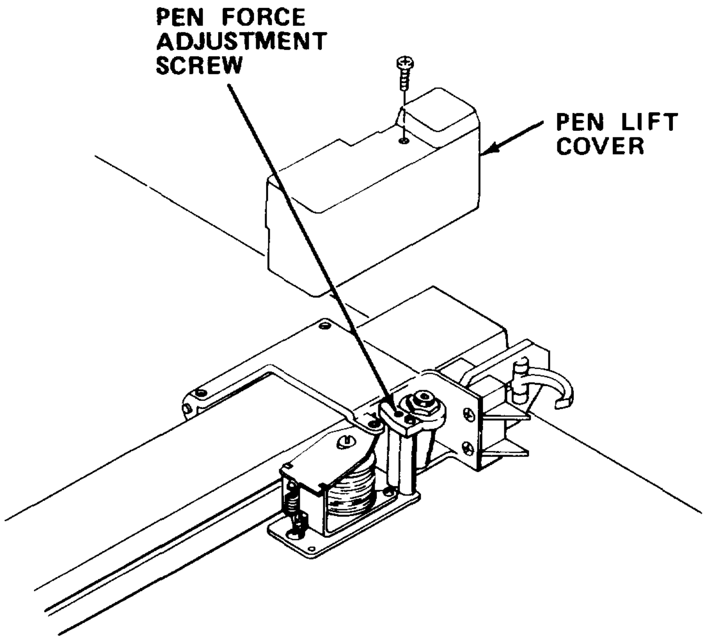
5. Loosen screw and remove plastic shield over A5 board.

6. Check VOLTAGE SELECTOR jumper. Should be set at 120 V ac.

Table 3-23. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before D - During A - After	W - Weekly M - Monthly Q - Quarterly	AN - Annually S - Semiannually BI - Biennially	(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE
		GRAPHICS PLOTTER - Cont
2	Q	Non-Horizontal Mounting Adjustment.



1. Remove pen lift cover screw and remove cover.

2. Turn brass pen force adjustment screw appropriate number of turns.

Table 3-23. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

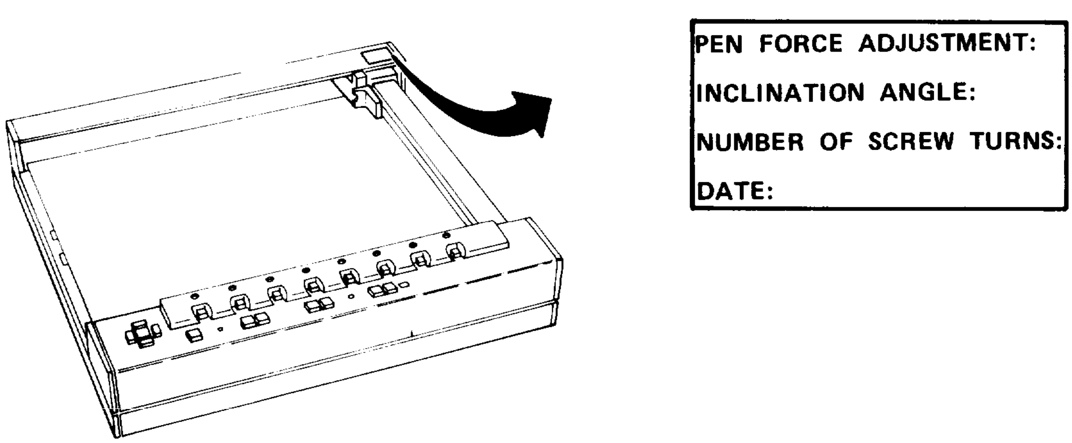
B - Before W - Weekly AN - Annually (Number) - Hundreds of Hours
D - During M - Monthly S - Semiannually
A - After Q - Quarterly BI - Biennially

ITEM NO,	IN-TER. VAL	ITEM TO BE INSPECTED / PROCEDURE
		GRAPHICS PLOTTER - Cont
2	Q	Non-Horizontal Mounting Adjustment - Cont

Plotter Inclination Angle in Degrees	No. Turns to Right on Pen Force Adjustment Screw from Factory Setting
0-15°	None Necessary
30°	3/4
45°	1-3/4
60°	3
75°	4-1/4
90°	5-3/4

NOTE

Place a sticker on plotter and make note on it of inclination angle, number of screw turns, and date.



3-24. ORGANIZATIONAL TROUBLESHOOTING. There are no organizational troubleshooting procedures assigned for this equipment.

3-25. MAINTENANCE PROCEDURES. There are no organizational maintenance procedures assigned for this equipment,

3-26. PREPARATION FOR STORAGE OR SHIPMENT. Contact your battalion for packing and shipping instructions.

Section X DIRECT/GENERAL SUPPORT MAINTENANCE

3-27. REPAIR PARTS. SPECIAL TOOLS: TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE) ; AND SUPPORT EQUIPMENT.

3-27.1 Common Tools and Equipment. For authoriaed common tools and equipment refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

3-27.2 Special Tools: Test. Measurement, and Diagnostic Equipment; and Support Equipment. Special Tools, TMDE, and Support Equipment is listed in the applicable repair parts and special tools list and in Appendix B of this manual.

3-27.3 Repair Parts. Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 5-6675-323-24P covering direct/general support maintenance for this equipment.

3-28. DIRECT/GENERAL SUPPORT TROUBLESHOOTING PROCEDURES.

a. Direct/general support troubleshooting procedures cover the most common malfunctions that may be repaired at the direct/general support level. Repair or adjustment requiring specialized equipment is not authorized unless such equipment is available. Troubleshooting procedures used by lower level maintenance should be conducted in addition to the direct/general support troubleshooting procedures.

b. If the graphics plotter does not power up when turned on, verify that 120 V ac is present at the receptacle. If voltage is not present, plug equipment into receptacle with power available and proceed with equipment troubleshooting. Perform no-power procedures for dead receptacle (Table 1-4).

NOTE

Sufficient data is not available for you to test or troubleshoot printed circuit boards. When associated wiring, ribbon cables, power cords and other related electrical components have been eliminated as possible faults, then the printed circuit boards must be substituted, one for one, until the fault is isolated.

The following steps should precede any troubleshooting procedures involving the interior of the plotter:

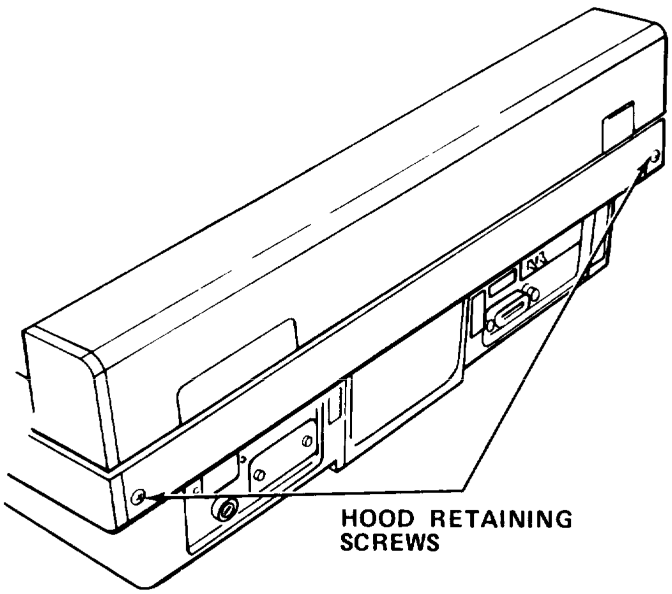
(1) Check that all switches are in proper positions for normal operation.

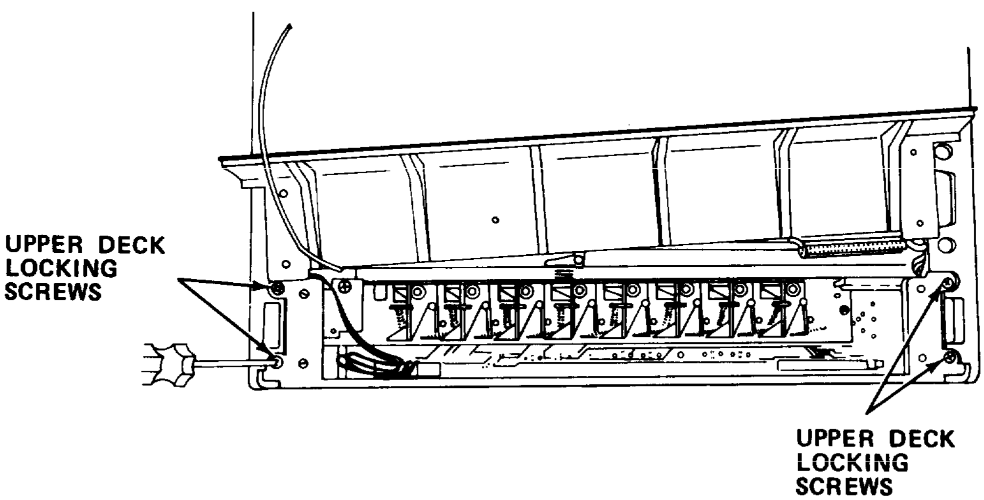
(2) Be sure that HP-IB Interface and computer are connected.

(3) Be sure that computer has power.

(4) Place pen in each stall.

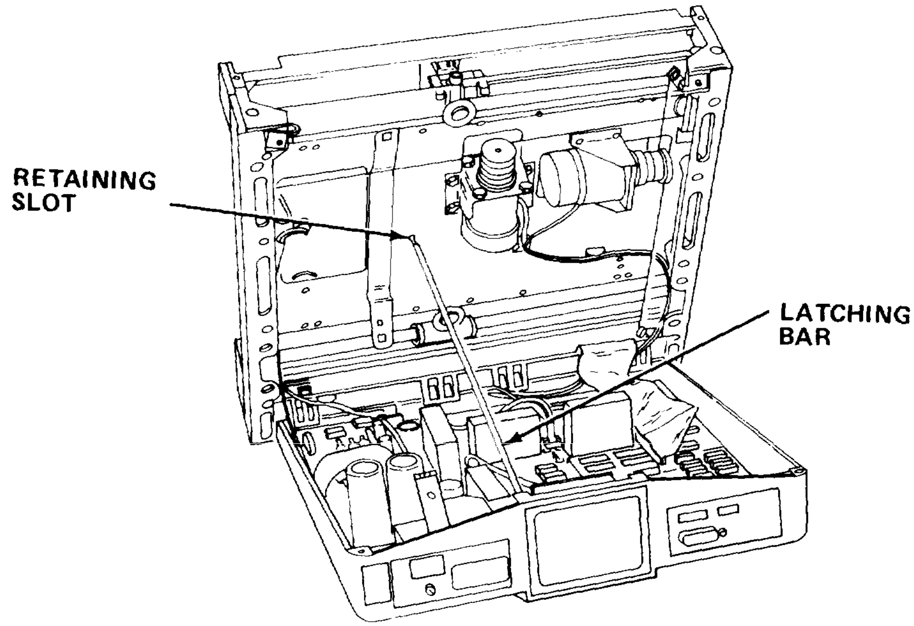
3-28.1 <u>Interior of Plotter.</u> For those tests or inspections required inside the plotter, open the plotter.



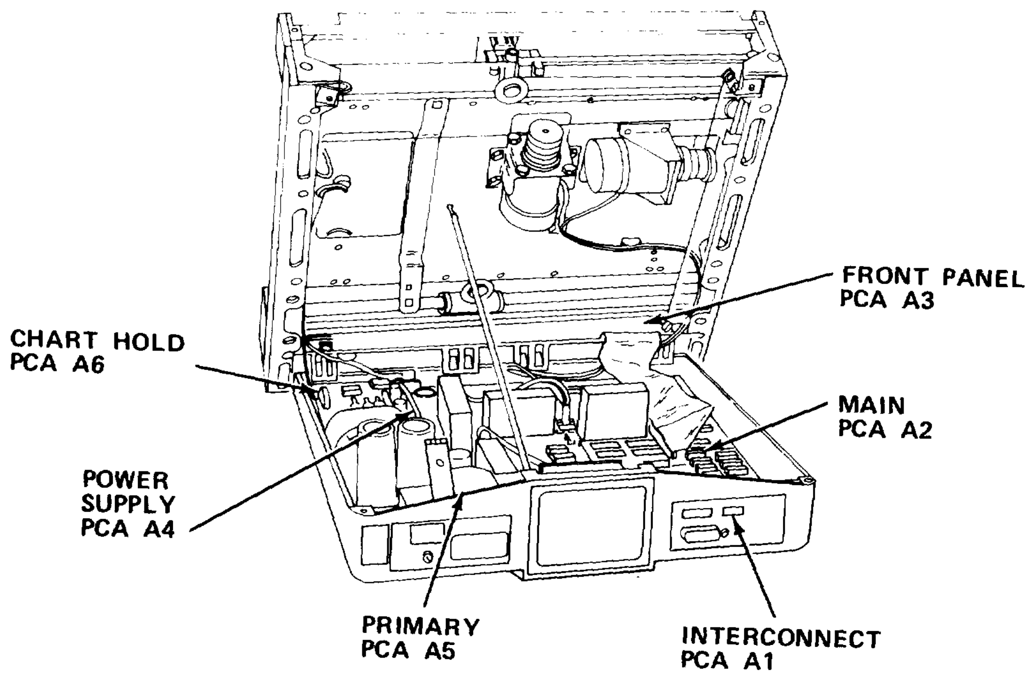


a. Unscrew hood retaining screws and remove rear hood.

b. Center plotter arm on platen and unscrew upper deck locking screws.



c. Raise upper deck. Swing latching bar up and secure in retaining slot.



d. Locate component to be tested.

Symptom Index

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING

MALFUNCTION

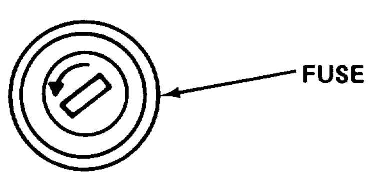
TEST OR INSPECTION

CORRECTIVE ACTION

1. PLOTTER IS TOTALLY INOPERATIVE. PEN WILL NOT MOVE.

WARNING

Death or serious injury may occur from electrical shock. Be careful not to contact high-voltage connections of 115 V ac.



Step 1. Check line voltage at outlet.

(a) If voltage is present, proceed to step 2.

(b) Refer to paragraph 3-28b.

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. PLOTTER IS TOTALLY INOPERATIVE. PEN WILL NOT MOVE - Cont

Step 2. Check fuse for continuity.

(a) If continuity is present, proceed to step 3.

(b) If continuity is not present, replace fuse.

Step 3. Check that line voltage selection switches are set to 120 V.

(a) If line voltage selection switches are correct, proceed to step 4.

(b) Correct switch settings.

Step 4. Check that power supply outputs are correct.

See Malfunction 9 (Power Supply Failure) to continue troubleshooting.

2. PLATEN DOES NOT HOLD PAPER.

Step 1. Open plotter. Check that platen wiring connector is tight.

(a) If tight, proceed to step 2.

(b) If loose, tighten connector.

Step 2. Check A6, J101, pins 1 and 2 to be sure platen drive voltage is greater than or equal to 500 V ac.

If voltage is not present, replace A6 (paragraph 3-29.7).

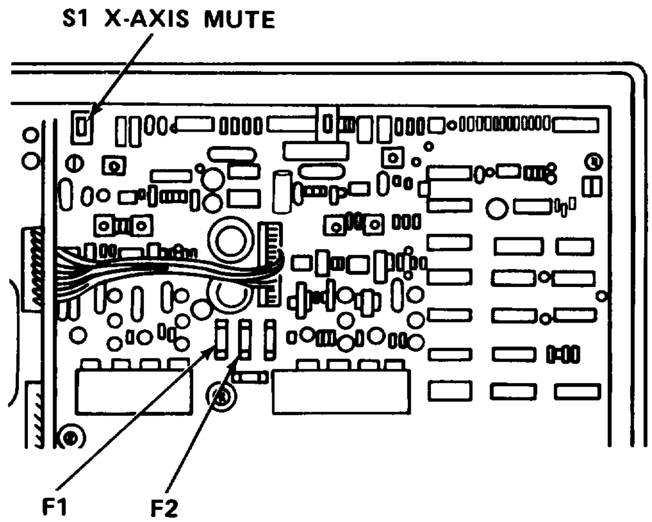
Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

3. NO PEN MOVEMENT IN "X" DIRECTION.



Step 1. Open plotter. Check position of X-axis mute switch S1 on PCA A2.

(a) If S1 is off, proceed to step 2.

(b) Turn off mute switch S1.

Step 2. Check fuses F1 and F2 on A2 for continuity.

(a) If either is defective, replace fuse and turn S1 on.

(b) If pen fails to move, replace A2 (paragraph 3-29.7).

(c) If problem persists, replace X-drive motor (paragraph 3-29.14).

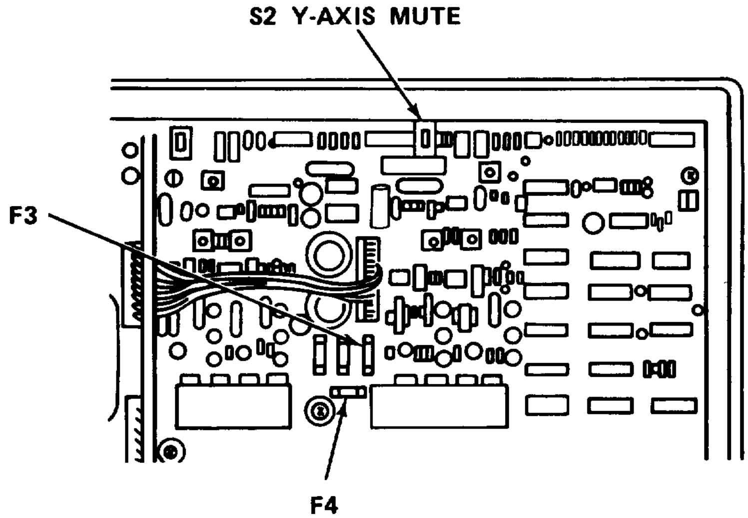
Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

4. NO PEN MOVEMENT IN “Y” DIRECTION



Step 1. Open plotter. Check position of Y-axis mute switch S2.

(a) If S2 is turned off, proceed to step 2.

(b) Turn off S2.

Step 2. Check fuses F3 and F4 on A2 for continuity.

(a) If either is defective, replace fuse and turn S2 on.

(b) If pen fails to move, replace A2 (paragraph 3-29.7).

(c) If problem persists, replace Y-drive motor (paragraph 3-29.14).

5. PLOTTER INITIALIZES; OSCILLATES; THEN STOPS .

Step 1. Initialize plotter using wrt 705, "IN" program command and perform X- and/or Y- limit switch adjustments (paragraph 3-29.9, 3-29. 10) to correct oscillations at power-up.

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

---

6. PEN SKIPS WHILE PLOTTING OR PEN LEAVES NO MARK.

Step 1. Press PEN down switch. Move pen using all five front panel controls. Be sure that pen draws complete lines.

Perform height adjustment of pen (paragraph 3-29.1).

Step 2. Test operation by repeating step 1.

If problem persists, repeat pen adjustment procedures (paragraph 3-29. 1).

7. PLOTTER PLOTS APPEAR INACCURATE OR IMPROPERLY OFFSET.

Perform plotter repeatability and accuracy test (Table 3-19), and adjust X and Y cable tension (paragraph 3-29.3) to correct problem.

8. PLOTTER DOES NOT RESPOND TO COMMANDS OR GENERATES "ERROR" FOR EACH INSTRUCTION.

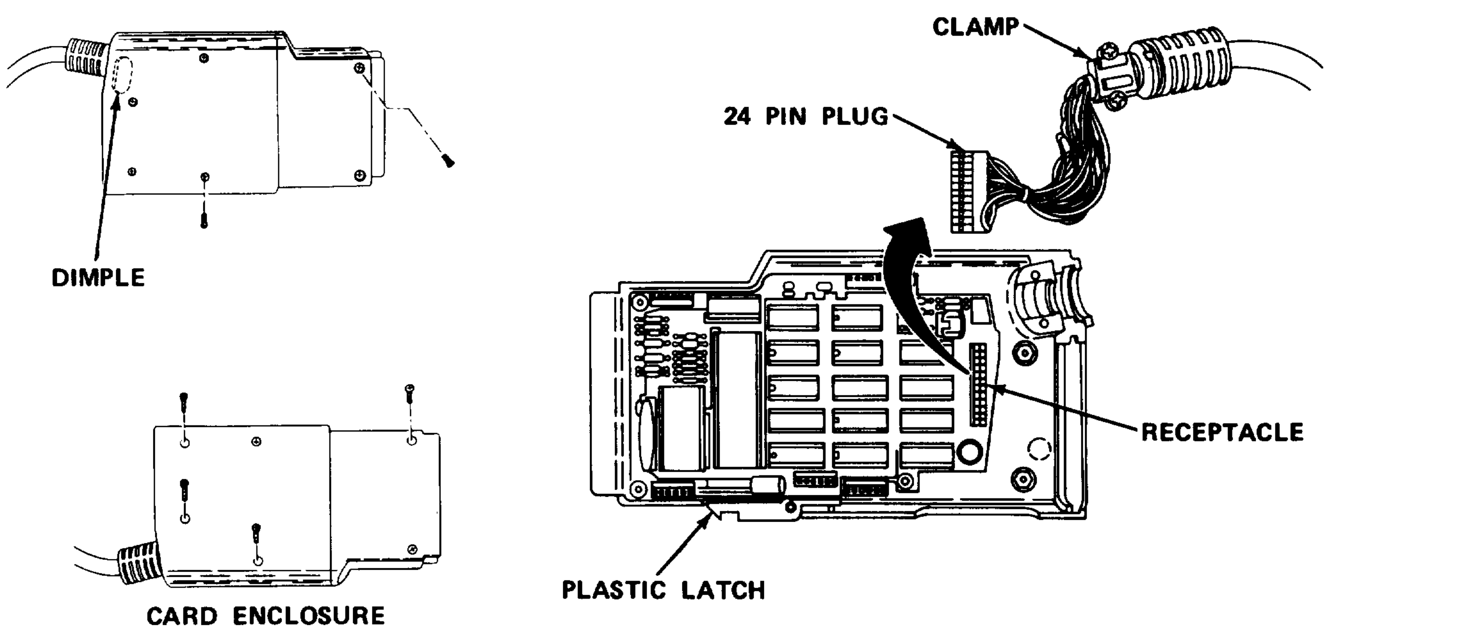


Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

8. PLOTTER DOES NOT RESPOND TO COMMANDS OR GENERATES “ERROR” FOR EACH INSTRUCTION - Cont

Step 1. Checkk power cord for continuity using the following procedure.

(a) Disconnect interface cable from computer and plotter.

(b) Remove two screws shown on side of PCA enclosure with dimple.

WARNING

Death or serious injury may occur from electrical shock. Be careful not to contact high-voltage connections.

(c) Turn PCA over and remove four screws shown.

(d) Grasp both sides of PCA enclosure and carefully pull them apart.

(e) Check for continuity between cable plug and receptacle on card.

(f) Unplug power cable connector from PCA enclosure and check for continuity between cable wiring and cable connector. Replace cable if defective.

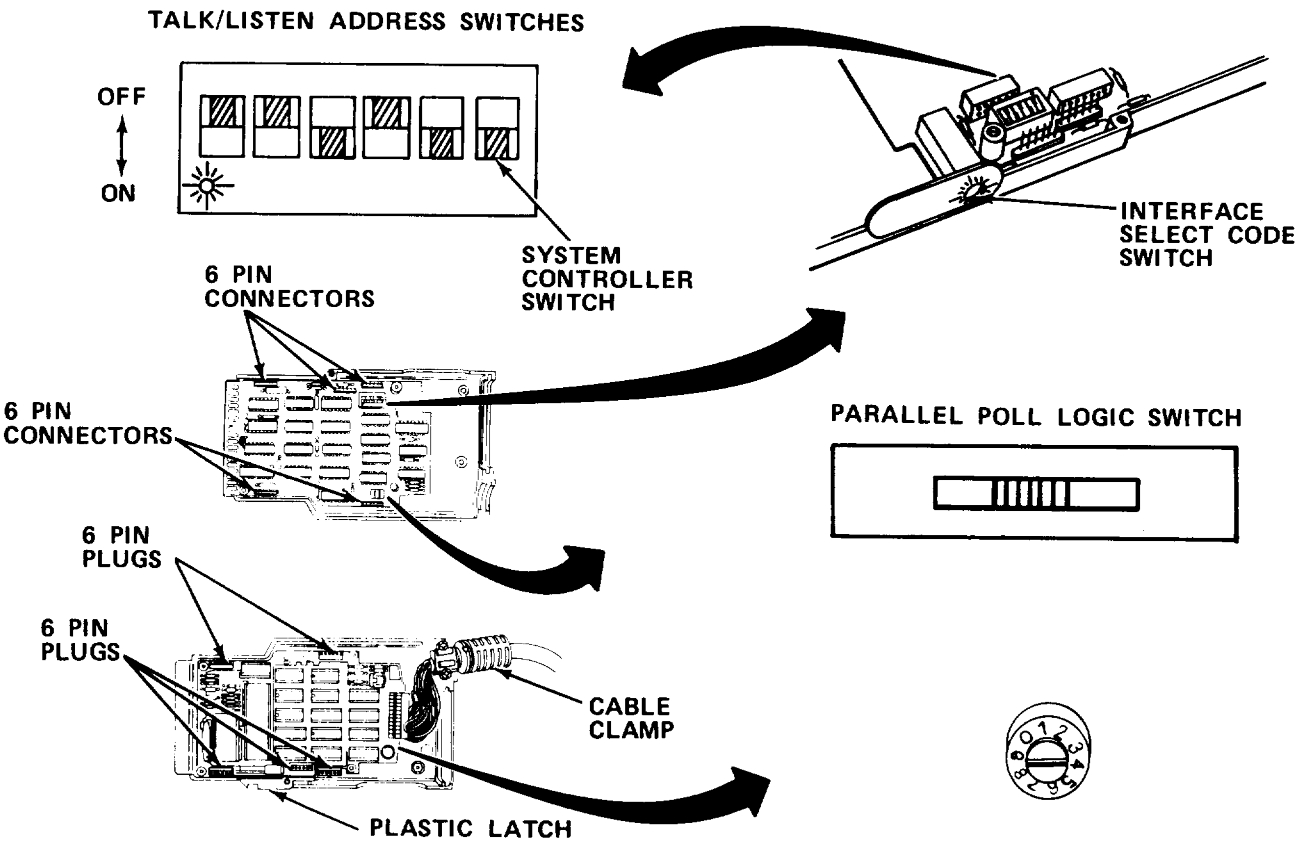
Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

8. PLOTTER DOES NOT RESPOND TO COMMANDS OR GENERATES “ERROR” FOR EACH INSTRUCTION - Cont



Step 2. Check switch address codes for accuracy using the following procedures.

NOTE

When setting parallel poll bit switch, be sure a detent is felt on head.

(a) Change parallel poll bit from 1 to 2.

(b) Change talk/listen address switches to off, off, on, off, on, on.

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

8. PLOTTER DOES NOT RESPOND TO COMMANDS OR GENERATES "ERROR" FOR EACH INSTRUCTION - Cont

(c) Set system controller switch to off.

(d) Change HP-IB Interface select code switch to 6.

(e) Set parallel poll bit switch to 1.

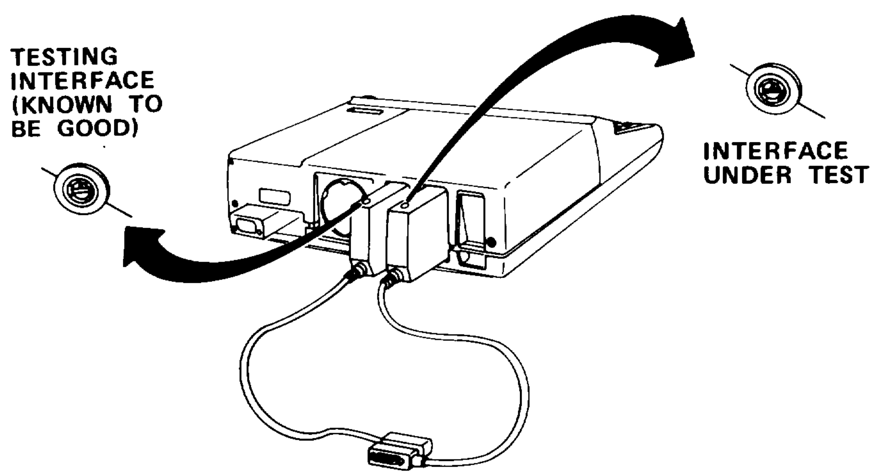
Step 3. Press two halves of HP-IB Interface back together. Be sure that six-pin connectors are lined up with their respective plugs on PCA A2. Be sure that plastic latch remains in place.

Step 4. Reinstall holding screws.

Step 5. Turn off computer.

Step 6. Plug HP-IB Interface into I/O slot in rear of computer.

Step 7. Plug in good, unchanged HP-IB Into another slot beside one to be tested.



Step 8. Connect ends of HP-IB Interface together.

Step 9. Turn on computer power.

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

8. PLOTTER DOES NOT RESPOND TO COMMANDS OR GENERATES "ERROR" FOR EACH INSTRUCTION - Cont

Step 10. Insert system test cartridge. Press following keys in sequence:

STOP
ERASE
A
EXECUTE
RESET
1
d
b
3
EXECUTE

NOTE

- Tape should load and printer should print message similar to following:

PLEASE VERIFY THE FOLLOWING:

GEN. I/0 ROM IN

EXT. I/0 ROM IN

9862 ROM OUT

9872 ROM IN

- Message will vary depending on which ROM's are plugged into computer.

Step 11. Check that plotter ROM, general and extended 1/0 ROM's, are present in computer for the 9825A model.

Step 12. When computer display says ENTER MODEL # TO BE TESTED. ... press following keys in succession: 9, 8, 0, 3, 4, SHIFT and A, and CONTINUE.

Step 13. When display says . . . ENTER SELECT CODE . . ., press CONTINUE.

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

---

8. PLOTTER DOES NOT RESPOND TO COMMANDS OR GENERATES "ERROR" FOR EACH INSTRUCTION - Cont

NOTE

Pressing CONTINUE specifies factory select code 705.

Step 14. When computer display says ENTER # OF TIMES TO RUN TEST . . . . enter number (press corresponding key) for number of times you want to run test and press CONTINUE.

NOTE

- One test takes approximately 2 min to complete. Do not run test more than 10 times.
- After each test is complete, computer will display title of test and TEST COMPLETE.

TEST TAPE SAMPLE

```
PLUG IN ROM TEST
PLEASE VERIFY THE FOLLOWING:
GEN. 1/0 ROM IN
EXT. 1/0 ROM IN
9862A ROM OUT
9872A ROM IN
ENTER MODEL # TO BE TESTED...
98834R
98834A TEST
ENTER SELECT CODE...
ENTER OF # TIMES TO RUN TEST...
OPERATOR SET. (1 TO 10).
ADDRESSES SET IN TEST INTERFACE
STATUS TEST
STATUS TEST COMPLETE
CONTROL BYTE TEST
CONTROL BYTE TEST COMPLETE
IFC TEST
```

```
IFC TEST COMPLETE
SELF ADDRESS TEST
SELF ADDRESS TEST COMPLETE
HANDSHAKE TEST
HANDSHAKE TEST COMPLETE
DATA TRANSFER TEST
DATA TRANSFER TEST COMPLETE
PASS CONTROL TEST
PASS CONTROL TEST COMPLETE
EXTERNAL ADDRESS TEST
EXTERNAL ADDRESS TEST COMPLETE
SERVICE REQUEST TEST
SERVICE REQUEST TEST COMPLETE
INTERRUPT TEST
INTER TEST COMPLETE
PARALLEL POLL TEST
PARALLEL POLL TEST COMPLETE
TEST COMPLETE
```

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

8. PLOTTER DOES NOT RESPOND TO COMMANDS OR GENERATES "ERROR" FOR EACH INSTRUCTION - Cont

Step 15. Compare output of display and printout to above illustration to be sure test has run correctly.

Step 16. If test is not correct, compare displayed or printed error and messages to Table 3-26 and perform indicated maintenance. Table 3-25 lists the HP-IB tests. Test will halt on failed portion.

Step 17. If test is positive (no errors), repeat steps 1-4 on tested interface and restore switches to their factory settings, as follows:

Select code switch to 7.
Parallel poll bit to 1.
Talk/Listen ADDRESS switches to on, off, on, off, on, and off.
System controller to ON.
Parallel poll logic stops on I.
If test failed, replace HP-IB.

Step 18. Repeat steps 5 and 6, and reassemble HP-IB Interface.

9. POWER SUPPLY FAILURE.

Step 1. Remove HP-IB Interface from plotter.

Step 2. Turn LINE power switch to on (I).

WARNING

Death or serious injury may occur from electrical shock. Be careful not to touch any electrical connections. Be sure you are standing on an insulated floor or mat.

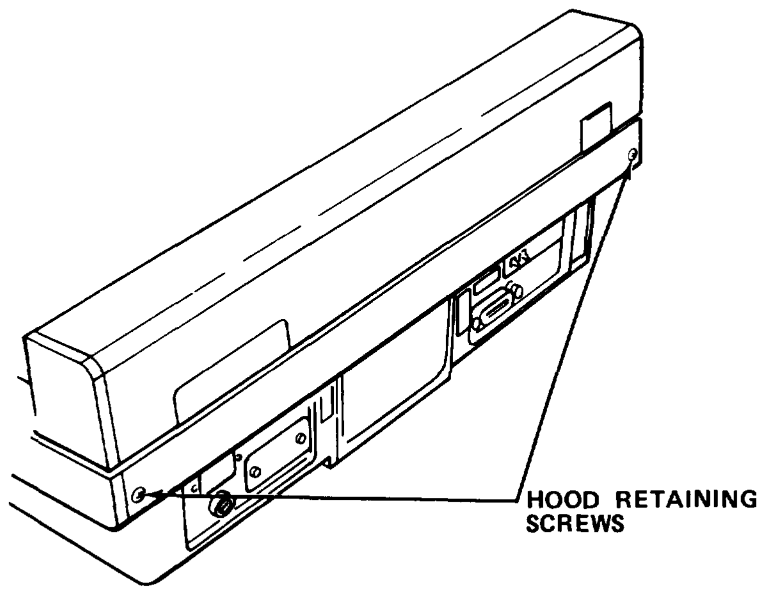
Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

9. POWER SUPPLY FAILURE - Cont



Step 3. To open up plotter:

(a) Unscrew two hood retaining screws and remove rear hood.

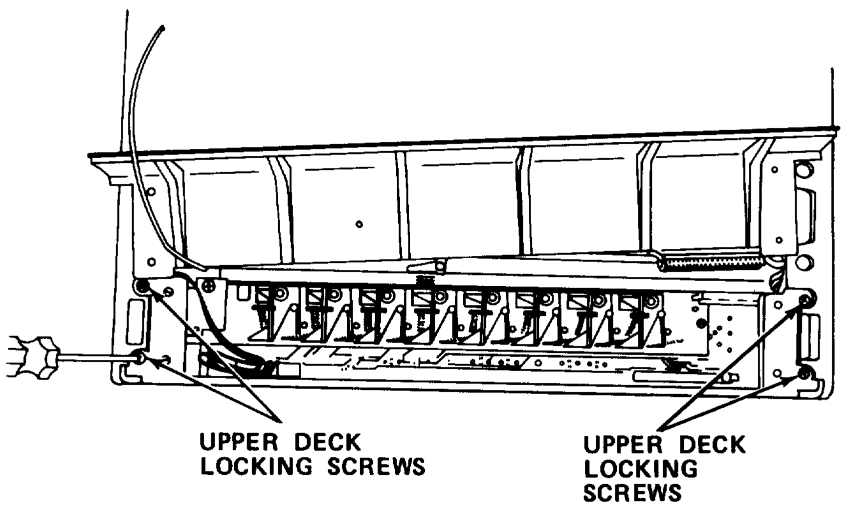
Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

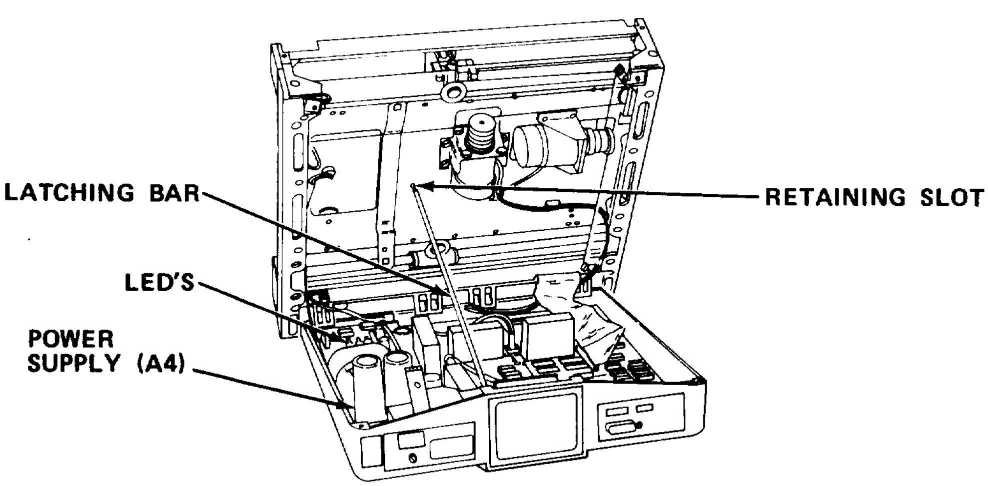
MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

9. POWER SUPPLY FAILURE - Cont





(b) Raise upper deck. Swing latching bar and engage it securely in retaining slot.

Table 3-24. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

9. POWER SUPPLY FAILURE - Cont

Step 4. Check fuses F1, F2, and F3 on A4.

(a) If fuses are good, proceed to step 5.

(b) Replace fuse.

Step 5. Check LED's DS1-6 on A4.

(a) If all are lit, proceed to step 6.

(b) If any LED is not illuminated, replace A4 (paragraph 3-29.7).

Step 6. Check output of ribbon cables J2 and J4 on 4.

If no voltage is present, replace ribbon cable.

Table 3-25. HP-IB TESTS

NOTE

Complete program referred to as "Supervisor Program".

Test	Function
Status	Sends four bytes: error byte, address byte, control byte, and status byte.
Control Byte	Checks to be sure that all control lines can be set and cleared independently using R7 out.
IFC	Ensures IFC works correctly.
Self-Address	Makes sure IUT* can address itself to talk and listen.
Handshake	Ensures that handshake lines** operate correctly and IUT can act as talker and listener.
Data Transfer	Ensures that all DIO lines operate correctly and independently.
Pass Control	Ensures IUT* can pass control to another device.
External Address	Ensures that IUT can be addressed to be both active talker and active listener by another controller.
Service Request	Ensures that IUT can request service and can respond correctly to serial poll.
Interrupt	Ensures IUT can accept interrupt enable, and mask and issue interrupt at appropriate time.
Parallel Poll	Makes sure IUT can issue parallel poll to other devices and respond to parallel poll request.

* IUT - Interface Unit Tested (refers to HP-IB Interface)

** DAV, NRFD, and NDAC are handshake lines.

Table 3-26. HP-IB ERROR DISPLAYS AND POSSIBLE CAUSES

Display or Printout	Possible Causes
	STATUS TEST FAILURES
"HP-IB IDENTIFIER BYTE IS NOT CORRECT--IT IS ____, IT SHOULD BE 60(OCT)"	(1) Failure of PCA A2. (2) Bus ADDRESS switch set incorrectly.
"ERROR BYTE IS NOT CORRECT --IT IS ____, IT SHOULD BE 0"	(1) Failure of ROM. (2) Failure of input/output multipliers.
"ADDRESS BYTE IS INCORRECT -- IT IS ____ , IT SHOULD BE 325(OCT)" "CHECK SWITCH SETTING"	(1) Improper select code switch setting. (2) Failure of select code switch. (3) Failure of select code decoders. (4) Improper ADDRESS switch setting.
"CONTROL BYTE IS NOT RESET CORRECTLY--IT IS ____ , IT SHOULD BE 100(OCT)"	(1) Failure of control logic circuitry. (2) Failure of interrupt logic.
"STATUS BYTE IS NOT RESET CORRECTLY--IT IS ____ , IT SHOULD BE 14(OCT)	(1) Failure of microprocessor. (2) Failure of computer interrupt circuits.
	CONTROL BYTE TEST FAILURES
"TRIED TO CLEAR (SRQ, REN, ATN, IFC or EDI) BUT COULD NOT"	(1) Failure of HP-IB transceivers. (2) Failure of control bus latch. (3) Failure of control logic.

Table 3-26. HP-IB ERROR DISPLAYS AND POSSIBLE CAUSES - Cont

Display or Printout	Possible Causes
	IFC TEST FAILURE
"IFC DID NOT PROPERLY RESET CONTROL BYTE"	Failure of control bus latch, HP-IB transceiver, or control logic.
"TRIED TO SET ATN EOI, AND TO CLEAR REN SIMULTANEOUSLY, BUT COULD NOT. CONTROL BYTE IS _ , IT SHOULD BE 260(OCT)"	Failure of control logic or HP-IB transceiver.
	SELF-ADDRESS TEST FAILURES
" IUT DOES NOT BECOME ACTIVE TALKER WHEN ADDRESSED"	(1) Failure of computer PCA A1. (2) System controller switch is set incorrectly or failed. (3) Failure of processor or interrupt logic.
"IUT DOES NOT BECOME ACTIVE LISTENER WHEN Addressed	Same as items (1)-(3) above.
	HANDSHAKE TEST FAILURES
"DIO LINES ARE BAD, TRIED TO ADDRESS THE TEST CARD WITH ____ BUT IT DID NOT RECOGNIZE ITS ADDRESS" "CHECK TO BE SURE CABLE IS CONNECTED" Example:	(1) Failure of select code switch or set incorrectly. (2) Failure of bus ADDRESS switch or set incorrectly.
"HANDSHAKE FAILURE. IUT IS ACTIVE (LISTENER or TALKER)" DAV = 0 NRFD = 0 NDAC = 0 SHOULD BE: DAV = 0 NRFD = 1 NDAC = 1	(1) Failure of control or interrupt logic. (2) Failure of system controller switch or switch is set to off. (3) Select code switch is set incorrectly.

Table 3-26. HP-IB ERROR DISPLAYS AND POSSIBLE CAUSES - Cont

Display or Printout	Possible Causes
HANDSHAKE TEST FAILURES - Cont	
Example: "HANDSHAKE FAILURE . IUT ACTIVE (LISTENER or TALKER). (LISTENER or TALKER) HAS ISSUED AN R4 (IN or OUT)" DAV = O NRFD = O NDAC = O SHOULD BE: DAV = O NRFD = 1 NDAC = 1	Same as prior items (1)-(3).
DATA TRANSFER FAILURES	
"DATA WRITE ERROR- -DATA WRITTEN WAS MORE THAN 5 WRITE ERRORS . PRESS CONTINUE TO SEE MORE. SHOULD HAVE BEEN ______"	(1) Failure of HP-IB Interface data registers on PCA A1. (2) Failure of output data and control latch, microprocessor, or input multiplexer on PCA A2.
"DATA READ ERROR- -DATA READ WAS MORE THAN 5 READ ERRORS. PRESS CONTINUE TO SEE MORE. SHOULD HAVE BEEN ______"	Same as items (1) and (2) above.

Table 3-26. HP-IB ERROR DISPLAYS AND POSSIBLE CAUSES - Cont

Display or Printout	Possible Causes
PASS CONTROL FAILURES	
" INTERFACE DOES PASS CONTROL, BUT DOES NOT ITSELF RELINQUISH CONTROL"	Failure of computer interrupt circuit on PCA A1 or processor interrupt circuit on PCA A2.
" INTERFACE DOES NOT PASS CONTROL, BUT DOES ITSELF RELINQUISH CONTROL. CHECK TO BE SURE CABLE IS CONNECTED"	(1) Cable is disconnected or loose. (2) Failure of interrupt control circuit on PCA A2.
"INTERFACE NEITHER PASSES NOR RELINQUISHES CONTROL"	(1) Failure of interrupt circuits on both cards. (2) Failure of microprocessor.
EXTERNAL ADDRESS FAILURES	
"IUT CANNOT BE ADDRESSED AS A TALKER BY ANOTHER CONTROLLER. STATUS BYTE IS ________"	(1) Failure of output data or control bus latch circuits on PCA A2. (2) Failure of microprocessor.
"IUT CANNOT BE ADDRESSED AS A LISTENER BY ANOTHER CONTROLLER." STATUS BYTE IS ________	(1) Failure of data input multiplexer, control bus latch, or interrupt circuits on PCA A2. (2) Failure of microprocessor.

Table 3-26. HP-IB ERROR DISPLAYS AND POSSIBLE CAUSES - Cont

Display or Printout	Possible Causes
SERVICE REQUEST FAILURES	
" INTERFACE REQUESTED SERVICE BUT "SRQ IN STATUS BYTE" IS NOT SET	(1) Failure of control bus latch ROM U1 or I/0 register selector on PCA A2. (2) Failure of microprocessor.
" INTERFACE DOES NOT REQUEST SERVICE. CANNOT CLEAR "SRQ"	Same as items (1) and (2) above.
"INTERFACE INCORRECTLY RESPONDED TO SERIAL POLL. CANNOT CLEAR "SRQ"	Same as items (1) and (2) above.
INTERRUPT TEST FAILURES	
"IUT WAS ENABLED TO INTERRUPT ON SERVICE REQUEST, BUT NO INTERRUPT OCCURRED"	(1) Failure of interrupt logic, micro-processor, or control bus latch on PCA A2 . (2) Failure of output data latch on PCA A2 .
"IUT WAS ENABLED TO INTERRUPT INTERRUPT ON BECOMING ACTIVE CONTROLLER, BUT NO INTERRUPT OCCURRED"	(1) Same as items (1) and (2) above. (2) Failure of computer command register or interrupt logic on PCA A1.
"IUT WAS ENABLED TO INTERRUPT INTERRUPT ON BECOMING ACTIVE TALKER, BUT NO INTERRUPT OCCURRED"	Same as items (1) and (2) above.
"IUT WAS ENABLED TO INTERRUPT INTERRUPT ON BECOMING ACTIVE LISTENER, BUT NO INTERRUPT OCCURRED"	Failure of interrupt logic, microprocessor, control bus latch, or data input multiplexer on PCA A2.

Table 3-26. HP-IB ERROR DISPLAYS AND POSSIBLE CAUSES - Cont

Display or Printout	Possible Causes
PARALLEL POLL FAILURE	
" IUT DID NOT CONDUCT PARALLEL POLL CORRECTLY . NO "SRQ" WAS PRESENT AND POLL RETURNED ____"	(1) Failure of parallel poll logic on PCA A1. (2) Parallel poll logic switch is set incorrectly. (3) Failure of parallel poll logic, output data latch, or control bus latch on PCA A2.
" IUT DID NOT CONDUCT PARALLEL POLL CORRECTLY. "SRQ" WAS PRESENT; POLL RETURNED _, SHOULD HAVE BEEN 2"	(1) Parallel poll switch is misset. (2) Failure of parallel poll logic on PCA A1 and A2. (3) Failure of ROM U1.
"IUT DID NOT RESPOND CORRECTLY TO PARALLEL POLL. RESPONSE WAS ______ , SHOULD HAVE BEEN 1. CHECK PARALLEL POLL SWITCH SETTING--SHOULD BE 1"	Failure or wrong setting of parallel poll switch.

3-29. MAINTENANCE PROCEDURES.

a. This section contains instructions covering direct/general support maintenance functions for the X-Y graphics plotter. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

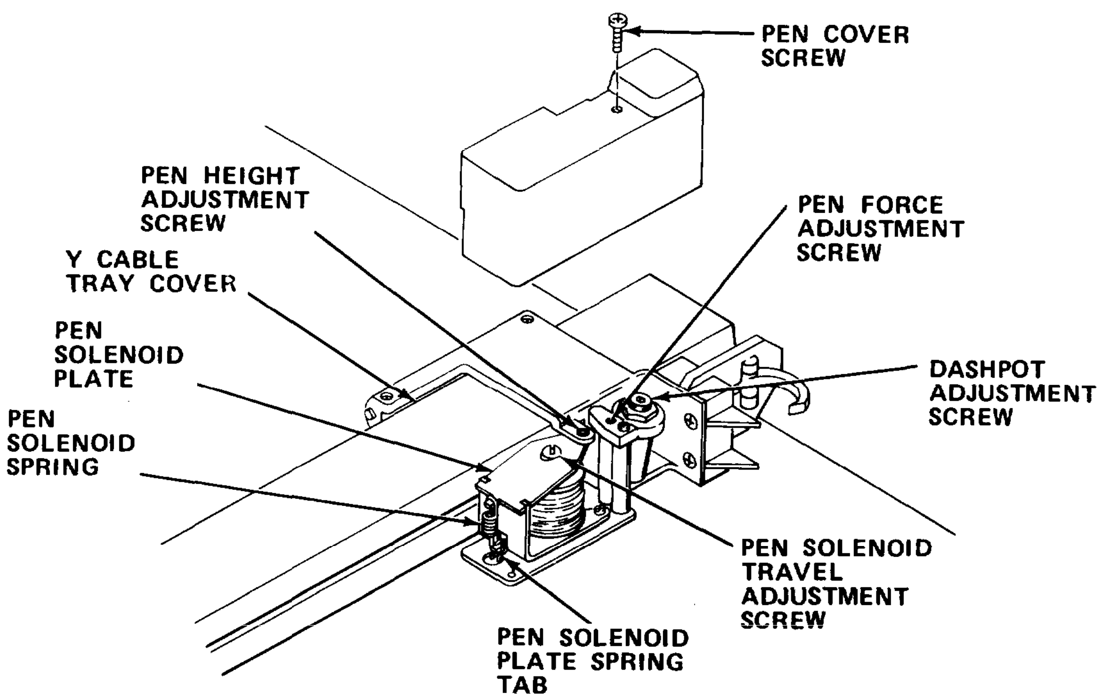
INDEX

3-29.1 Pen Adjustments.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: HP-9825A Desk-Top Computer
Flat Tip Screwdriver (0.25 in.)
Machinist's Rule
No. 1 Cross Tip Screwdriver
5/64 in. Hex Head Key Wrench
.050 in. Hex Head Key Wrench
Jeweler's Screwdriver
Gram Gage Set: 0-60 g
0-30 g

a. Remove pen cover from pen arm assembly by first removing pen cover screw.



b. Adjust travel adjustment screw to obtain 3.4 mm vertical travel with no pen in the pen holder.

c. Adjust pen height:

(1) Install a pen into the pen holder.

(2) Move pen to lower left corner of platen.

(3) Adjust pen height adjustment screw until the pen tip is 2.3 mm above the platen surface.

(4) Check the pen height in remaining three corners and at the center of platen.

```
0:  fmt 1,2f6.0
1:  1000    x
2:  wrt 705, "si.5
 ,.8:sp1"
3:  wrt 705,1,
 "pu;pa'',X,",
 9000"
4:  for I=1 to 5
5:  wrt 705, "1bH"
 ,13,10,3
6:  wait 2000
7:  next I
8:  dsp "for next
  column, press
 CONTINUE'';stp
9:  X+1000    x
10:  gto 3
*27934
```

DETAIL "A"
NOT ENOUGH DAMPING. ADJUST DASHPOT SCREW TO THE RIGHT.

DETAIL "B'
TOO MUCH DAMPING. ADJUST DASHPOT SCREW TO THE RIGHT TO OBTAIN THIS CONDITION. THEN ADJUST DASHPOT SCREW 1 TO 1½ TURNS TO THE LEFT.

DETAIL "C"
CORRECT DAMPING ADJUSTMENT.

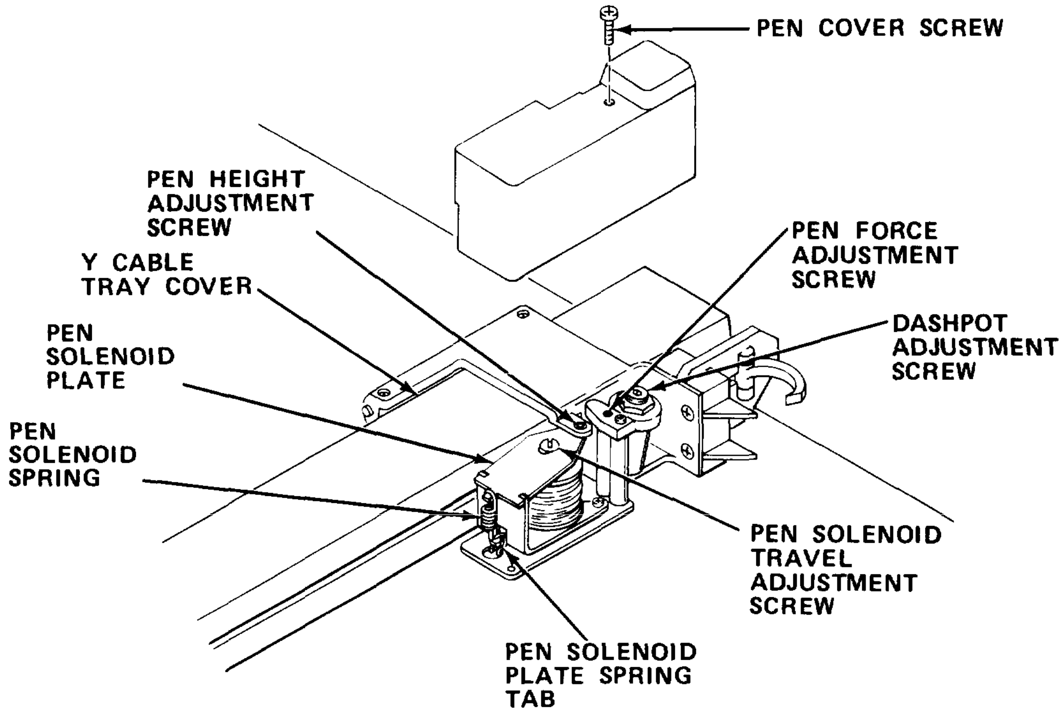
d. Adjust dashpot:

(1) Load paper on platen of plotter.

(2) Insert pen in pen holder.

(3) Hook up required interface cables between plotter and HP-9825 Desk-Top Computer.

(4) Insert "Pen Damping Adjustment Program" into computer. Do not execute program until completion of next step.



(5) Insert appropriate size hex head key into dashpot adjustment screw and be ready for adjustment,

(6) Execute computer program.

(7) Program will plot a series of characters. Check beginning of each plot.

(8) Turn dashpot adjustment screw to right until too much damping occurs as shown in detail “B” of illustration prior to d.

(9) Turn dashpot adjustment screw to the left until the correct damping is just reached, and then continue turning the adjustment 1/4 turn to the left.

e. Pen force adjustment:

(1) Press P1 to return pen carriage to lower left corner of platen.

(2) Press PEN DOWN button.

(3) Using 0-30 g gage, adjust the pen adjustment screw so it takes a force of 23 ± 3 g to lift pen tip off platen.

f. Pen lift adjustment:

(1) Using a 0-60 g gage, place the gage feeler on the solenoid plate near where the pen height adjustment screw touches the solenoid plate.

(2) The solenoid plate should start to move downward when a pressure of 51 ± 2 g is applied with the gage feeler.

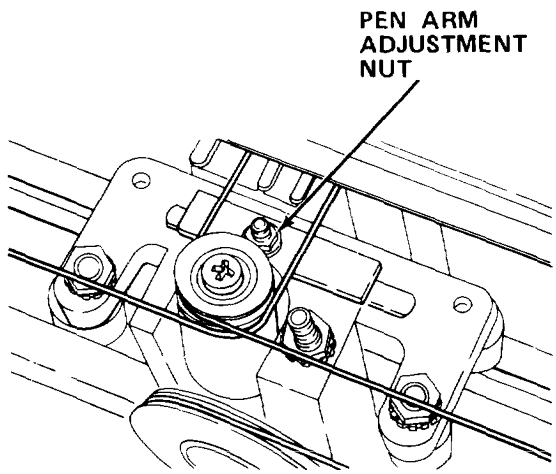
(3) To adjust, bend the bottom solenoid plate pen spring tab upward to decrease the pressure or downward to increase the pressure to obtain the correct gram pressure.

g. Reinstall the pen cover.

3-29.2 Pen Arm Adjustment (X-Drive).

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Flat Tip Screwdriver
Cross Tip Screwdriver



a. Remove rear hood from plotter.

b. Load the plotter with lined chart paper and a new pen.

c. Draw one line in the Y-axis on a chart grid line.

d. Check this drawn line for any offset from the grid line.

e. Set pen arm adjustment nut to correct any offset in perpendicular plot line.

f. Reinstall rear hood.

3-29.3 Cable Tension Adjustment.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 2)
Tension Gage
5/32 in. Hex Head Key Wrench
Dynamometer, 100-500 g

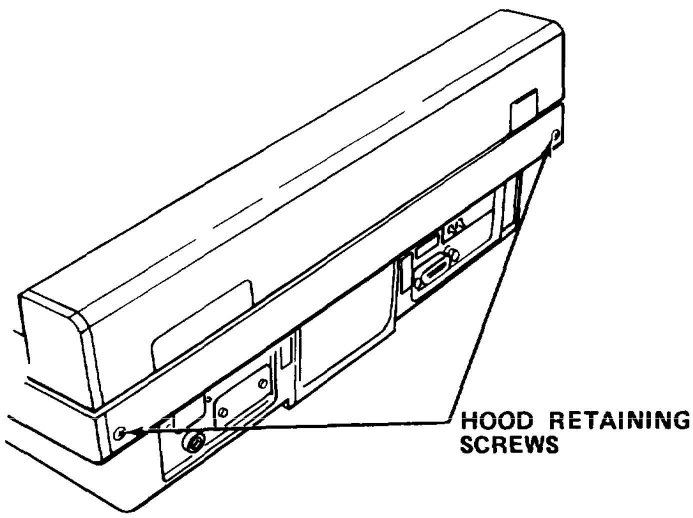
WARNING

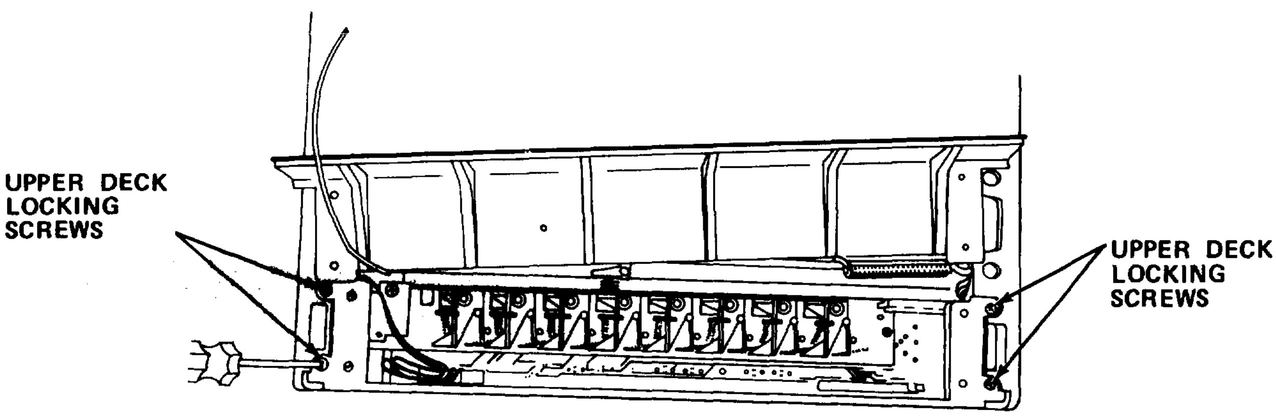
Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing the graphics plotter.

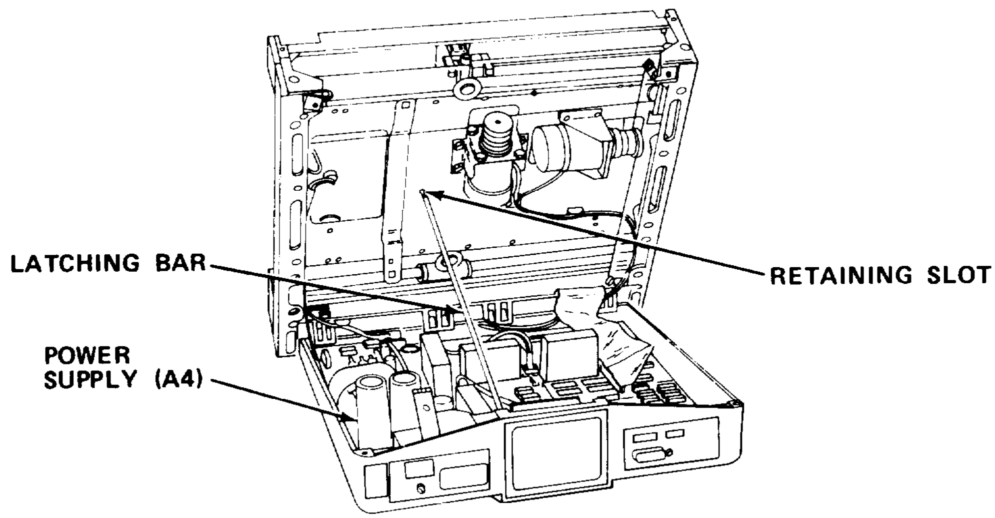
a. Set LINE power switch to off. Remove power cord and HP-IB Interface.

b. To open up plotter:

(1) Unscrew two hood retaining screws and remove rear hood.



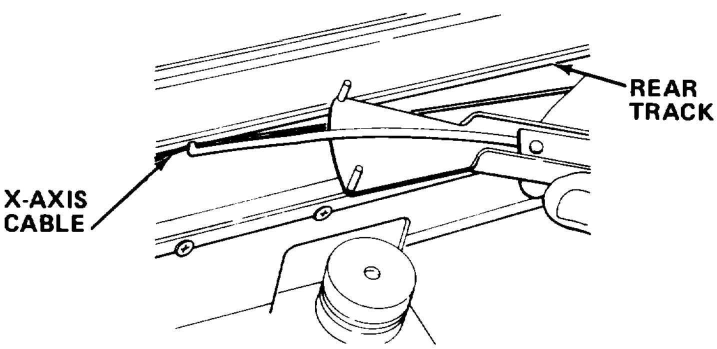


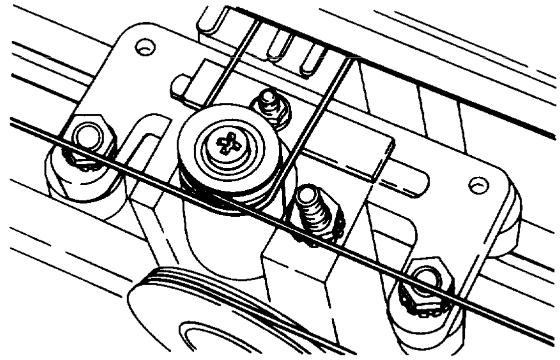


(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

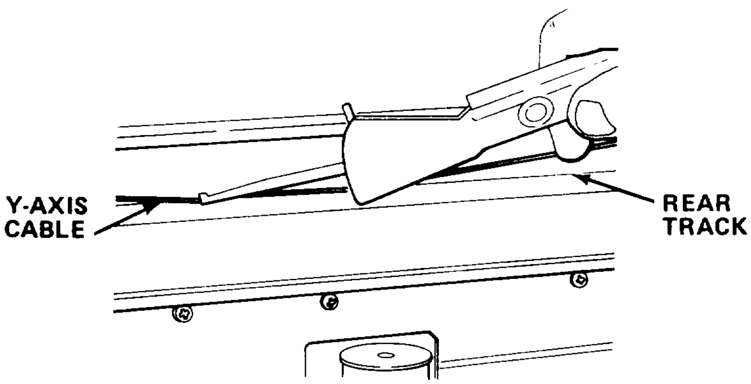
c. Move pen arm to extreme right edge of platen and pen carriage to top of arm (as viewed from front of plotter).

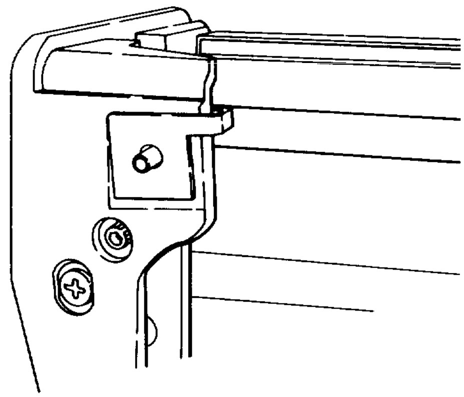
d. Locate midpoint between pulleys on axis cable to be adjusted.





X-AXIS CABLE TENSION
ADJUSTMENT NUT





Y-AXIS CABLE
TENSION ADJUSTMENT

e. Using dynamometer, push cable at midpoint until it just touches rear track edge.

f. Rotate related cable tension adjustment with a 5/32 in. hex head key wrench (to right tightens cable) to obtain gage reading of 325 ± 25 g. Adjustment is located in access hole.

g. After each adjustment, manually move pen arm (X-cable adjustment) or pen carriage (Y-cable adjustment) through its respective range of travel several times. Then recheck cable tension.

h. Reassemble plotter.

3-29.4 X- and Y-Limit Switch Adjustment,

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)
Multimeter

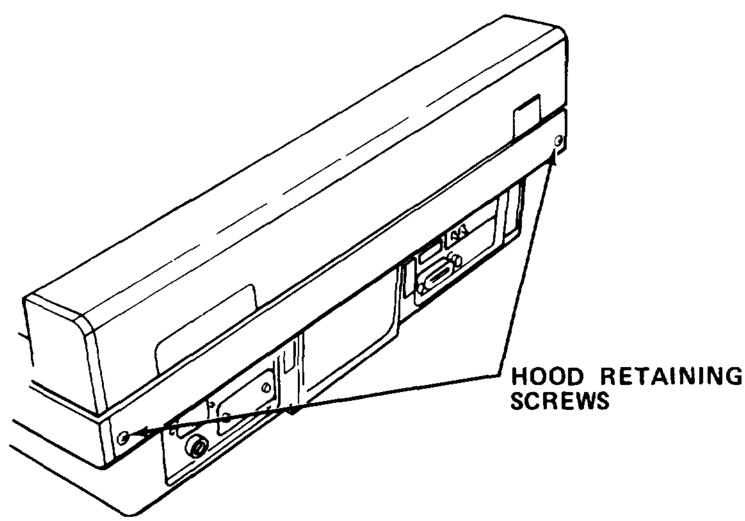
SUPPLIES: Rubber Matting

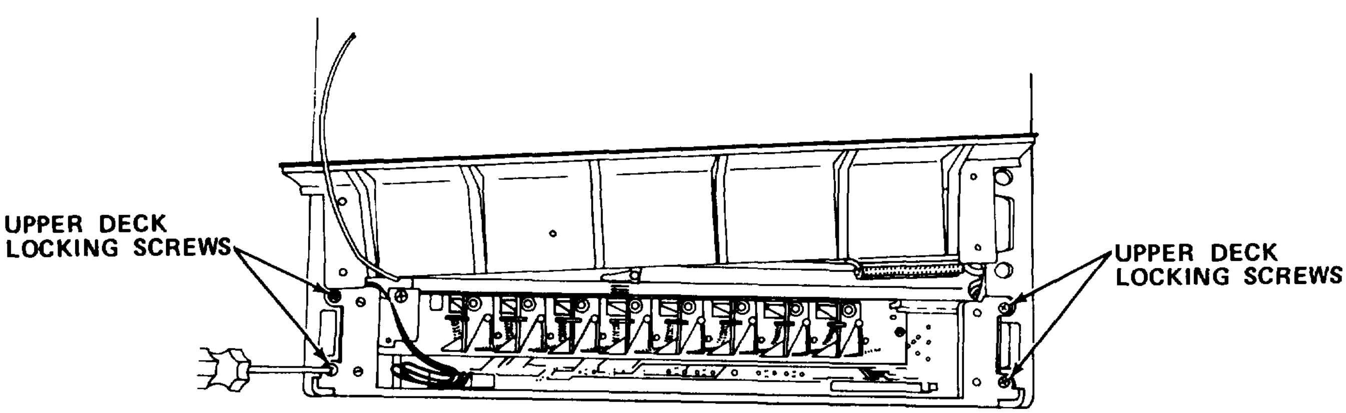
WARNING

Electrical shock hazard. You must stand on rubber matting as a protective measure before performing this procedure. Death or serious injury could result.

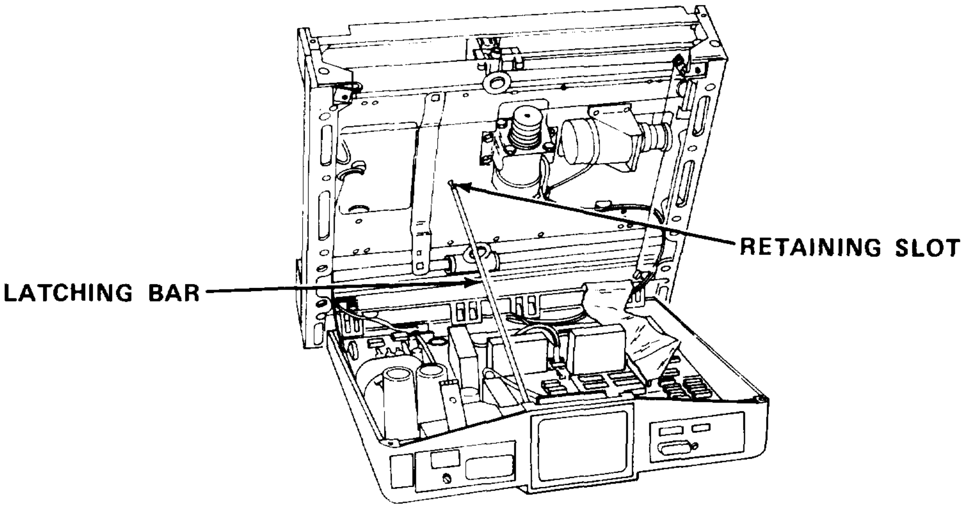
a. Turn LINE power switch to off (0).

b. To open up plotter.

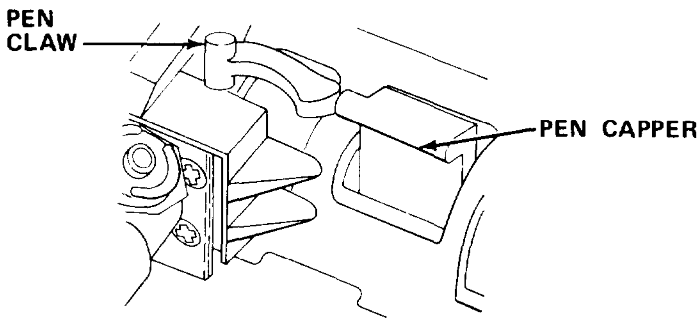




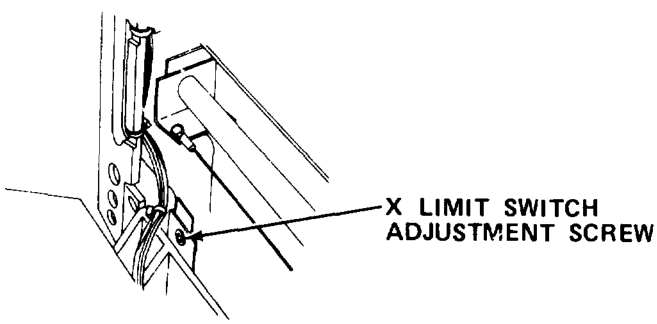
(1) Unscrew two hood retaining screws and remove hood.



(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

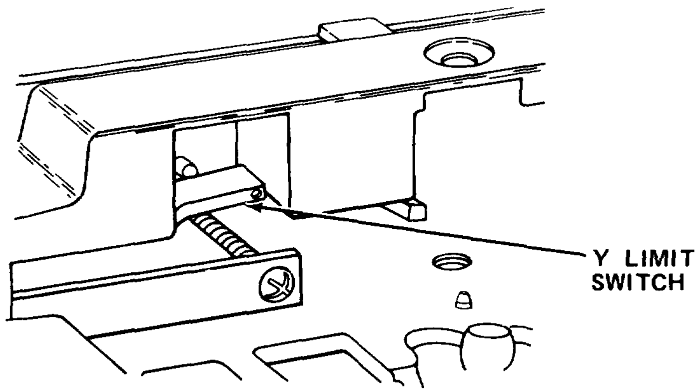


c. Move the arm assembly to the extreme right side of its travel as viewed from the front of the plotter. Position the pen claw so that it just touches the right end of the pen capper assembly of stall #8.



d. Connect a multimeter across X-limit switch connector located on the front panel PCA. Adjust the switch bracket until the switch just closes. Tighten the adjustment screw and reinitialize the plotter to check the adjustment. Repeat if necessary.

e. Place a pen in the holder. Move the holder into the Y-limit switch stall.



f. Listen for the sound of the pen-in-arm switch and then the Y-limit switch. If this sequewnce is not heard, adjust the Y-limit switch.

3-29.5 X-Axis Motor Driver Adjustments.

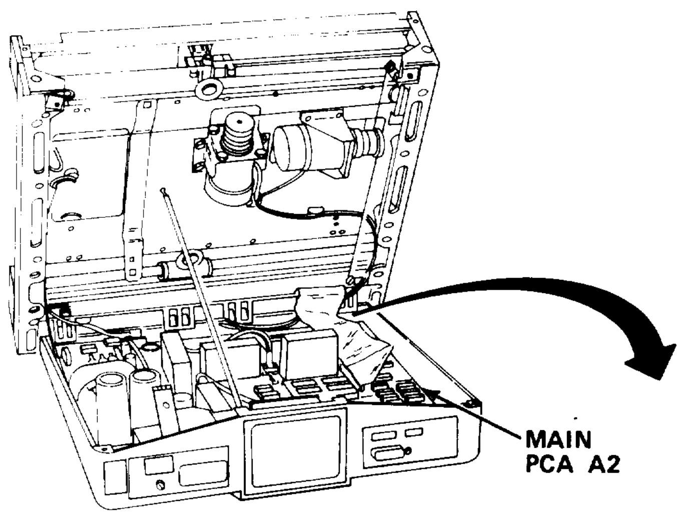
MOS: 35E, Special Electronic Devices Repairer

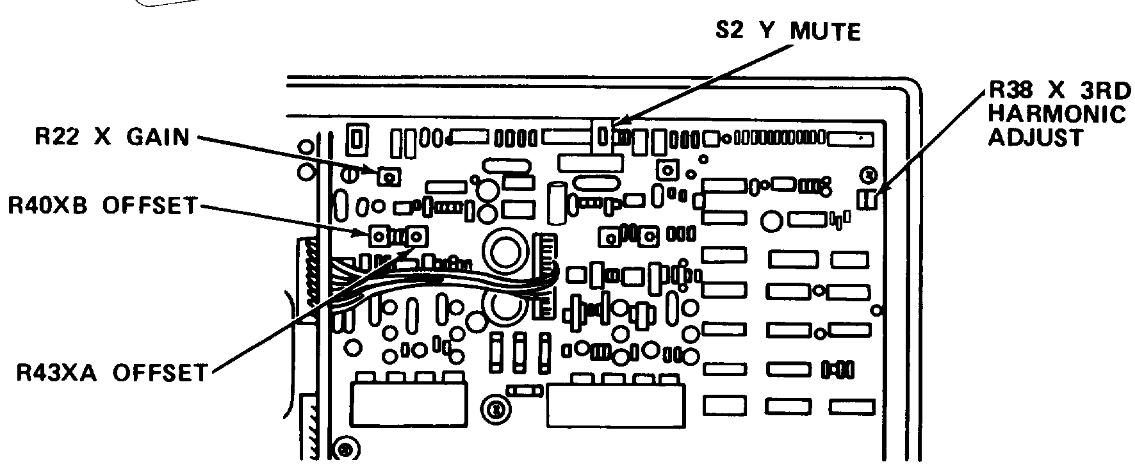
TOOLS: Cross Tip Screwdriver (No. 1)
Flat Tip Screwdriver

SUPPLIES: Rubber Matting

WARNING

Electrical shock hazard. You must stand on rubber matting as a protective measure before performing this procedure. Death or serious injury could result.





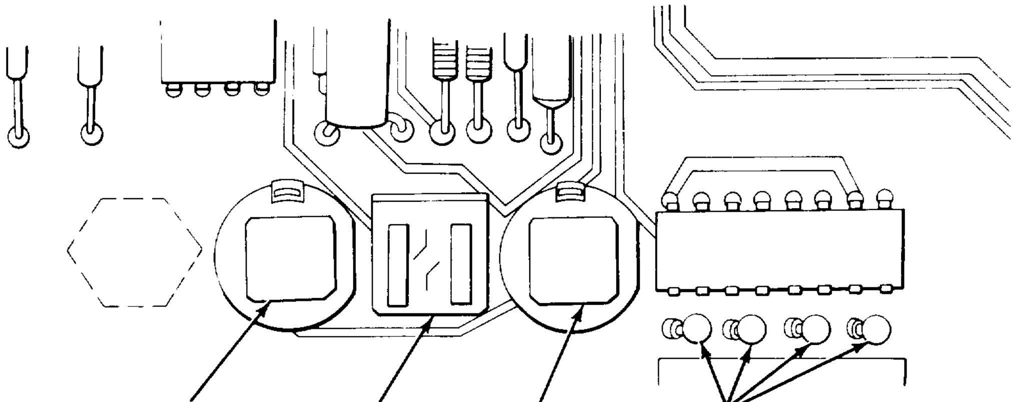
a. Open the plotter.

(1) Unscrew two hood retaining screws and remove hood.

(2) Raise upper deck. Swing latching bar up and engage it securely into retaining slot.

NOTE

After each adjustment, return to step b and begin again until minimum vibration is achieved.



b. Place the SELF TEST switch S4-2 in the ON position. Press RESET and then STEP.

c. Set the Y-MUTE S2 to the OFF position.

d. Press and hold the #1 PEN SELECT pushbutton for approximately 5 seconds. Release.

e. Adjust the X-3rd harmonic potentiometer R38 for minimum vibration of the pen holder.

f. Press and hold the #2 PEN SELECT pushbutton until the plotter arm stops. Release.

g. Adjust the X-gain potentiometer R22 for minimum vibration of the pen holder.

h. Press and hold the #3 PEN SELECT pushbutton until the plotter arm stops. Release.

i. Center the X-B offset potentiometer R40 and adjust the X-A R43 for minimum vibration of the pen holder.

Adjust the X-B offset potentiometer R40 for minimum vibration of the pen holder.

k. Return the Y-MUTE switch S2 to the ON position.

l. Reset SELF TEST switch to OFF position.

m. Press RESET.

n. Lower upper deck assembly and reinstall rear hood.

3-29.6 Y-Axis Motor Driver Adjustments.

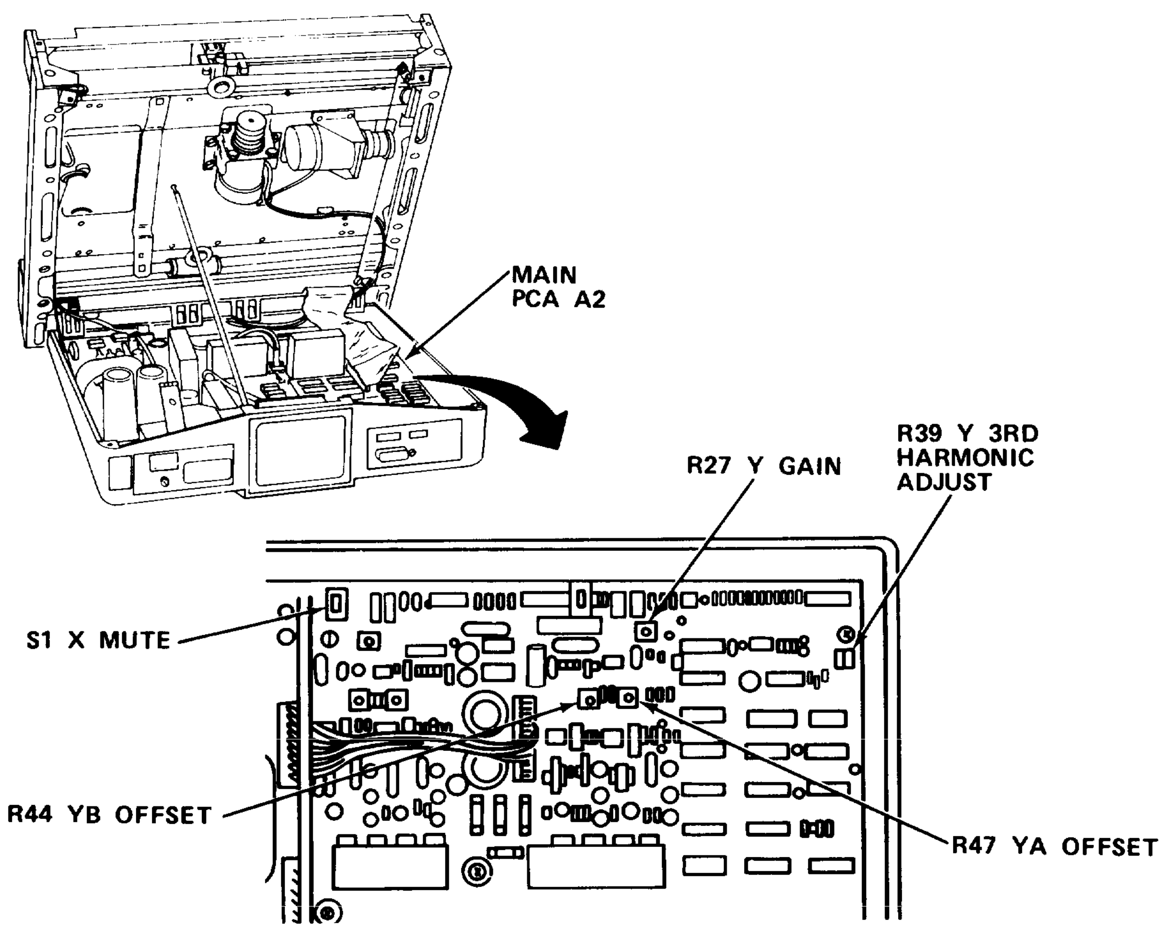
MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)
Flat Tip Screwdriver

SUPPLIES: Rubber Matting

WARNING

Electrical shock hazard. You must stand on rubber mating as a protective measure before performing this procedure. Death or serious injury could result.



a. To open up plotter:

(1) Unscrew two hood retaining screws and remove rear hood.

(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

b. Place the SELF TEST switch S4-2 in the ON position. Press RESET and then press STEP.

c. Set the X-MUTE S1 to the OFF position.

d. Press and hold the #4 PEN SELECT pushbutton for approximately five seconds. Release.

e. Adjust the Y-3rd harmonic potentiometer R39 for minimum vibration of the pen holder.

f. Press and hold the #5 PEN SELECT pushbutton until the plotter arm stops . Release.

g. Adjust the Y-gain potentiometer R27 for minimum vibration of the pen holder.

h. Press and hold the #6 PEN SELECT pushbutton until the plotter arm stops . Release.

i. Center the Y-B offset potentiometer R44 and adjust the Y-A R47 for minimum vibration of the pen holder.

j. Adjust the Y-B offset potentiometer R44 for minimum vibration of the pen holder.

k. Return the X-MUTE switch S1 to the ON position. Also place the SELF TEST switch to the OFF position.

l. Press RESET.

m. Lower upper deck assembly and reinstall rear hood.

3-29.7 Printed Circuit Assemblv Replacement.

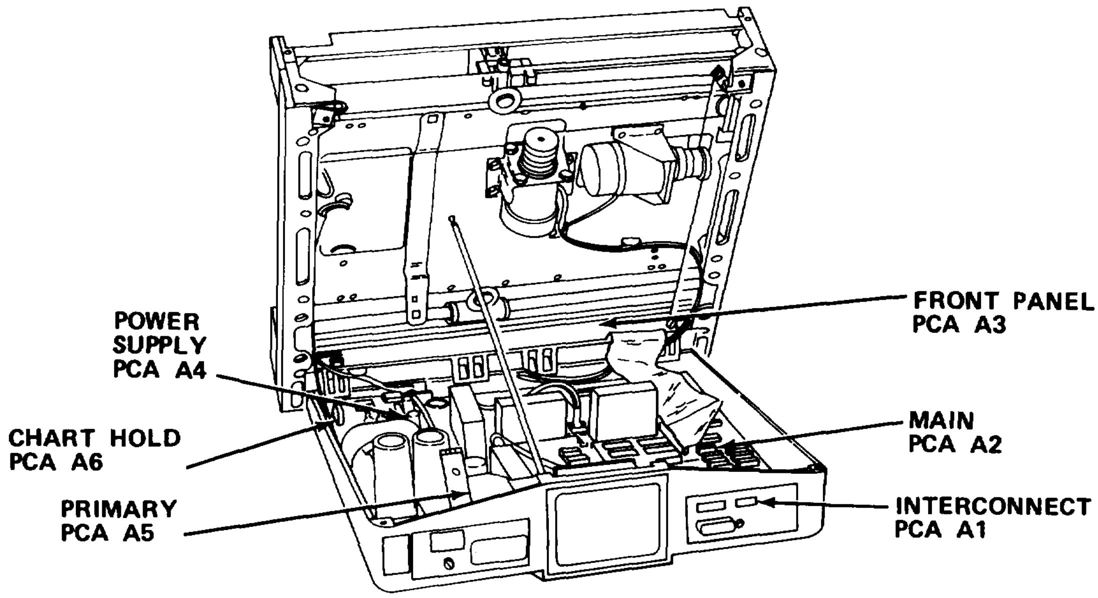
MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)
9/32 in. Nut Driver

SUPPLIES: PCA Assembly

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

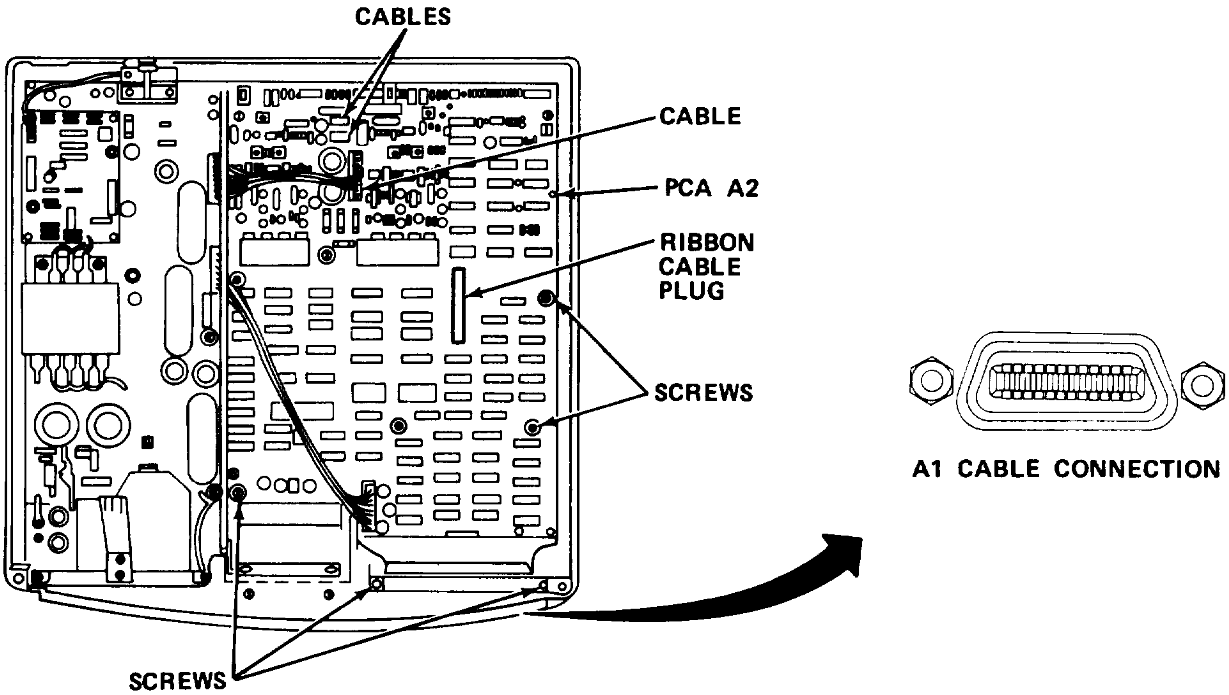


a. Replace PCA A2.

(1) Open the plotter.

(a) Unscrew two hood retaining screws and remove hood.

(b) Raise upper deck. Swing latching bar up and engage it securely into retaining slot.



(2) Tag, unplug and disconnect all interconnecting wires between upper and lower deck assemblies.

(3) Remove the two screws from the rear panel.

(4) Unplug A1 cable connection.

(5) Remove eight screws and defective PCA A2 from the plotter.

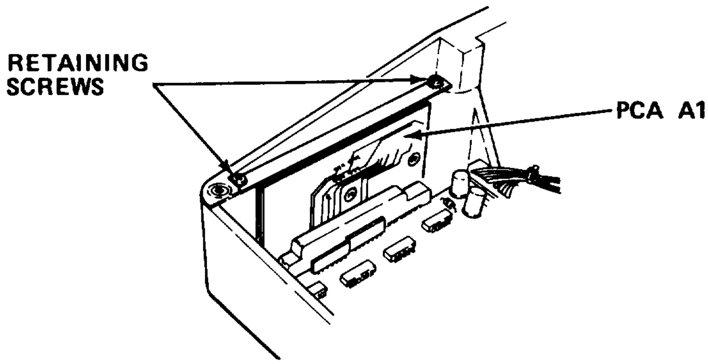
(6) Install new PCA A2 and secure with eight screws.

(7) Plug in A1 cable connection.

(8) Reconnect all interconnecting cables and wiring between upper and lower deck assemblies.

(9) Lower upper deck assembly and reinstall rear hood.

b. Replace PCA A1.



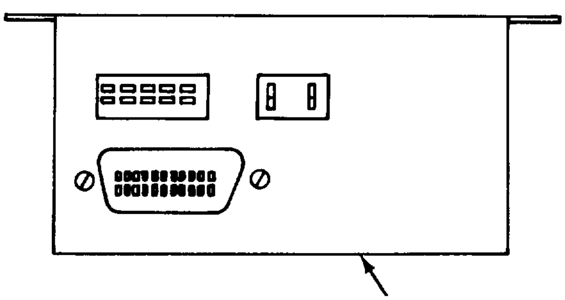
WARNING

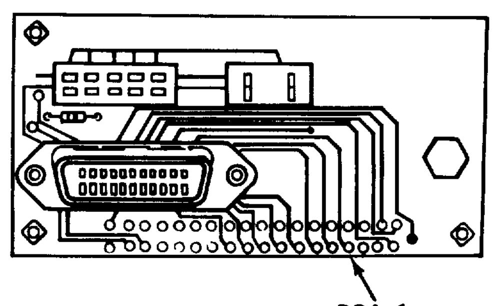
Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

(1) Remove two retaining screws securing board to plotter housing.

(2) Remove eight screws from PCA A2.

(3) Lift rear of PCA A2 and move toward front of plotter to disconnect PCA A1 and PCA A2 connector.





(4) Remove defective PCA A1 assembly from plotter.

(5) Remove two screws and PCA A1 housing.

(6) Install new PCA A1 into housing and secure with two screws.

(7) Push A2 board into A1-A2 connector until properly seated, and secure A2 board with eight screws.

(8) Secure A1 board to plotter housing with two retaining screws.

c. Replace PCA A5.

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

(1) Remove two screws and grounding spring.

(2) Loosen retaining screw and remove plastic shield.

(3) Tag and disconnect wiring from board.

(4) Remove two screws and defective PCA A5 board.

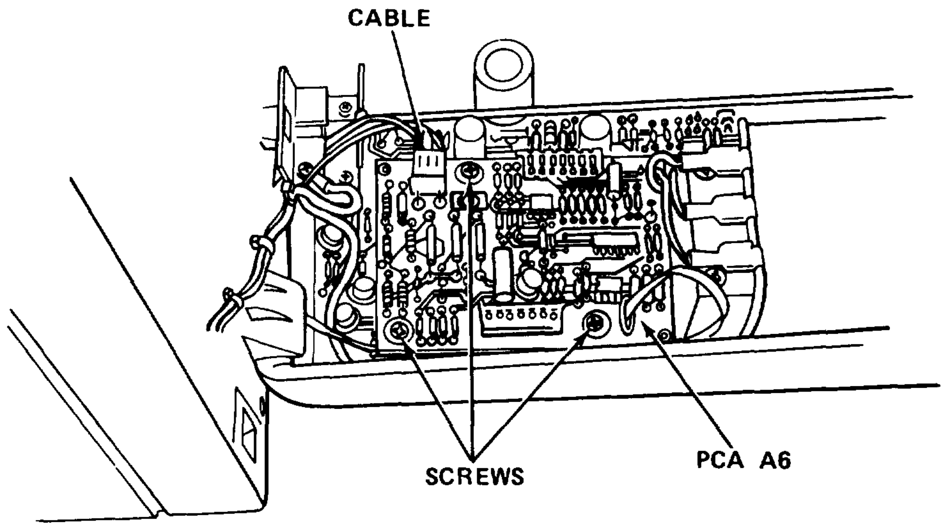
(5) Install new PCA A5 board and secure with two screws.

(6) Reconnect wiring.

(7) Replace plastic shield and tighten retaining screw.

(8) Reinstall grounding spring and secure with two screws.

d. Replace PCA A6.



WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

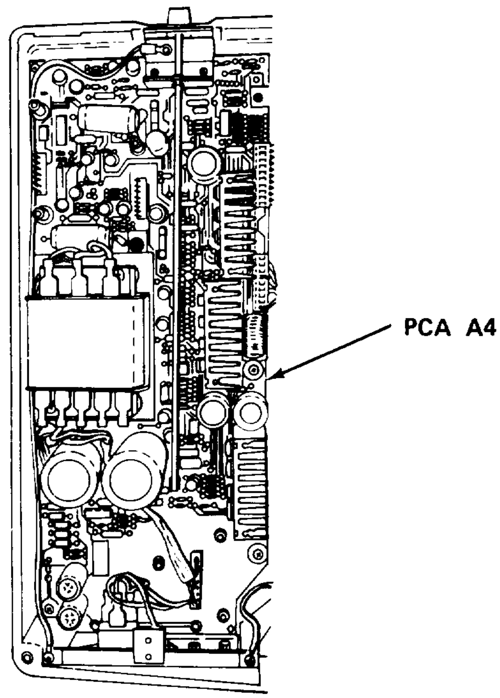
(1) Unplug cable.

(2) Remove three screws and defective PCA A6 board.

(3) Install new A6 board and secure with three screws.

(4) Plug cable in.

e. Replace PCA A4.



WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

(1) Remove PCA A5 (paragraph 3-29.7c).

(2) Remove PCA A6 (paragraph 3-29.7d).

(3) Tag and disconnect all wiring.

(4) Tag and unplug all disconnects.

(5) Remove two screws from top of power panel frame.

(6) Remove five screws and defective board.

(7) Remove two screws and rear retaining bracket.

(8) Remove two screws and power panel.

(9) Reinstall power panel and rear retaining bracket on new PCA A4.

(10) Install new A4 assembly into plotter and secure with five screws.

(11) Reconnect wiring.

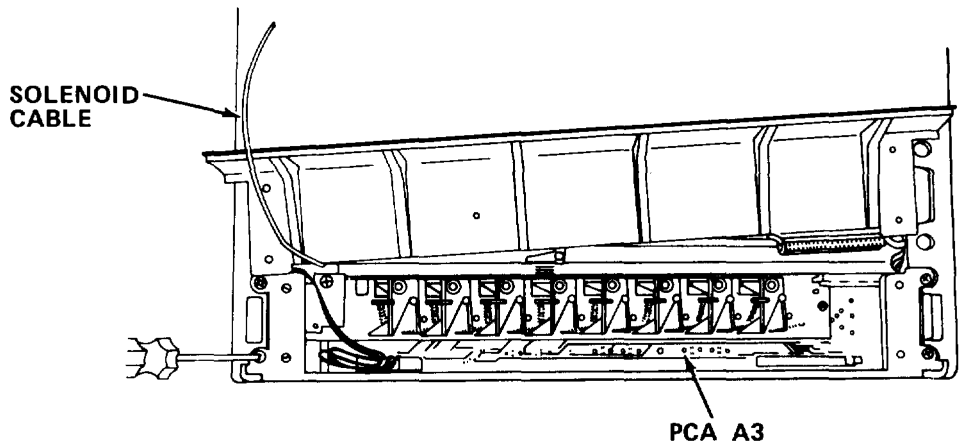
(12) Plug in disconnects.

(13) Reinstall two retaining screws in top of power panel.

(14) Reinstall PCA A6.

(15) Reinstall PCA A5.

f. Replace PCA A3.



WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

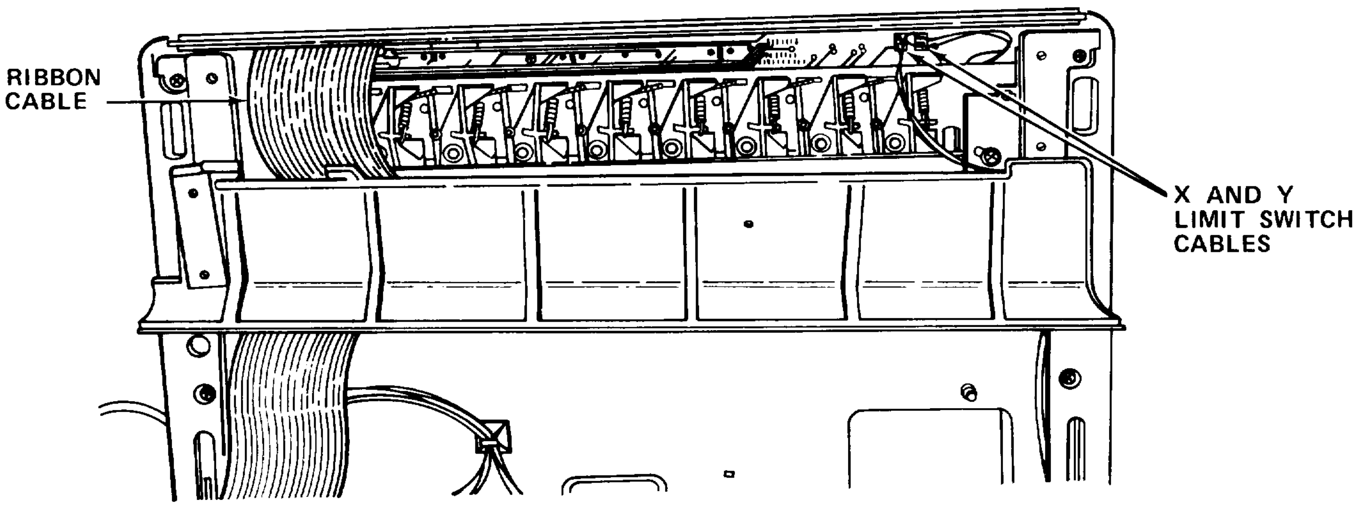
(1) Tag and unplug solenoid cable and platen cable from PCA A6.

(2) Tag and unplug motor cables and front panel cables from PCA A2.

(3) Disconnect ground cable from forward line switch brackets.

(4) Remove upper deck assembly from plotter, and place on work surface face down.

(5) Remove four screws and front bottom panel.



(6) Remove four screws and front panel assembly.

(7) Tag and unplug X-and Y-limit switch cables from PCA A3.

(8) Unplug ribbon cable from PCA A3.

(9) Remove two screws and capper assembly.

(10) Remove seven screws and defective PCA A3 board.

(11) Install new A3 board and secure with seven screws.

(12) Reinstall capper assembly and secure with two screws.

(13) Plug ribbon cable into new PCA A3.

(14) Plug in X-and Y-limit switches.

(15) Reinstall front panel assembly and secure with four screws.

(16) Reinstall bottom panel and secure with four screws.

(17) Reattach upper deck assembly to plotter.

(18) Reconnect ground cable on forward line switch brackets.

(19) Reconnect motor cables and front panel cables to PCA A2.

(20) Plug pen solenoid cable and platen cable into PCA A6.

3-29.8 Electrostatic Table (Platen) Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)

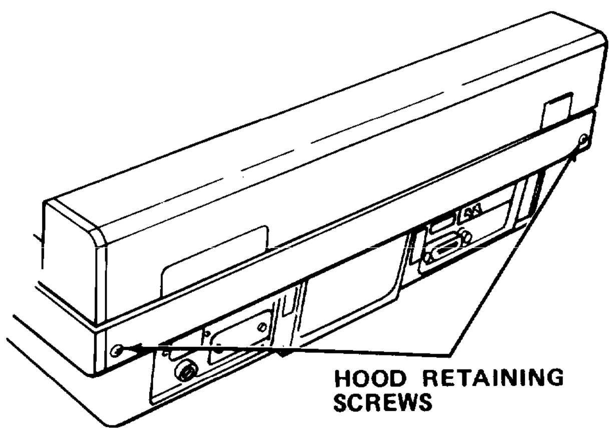
SUPPLIES: Platen

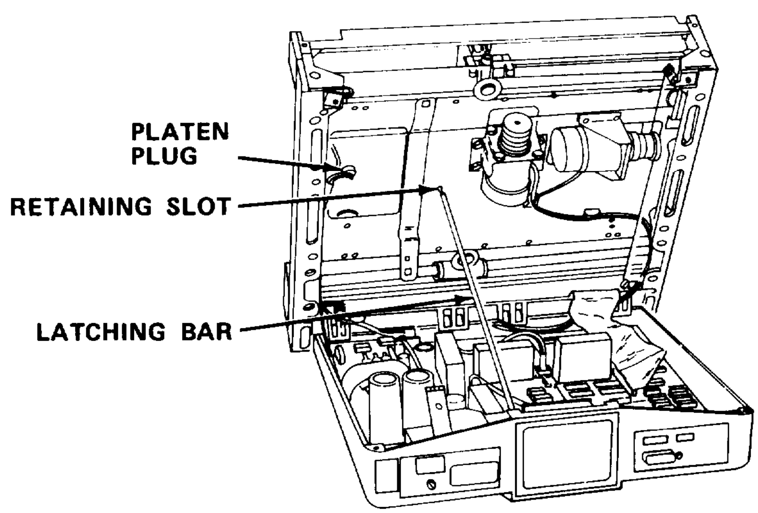
WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Turn off LINE power switch. Remove power cord and HP-IB Interface.

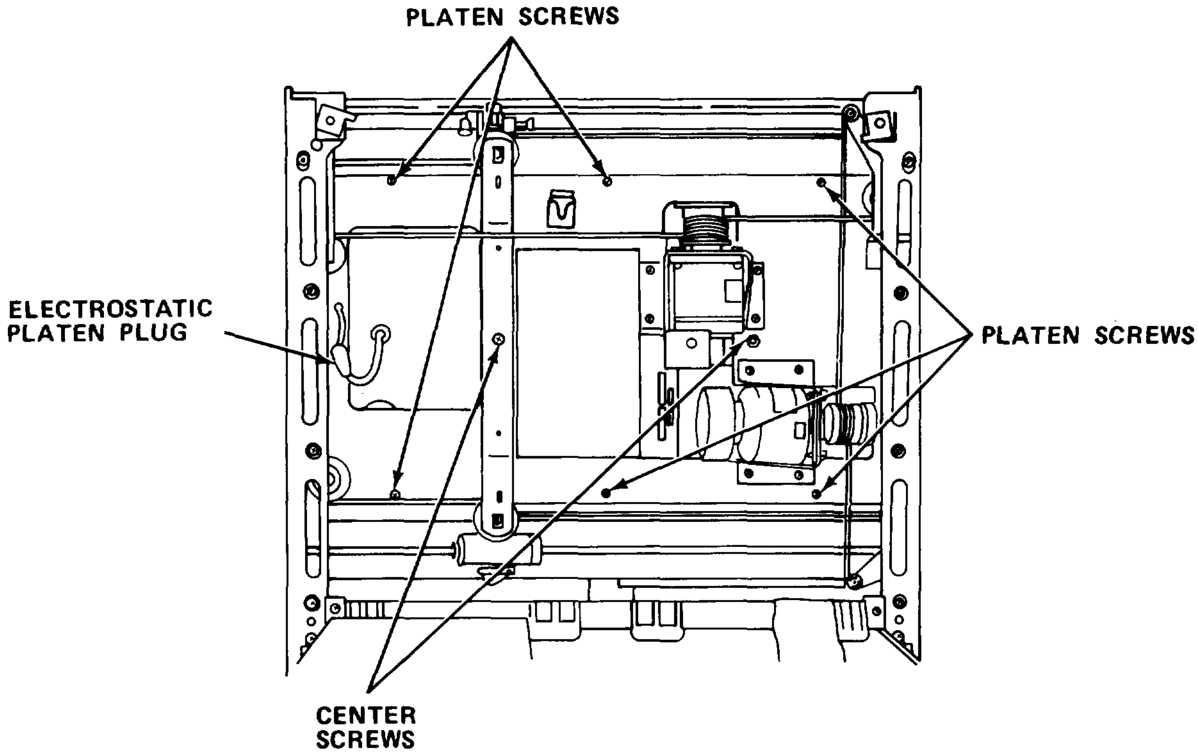
b. To open up plotter:





(1) Unscrew two hood retaining screws and remove rear hood.

(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.



c. Unplug electrostatic platen plug.

d. Position pen arm at extreme right end of plotter.

NOTE

When retaining screws are removed from platen, it will fall. Place supporting material under platen before removing all screws.

e. Remove six screws around edge of platen and two screws from center of platen.

f. Lift defective platen out carefully from end opposite pen arm.

g. Install new platen and secure with eight screws.

h. Plug in electrostatic platen plug.

i. Lower upper deck assembly and reinstall rear hood.

3-29.9 X-Limit Switch Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)
Cross Tip Screwdriver (No. 0)

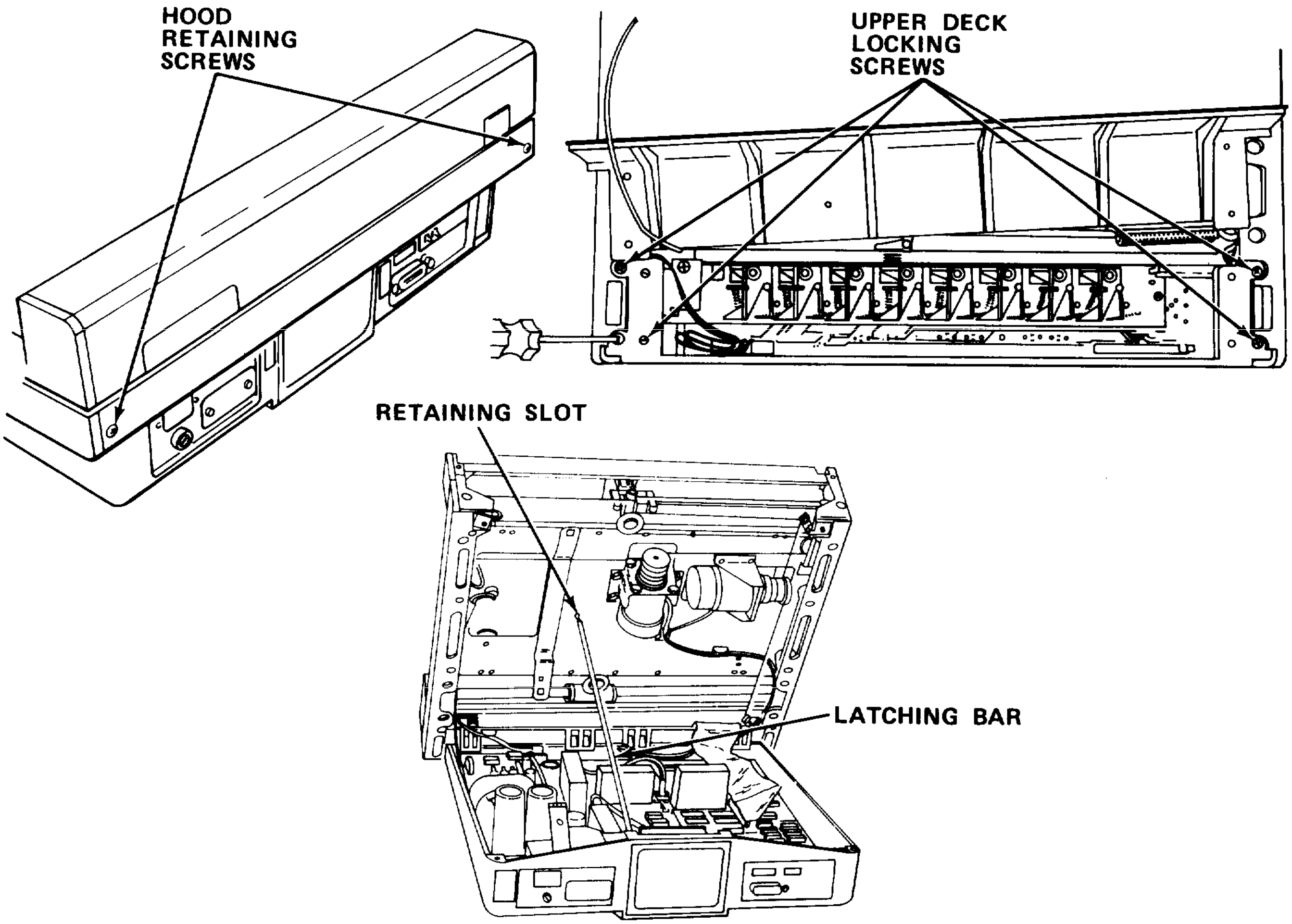
SUPPLIES: Cable Ties
X-Limit Switch

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

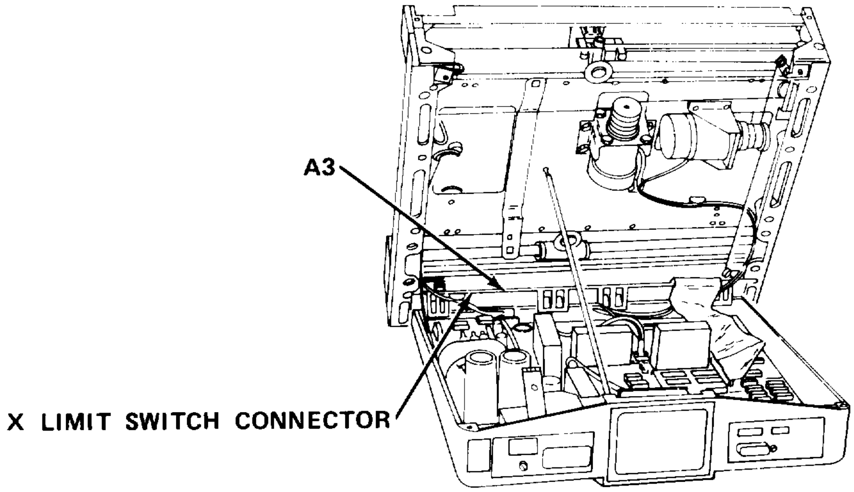
a. Turn off equipment and remove power cord.

b. To open up plotter:

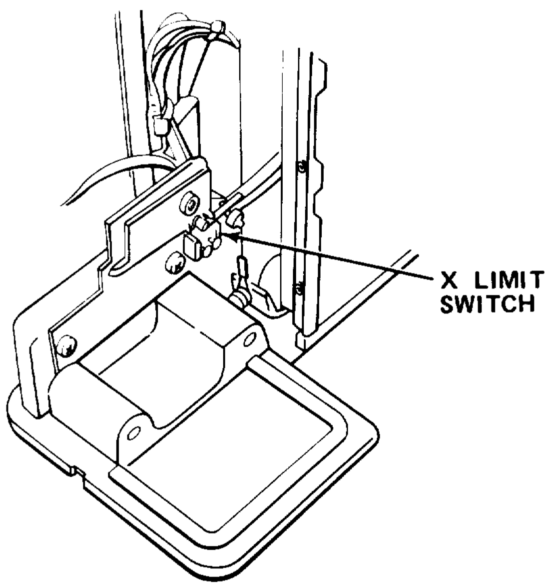


(1) Unscrew two hood retaining screws and remove rear hood.

(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.



c. Unplug X-limit switch connector from PCA A3.



d. Remove screw that secures X-limit switch to switch bracket and remove defective switch.

e. Install new X-limit switch.

f. Plug in X-limit switch connector.

g. Set X-limit adjustment screw according to X-limit adjustment procedure (paragraph 3-29.4).

h. Lower upper deck assembly and reinstall rear hood.

3-29.10 Y-Limit Switch Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)

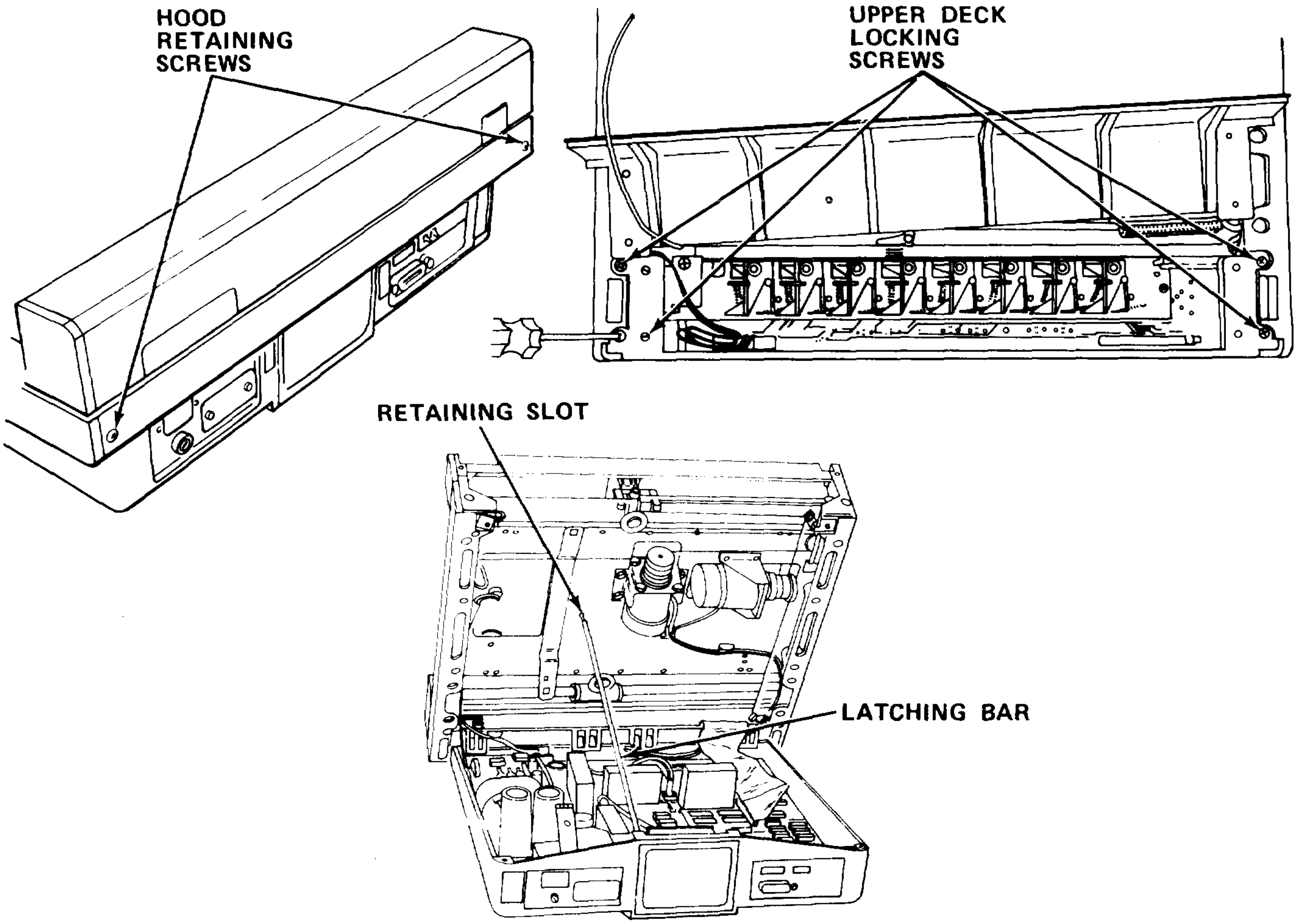
SUPPLIES: Y-Limit Switch

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Turn off equipment and remove power cord.

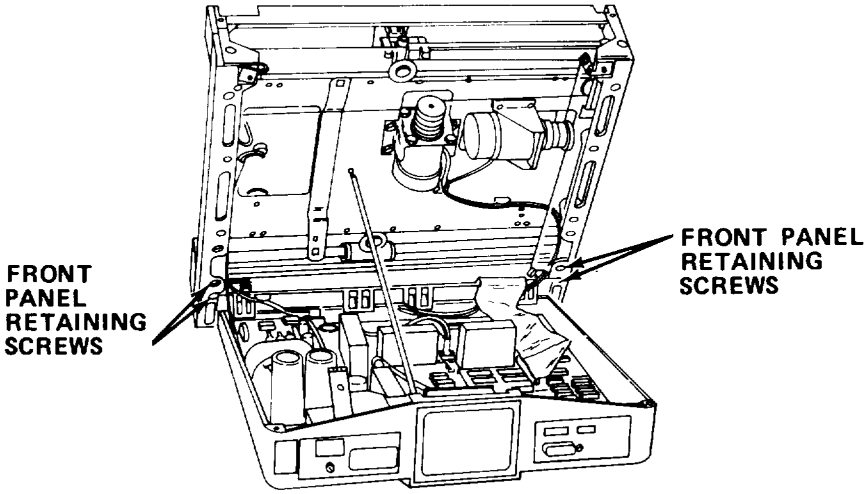
b. To open up plotter:

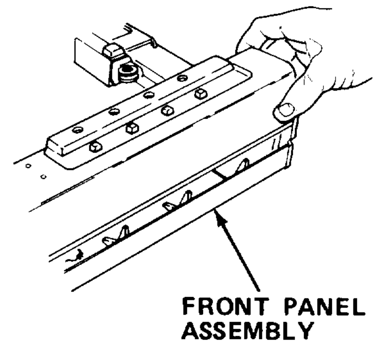


(1) Unscrew two hood retaining screws and remove rear hood.

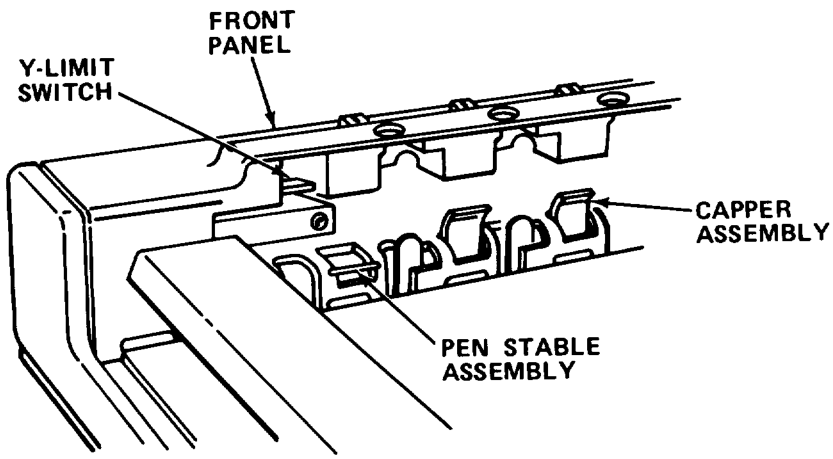
(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

c. Unplug two connectors from PCA A3.





d. Remove retaining screws and lift off front panel assembly.



e. Remove two screws and capper assembly.

f. Remove two screws and defective switch.

g. Install new switch and secure with screws.

h. Reinstall capper assembly.

i. Reinstall front panel assembly.

j. Plug connectors into A3.

k. Lower upper deck assembly and reinstall rear hood.

3-29.11 Transformer Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)

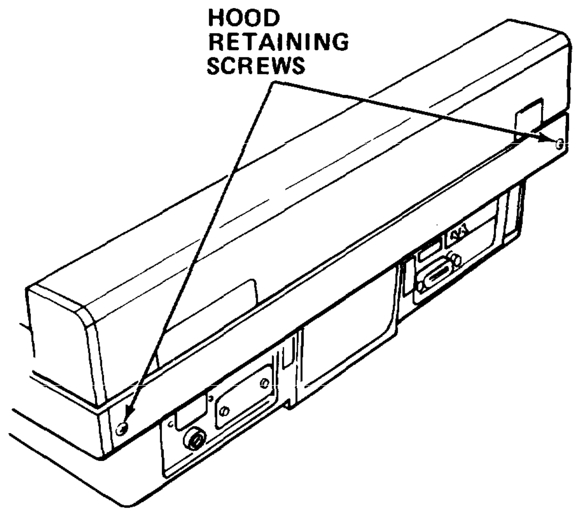
SUPPLIES: Transformer

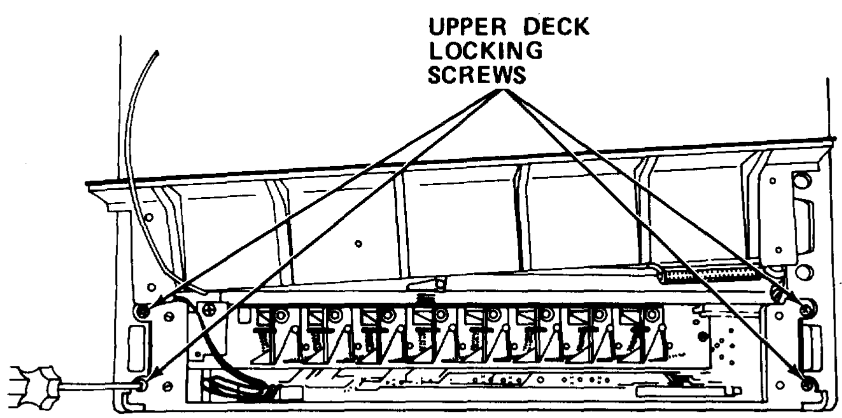
WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

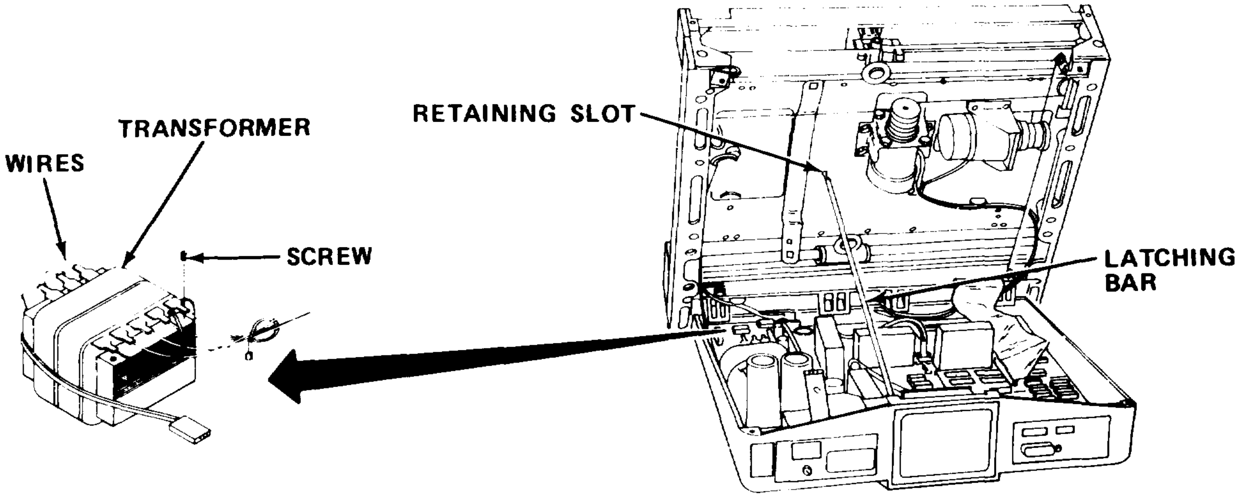
a. Turn off equipment and remove power cord.

b. To open up plotter:





(1) Unscrew two hood retaining screws and remove rear hood.



(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

c. Tag and unplug wires from transformer.

d. Remove retaining screws and defective transformer.

e. Install new transformer and secure with screws.

f. Reconnect wires.

g. Lower upper deck assembly and reinstall rear hood.

3-29.12 Fan Replacement.

MOS: 35E, Special Electronic Devices Repairer

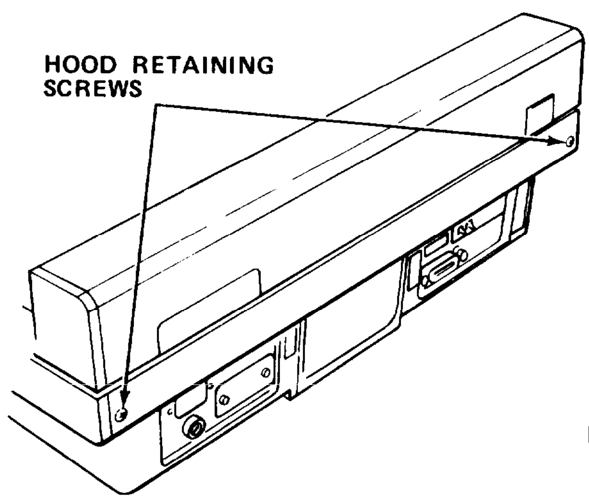
TOOLS: Cross Tip Screwdriver (No. 1)
Cross Tip Screwdriver (No. 0)

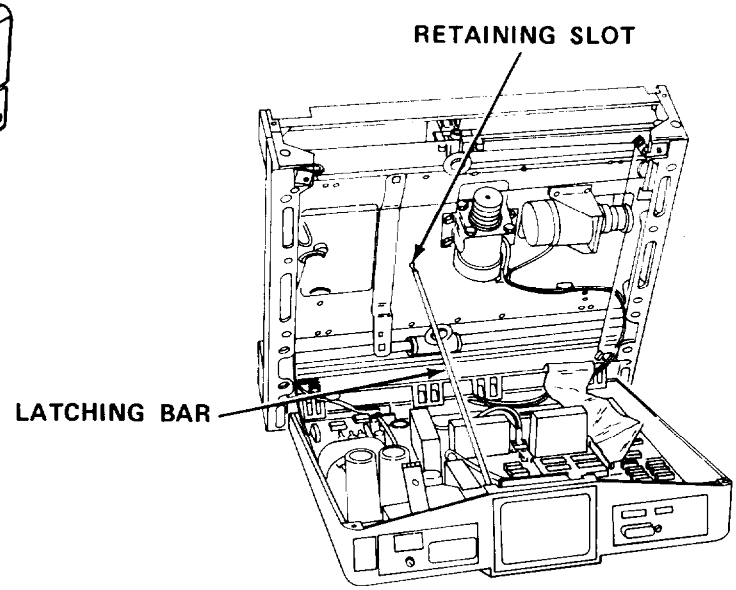
SUPPLIES: Fan

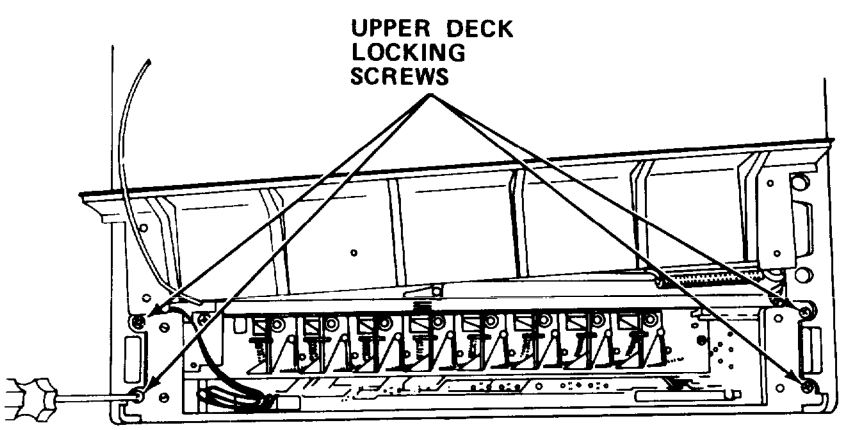
WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Turn off equipment and remove power cord.



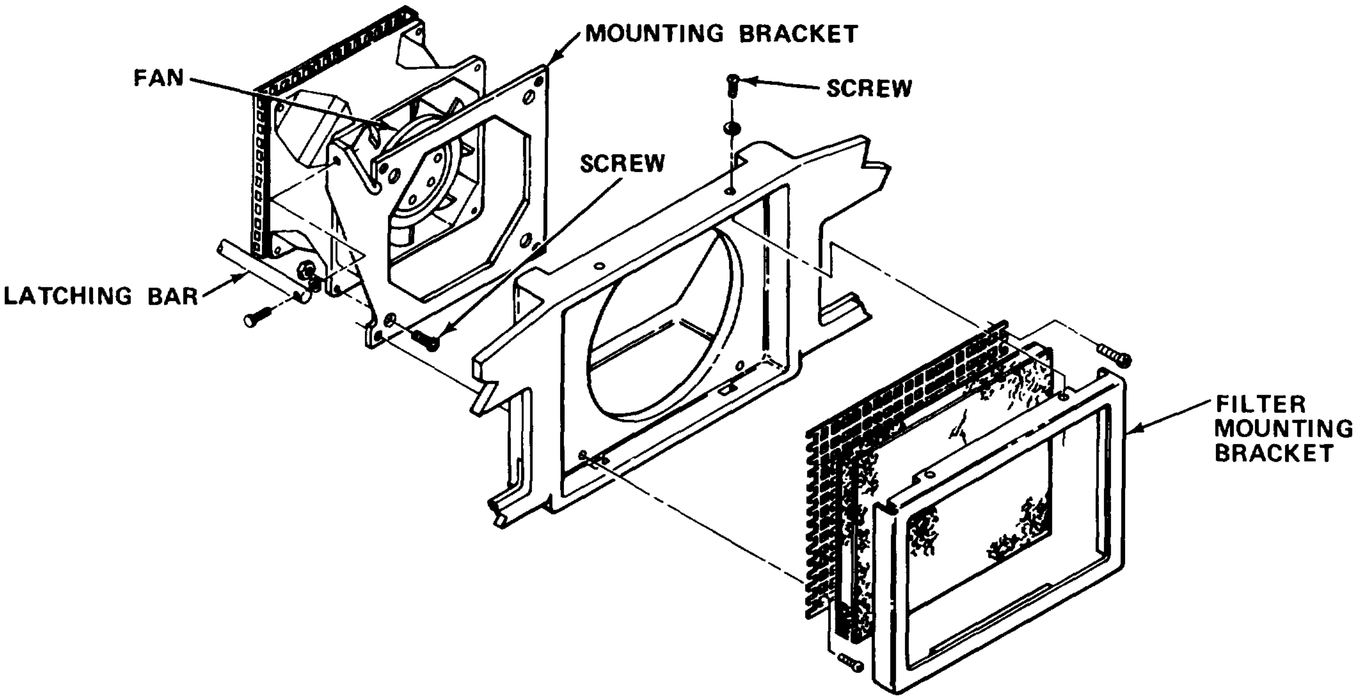




b. To open up plotter:

(1) Unscrew two hood retaining screws and remove rear hood.

(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

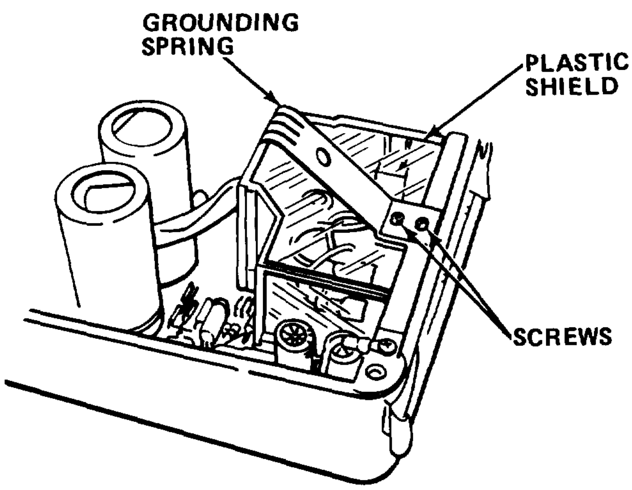


c. Remove two screws, filter, and filter mounting bracket.

NOTE

One screw is longer than remaining three screws. Note its position.

d. Remove four screws and partially remove fan assembly.



e. Remove two screws and grounding spring.

f. Remove screw and plastic shield from PCA A5.

g. Unplug fan cable from PCA A5.

h. Disconnect ground wire from fan.

i. Remove screw and latching bar.

j. Remove four screws and fan mounting bracket.

k. Discard defective fan.

l. Install new fan on bracket and secure with four screws.

m. Reinstall latching bar and secure with screw.

n. Reconnect ground wire.

o. Plug fan cable into PCA A5.

p. Reinstall plastic shield and tighten screw.

q. Reinstall grounding spring and secure with two screws.

r. Reinstall fan assembly and secure with four screws.

s. Reinstall filter and filter mounting bracket and secure with two screws.

t. Lower upper deck assembly and reinstall rear hood.

3-29.13 Pen Solenoid Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 0)

SUPPLIES: Pen Solenoid

WARNING

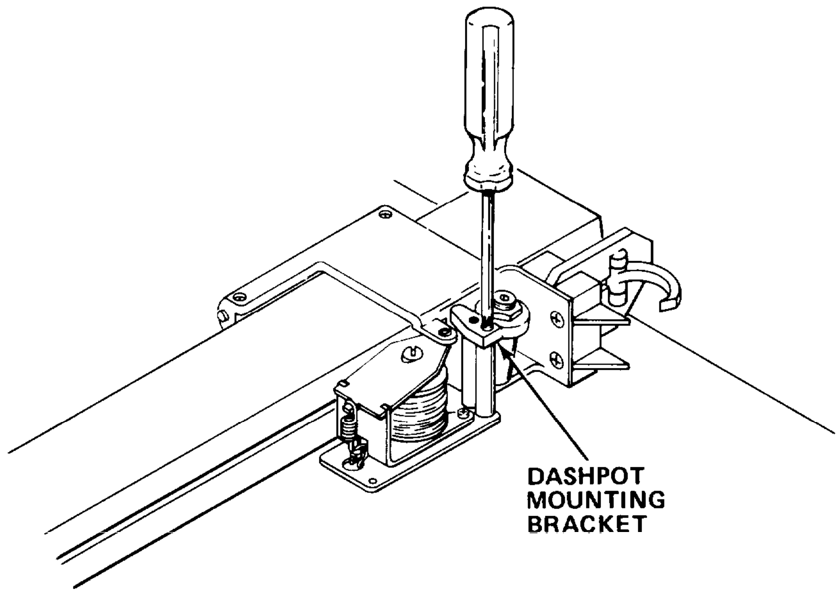
Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

CAUTION

Do not touch dashpot piston with bare hands. Skin oils will damage surface of piston.

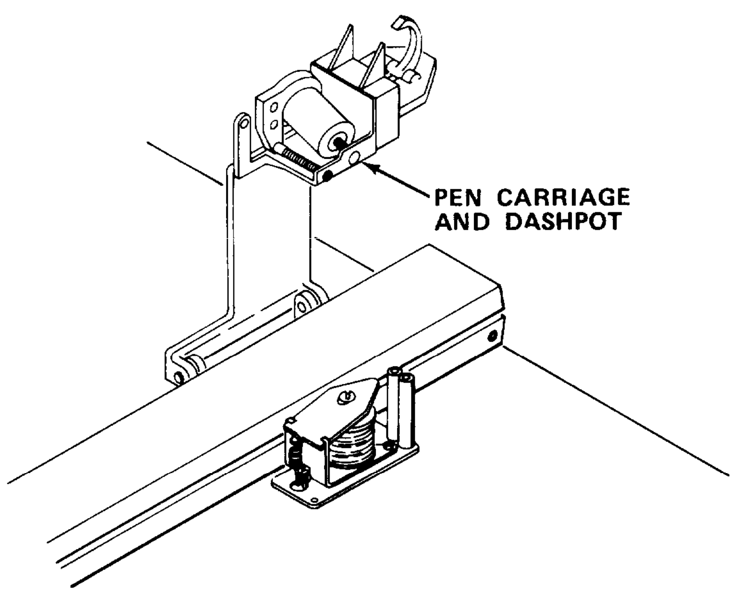
a. Remove pen carriage cover.

b. Tape pen carriage top and dashpot securely together to prevent any parts from getting lost.



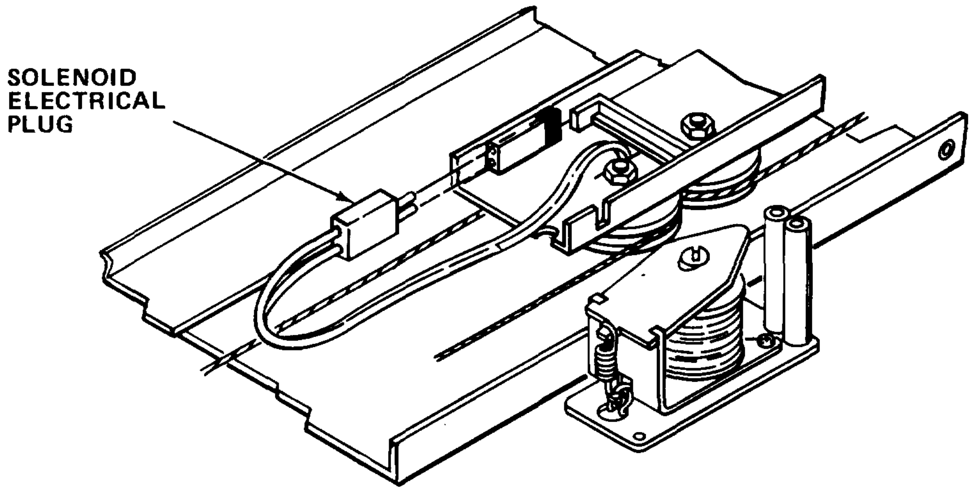
c. Remove screw from dashpot mounting bracket.

d. Carefully swing dashpot and pen carriage away from pen arm.



e. Lift pen claw assembly up and to the side.

f. Remove trailing cable tray cover (snaps in place).



g. Disconnect solenoid electrical plug.

h. Disconnect spring.

i. Thread solenoid electrical plug from pen claw assembly.

j. Remove retaining screw and defective solenoid.

k. Install new solenoid and secure with screws.

l. Reconnect spring.

m. Connect electrical plug.

n. Reinstall cable cover by snapping in place.

o. Lower pen claw assembly in place.

p. Reinstall dashpot mounting bracket screw. Remove tape.

q. Reinstall pen carriage cover.

r. Perform pen adjustment procedures (paragraph 3-29.1).

3-29.14 X- and Y-Drive Motor Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver
3/32 in. Hex Head Key Wrench

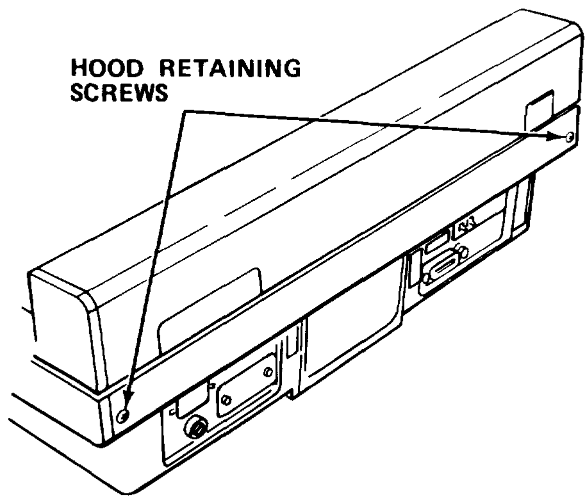
SUPPLIES: Drive Motor

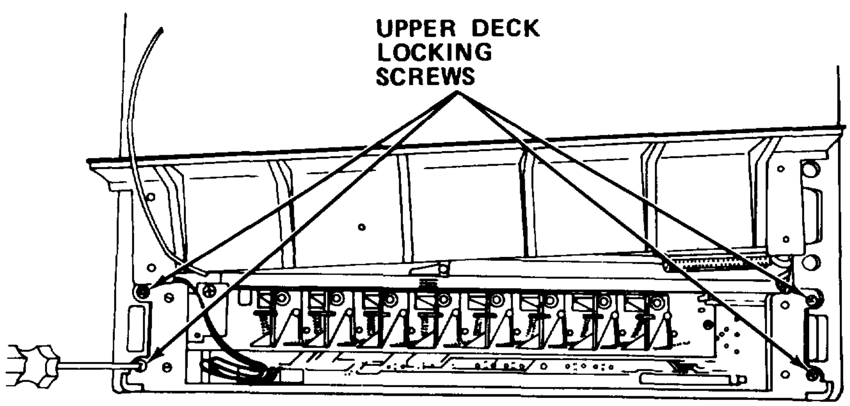
WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

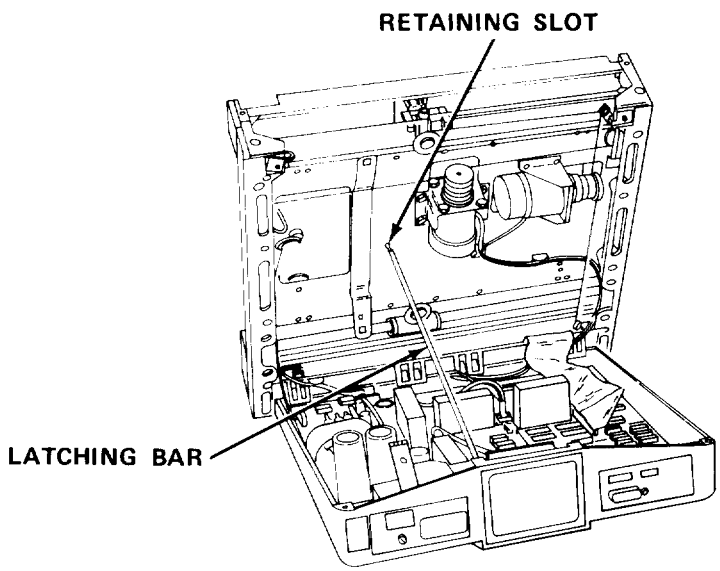
a. Turn off equipment and remove power cord and HP-IB Interface.

b. To open up plotter:

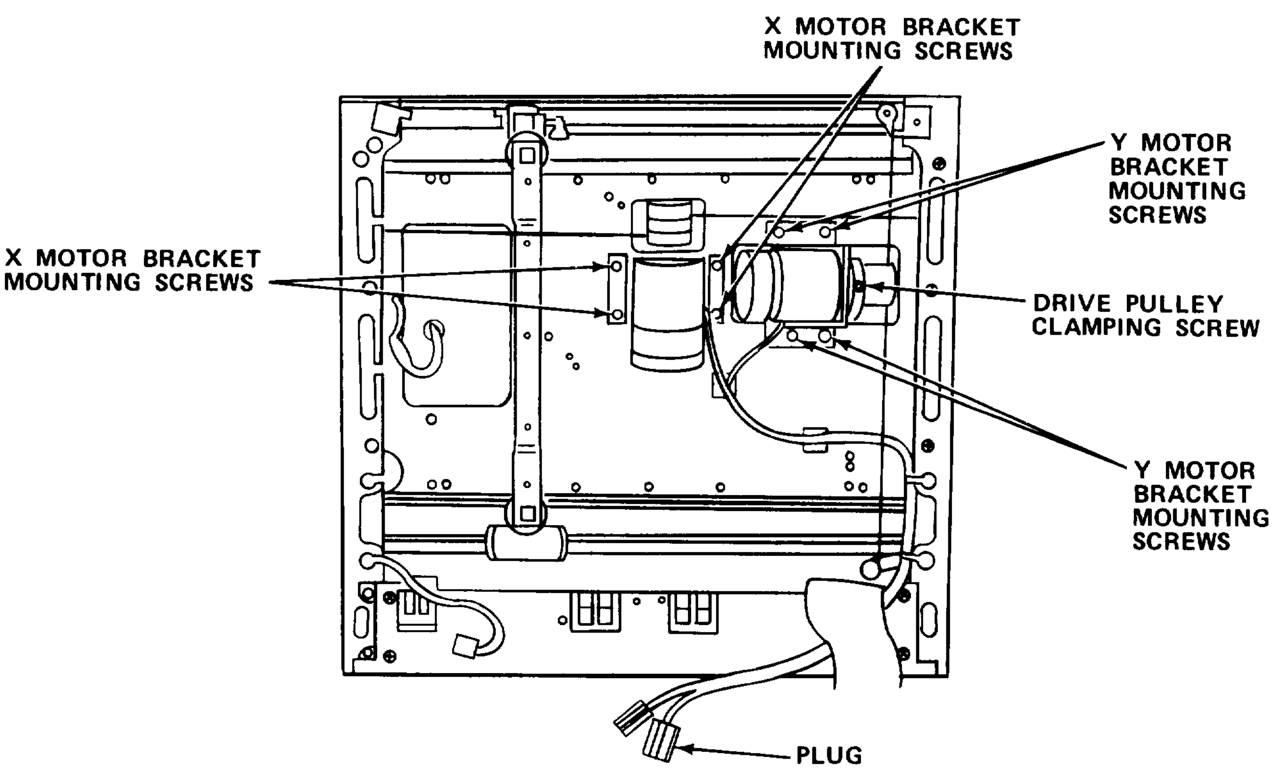




(1) Unscrew two hood retaining screws and remove rear hood.



(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.



c. Unplug motor connectors from A2.

d. Loosen hex head drive pulley clamping screw and secure drive pulley to prevent its movement.

e. Remove four motor mounting screws and carefully remove motor and bracket.

f. Detach defective motor from motor bracket by removing nuts, bolts, and washers holding motor to its bracket.

g. Install new motor on mounting bracket and secure with bolts, washers, and nuts.

h. Install new motor and bracket on plotter and secure with four screws.

i. Reconnect cable assemblies to A2.

j. Tighten drive pulley clamping screw.

k. Verify cable tension by performing respective (X- or Y-) cable tension adjustment procedure (paragraph 3-29.3).

l. Perform motor driver adjustments (paragraphs 3-29.5, 3-29.6).

m. Lower upper deck assembly and reinstall rear hood.

3-29.15 X-Drive Cable Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)
3/32 in. Hex Head Key Wrench
Dynamometer (100 - 500 g)

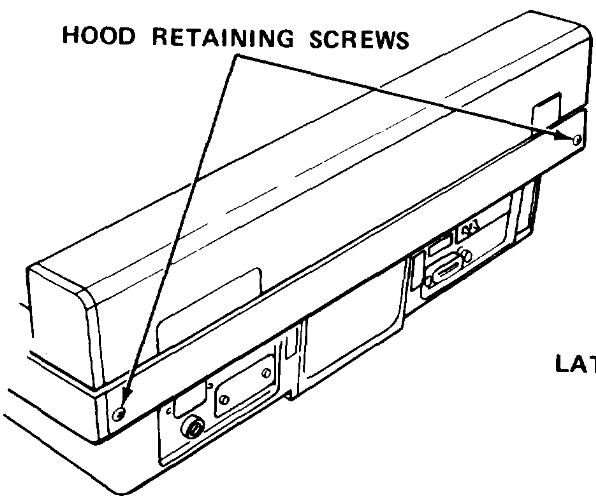
SUPPLIES: Insulation Tape
X-Drive Cable

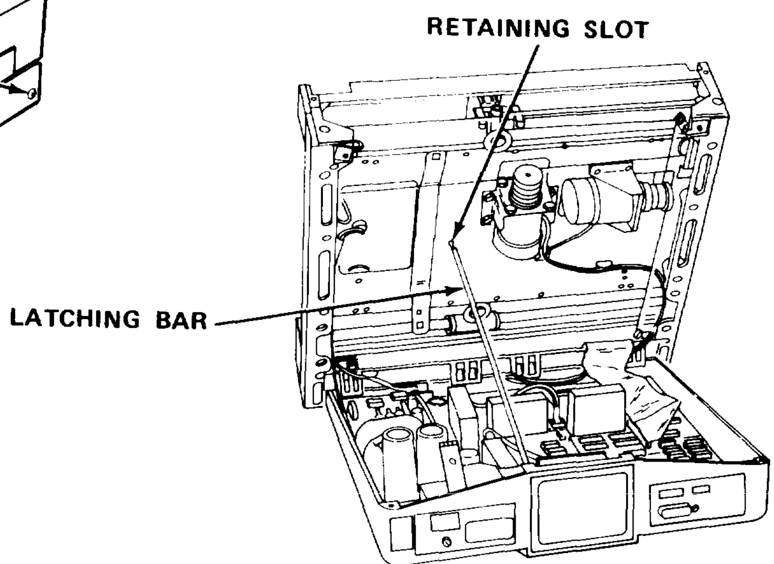
WARNING

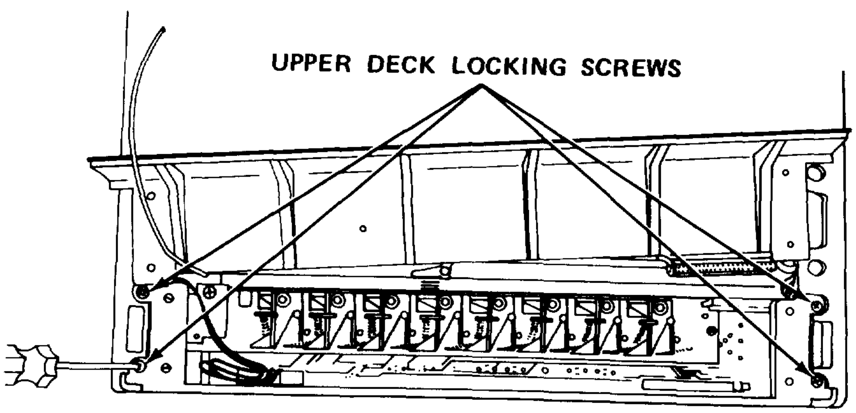
Death or serious injury may occur from electrical shock. Be careful not to contact high voltage connections.

a. Set LINE power switch to off. Remove power cord and HP-IB Interface.

b. To open up plotter:

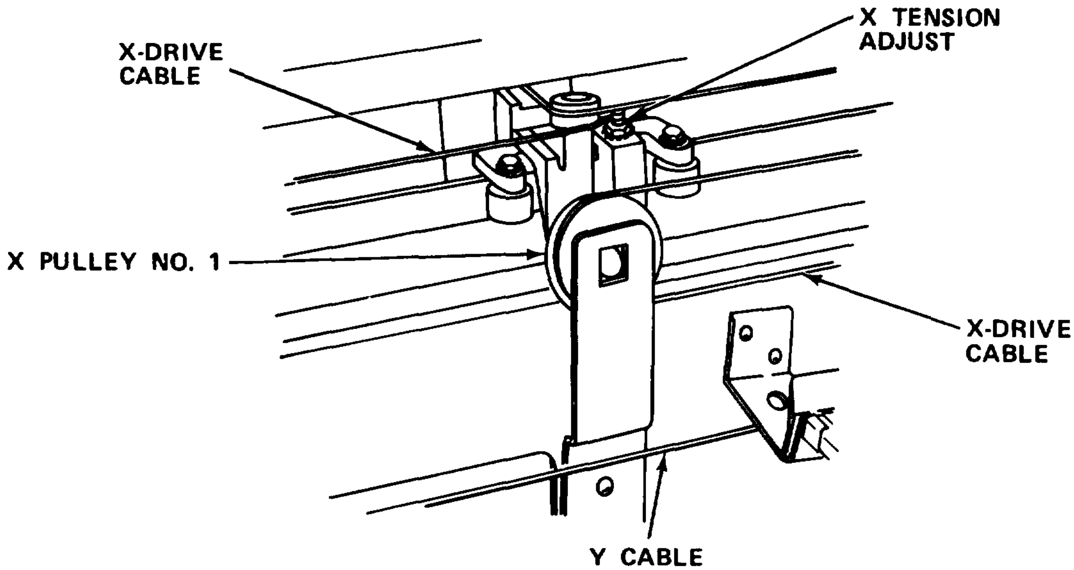






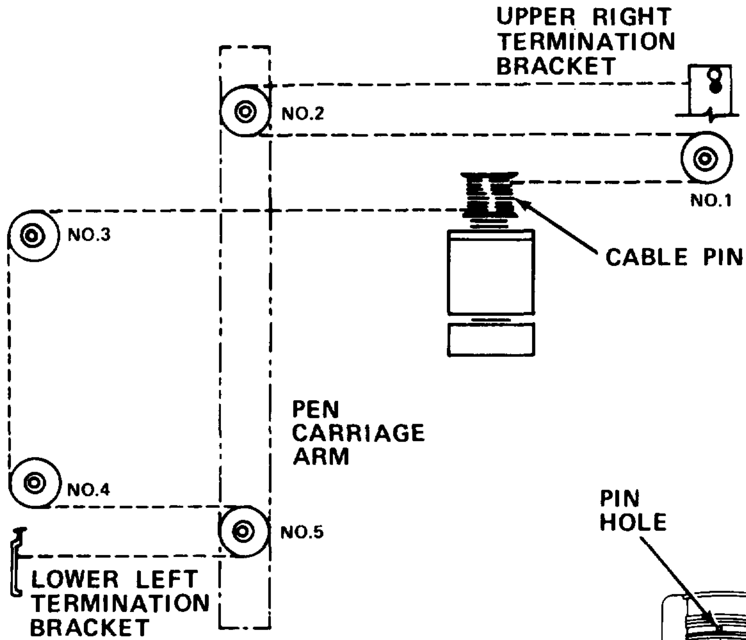
(1) Unscrew two hood retaining screws and remove rear hood.

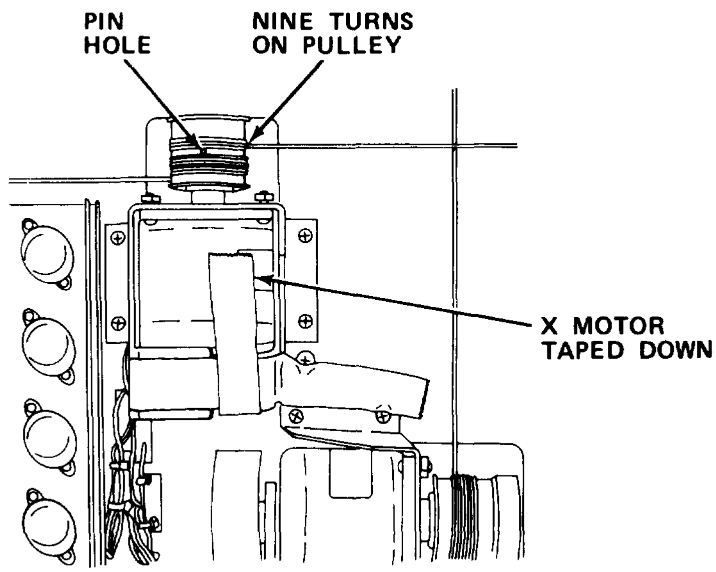
(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.



c. Loosen but do not remove X-tension adjustment nut.

d. Remove defective X-drive cable from upper right and lower left termination brackets and all pulleys.





e. Install new X-drive cable:

(1) Turn X-motor pulley so that pin hole is directly up.

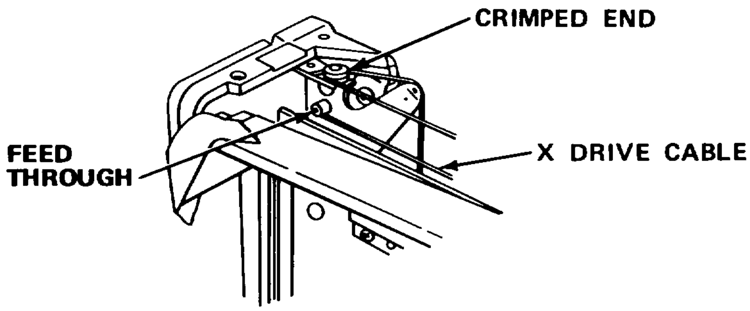
(2) Secure motor in this position with tape so that it will not turn.

(3) Unwind new X-drive cable taking care not to kink cable.

(4) Wind nine turns around motor pulley so that there are three turns above pin and six turns below pin.

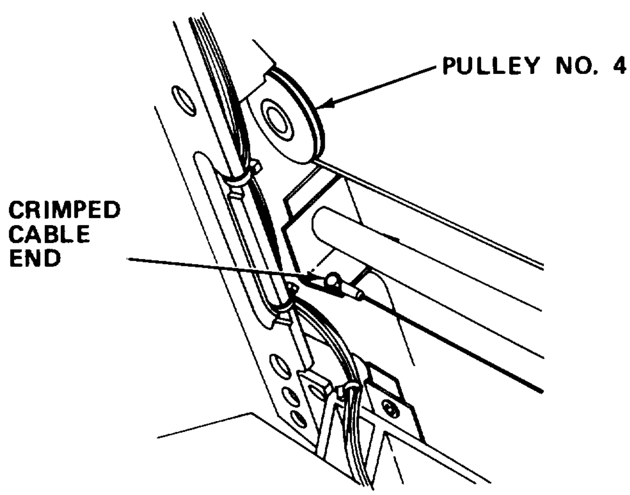
(5) Tape pulley windings down securely.

(6) Thread shorter length of cable around pulleys 1 and 2.



(7) From pulley 2, thread crimped cable end through feed through hole and up behind upper right bracket to anchor crimped end. Cut off excess cable end.

(8) Thread longer cable length around pulleys 3, 4, and 5.



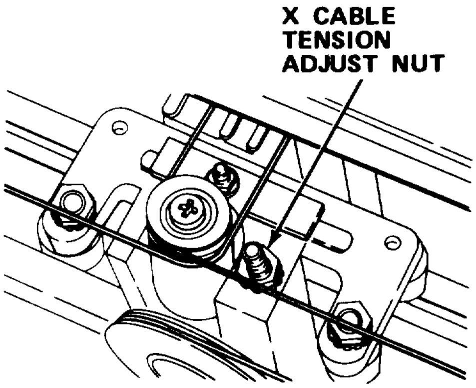
(9) Anchor crimped cable end in lower left bracket.

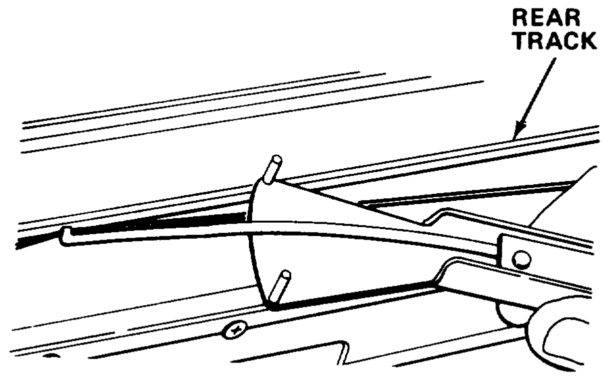
(10) Remove tape from motor windings.

(11) Remove two thumbscrews holding plotter arm in place.

(12) Move pen carriage arm assembly to extreme right edge of platen.

(13) Move pen holder at the assembly to the top of the arm assembly.





(14) Perform cable tension adjustment procedures (paragraph 3-29.3).

(15) Manually move carriage arm assembly and pen holder, and recheck cable tension.

f. Lower upper deck assembly and reinstall rear hood.

3-29.16 X-Cable Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)
Cross Tip Screwdriver (No. 0)
3/32 in. Hex Head Key Wrench
Nut Driver (0.25 in.)
Dynamometer (100-500 g)

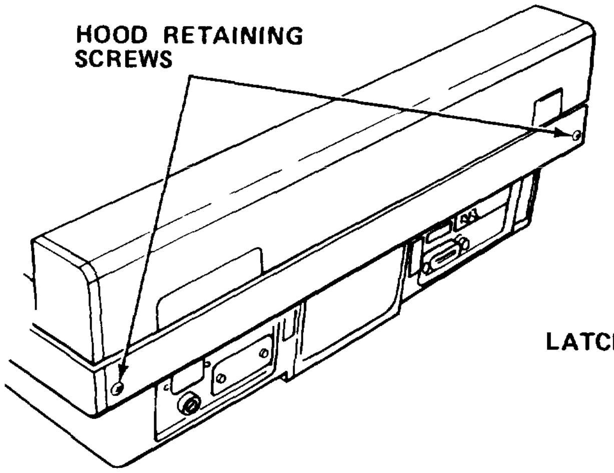
SUPPLIES: X-Cable

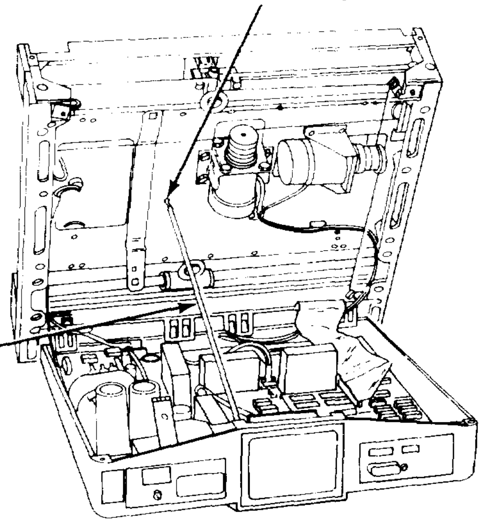
WARNING

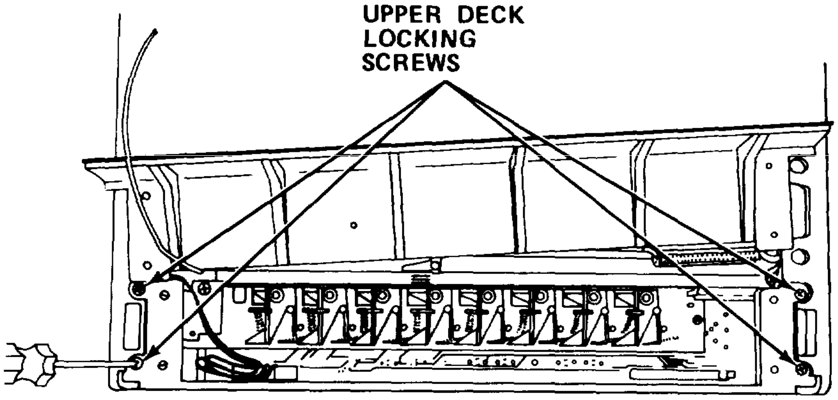
Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Set LINE power switch to off. Remove power cord and HP-16 Interface.

b. To open up plotter:



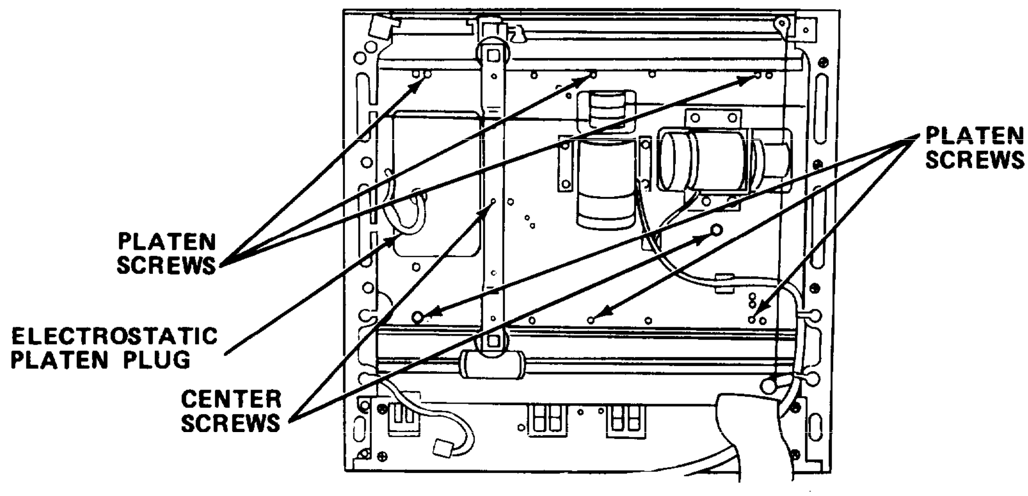




(1) Unscrew two hood retaining screws and remove rear hood.

(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

c. Position pen arm at extreme right (pen stall end) edge of plotter.



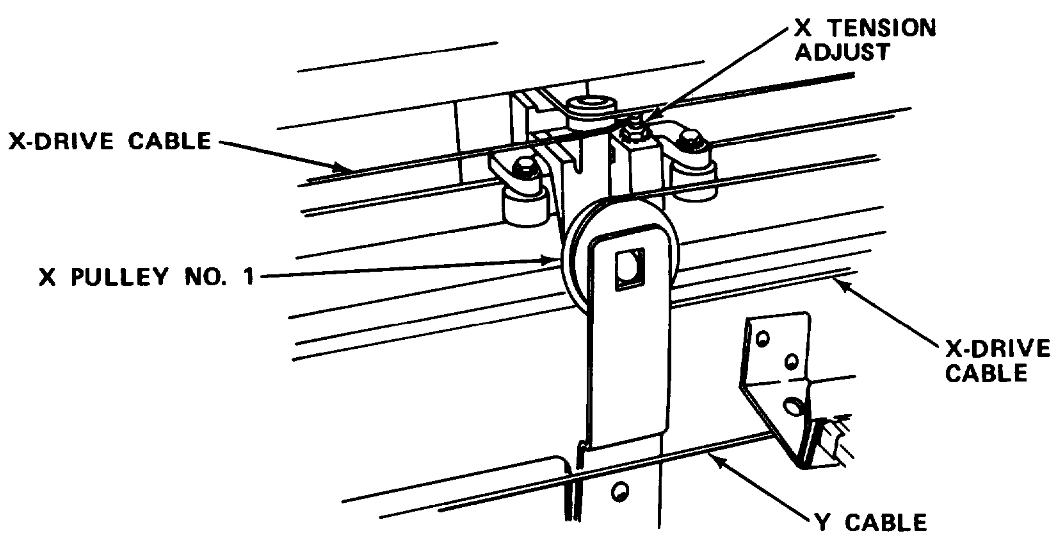
d. Unplug electrostatic platen plug.

e. Remove X-cable:

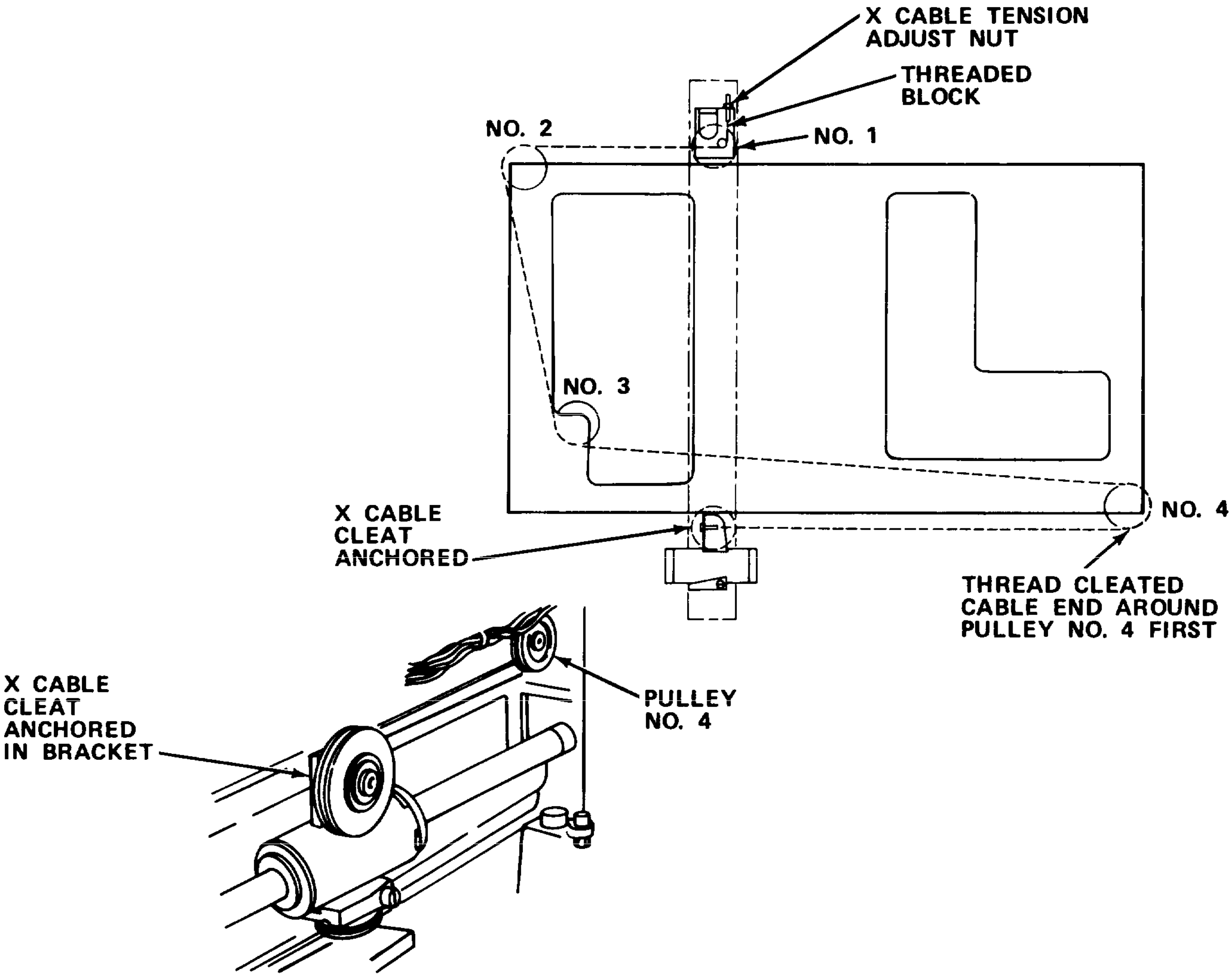
(1) Move the pen carriage arm to extreme right edge of platen.

(2) Remove six screws around edge of electrostatic platen and two screws from center of electrostatic platen.

(3) Lift electrostatic platen out carefully from end opposite pen arm.



(4) Remove X-tension adjust nut, and push threaded block down and out of bracket.

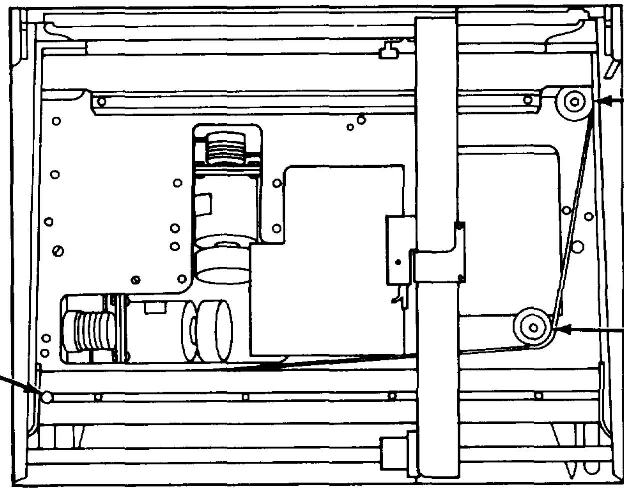


(5) Remove defective X-cable from all four pulleys and unlatch cleated cable end from lower pen carriage bracket.

g. Install new X-cable:

(1) Remove pulley 4. Take care not to lose washer underneath pulley.

(2) Unwind new X-cable taking care not to kink.



(3) Thread cleated cable end down through space normally occupied by pulley 4 and anchor cleated end in bracket.

CAUTION

Pulley will not rotate if washer is not in place.

(4) Reinstall pulley 4 making sure that washer is reinstalled under pulley, and thread cable around pulley.

(5) Bypass pulley 3 and thread cable around pulley 2 to pulley 1.

(6) Thread cable end adjustment block up into bracket above pulley 1 and install adjust nut finger tight only.

(7) Check that cable is around pulleys 1 and 2. Then complete stringing by threading cable around pulley 3.

(8) Adjust tension nut until 5/16 in. (8 mm) of thread is exposed above nut.

h. Position pen carriage arm at pen stable end of plotter. Adjust cable tension for 325 ± 25 g. Refer to cable tension adjustment procedure (paragraph 3-29.3).

i. Manually exercise pen carriage arm several times along X-axis and recheck cable tension. Readjust if necessary. Repeat manual exercising and checking after each adjustment until tension is set to 325 ± 25 g.

j. Lower upper deck assembly and reinstall rear hood.

3-29.17 Y-Cable Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)
3/32 in. Hex Head Key Wrench
1/4 in. Nut Driver
Crimping Pliers with Cutters
Dynamometer (100-500 g)

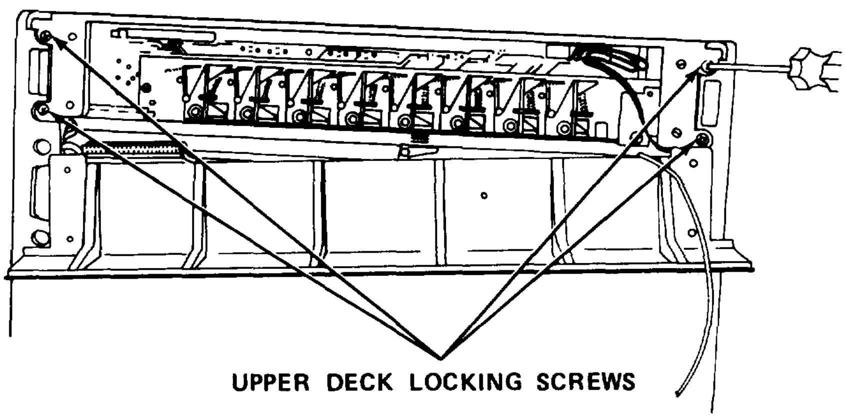
SUPPLIES: Insulation Tape (Item 21, Appendix E)
Y-Cable

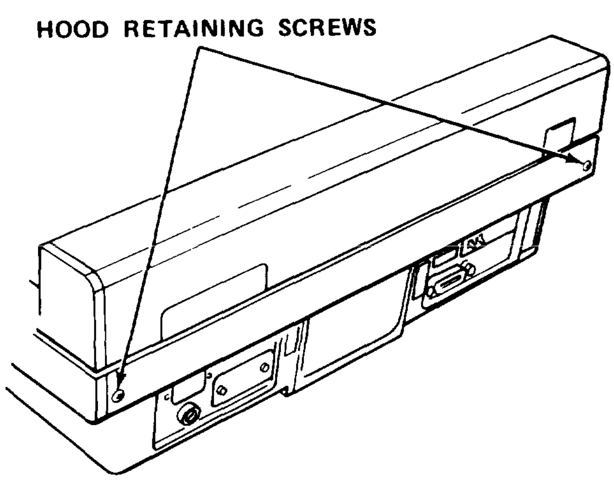
WARNING

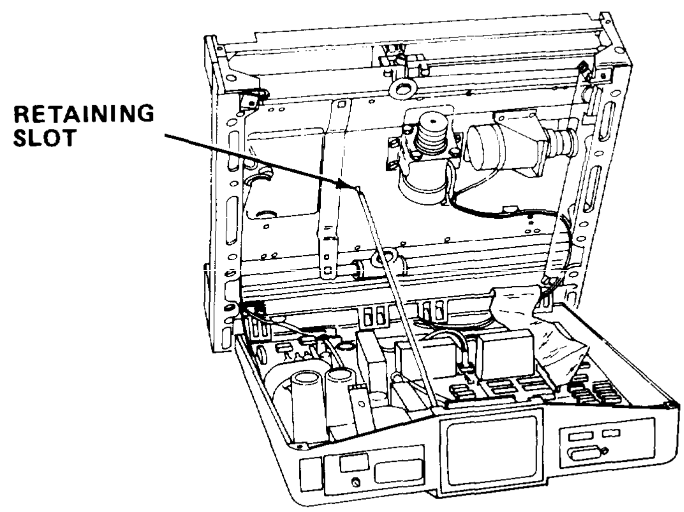
Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Set LINE power switch to off. Remove power cord and HP-IB Interface.

b. To open up plotter:







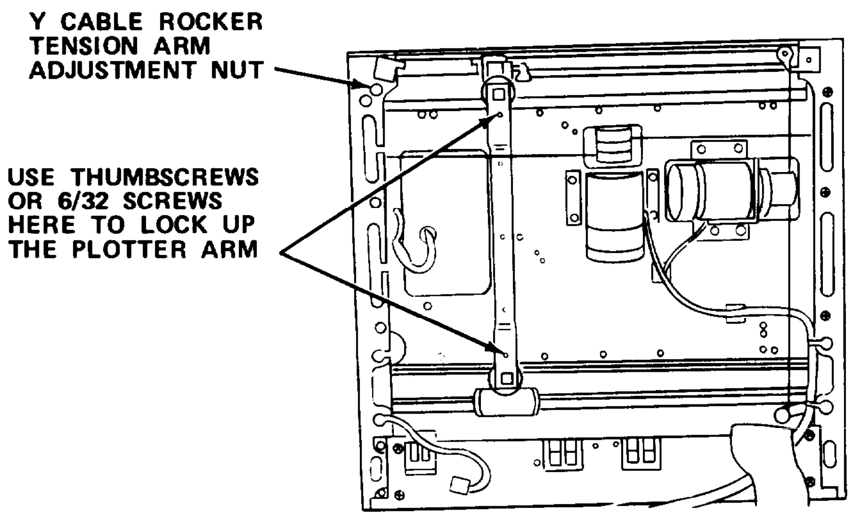
(1) Unscrew two hood retaining screws and remove rear hood.

(2) Raise upper deck. Swing latching bar up and engage it securely in retaining slot.

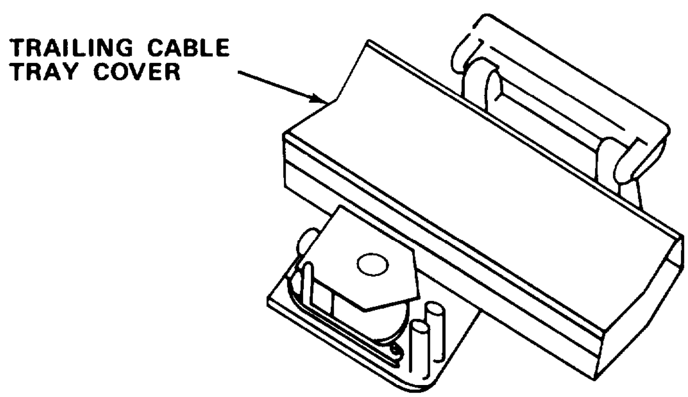
c. Manually position plotting arm over deck lock assembly, and secure arm using two thumbscrews from service kit or 6/32 in. screws.

d. Remove Y-cable:

(1) Disengage latching bar and lower the upper deck.



(2) Place pen carriage to center of plotting arm.



(3) Remove pen carriage cover by removing pen carriage cover screw.

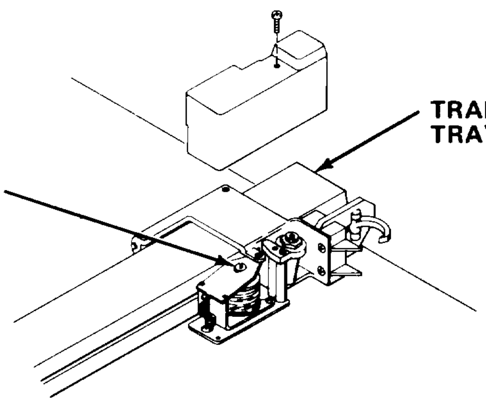
CAUTION

Do not touch dashpot piston with bare hands. Skin oils will damage surface of piston.

(4) Tape pen carriage top and dashpot securely together to prevent any parts from getting lost.

(5) Remove screw from dashpot assembly.

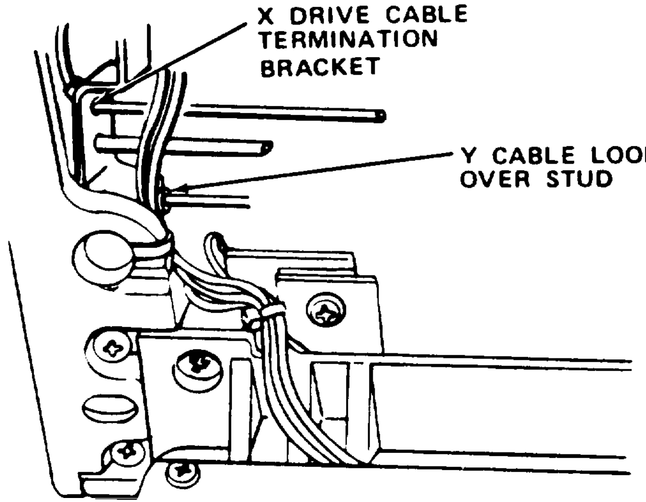
(6) Carefully swing dashpot and pen carriage away from pen arm.

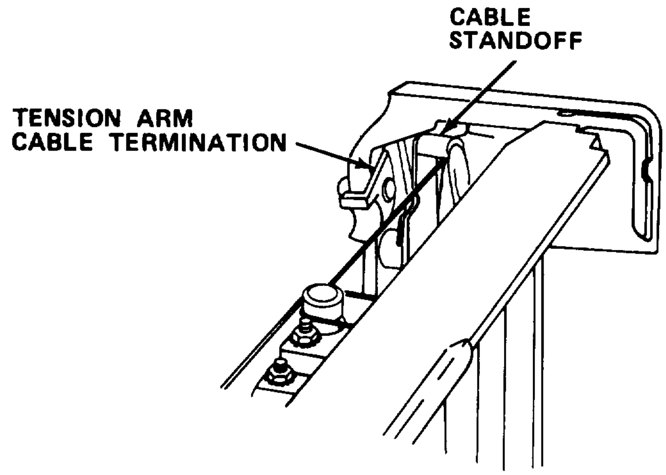


(7) Pull up trailing cable tray cover.

(8) Move trailing cable wires away from two nuts on pen carriage assembly. Remove two nuts from top of pen carriage assembly.

(9) Lift trailing cable termination bracket off threaded studs. Tape down carefully to plotter arm. Reinstall two nuts over pulleys finger tight.





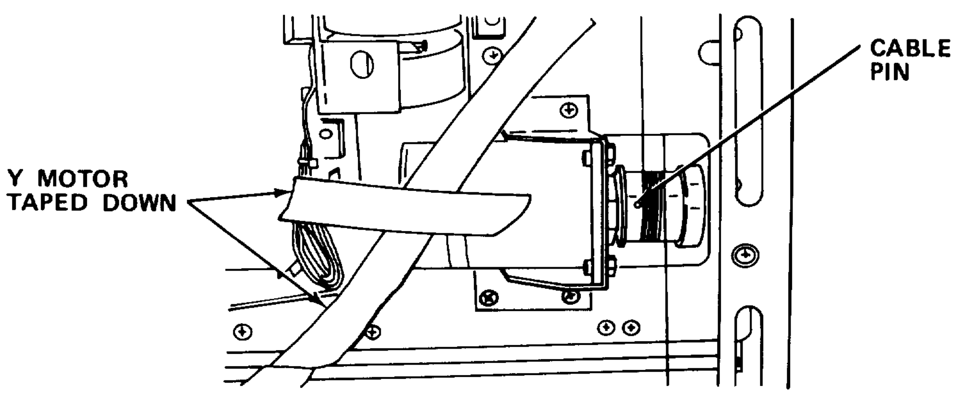
(10) Loosen rocker tension arm nut with 3/16 in. nut driver until cable tension is fully released.

(11) Unhook cable loop from lower left stud.

(12) Unhook cable from tension arm.

(13) Remove defective Y-cable from pulleys and motor.

e. Install new Y-cable:



(1) Turn Y-drive motor pulley so that pin hole is directly up.

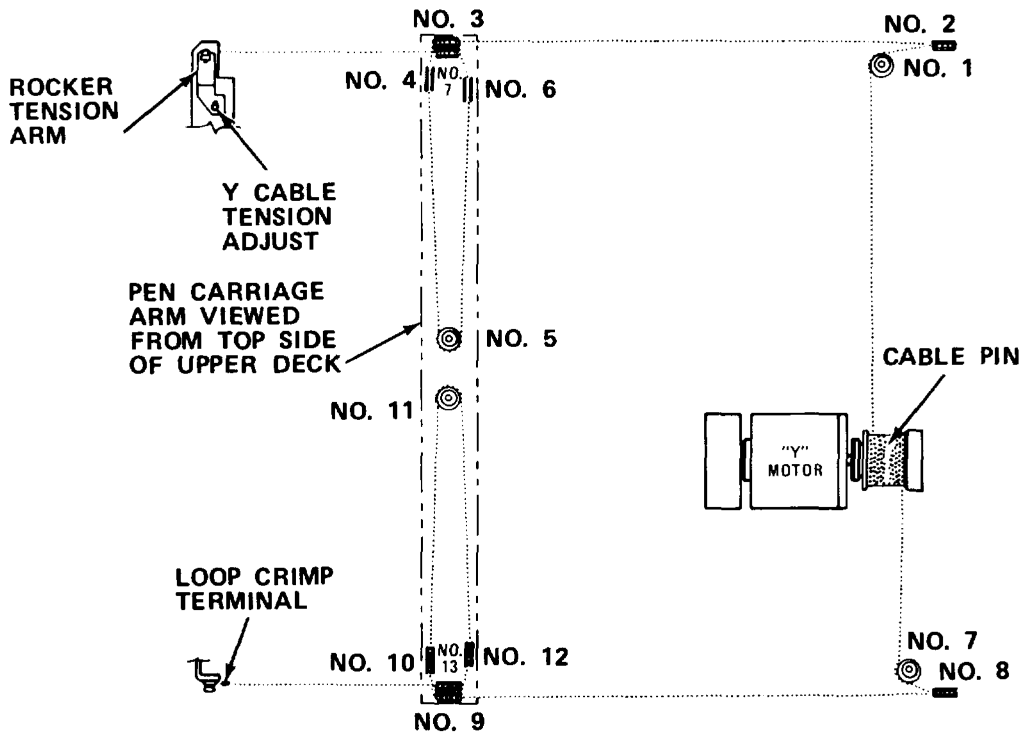
(2) Secure Y-drive motor in this position with tape so that it will not turn.

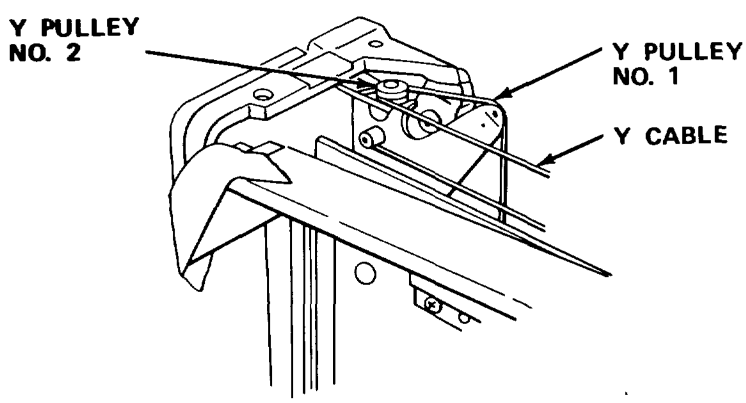
(3) Unwind new Y-drive cable taking care not to kink.

(4) Insert cable pin into pulley hole so that long end (crimped end) can be draped out of way over top of upper deck.

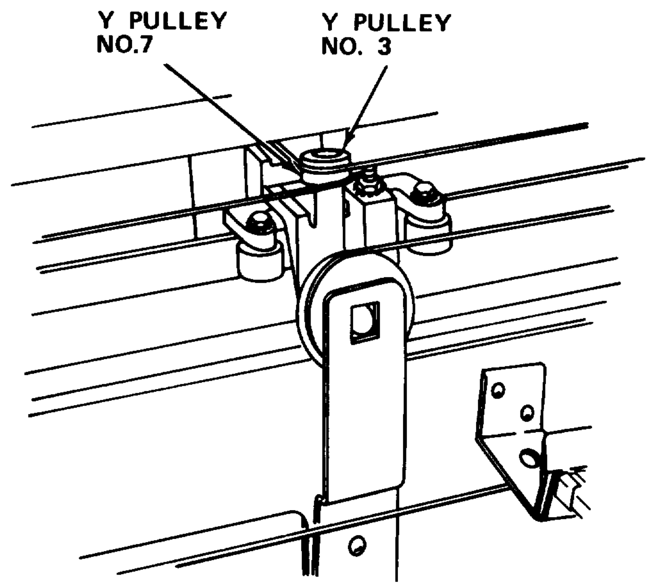
(5) Wrap short end (looped end) of cable, four turns around pulley wrapping away from body and right of pin.

(6) Holding long end with one hand, pull shorter end of cable until four turns are wound on pulley to left of pin. Tape these four windings down securely.





(7) Thread long end around pulleys 1, 2, and 3 and from pulley 3 under tray to pulley 4.



(8) Either rotate plotter so platen faces you or, taking care not to damage short end of cable, close up plotter to facilitate threading cable along pen carriage arm.

(9) Thread long end around pulleys 4, 5, and 6 and from pulley 6 back under tray to pulley 7.

(10) Rotate or open plotter. Thread long end around pulley 7 and through standoff. Hook crimped end in rocker tension arm.

(11) Remove tape from motor pulley windings. Thread short ends of cable around motor pulley to form five turns to right of pin and tape across winding to secure them to pulley.

(12) Thread short end around pulleys 8 and 9. Then thread under tray to pulley 10.

(13) Either rotate or close up plotter to facilitate threading cable along pen carriage arm.

(a) Thread short end around pulleys 11, 12, and 13, then back under tray to pulley 14.

CAUTION

Do not crimp terminal at this point.

(b) Either rotate or open up plotter and thread cable around pulley 14. Loop hooked end over cable stud. Pull loose cable end to provide a snug loop fitting at stud.

(c) Securely crimp the cable terminal and cut off the excess.

(d) Remove all tape from motor and pulleys.

(e) Remove nuts from pen holder assembly.

(f) Reinstall trailing cable termination bracket over threaded studs. Reinstall nuts and tighten.

(g) Position pen solenoid wires so that they will not rub on pulleys.

(h) Reinstall trailing cable tray cover. Check ends for flush fit.

CAUTION

Do not touch dashpot piston with bare hands. Skin oils will damage surface of piston.

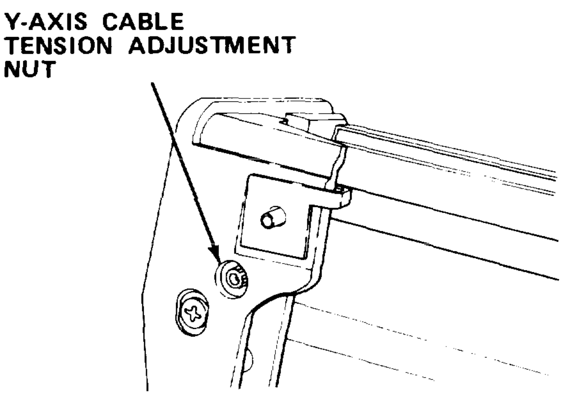
(i) Reinstall dashpot assembly. Hook end of piston into notch and position spring over pin. If piston becomes separated from dashpot, do not touch with bare hands.

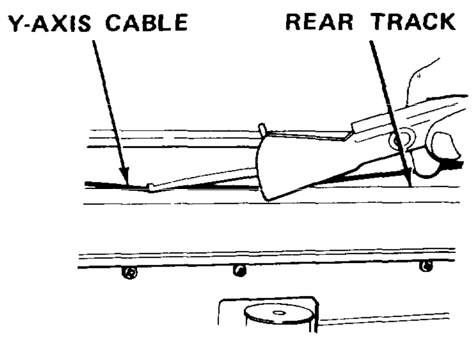
(j) Position upper pen holder and install screw.

(k) Reinstall pen holder cover and install screw.

(l) Position plotter arm at the left (pen stall) end of plotter.

(m) Position pen carriage assembly at top right corner of platen.





(n) Pull on loose cable at loop crimp terminal until all slack is gone from cable. Locate midpoint between two pulleys on Y-axis cable.

(o) Using dynamometer, push cable at midpoint until it just touches rear track edge. Pull cable at loop crimp terminal until cable tension of about 300 grams is obtained on gage. Securely crimp loop crimp terminal to cable and cut off excess cable.

(14) Adjust cable tension for 325 + 25 g. Refer to cable tension adjustment procedure (paragraph 3-29.3).

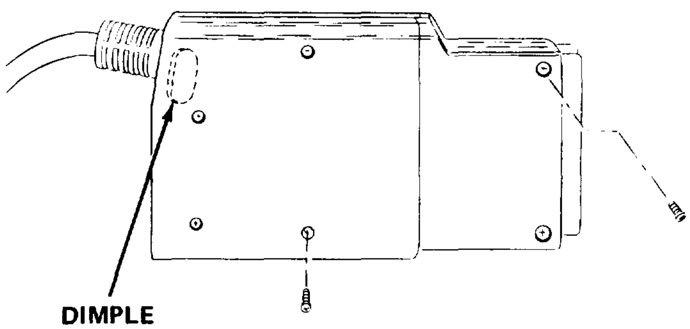
(15) Lower upper deck assembly and reinstall rear hood.

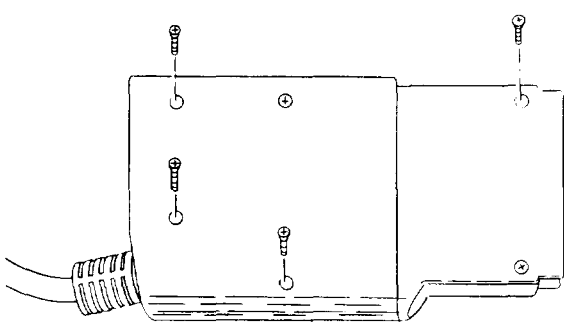
3-29.18 HP-IB Logic Board Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)

SUPPLIES: PCA Assembly



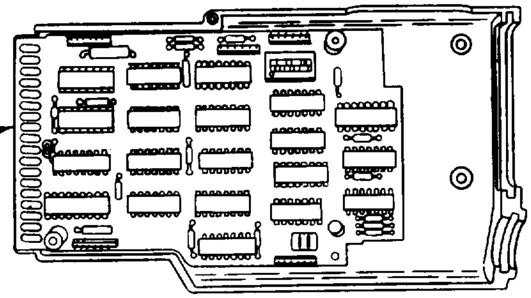


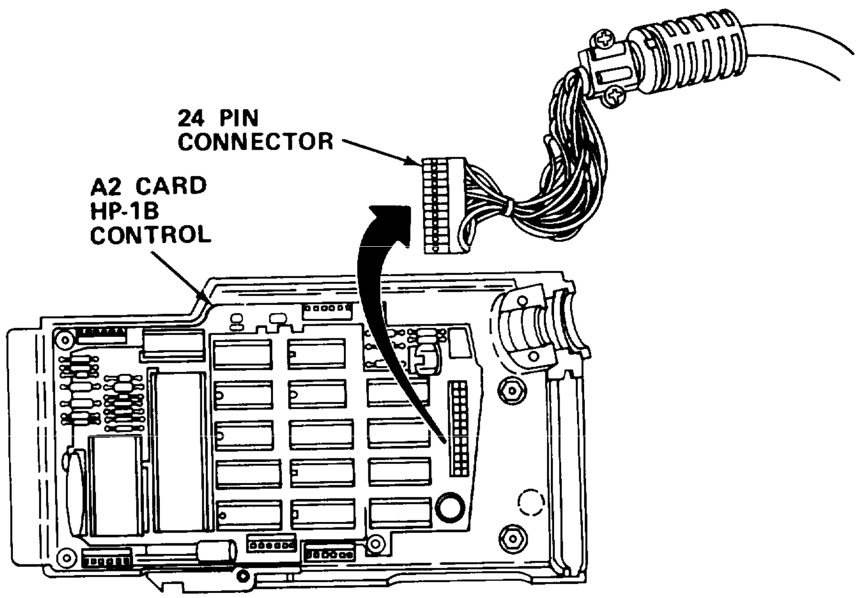
CARD ENCLOSURE

a. On side of PCA enclosure with dimple, remove two screws shown.

b. Turn PCA enclosure over and remove four screws shown.

c. Grasp both sides of PCA enclosure and carefully pull them apart.





d. If A2 (HP-IB control logic board) is to be removed, unplug 24 pin connector.

e. Turn over side of PCA enclosure holding card to be replaced. Remove remaining mounting screws and offsets.

f. Remove defective PCA.

g. Install new PCA and secure with screws and offsets.

h. Plug cable pin connector back into A2 if A2 was removed. Be sure bulk of wiring is in cavity and not obstructing PCA's.

i. Be sure that six-pin connectors are lined up with their respective plugs on A2 and plastic latch is in place. Press two halves of PCA enclosure back together.

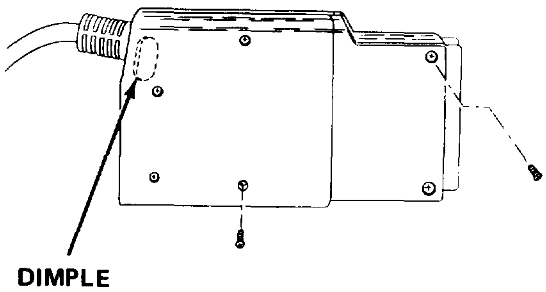
j. Reinstall screws.

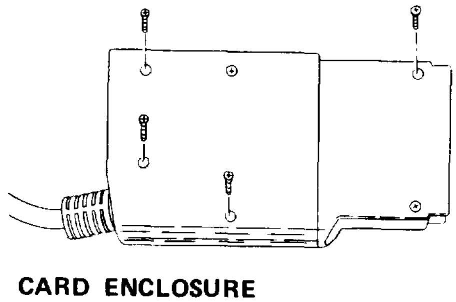
3-29.19 Interface Cable Replacement.

MOS: 35E, Special Electronic Devices Repairer

TOOLS: Cross Tip Screwdriver (No. 1)

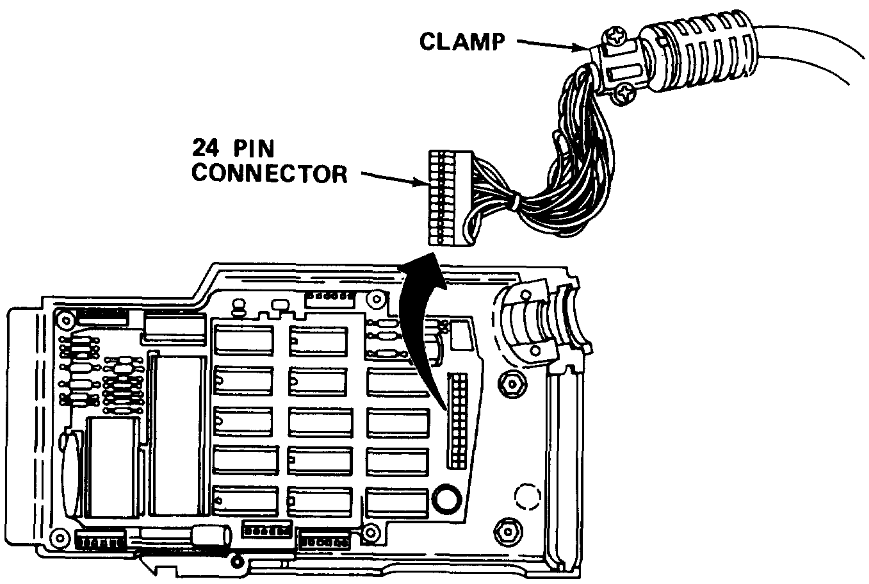
SUPPLIES: Cable Assembly





a. On side of PCA enclosure with dimple, remove two screws shown.

b. Turn PCA enclosure cover over and remove four screws shown.



c. Grasp both halves of PCA enclosure and carefully pull apart.

d. Remove screws and cable clamp and remove end of cable from cable ridge groove.

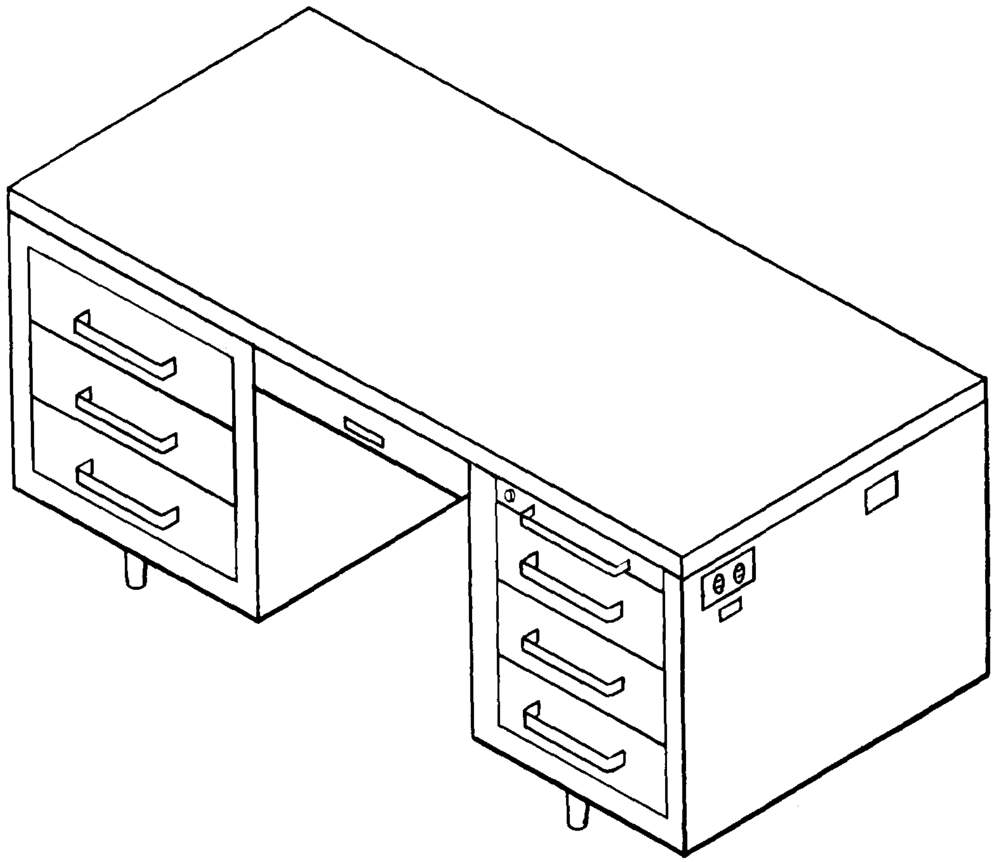
e. Gently pull 24 pin connector and defective cable away from base.

f. Plug new 24 pin connector onto pins.

g. Snap ridge on end of cable into ridge groove and reinstall cable clamp.

h. Press wires so they fill cavity next to 24 pin connector, but do not lay on the PCA.

i. Press halves of PCA enclosure back together and reinstall screws.



CHAPTER 4

PHOTOINTERPRETER DESK

Section I INTRODUCTION

4-1. GENERAL INFORMATION.

4-1.1 Scope

a. Model Number and Equipment Name. Model 910564 Photointerpreter Desk.

b. Purpose of Equipment. To provide photointerpreter with work station to view film chips and aerial roll film.

4-2. EQUIPMENT DESCRIPTION.

4-2.1 Equipment Characteristics, Capabilities. and Features.

a. Controlled transillumination light source.

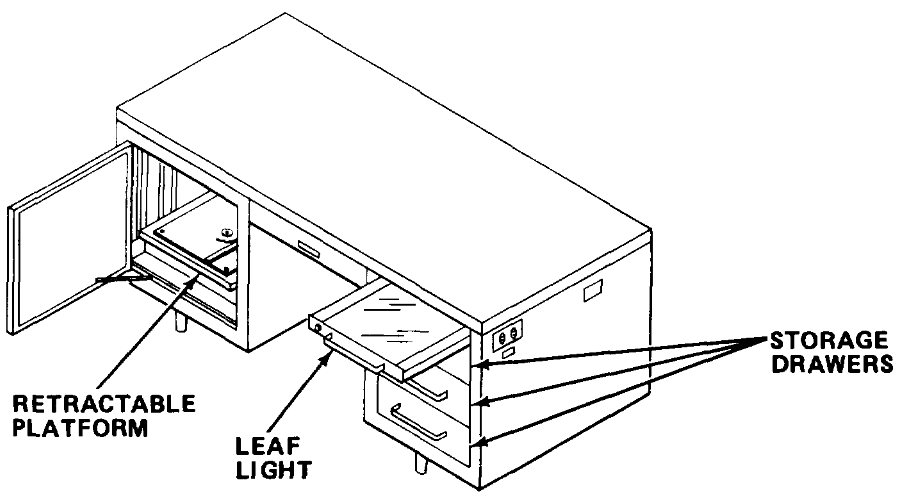
b. Mounts microscan light table.

c. Storage facilities for photointerpretation equipment.

d. Retracting leaf light and light table pedestal.

e. Swivel base for microscan light table.

4-2.2 Location and Description of Major Components.



RETRACTABLE PLATFORM. Mounts microscan. Retracts into typewriter well.

STORAGE DRAWERS. Provide storage for working photographs and papers.

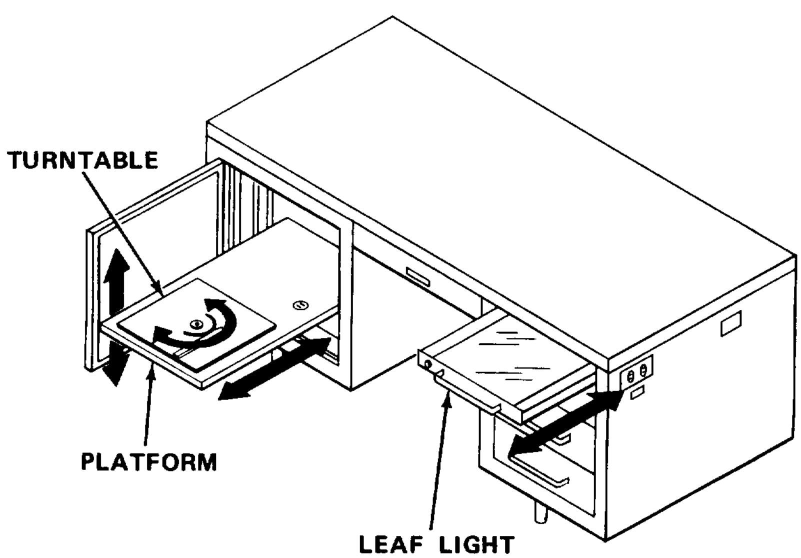
LEAF LIGHT. Provides a controlled transillumination source.

4-2.3 Equipment Data.

Width	60 in. (152.4 cm)
Depth	30 in. (76.2 cm)
Height	20 in. (50.8 cm)
Weight	258 lbs (117 kg)
Power Requirements	120 V, 60 Hz, 7 amps
Leaf Light	
Illuminated Surface	10 in. X 17 in. (25.4 cm X 43.2 cm)
Light Intensity	100 to 2000 ft lamberts (342.6 to 6852 candela/m^2)
Microscan Mounting	
Rotation with Positive Lock	90 degrees
Forward/Backward Movement	3 in. (7.62 cm)

4-3. TECHNICAL PRINCIPLES OF OPERATION.

4-3.1 General.

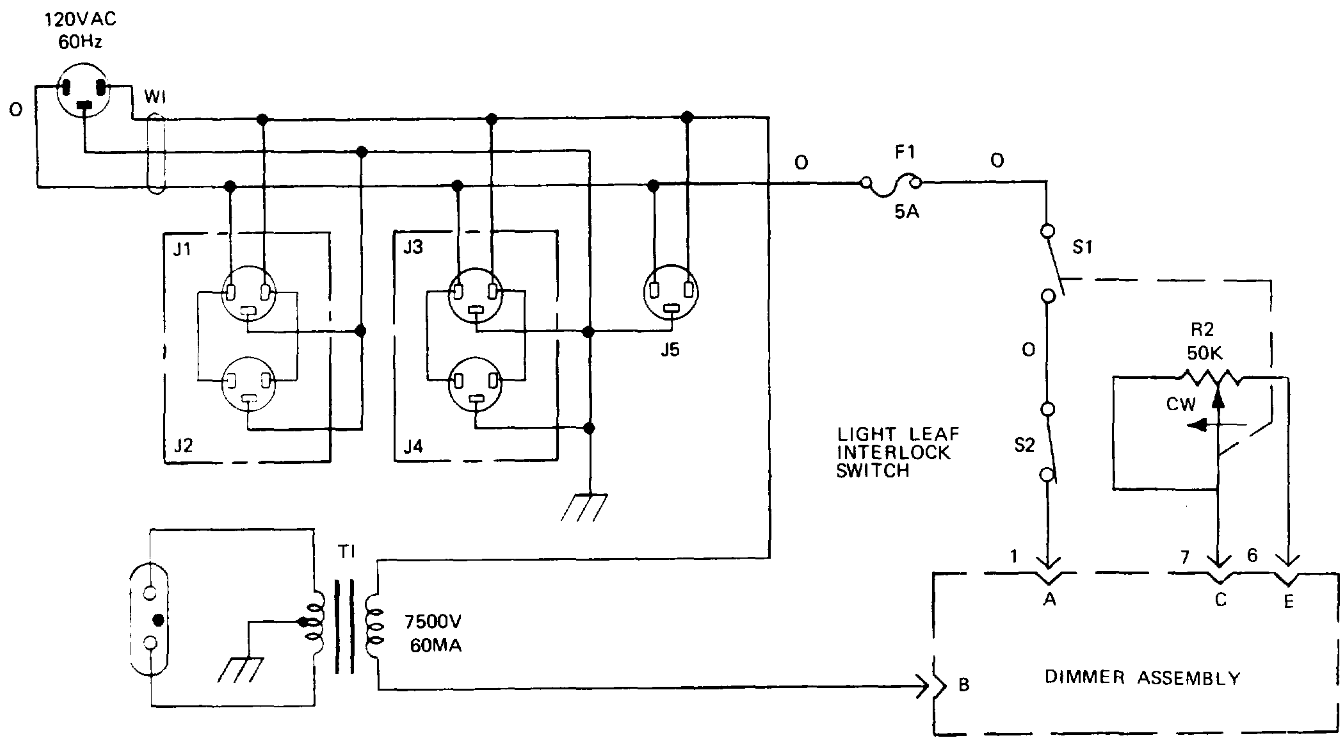


a. Platform moves up and down under spring tension and supports microscan.

b. Turntable rotates microscan left or right.

c. Leaf light pulls in or out. Light operates only with leaf in the out position.

4-3.2 Electrical Schematic.



a. Unfused 120 V, 60 Hz power is provided to duplex sockets on each end of desk and socket on microscan platform. Remaining circuits are protected by 5 amp fuse.

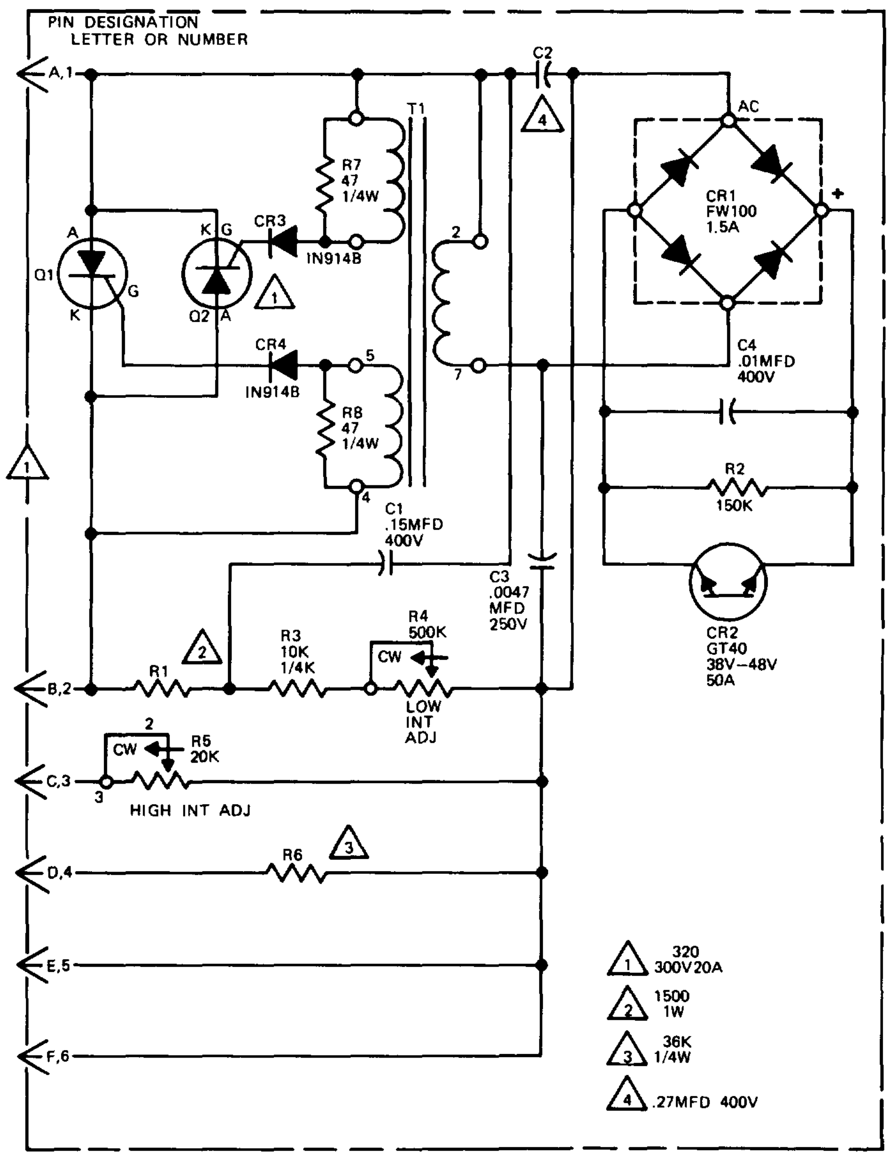
b. Switch S1 is coupled to variable resistor R2 to provide power to leaf light.

c. Switch S2, interlock on leaf light, interrupts power when leaf light is pushed into desk.

d. Dimmer assembly modifies ac at transformer to regulate intensity of light.

4-3.3 Dimmer Card.

a. When operated to ON, the ON/OFF/INCREASE control applies voltage from the power source through plug P1 and cable W1 to the dimmer circuit board to operate the system whenever the leaf is pulled out from the stowed position. When the leaf is in the stowed position, switch S2 opens, breaking the circuit. The INCREASE control is a potentiometer that adjusts he light level of the grid lamp from a maximum of 2000 ft lamberts (6852 candela/m^2) to a minimum of approximately 5% of maximum. The INCREASE potentiometer is an integral part of switch S1, and is connected across two of the terminals of the dimmer circuit board.



b. The ac voltage enters the dimmer circuit board through pin A and is transferred to pin B through SCR Q1 or Q2, which determines the amount of the ac sine wave voltage that is applied to the external high voltage transformer to light the grid lamp. The SCR's are triggered by the action of the remaining components on the board. Normally, the SCR's prevent all of each ac half-wave from being transferred, but when triggered, allow current to flow during the remaining portion of each half sine wave until the zero crossing point is reached, whereupon the SCR is turned off and the ac waveform is again blocked.

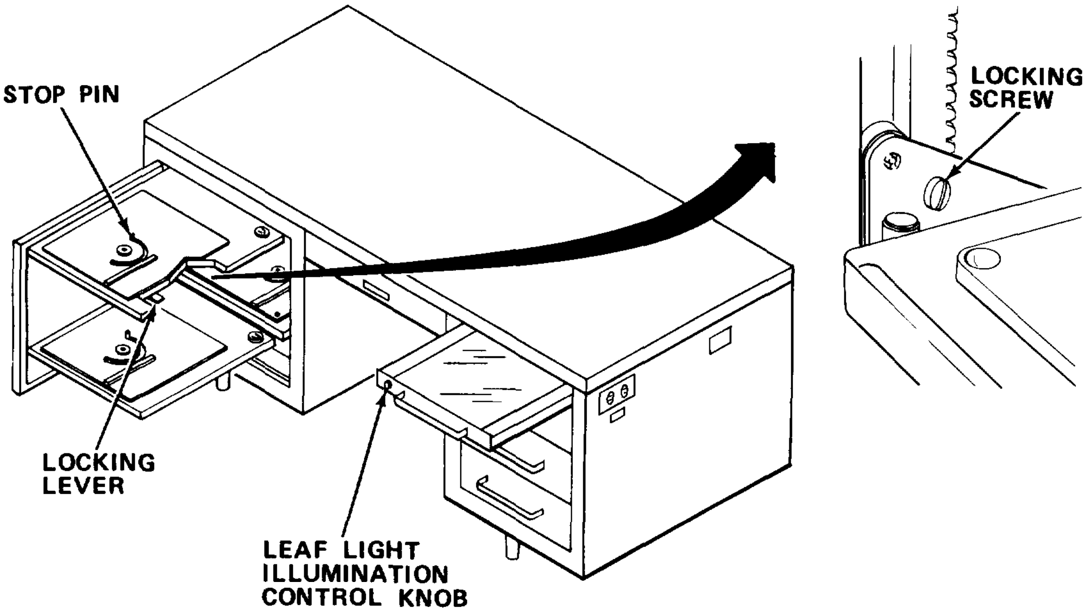
c. When ac voltage enters the control board, it is applied to C1 and R1 which provide a slight delay in the input voltage, which is applied to the timing circuit composed of capacitor C2 and resistors R4, R3, R5, and external INCREASE potentiometer 1R1. (Note that resistor R6 is not used in this application.)

d. As the delayed ac voltage is applied across capacitor C2, the capacitor begins to charge at a rate depending upon the setting of INCREASE potentiometer R5. The voltage across C2 also appears across rectifier CR1 and trigger diode CR2. When the trigger diode reaches the breakover voltage of 43 ± 5 V, it conducts to complete the path across rectifier bridge CR1. This forms a closed loop circuit through ‘ capacitor C2, the primary of pulse transformer T1, and rectifier CR1, and current flows until capacitor C2 is discharged. The discharge time is very fast and a short duration pulse is generated, shaped by capacitor C3.

e. The pulse current flowing through the primary of pulse transformer T1 induces a voltage across the appropriate secondary which is applied through diode CR3 or CR4 to the gates of SCR Q2 or Q1, respectively. When either SCR is triggered, it allows the rest of the ac half-wave to pass to external grid lamp transformer 1T1 through pin B. The SCR will continue to conduct until the ac half-wave reaches the zero crossing point, at which time it turns off.

Section II OPERATING INSTRUCTIONS

4-4. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS.



Control or Indicator	Function
Locking Lever	Locks microscan turntable at 0 degrees and 90 degrees.
Leaf Light Illumination Control Knob	Turns leaf light on/off. Adjusts intensity of light.
Locking Screw	Locks platform in down position (removed during operation).

4-5. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES.

a. Before You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your before (B) PMCS.

b. While You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your during (D) PMCS.

c. After You Operate. Be sure to perform your after (A) PMCS.

d. If Your Equipment Fails to Operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA Pam 738-750.

4-5.1 PMCS Procedures.

a. PMCS are designed to keep the equipment in good working condition by performing periodic service tasks.

b. Service intervals provide you, the operator, with time schedules that determine when to perform specified service tasks.

c. The “Equipment is Not Ready/Available If” column is used for identification of conditions that make the equipment not ready/available for readiness reporting purposes or denies use of the equipment until corrective maintenance is performed.

d. If your equipment fails to operate after PMCS is performed, immediately report this condition to your supervisor.

e. Perform weekly as well as before operation if you are the assigned operator and have not operated the item since the last weekly or if you are operating the item for the first time.

f. Item number column. Item numbers are assigned in chronological ascending sequence regardless of interval designation. These numbers are used for your “TM Number” Column on DA Form 2404, Equipment Inspection and Maintenance Worksheet in recording results of PMCS.

g. Interval columns. This column determines the time period designated to perform your PMCS.

h. Item to be inspected and procedures column. This column lists functional groups and their respective assemblies and subassemblies as shown in the Maintenance Allocation Chart (Appendix B). The appropriate check or service procedure follows the specific item to be inspected.

i. Equipment is not ready/available if: column. This column indicates the reason or cause why your equipment is not ready/available to perform its primary mission.

j. List of tools and materials required for PMCS is as follows:

Item	Quanity
Liquid Detergent (Item 9, Appendix E)	ar
Cheesecloth (Item 7, Appendix E)	ar
Vacuum Cleaner	1 ea
Flat Tip Screwdriver	1 ea

Table 4-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can safely be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

B - Before **W - Weekly** **AN - Annually** **(Number) - Hundreds of Hours**
D - During **M - Monthly** **S - Semiannually**
A - After **Q - Quarterly** **BI - Biennially**

ITEM NO.	INTER. VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available if:
		PHOTOINTERPRETER DESK	
1	B	Inspect Electrical Circuit. **WARNING** Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing. 1. Inspect wiring for breaks, tears, burns, or defective plugs.	Wiring is defective.
		2. Plug desk power cord into 120 V, 60 Hz power source.	

Table 4-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

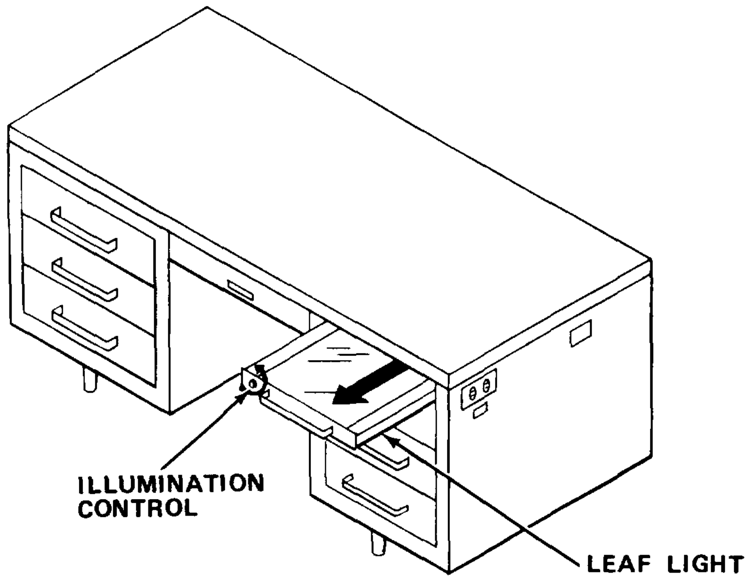
ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Reediness Reporting, Equipment Is Not Ready/ Available If:
		<u>PHOTOINTERPRETER DESK - Cont</u>	
1	B	<u>Inspect Electrical Circuit</u> - Cont	
			
		3. Pull leaf light out. 4. Turn illumination control fully right. Observe leaf light is on. 5. Turn illumination control slowly left. Observe decrease in light intensity.	

Table 4-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

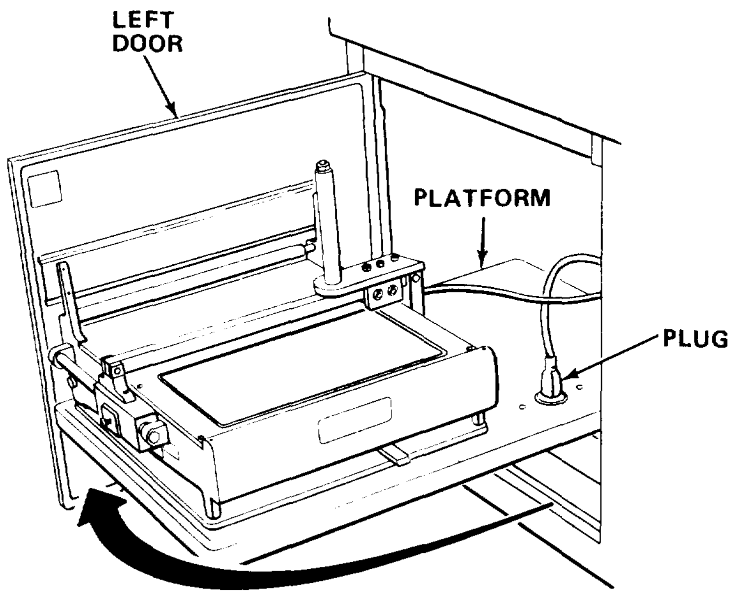
B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-VAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		PHOTOINTERPRETER DESK - Cont	
1	B	<u>Inspect Electrical Circuit</u> - Cont	
		6. Push leaf light in. Observe light out.	



7. Open left door.

WARNING

Table has powerful springs that will force the table upward and injure the operator unless the locking screw is installed. Operator must use two hands to force downward when the table is raised.

Table 4-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

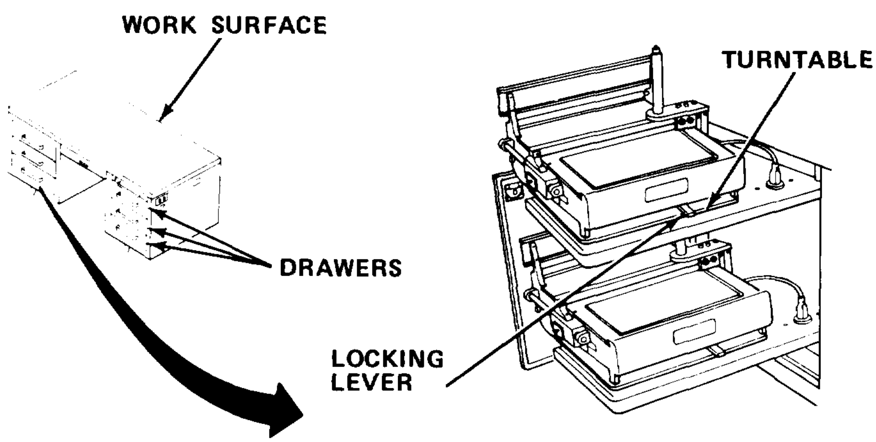
ITEM NO	IN-TER VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Readyi Available If:
		PHOTOINTERPRETER DESK - Cont	
1	B	Inspect Electrical Circuit - Cont 8. Pull out and raise platform. 9. Place microscan on platform with reels to left side of desk. 10. Plug in microscan. 11. Remove locking screw. 12. Turn fan on.	
2	B	Inspect Photointerpreter Desk.  1. Inspect work surface for dirt or gouges. 2. Open each drawer. Observe free movement and stop position when fully open. 3. Rotate turntable. Observe free rotation. Be sure lock stops turntable at 90 degree rotation.	

Table 4-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biennially

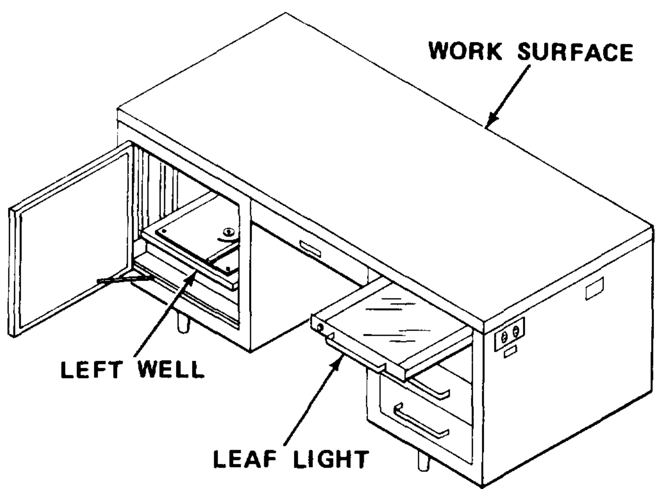
(Number) - Hundreds of Hours

ITEM NO,	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		PHOTOINTERPRETER DESK - Cont	
3	B	Clean Photointerpreter Desk.	

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

1. Unplug power cord.



2. Moisten cheesecloth with detergent and water solution.

3. Wipe work surface, leaf light, and left well with moistened cheesecloth.

4. Plug in power cord.

Table 4-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A - After

W - Weekly
M . Monthly
Q - Quarterly

AN - Annually
S . Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-IER. VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		PHOTOIHTERPRETER DESK - Cont	
4	Q	Vacuum PhotointerDreter Desk. **CAUTION** Remove all film and transparencies from desk before vacuuming to prevent damage to imagery products. 1. Remove all film and transparencies from desk. 2. Open all drawers and left door. 3. Vacuum inside of drawers to remove all dust. 4. Completely vacuum left well. 5. Vacuum microscan exterior surfaces. 6. Close doors and drawers. 7. Vacuum work surface.	

4-6. OPERATION UNDER USUAL CONDITIONS.

4-6.1 Assembly and Preparation for Use.

a. Plug in power cord.

b. Unlock and open center drawer slightly.

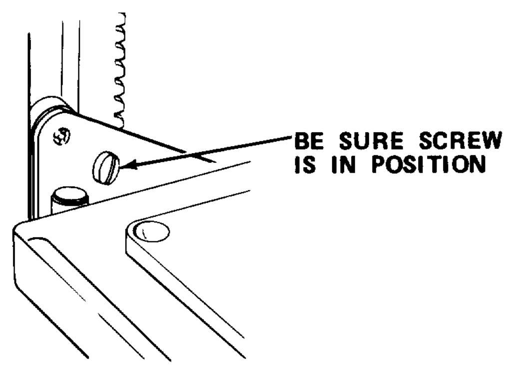
c. Pull leaf light straight out from desk to full extension.

d. Turn light control knob full right (maximum intensity). After 15 minutes, reduce light level by turning knob to left until intensity is comfortable to the operator.

4-6.2 Operating Procedures,

WARNING

Light table has powerful springs that will force the table upward and injure operator unless locking screw is installed. Operator must use two hands to force downward when table is raised.

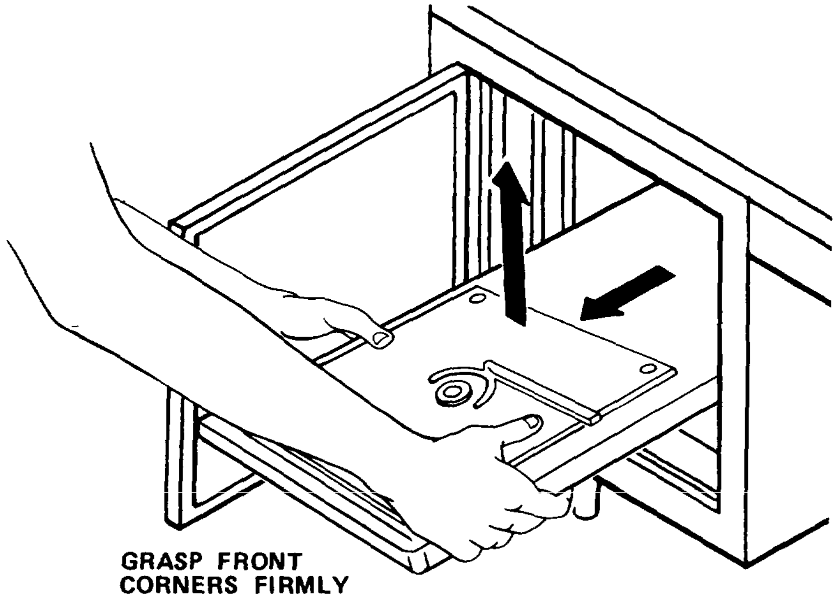


a. Pull out microscan platform.

b. Place microscan on turntable.

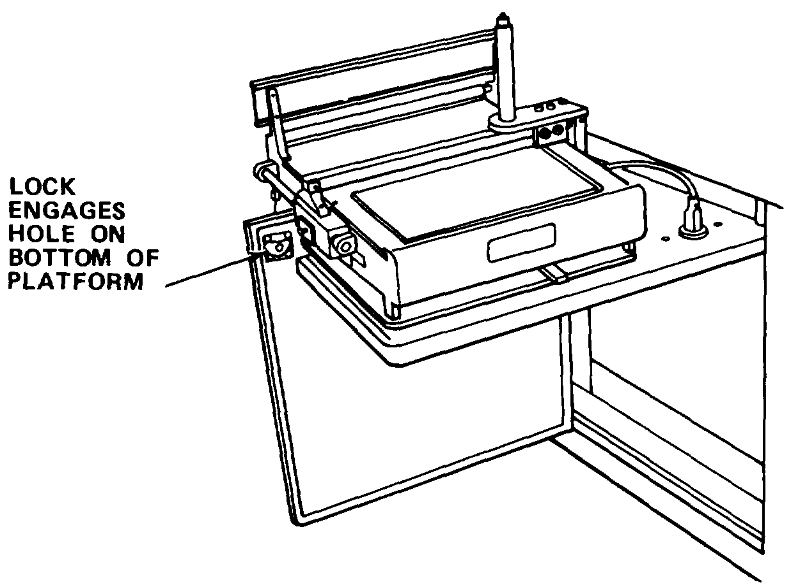
c. Remove locking screw and place in center drawer of desk.

d. Raise platform.



(1) Grasp front corners firmly and raise table.

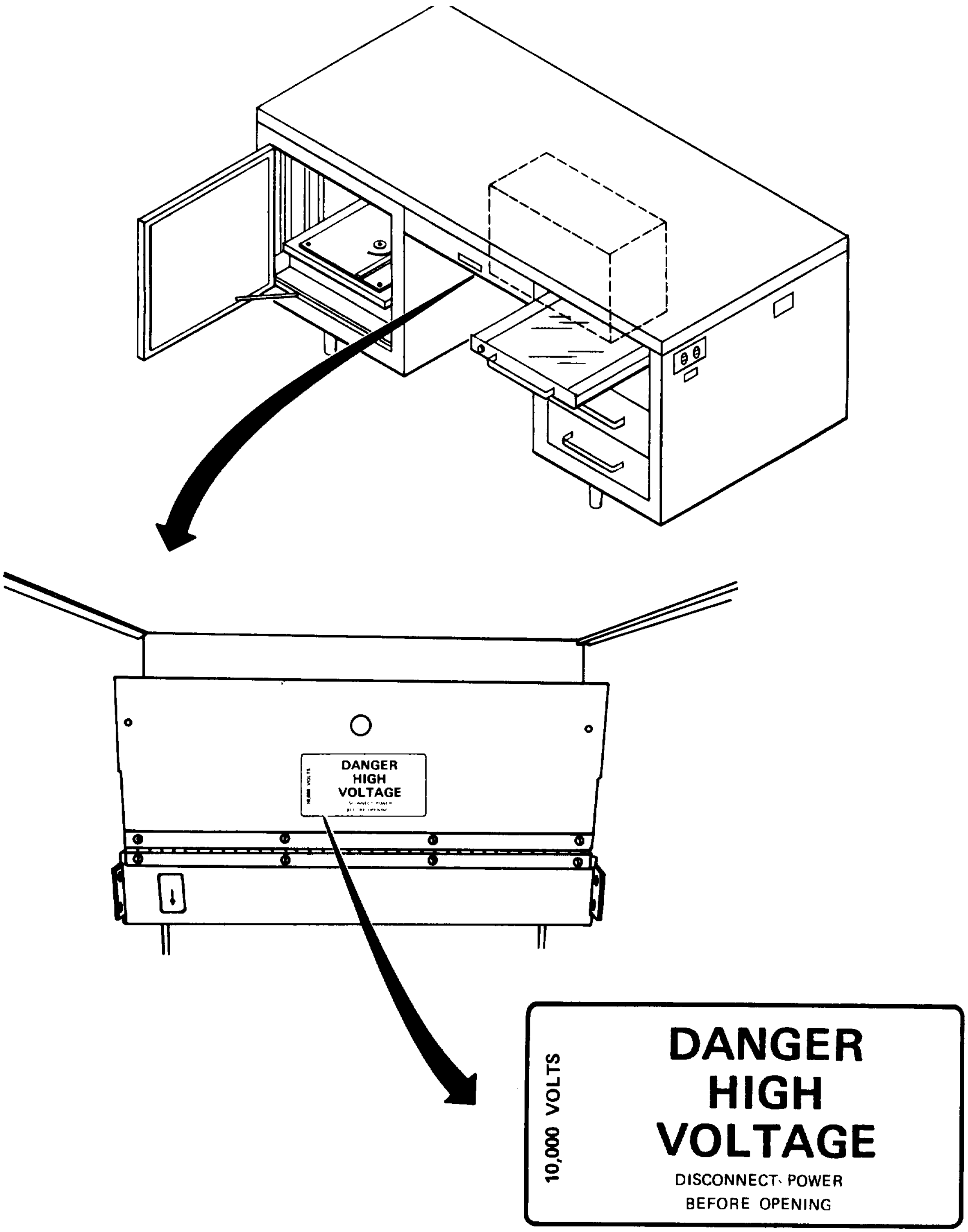
(2) Lock front door and platform.



e. Plug in microscan.

f. Refer to chapter **5** for information on how to operate the microscan.

4-6.3 Operating Instructions on Decals and Instruction Plates



4-6.4 Lower Platform.

a. Refer to Chapter 5 for microscan preparation for movement.

b. Unplug photointerpreter desk power cord.

c. Push left door to left until platform is unlocked.

d. Grasp front edge of platform and lift up. Then push down on table with two hands at front corners until platform is at bottom.

e. Push table into well.

f. Reinstall locking screw.

g. Turn off leaf light illumination and push leaf into well.

h. Close and lock center drawer.

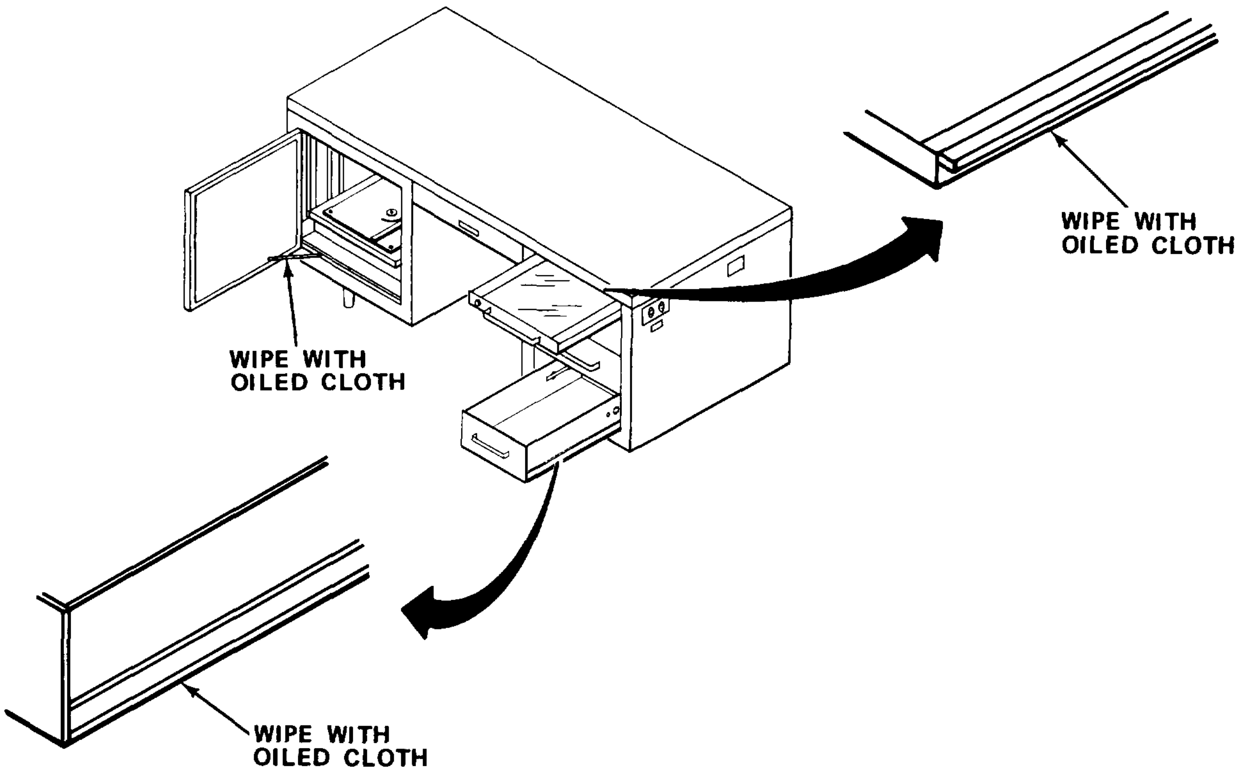
4-7. OPERATION UNDER UNUSUAL CONDITIONS. This equipment is designed for operation only in a controlled environment.

Section III OPERATOR MAINTENANCE

4-8. LUBRICATION INSTRUCTIONS .

NOTE

These lubrication instructions are mandatory.



4-8.1 Monthly Lubrication.

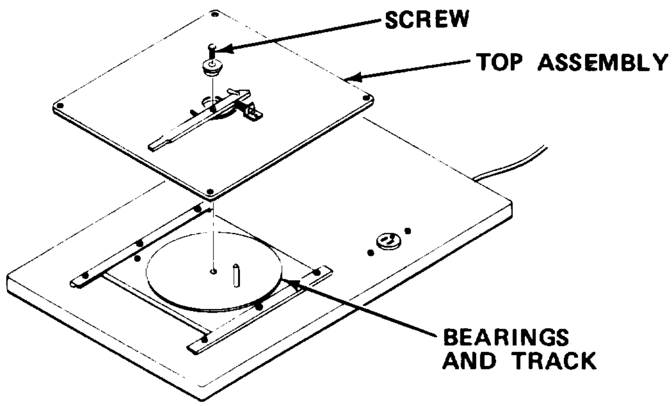
Moisten cheesecloth with lubricating oil, SAE 30 (Item 15, Appendix E), and wipe all door and drawer guides with oiled cloth.

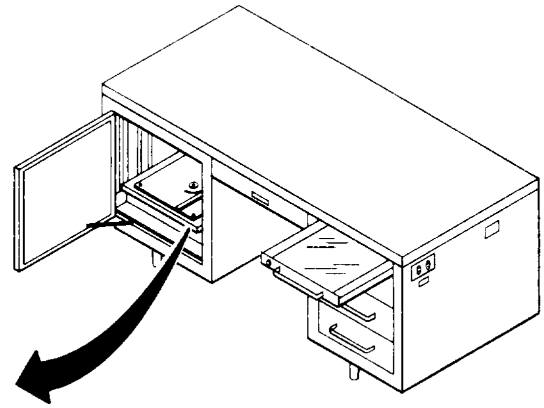
b. Operate drawers to full range of travel several times to evenly distribute lubricant.

c. Wipe two guides of leaf light monthly with oiled cloth and operate leaf light guide in and out several times.

d. Pull platform assembly out and raise to operating height.

e. Disconnect microscan power cord and move microscan to desk top.



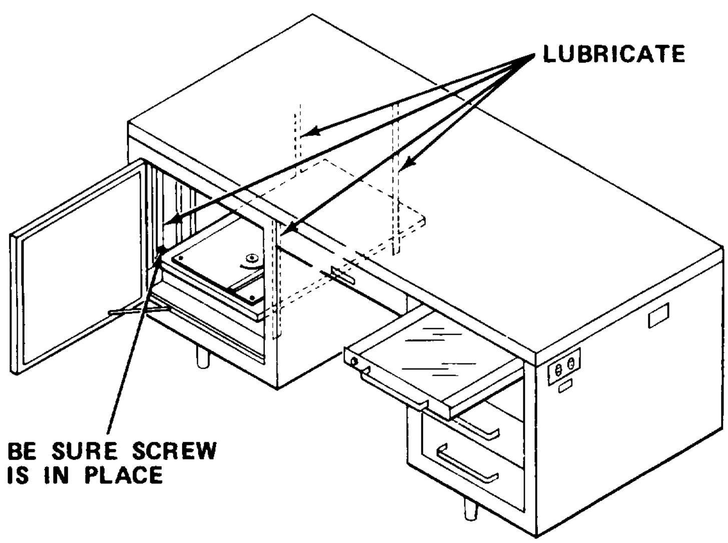


f. Remove screw and lift top assembly from bearing surface. Spray bearings and track of microscan turntable with silicone spray (Item 27, Appendix E).

g. Wipe excess silicone spray up with clean cheesecloth.

h. Lower top assembly on bearings and secure with screw.

i. Reinstall microscan and plug in power cord.



j. Lower platform to stored position and screw locking screw in.

k. Wipe tracks and mechanism with cheesecloth to remove old grease.

l. Place GAA grease (Item 11, Appendix E) on clean cheesecloth and rub tracks and mechanism.

m. Wipe grease from all other surfaces and close door.

4-9. TROUBLESHOOTING PROCEDURES.

a. The table lists the common malfunctions which you may find during operation or maintenance of the photointerpreter desk, or its components. You should perform the test/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all test or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

Table 4-2. TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. LIGHT GRID DOES NOT OPERATE.

Step 1. Check that photointerpreter desk power cord is plugged into 120 V, 60 Hz outlet.

Plug in power cord.

Step 2. Check that circuit breaker is properly set.

Reset circuit breaker.

Step 3. Visually inspect fuse for broken filament.

Replace defective fuse (paragraph 4-10.2).

2. LIGHT GRID DOES NOT TURN OFF WHEN LEAF IS CLOSED.

Check that leaf is fully closed.

(a) Fully close leaf.

(b) Refer to organizational maintenance.

4-10. MAINTENANCE PROCEDURES.

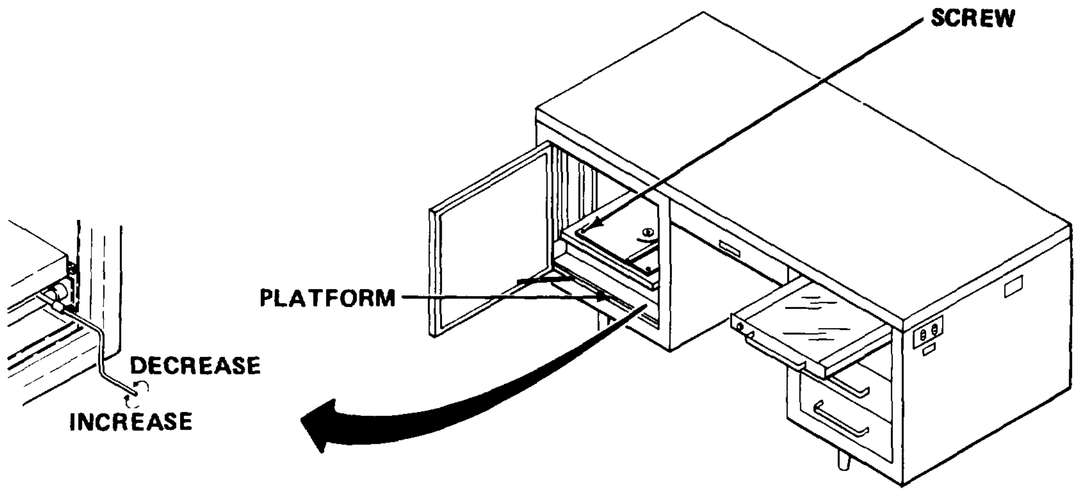
a. This section contains instructions covering operator maintenance functions for the photointerpreter desk. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

INDEX

4-10.1 Adjust Platform Spring Tension.

MOS: 81Q, Terrain Analyst



a. Fully open left door, remove spring adjusting crank.

b. Remove locking screw. Retain for reuse.

c. Place microscan on turntable.

d. Insert crank into square hole under table.

NOTE

Initial tension of spring is 100 right turns of crank, when spring has been fully relaxed.

e. Turn crank to left or right to change tension. Turning to right increases tension and turning to left decreases tension.

WARNING

To prevent injury, use two hands to hold table when raising.

f. Grasp front of platform with two hands, and apply downward force while pulling table out. Table should raise without excessive force.

g. Lift front of platform and push down to bottom of travel. Then push all the way to rear. Readjust spring tension as required by turning crank.

h. Replace spring adjusting crank.

4-10.2 Replace Fuse.

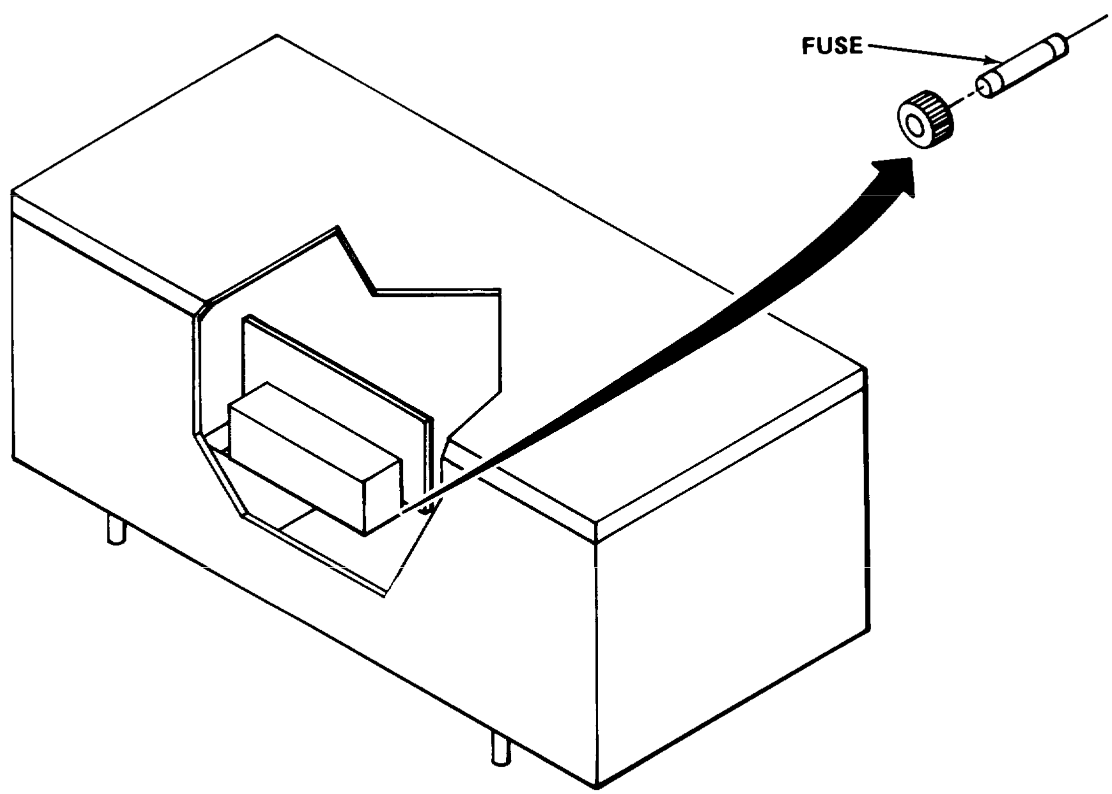
MOS: 81Q, Terrain Analyst

SUPPLIES: Fuse (5 amp)

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.



b. Push in fuse cap and twist to left.

c. Remove fuse from fuse cap and insert new fuse.

d. Push in fuse. Then twist to right until fuse cap locks.

e. Plug in power cord.

Section IV ORGANIZATIONAL MAINTENANCE

4-11. LUBRICATION INSTRUCTIONS. This equipment does not require lubrication at this level of maintenance.

4-12. REPAIR PARTS, SPECIAL TOOLS: TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT.

4-12.1 Common Tools and Equipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

4-12.2 Special Tools; Test, Measurement, and Diagnostic Equipment; and Support Equipment. Special Tools, TMDE, and Support Equipment is listed in the applicable repair parts and special tools list and in Appendix B of this manual.

4-12.3 Repair Parts. Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 5-6675-323-24P, covering organizational maintenance for this equipment.

4-13. SERVICE UPON RECEIPT.

4-13.1 Checking Unpacked Equipment.

a. Inspect the equipment for damamge incurred during shipment. If the equipment has been damaged, report the damage on DO Form 6, Packing Improvement Report.

b. Check the equipment against the packing list to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Check to see whether the equipment has been modified.

4-14. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES.

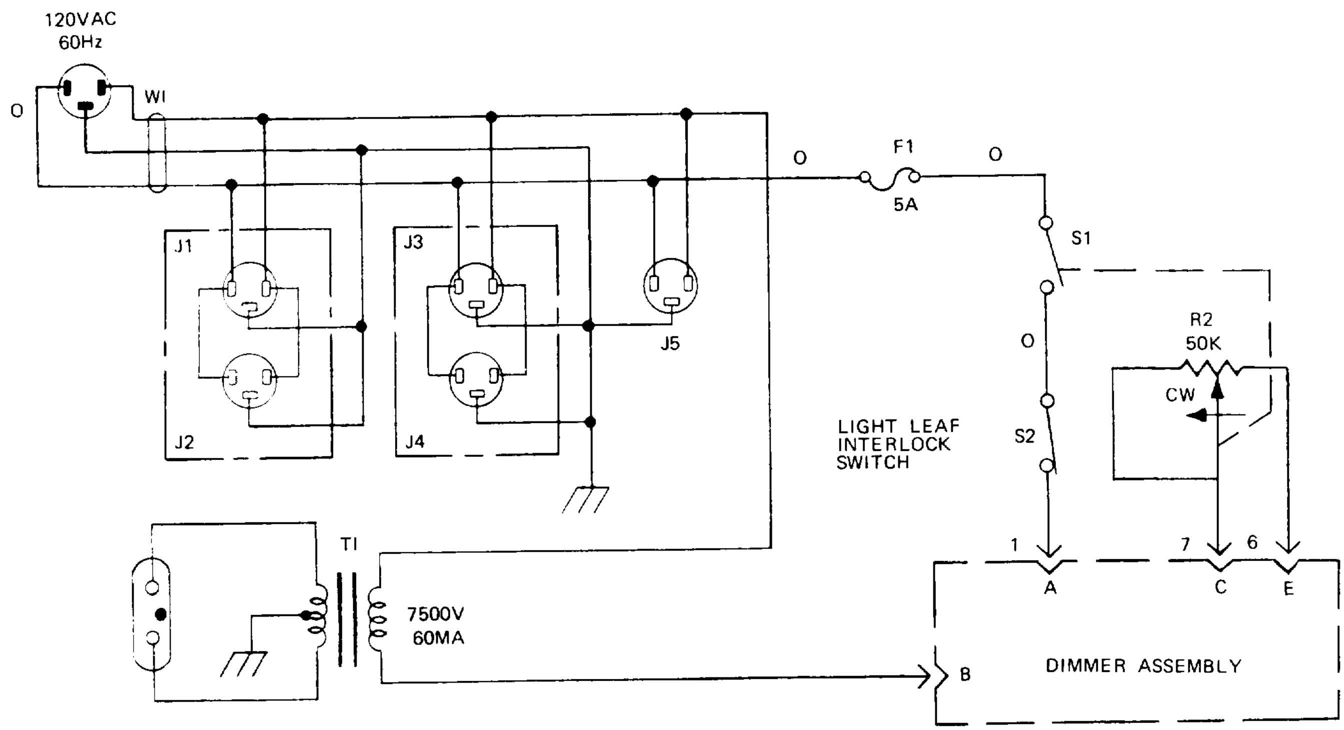
There are no organizational preventive maintenance checks and services assigned for this equipment.

4-15. ORGANIZATIONAL TROUBLESHOOTING PROCEDURES.

Organizational troubleshooting procedures cover the most common malfunctions that may be repaired at the organizational level. Repair or adjustment requiring specialized equipment is not authorized unless such equipment is available. Troubleshooting procedures used by the operator should be conducted in addition to the organizational troubleshooting procedures.

b. This manual cannot list all the possible malfunctions or every possible test/inspection and corrective action. If a malfunction is not listed or is not corrected by a listed corrective action, notify your supervisor.

c. For unidentified malfunctions, use the following schematic or the foldout located at the end of this manual for further fault analysis.



d. If the photointerpreter desk does not power up when turned on, verify that 120 V ac is present at the receptacle. If voltage is not present, plug equipment into receptacle with power available and proceed with equipment troubleshooting. Perform no-power procedures for dead receptacle (Table 1-4).

Table 4-3. ORGANIZATIONAL TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. LIGHT GRID DOES NOT TURN OFF WHEN LEAF IS CLOSED.

Check that microswitch is adjusted properly.

Adjust microswitch (paragraph 4-16.1).

2. LIGHT GRID DOES NOT OPERATE.

WARNING

Death or serious injury mav occur from electrical shock unless appropriate safety precautions observed while working on energized electrical circuits.

Step 1. Check voltage output of microswitch.

(a) If voltage is present, proceed to step 2.

(b) If no voltage is present, replace microswitch (paragraph 4-16.3).

Step 2. Check voltage output of potentiometer/switch.

(a) If voltage is present, proceed to step 3.

(b) If no voltage is present, replace potentiometer/switch (paragraph 4-16.2).

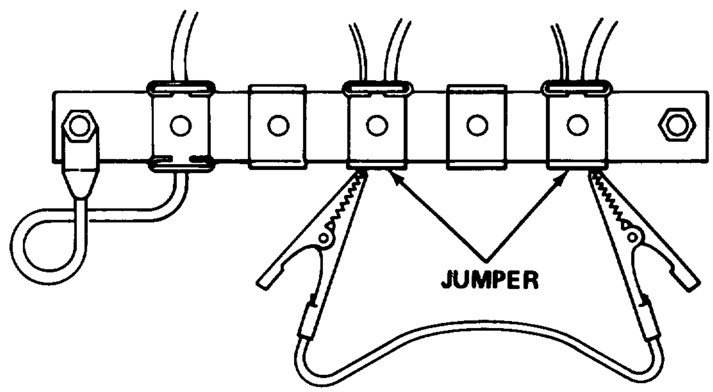
Table 4-3. ORGANIZATIONAL TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

2. LIGHT GRID DOES NOT OPERATE - Cont



Step 3. Connect insulated jumper wire to white and black leads at dimmer assembly terminal strip. Grid lamp should light.

(a) Replace dimmer assembly (paragraph 4-16.4).

(b) If light grid still does not operate, refer to direct/general support maintenance.

4-16. MAINTENANCE PROCEDURES.

This section contains instructions covering organizational maintenance functions for the photointerpreter desk. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

INDEX

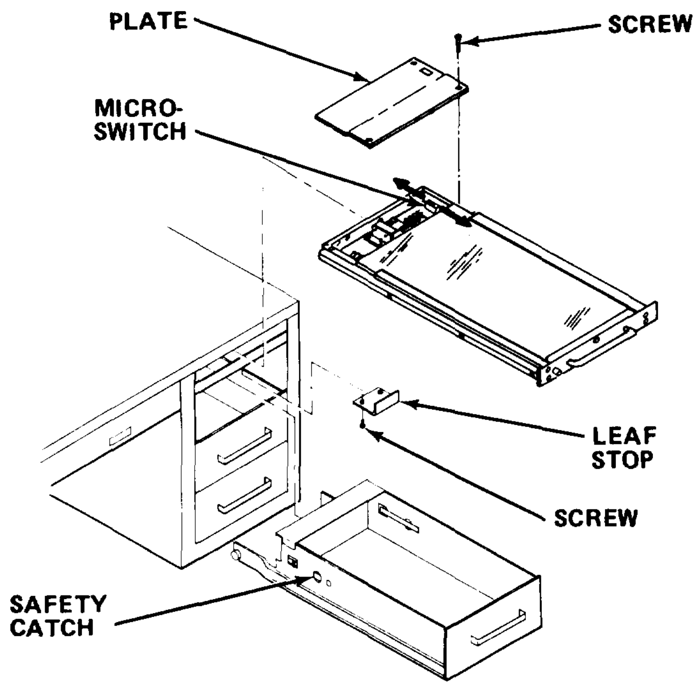
4-16.1 Adjust Microswitch.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver, 1½ in. shaft x 1/4 in. blade

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.



a. Unplug power cord.

b. Pull out bottom desk drawer.

c. Pull top desk drawer out as far as possible. Depress two safety catches with fingers and remove drawer.

d. Remove screws and leaf stop.

e. Pull leaf light out of desk and let handle rest on bottom drawer.

NOTE

Use care to avoid straining wiring attached to back of leaf light.

f. Remove screws and plate.

g. Loosen microswitch screws and adjust microswitch (up or down) until grid light goes out when leaf is closed. Tighten screws.

h. Reinstall plate and secure with screws.

i. Push in leaf light and reinstall leaf stop.

j. Depress two catches with fingers and reinstall top drawer.

k. Push in bottom drawer.

l. Plug in power cord.

4-16.2 Replace Potentiometer/Switch.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver
Cross Tip Screwdriver
.050 in. Hex Head Key Wrench
9/64 in. Hex Head Key Wrench
Adjustable Wrench
Soldering Iron

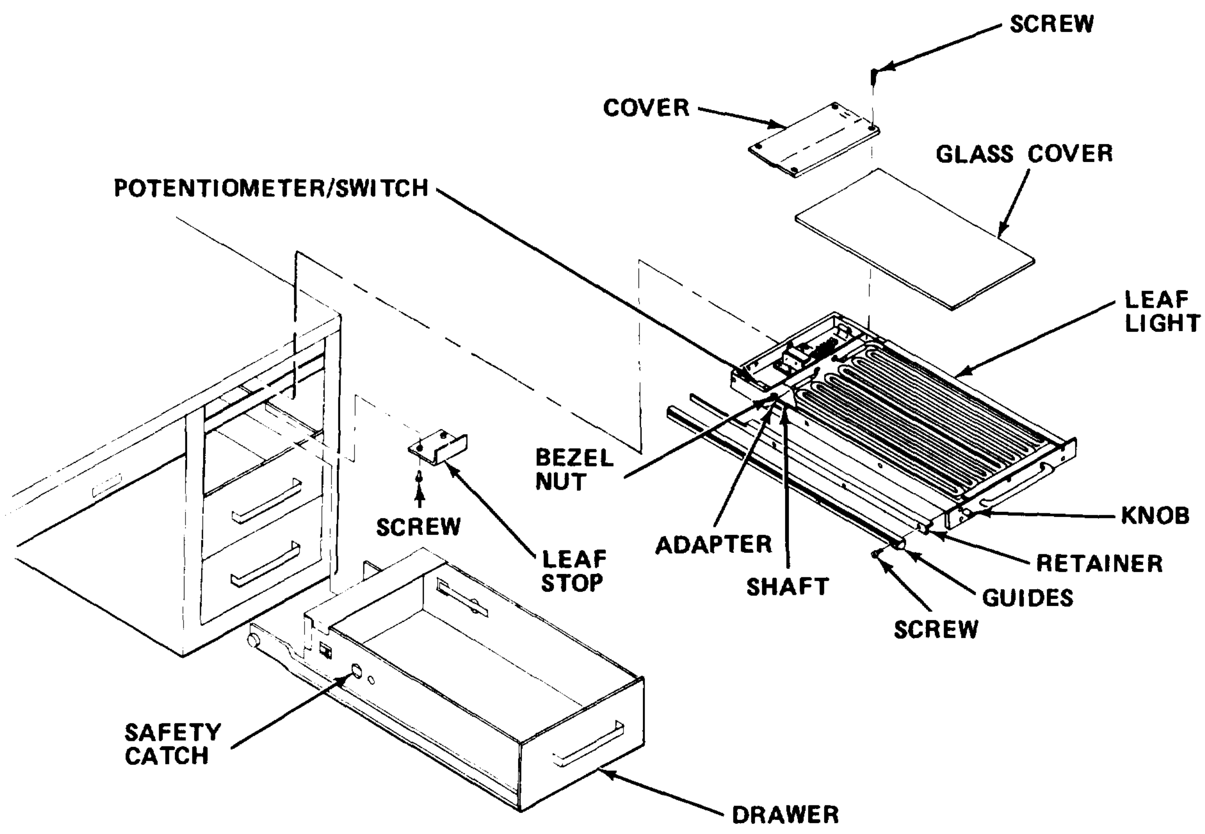
SUPPLIES: Potentiometer/Switch
Solder (Item 24, Appendix E)

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Pull top desk drawer out as far as possible.



c. Depress safety catch on drawer sides with fingers and remove drawer.

d. Remove screws and leaf stop.

e. Pull out bottom drawer.

CAUTION

Do not strain wires to leaf light or light will be damamged.

f. Pull leaf light from desk and rest on bottom drawer.

g. Remove screws and cover from leaf light.

h. Loosen screw and remove knob.

i. Tag and desolder wires to potentiometer/switch.

j. Remove screws, retainer, and guides from left side of leaf light.

k. Slide glass cover from leaf and place on work surface.

l. Disconnect shaft from adapter.

m. Remove bezel nut and defective potentiometer/switch.

n. Install new potentiometer/switch and secure with bezel nut.

o. Reinstall shaft and adapter.

p. Reinstall glass cover.

q. Reinstall retainers and guides. Secure with screws.

r. Solder wires to potentiometer/switch.

s. Reinstall knob and tighten screw.

t. Reinstall cover and secure with screws.

u. Insert leaf light (on guides) into desk.

v. Reinstall leaf stop and secure with screws.

w. Depress safety catches with fingers and insert top drawer into desk.

x. Close bottom drawer.

y. Plug in power cord.

4-16.3 Replace Microswitch.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver

SUPPLIES: Microswitch

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Pull top desk drawer out as far as possible.

c. Depress safety catch on drawer slides with fingers and remove drawer.

d. Pull out bottom drawer.

e. Remove screws and leaf stop. Then pull leaf light from desk and rest on front edge of bottom drawer.

CAUTION

Do not strain wires to leaf light or light will be damaged.

f. Remove screws and cover from leaf light.

g. Mark microswitch position and remove screws.

h. Tag and disconnect wires from microswitch.

i. Remove defective microswitch.

j. Install new microswitch and reconnect wires.

k. Loosely fasten screws and move microswitch to marked position and tighten screws.

l. Reinstall cover and secure with screws.

m. Slide leaf light into desk.

n. Reinstall leaf stop and secure with screws.

o. Depress safety catch on top drawer and insert drawer into desk.

p. Close bottom drawer.

q. Plug in power cord.

4-16.4 Replace Dimmer Assembly.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver, 1½ in. shaft, 1/4 in. blade
Cross Tip Screwdriver
.050 in. Hex Head Key Wrench
9/64 in. Hex Head Key Wrench

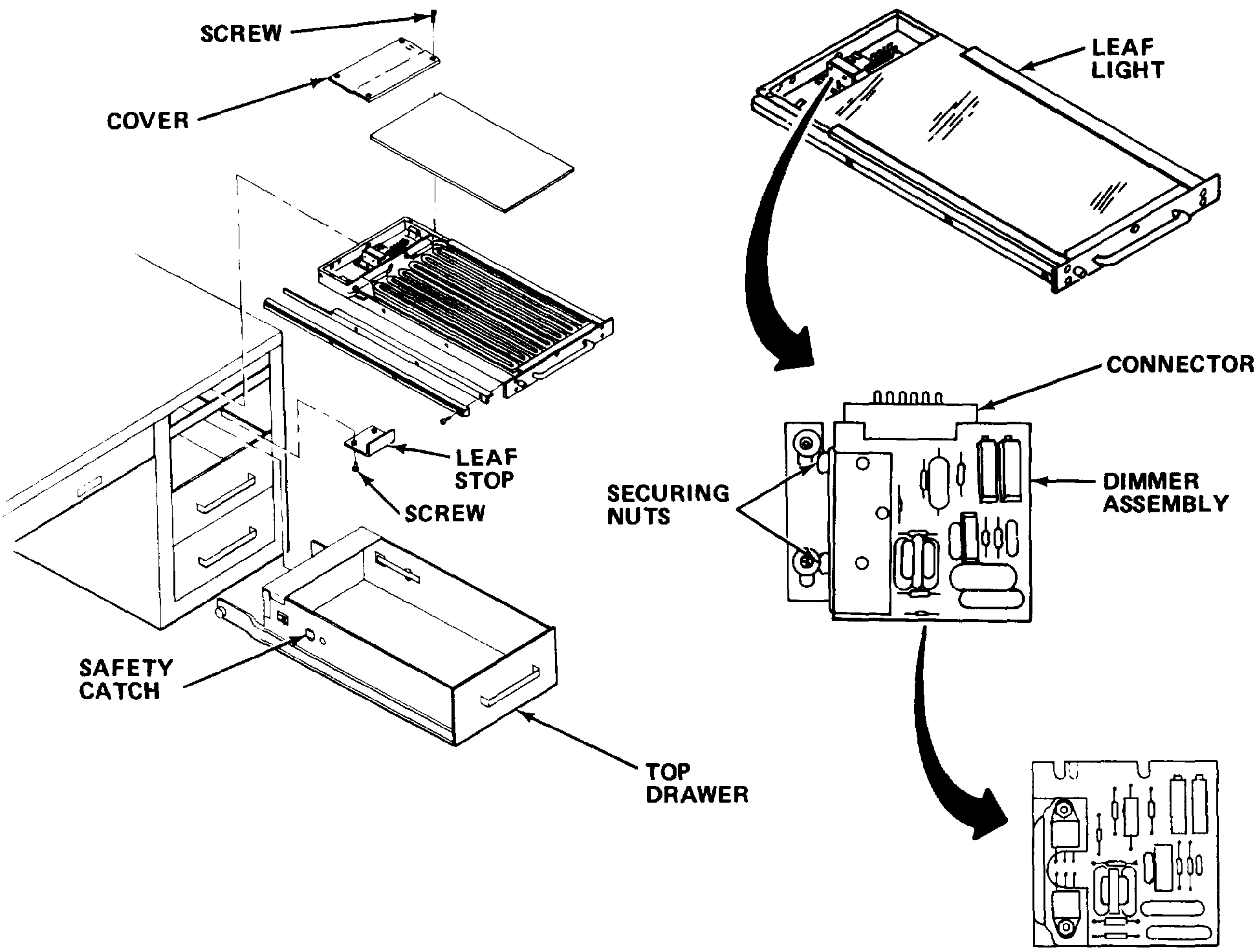
SUPPLIES: Dimmer Assembly
Heat Sink Compound (Item 13, Appendix E)

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Pull top desk drawer out as far as possible.



c. Depress safety catches on drawer sides with fingers and remove drawer.

d. Remove screws and leaf stop.

e. Open bottom drawer.

f. Pull leaf light from desk and rest on front edge of bottom drawer.

g. Remove five screws and cover from leaf light.

h. Remove screws and lift defective card from leaf.

i. Pull connector from pins on card.

j. Coat new card mounting surface with heat sink compound and install new card. Secure with screws.

k. Push connector on card pins.

l. Reinstall cover and secure with screws.

m. Reinstall leaf light.

n. Reinstall leaf stop and secure with screws.

o. Depress safety catches and reinsert drawer.

p. Close bottom drawer.

q. Plug in power cord.

4-16.5 Replace Glass.

MOS: 41B, Topographic Instrument Repair Specialist

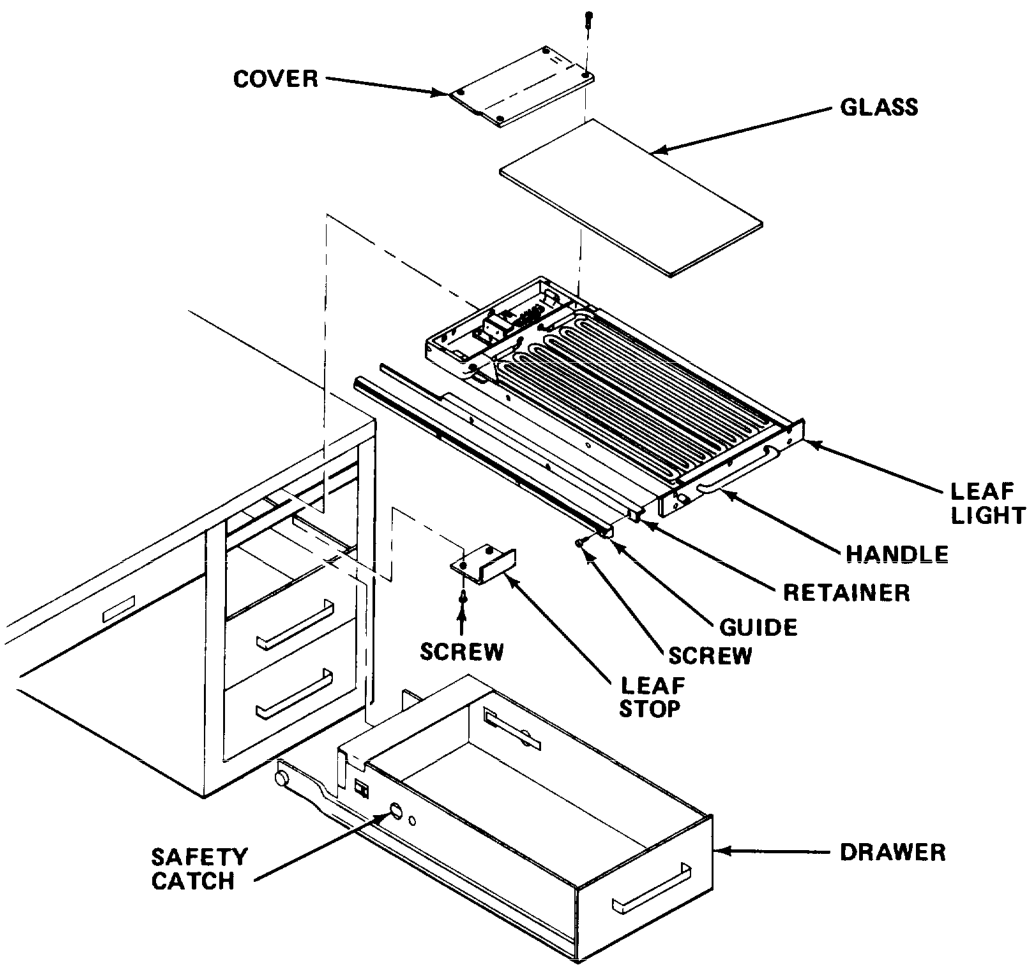
TOOLS: Flat Tip Screwdriver
Cross Tip Screwdriver
.050 in. Hex Head Key Wrench
9/64 in. Hex Head Key Wrench

SUPPLIES: Glass

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.



b. Remove top drawer by pulling out as far as possible, depressing safety catches with fingers, and withdrawing drawer.

c. Remove screws and leaf stop.

d. Open bottom drawer.

e. Pull leaf light out of desk and rest on bottom drawer.

f. Remove screws and retainer from left side of leaf.

g. Install new glass.

h. Reinstall retainer and guide, and secure with screws.

i. Reinsert leaf light into desk.

j. Reinstall leaf stop and secure with screws.

k. Reinstall top drawer.

l. Close bottom drawer.

m. Plug in power cord.

4-17. PREPARATION FOR STORAGE OR SHIPMENT. Contact your battalion for packing and shipping instructions.

Section V DIRECT/GENERAL SUPPORT MAINTENANCE

4-18. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT.

4-18.1 Common Tools and Eqipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

4-18.2 Special Tools; Test, Measurement. and Diagnostic Equipment; and Support Equipment. Special Tools, TMDE, and Support Equipment is listed in the applicable repair parts and special tools list and in Appendix B of this manual.

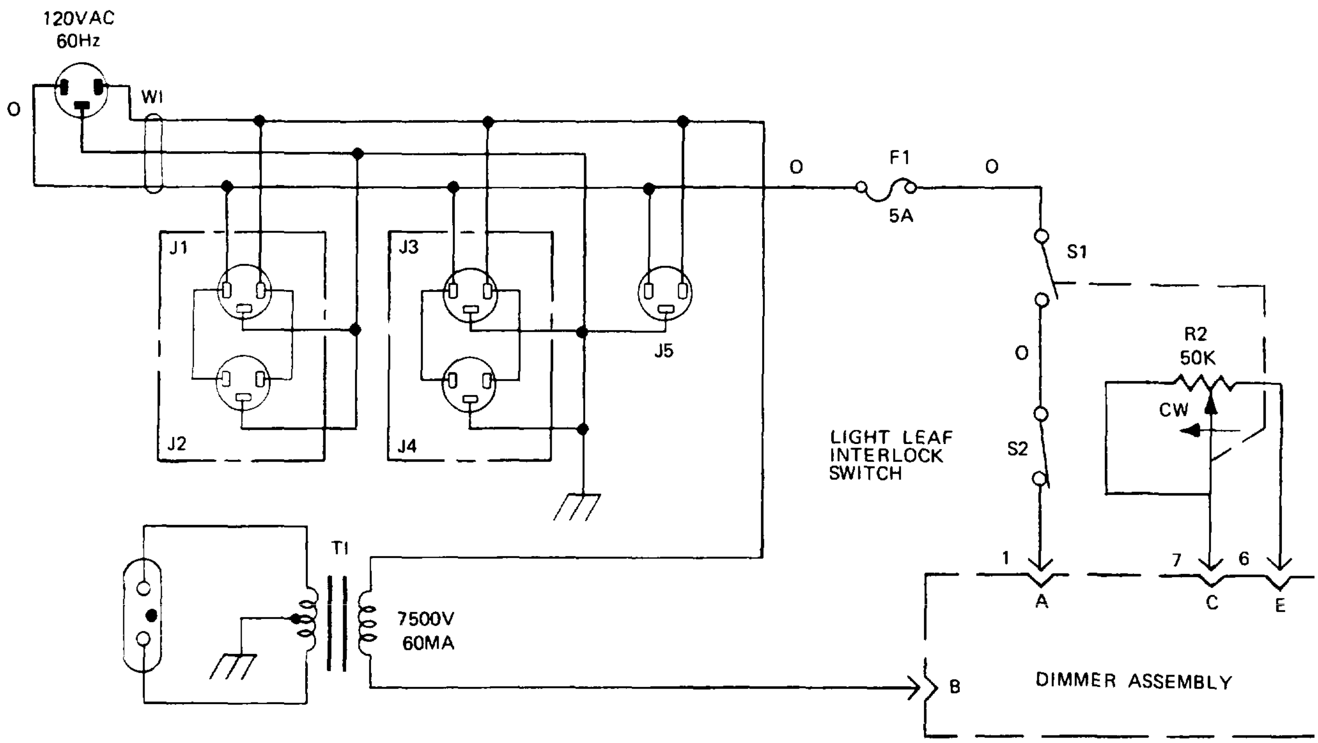
4-18.3 Repair Parts. Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 5-6675-323-24P covering direct/general support maintenance for this equipment.

4-19. DIRECT/GENERAL SUPPORT TROUBLESHOOTING PROCEDURES

a. Direct/general support troubleshooting procedures cover the most common malfunctions that may be repaired at the direct/general support level. Repair or adjustment requiring specialized equipment is not authorized unless such equipment is available. Troubleshooting procedures used at lower levels should be conducted in addition to the direct/general support troubleshooting procedures.

b. This manual cannot list all the possible malfunctions or every possible test/ inspection and corrective action. If a malfunction is not listed or corrected by a listed corrective action, notify your supervisor.

c. For unidentified malfunctions, use the facing schematic or the foldout located at the end of this manual for further fault analysis.



d. If the photointerpreter desk does not power up when turned on, verify that 120 V ac is present at the receptacle. If voltage is not present, plug equipment into receptacle with power available and proceed with equipment troubleshooting. Perform no-power procedures for dead receptacle (Table 1-4).

Table 4-4. DIRECT/GENERAL SUPPORT TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. LIGHT GRID DOES NOT OPERATE.

Step 1. Inspect high voltage transformer for burning, charring, broken wires or no output.

(a) If transformer appears normal and output is correct, proceed to step 2.

(b) Replace high voltage transformer (paragraph 4-20.2).

Step 2. Check for defective light grid.

Replace light grid (paragraph 4-20.1).

4-20. MAINTENANCE PROCEDURES.

a. This section contains instructions covering direct/general support maintenance functions for the photointerpreter desk. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

INDEX

Table 5-4. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

4. LIGHT GRID LIGHTS BUT INTENSITY WILL NOT CHANGE - Cont

Remove connection, mark card and connector to indicate proper connection.

Step 2. Check voltage output at potentiometer.

(a) If no change when knob is turned, replace dimmer switch (paragraph 5-16.2).

(b) Replace dimmer card (paragraph 5-20.3) and adjust dimmer circuit (paragraph 5-20.1).

5-20. MAINTENANCE PROCEDURES.

a. This section contains instructions covering direct/general support maintenance functions for the microscan light table. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

INDEX

5-20.1 Adjust Dimmer Circuit

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Light Meter
Alinement Tool

WARNING

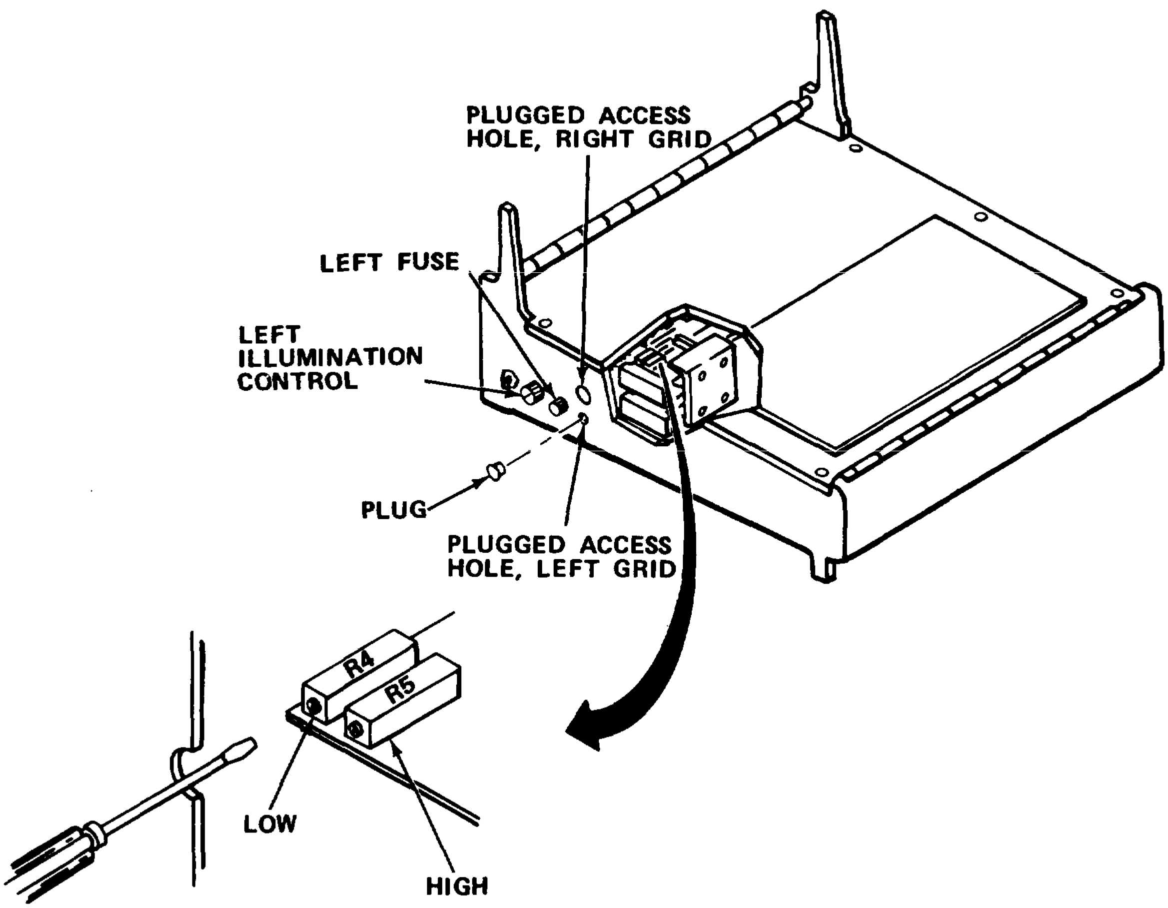
High voltages in light box may cause injury or death. Use insulated alinement tool, proper grounding of power cord, and care in adjustment to prevent injury.

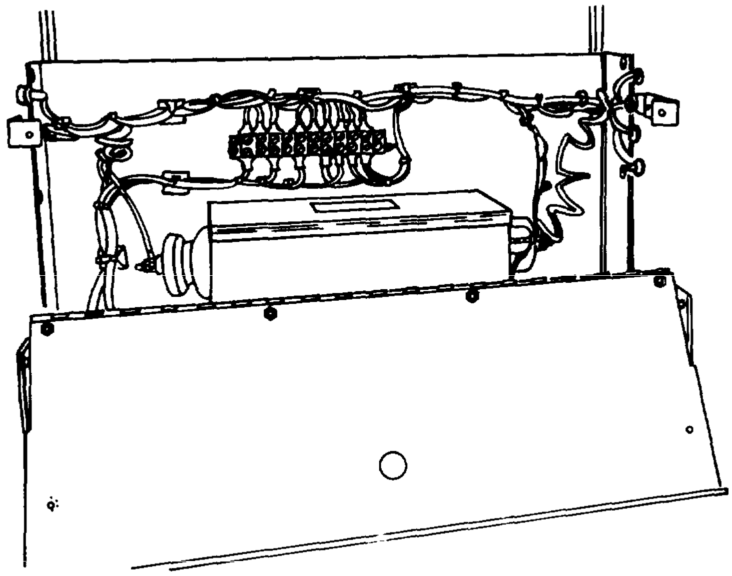
a. Plug in power cord.

b. Turn fan motor control switch on.

c. Turn illumination controls fully right and wait 15 minutes.

d. Place light meter in center of light grid being adjusted. (For right light grid, light meter is placed in center of right illuminated viewing stage.)





i. Tag and disconnect wires to light grid at transformer.

NOTE

Light grid is covered with polyethylene.

j. Remove defective light grid.

k. Apply potting compound to bottom of new grid and install in leaf light.

l. Reconnect wires to transformer after grid is seated. Thread wires through wire clips.

m. Reinstall rear cover.

n. Reinstall glass and cover.

o. Reinstall retainers and guides. Secure with screws.

p. Reinstall leaf light in desk.

q. Reinstall leaf stop and secure with screws.

r. Reinstall top drawer.

s. Close bottom drawer.

t. Plug in power cord.

4-20.2 Replace High Voltage Transformer.

MOS: 41B, Topographic Instrument Repair Specialist

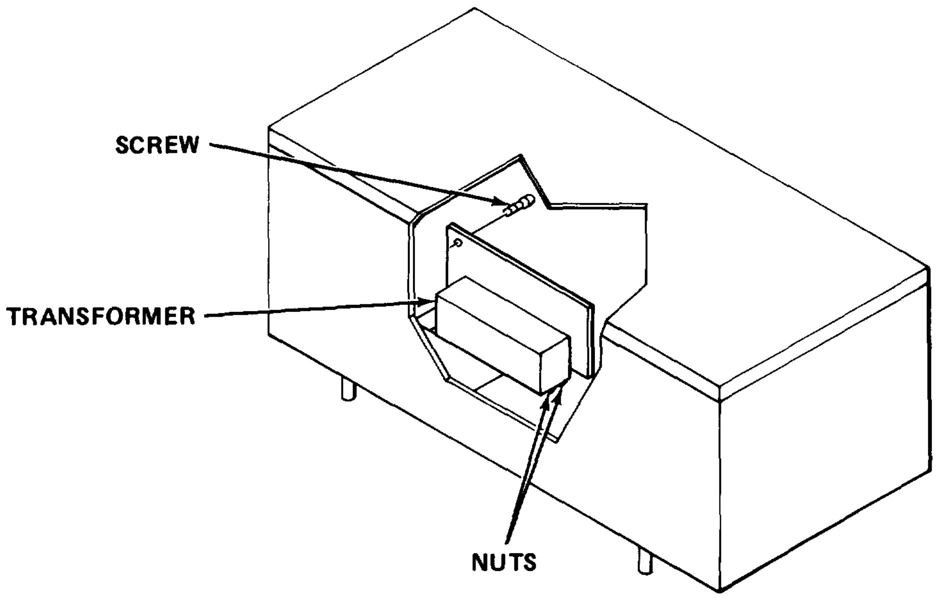
TOOLS: Flat Tip Screwdriver
3/8 in. Combination Wrench
7/16 in. Combination Wrench

SUPPLIES: Transformer (7500 W)

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.



b. Loosen screws at top of center panel. Panel will drop down.

c. Tag and disconnect wires from transformer.

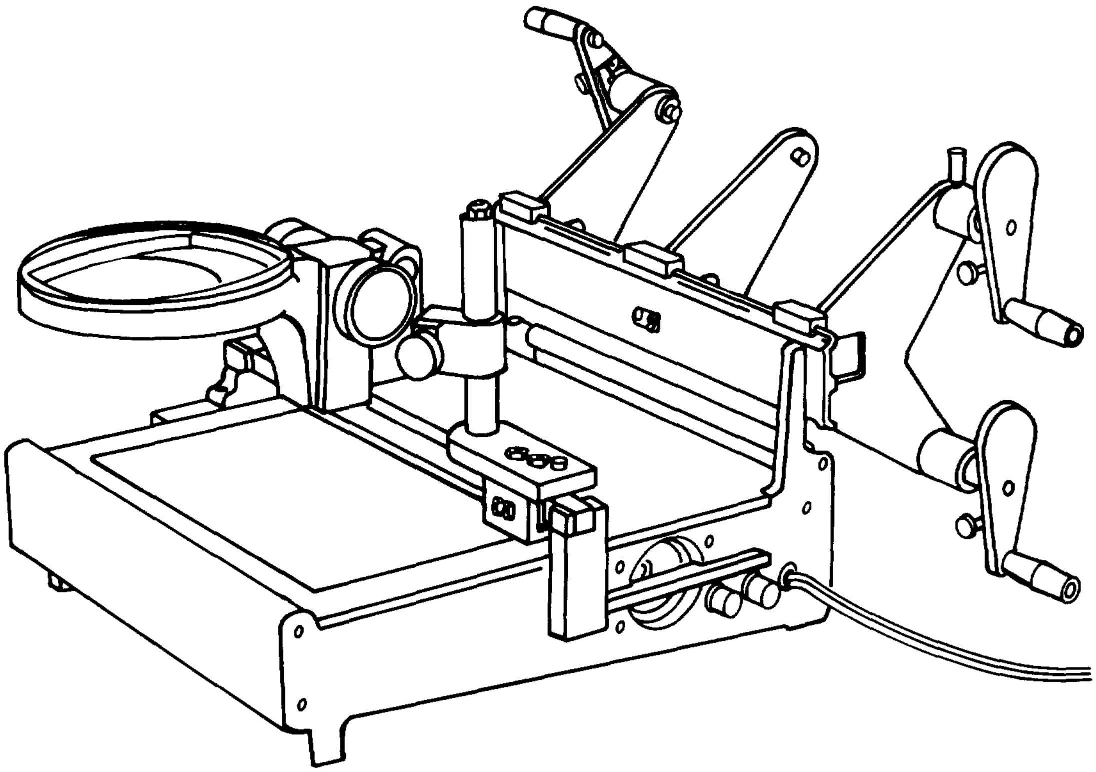
d. Remove screws and remove defective transformer.

e. Install new transformer and secure with screws.

f. Reconnect wires.

g. Push panel up and secure.

h. Plug in power cord.



CHAPTER 5

MICROSCAN LIGHT TABLE

Section I INTRODUCTION

5-1. GENERAL INFORMATION.

5-1.1 Scope.

a. Model Number and Equipment Name. Model 910563 Microscan Light Table.

b. Purpose of Equipment. To view film chips or roll film singularly or in stereopairs.

5-2. EQUIPMENT DESCRIPTION.

5-2.1 Equipment Characteristics, Capabilities, and Features.

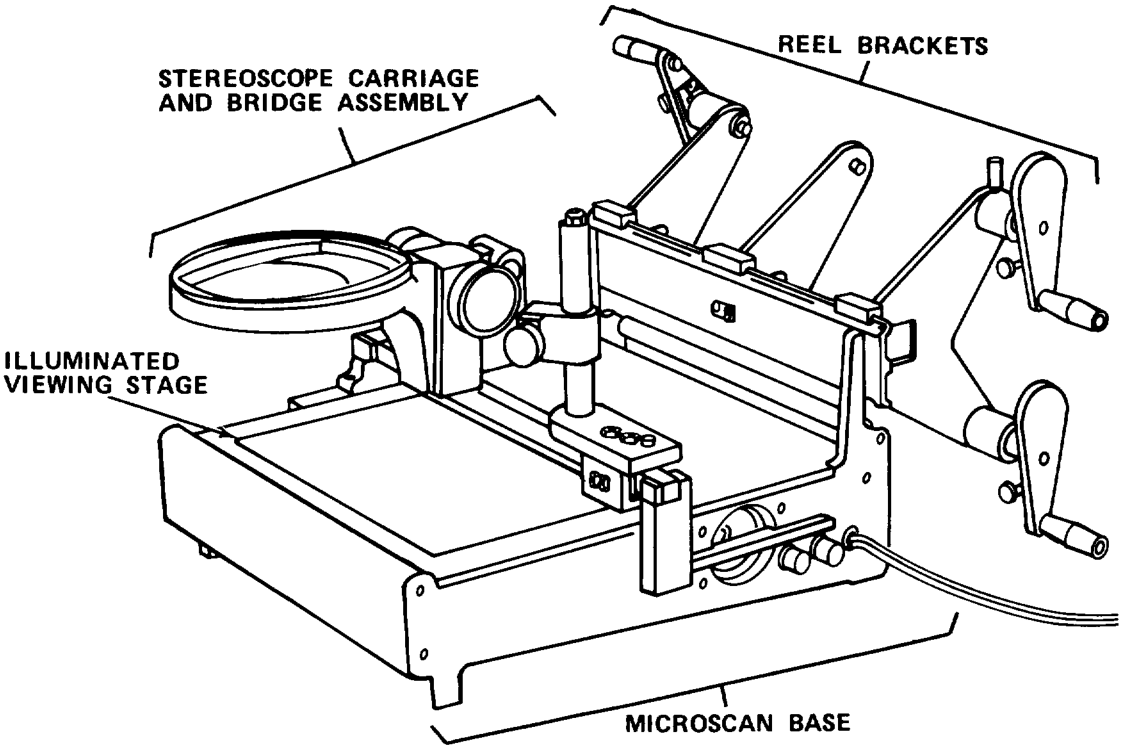
a. Two independently controlled, illuminated viewing stages.

b. Forced air cooling of illuminated viewing stages.

c. Compact.

d. Mounts in photointerpreter desk well.

5-2.2 Location and Description of Major Components.



STEREOSCOPE CARRIAGE AND BRIDGE ASSEMBLY. Mounts stereoscope and provides three-axis movement of stereoscope over illuminated viewing stages.

REEL BRACKETS. Support and move film reels to move roll film across illuminated viewing stages.

MICROSCAN BASE. Mounts on rotating table in photointerpreter desk. Contains light grid and electrical components.

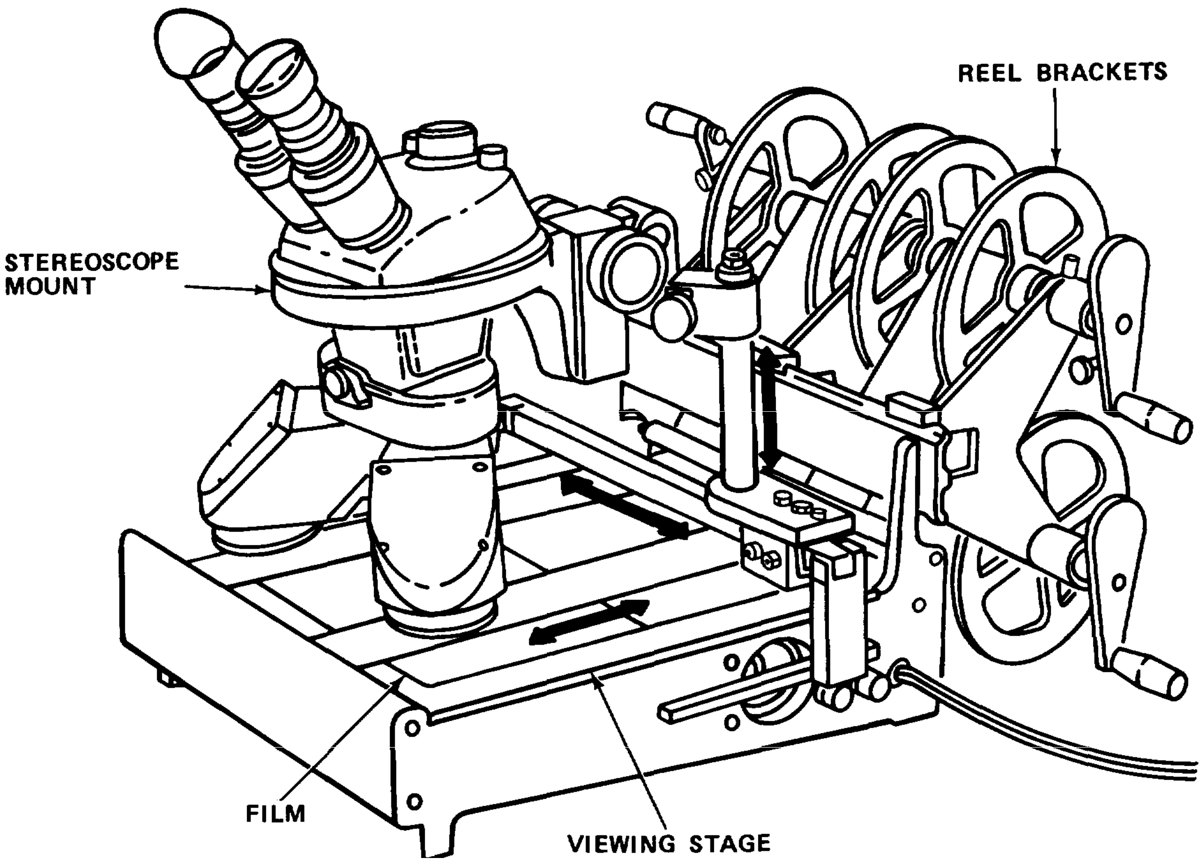
ILLUMINATED VIEWING STAGES. Provide diffused light from two light grids to illuminate film for viewing.

5-2.3 Equipment Data.

Dimensions	
Length	
With Reel Brackets	22 in. (55.88 cm)
Without Reel Brackets	15.625 in. (39.69 cm)
Width	
With Reel Brackets	21 in. (53.34 cm)
Without Reel Brackets	16.25 in. (41.28 cm)
Height	12 in. (30.48 cm)
Weight	35 lbs (15.9 kg)
Power Requirements	120 V, 50/60 Hz, 2 amps
Illumination Range	500-2000 ft lamberts (1713.1 - 6852.5 cd/m^2)
Viewing Surface	6.25 in. X 10.75 in. (15.88cm X 27.31 cm)
Film Reel Capacity	250 ft (76.20m)
Film Size	7.0 cm 5 in. (12.7 cm) 9.5 in. (24.13 cm)
Film Configuration	Conventional threading, single or dual strand 7.0 cm and 5 in. (12.7 cm) Single strand, 9.5 in. (24.13 cm)

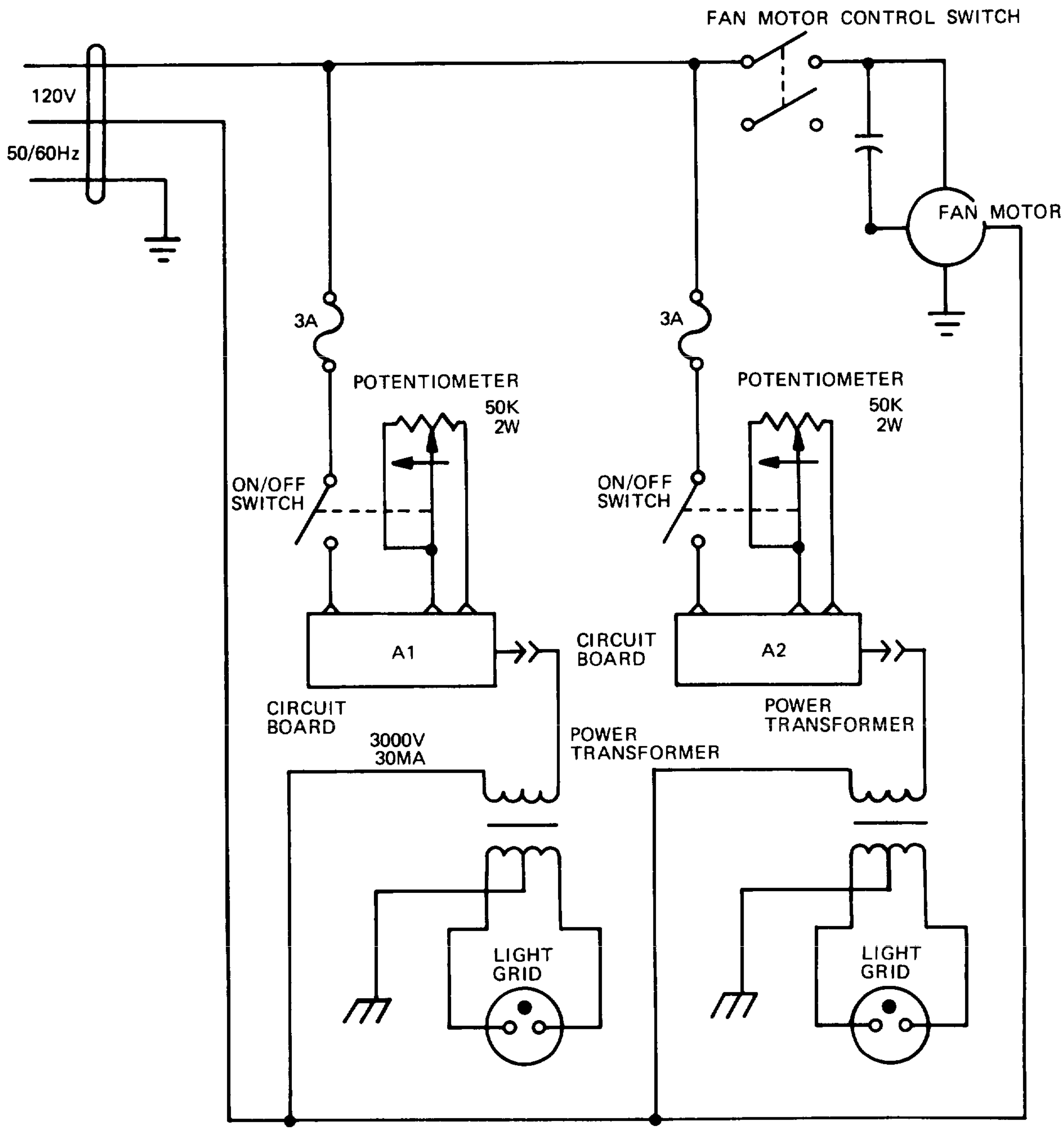
5-3. TECHNICAL PRINCIPLES OF OPERATION.

5-3.1 General.

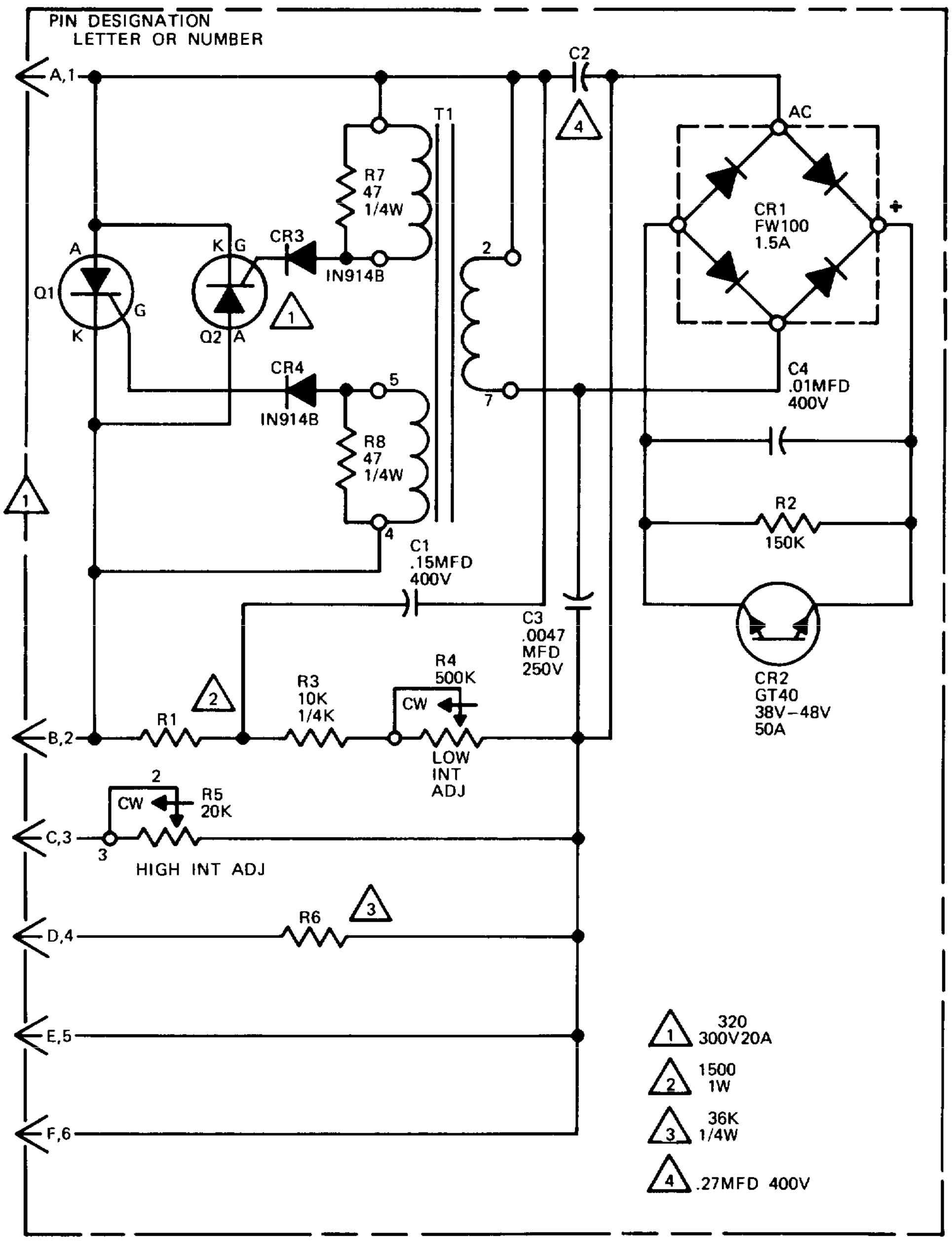


Reel brackets draw film over illuminated viewing stage. Stereoscope is moved in mount in X- and Y-axis to cover view field or Z-axis to focus stereoscope.

5-3.2 Electrical.



a. Fan motor control switch controls power to fan motor. Individual on/off switch and potentiometer (combined) regulate ac to circuit card (A1/A2). Ac is amplified and changed from full-wave to partial wave by circuit card. Power transformer provides high voltage ac to illuminate light grids. Intensity of each light grid is controlled by potentiometer to provide illumination from 500 to 2000 foot lamberts (1713.1 to 6852.5 cd/m_2).



A1/A2 CIRCUIT CARD

b. Ac voltage enters the dimmer circuit board through pin A and is transferred to pin B through SCR Q1 or Q2, which determines the amount of the ac sine wave voltage that is applied to the external high voltage transformer to light the grid lamp. The SCRS are triggered by the action of the remaining components on the board. Normally the SCRS prevent all of each ac half-wave from being transferred, but when triggered, allow current to flow during the remaining portion of each half sine wave until the zero crossing point is reached, whereupon the SCR is turned off and the ac waveform is again blocked.

c. When the ac voltage enters the control board, it is applied to C1 and R1 which provide a slight delay in the input voltage, which is applied to the timing circuit composed of capacitor C2 and resistors R4, R3, R5, and external INCREASE potentiometer 1R1. (Note that resistor R6 is not used in this application.)

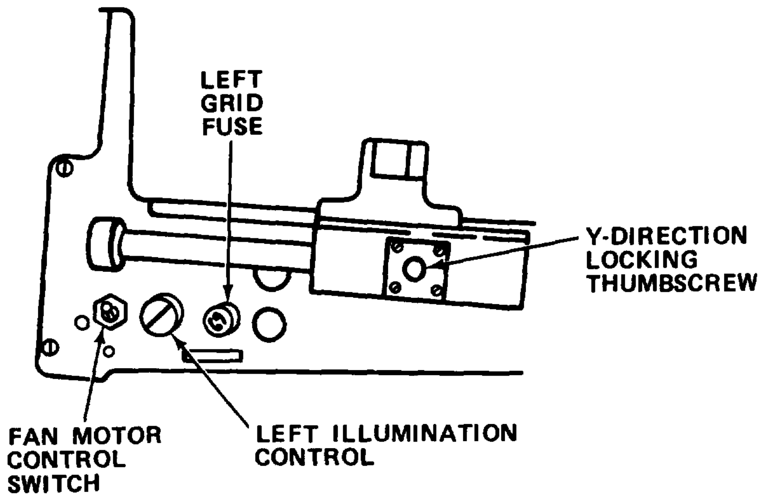
d. As the delayed ac voltage is applied across capacitor C2, the capacitor begins to charge at a rate depending upon the setting of INCREASE potentiometer 1R1. The voltage across C2 also appears across rectifier CR1 and trigger diode CR2. When the trigger diode reaches the breakover voltage of 43 ± 5 V, it conducts to complete the path across rectifier bridge CR1. This forms a closed loop circuit through capacitor C2, the primary of pulse transformer T1, and rectifier CR1. Current flows until capacitor C2 is discharged. The discharge time is very fast and a short duration pulse is generated, shaped by capacitor C3.

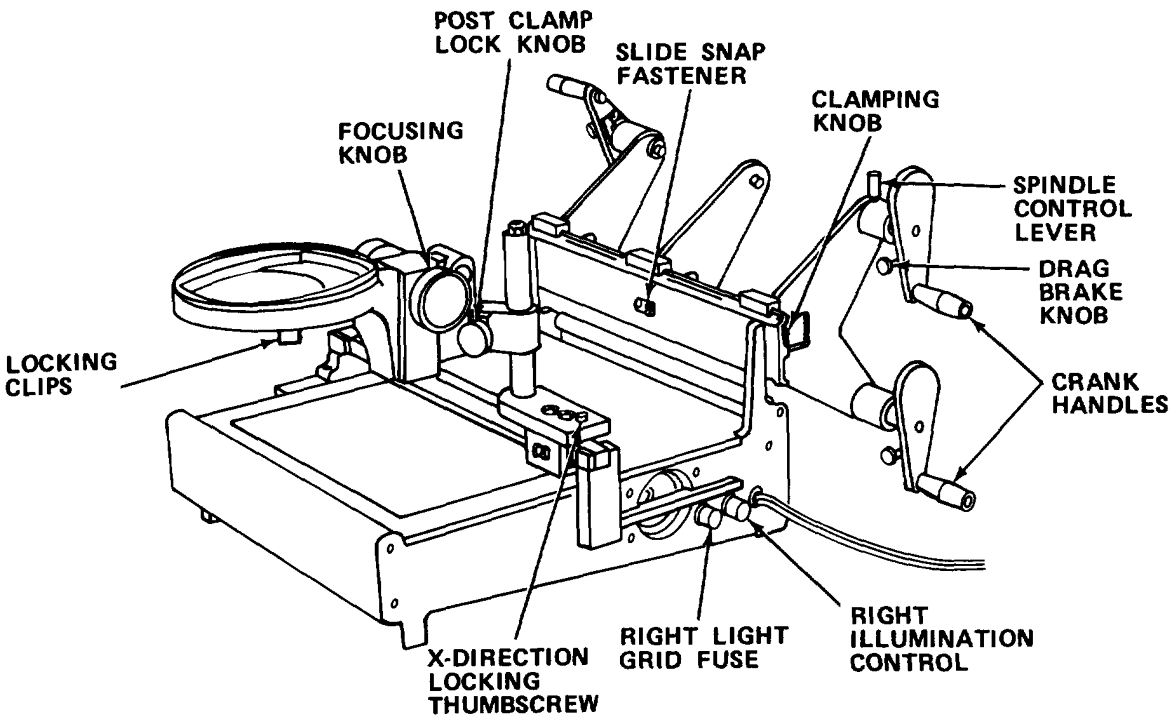
e. The pulse current flowing through the primary of pulse transformer T1 induces a voltage across the appropriate secondary which is applied through diode CR3 or CR4 to the gates of SCR Q2 or Q1, respectively. When either SCR is triggered, it allows the rest of the ac half-wave to pass to external grid lamp transformer 1T1 through pin B. The SCR will continue to conduct until the ac half-wave reaches the zero crossing point, at which time it turns off.

Section II OPERATING INSTRUCTIONS

5-4. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS.

Control or Indicator	Function





Control or Indicator	Function
Y-Direction Locking Thumbscrew	Locks bridge from moving front to back.
Left Light Grid Fuse	Protects left light grid circuits.
Fan Motor Control Switch	Turns cooling fan on/off.
Left Illumination Control	Turns left light grid on/off. Varies illumination intensity.
Locking Clips	Lock stereoscope optical assembly in optical mount.
Focusing Knob	Moves stereoscope mount up or down to focus stereoscope.
Post Clamp Lock Knob	Locks clamp link position vertically and horizontally.
Snap Slide Fastener	Locks idler bracket to rail.
Clamping Knob	Locks film reel brackets to rail at back of microscan.
Spindle Control Lever	Retracts or extends film reel spindle to hold film reels.
Drag Brake Knob	Provides friction on film reel spindle to hold film reels.

Control or Indicator	Function
Crank Handles	Turning handle moves film over illuminated viewing stages.
Right Illumination Control	Turns right light grid on/off. Varies illumination intensity.
Right Light Grid Fuse	Protects right light grid circuits.
X-Direction Locking Thumbscrew	Locks bridge from moving left to right.

5-5. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES.

a. Before You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your before (B) PMCS.

b. While You Operate. Always keep in mind the WARNINGS and CAUTIONS. Perform your during (D) PMCS.

c. After You Operate. Be sure to perform your after (A) PMCS.

d. If Your Equipment Fails to Operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA Pam 738-750.

5-5.1 PMCS Procedures.

a. PMCS are designed to keep the equipment in good working condition by performing periodic service tasks.

b. Service intervals provide you, the operator, with time schedules that determine when to perform specified service tasks.

c. The “Equipment is Not Ready/Available If” column is used for identification of conditions that make the equipment not ready/available for readiness reporting purposes or denies use of the equipment until corrective maintenance is performed.

d. If your equipment fails to operate after PMCS is performed, immediately report this condition to your supervisor.

e. Perform weekly as well as before operation if you are the assigned operator and have not operated the item since the last weekly or if you are operating the item for the first time.

f. Item number column. Item numbers are assigned in chronological ascending sequence regardless of interval designation. These numbers are used for your “TM Number” column on DA Form 2404, Equipment Inspection and Maintenance Worksheet in recording results of PMCS.

g. Interval columns. This column determines the time period designated to perform your PMCS.

h. Item to be inspected and procedures column. This column lists functional groups and their respective assemblies and subassemblies as shown in the Maintenance Allocation Chart (Appendix B). The appropriate check or service procedure follows the specific item to be inspected.

i. Equipment is not ready/available if: column. This column indicates the reason or cause why your equipment is not ready/available to perform its primary mission.

d. List of tools and materials required for PMCS is as follows:

Item	Quantity
Detergent (Item 9, Appendix E)	ar
Cheesecloth (Item 7, Appendix E)	ar
Chamois	1 ea

Table 5-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES

NOTE

If the equipment must be kept in continuous operation, check and service only those items that can safely be checked and serviced without disturbing operation. Make the-complete checks and services when the equipment can be shut down.

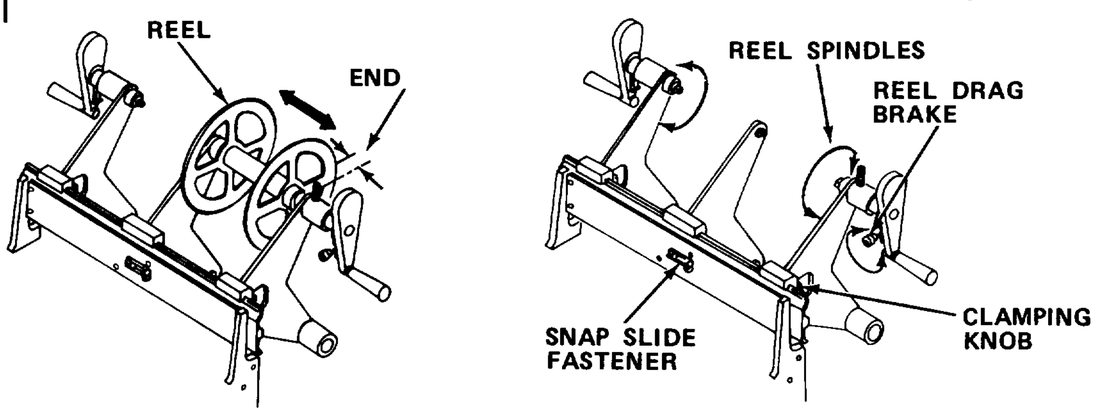
B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterly

AN - Annually
S - Semiannually
BI - Biannually

(Number) - Hundreds of Houre

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		MICROSCAN LIGHT TABLE	
1		Inpect Reel Brackets.	

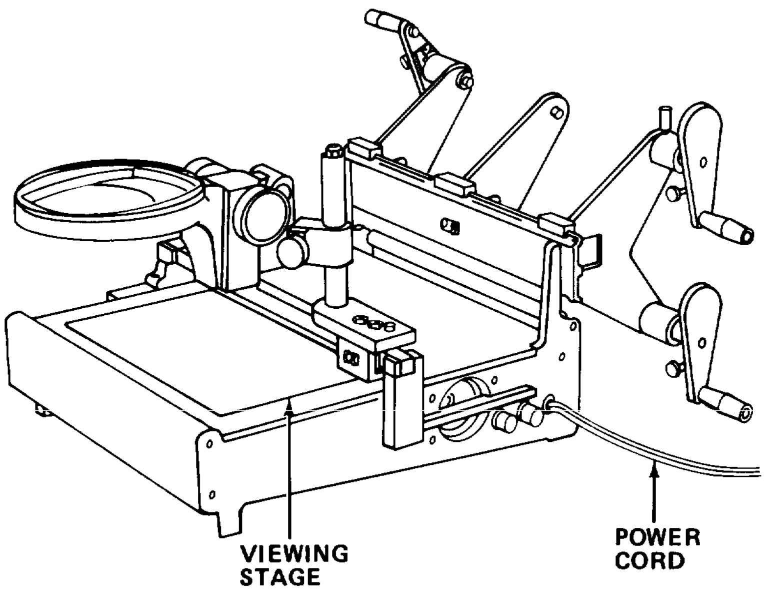


1. Inspect reel brackets for security of mounting and to be sure clamping knobs are tight and snap slide fastener is engaged.
2. Inspect reel spindles for free movement: in/out and rotation.
3. Inspect reel end play. Slight end play is required for mounted reels.
4. Inspect reel drag brakes. Tightening increases tension. Loosening decreases tension.

Table 5-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before D - During A - After | W - Weekly M - Monthly Q - Quarterly | AN - Annually S - Semiannually BI . Biennially | (Numbed - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		MICROSCAN LIGHT TABLE - Cont	
2	B	Inspect Microscan.	



WARNING

Death or serious injury may occur if equipment is operated with defective wiring.

		1. Inspect power cord for breaks, tears, burns, and cracks.	Power cord is defective.
		2. Inspect illuminated viewing stage for cracks or scratches.	Viewing stage is cracked or scratched.
		3. Inspect for loose or missing screws, nuts, and fixtures.	

Table 5-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

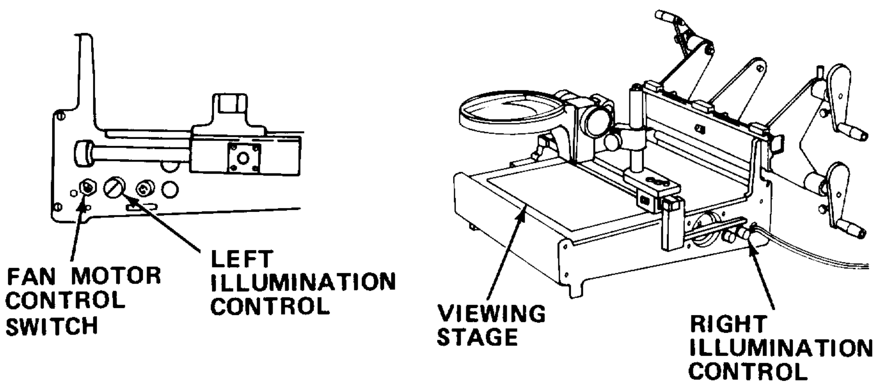
B - Before
D - During
A - After

W - Weekly
M - Monthly
Q - Quarterlv

AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO	IN-TER VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		MICROSCAN LIGHT TABLE - Cont	
3	B	Inspect Illumination Controls.	



		1. Turn power on. Check that fan motor runs.	Fan is inoperative,
		2. Slowly turn riqht illumination control fully right. 0bserve that right half of illuminated viewing stage is illuminated.	
		3. Slowly turn right illumination control fully left. Observe that illumination decreases and then is off.	
		4. Turn left illumination control fully right. Observe that left half of illuminated viewing stage is illuminated.	
		5. Slowly turn left illumination control fully left. Observe that illumination decreases and then is off.	

Table 5-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before
D - During
A . After

W - Weekly
M - Monthly
Q - Quarterly

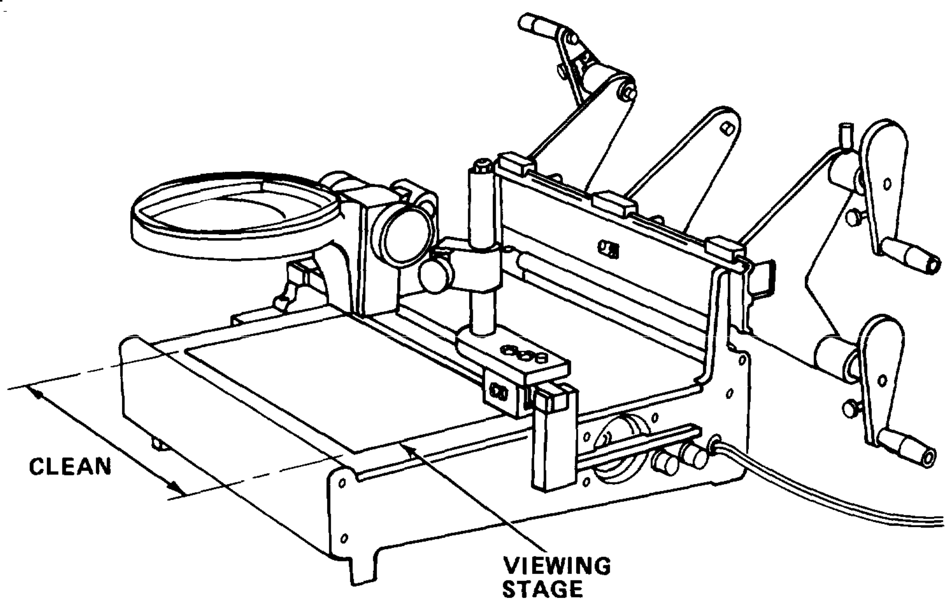
AN - Annually
S - Semiannually
BI - Biennially

(Number) - Hundreds of Hours

ITEM NO.	IN-TER-VAL	ITEM TO BE INSPECTED PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		MICROSCAN LIGHT TABLE - Cont	
3	B	Inspect Illumination Controls - Cont	
		6. Turn left and right illumination controls fully on. Observe that intensity of left and right grids are equal.	Light grids do not operate.
		7. Turn off illumination controls.	
		8. Turn power off.	
4	B	Clean Glass Illuminated Viewing Stage.	
		WARNING Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.	

Table 5-1. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES - Cont

B - Before | W - Weekly | AN - Annually | (Number) - Hundreds of Hours
D - During | M - Monthly | S - Semiannually
A - After | Q - Quarterly | BI - Biennially

ITEM NO.	INTERVAL	ITEM TO BE INSPECTED / PROCEDURE	For Readiness Reporting, Equipment Is Not Ready/ Available If:
		MICROSCAN LIGHT TABLE - Cont	
4	B	Clean Glass Illuminated Viewing Stage - Cont 1. Unplug power cord.  2. Moisten cheesecloth with solution of detergent and water. 3. Wipe glass surface and top of microscan with moistened cheesecloth. 4. Moisten cheesecloth with fresh water and wipe cleaned surfaces. 5. Wipe glass surface with chamois to remove streaks.	

5-6. OPERATION UNDER USUAL CONDITIONS.

5-6.1 Assembly and Preparation For Use.

a. Remove microscan from storage container.

b. Mount microscan on photointerpreter desk turntable.

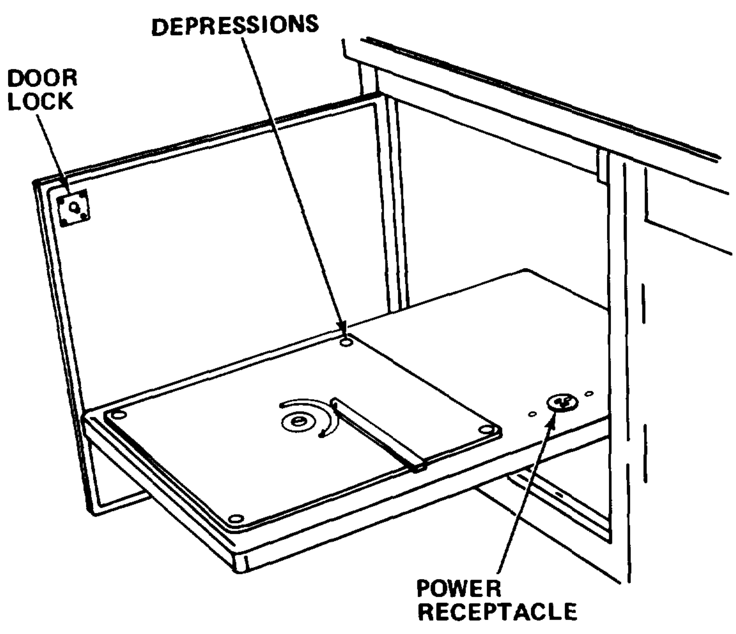
WARNING

Microscan table in photointerpreter desk has powerful spring in it which will tend to raise table. Be sure to restrain it with both hands to prevent personal injury.

NOTE

Microscan may be mounted on suitable desk or work surface that provides clearance for film reels and has 120 V, 60 Hz power source.

(1) Extend and raise microscan table to operating position.



CAUTION

Be sure door lock is engaged with table or microscan can be damaged in operation.

(2) Lock table to door.

(3) Place microscan on turntable so that feet rest in depressions.

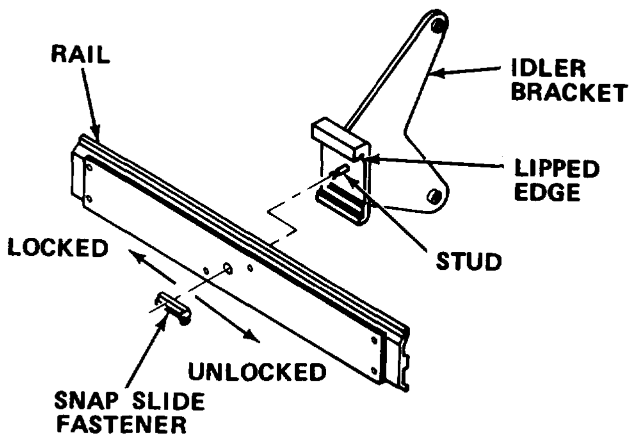
(4) Plug in power cord.

(5) Move red lever to rotate microscan.

NOTE

Lever locks when it contacts pin and must be pushed to left to unlock. Pin acts as motion stop to prevent complete rotation of turntable.

c. Install film reel brackets.

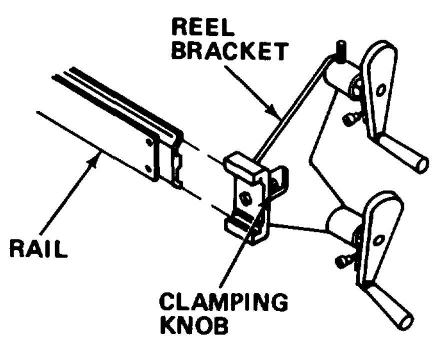


(1) Hook lipped edge of base on idler bracket over top of rail.

(2) Lower bracket so stud enters center hole.

(3) Press snap slide fastener to left to lock stud.

(4) Slide reel brackets on rail.



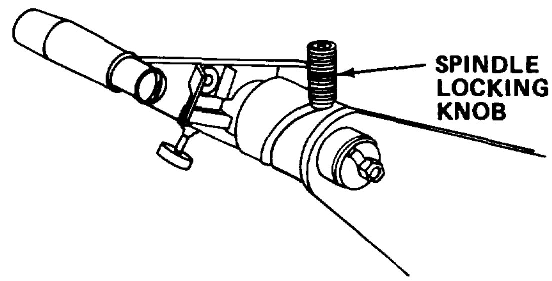
(5) Position reel brackets on rail. Then tighten clamping knob.

5-6.2 Operating Procedures.

a. Mount film reels.

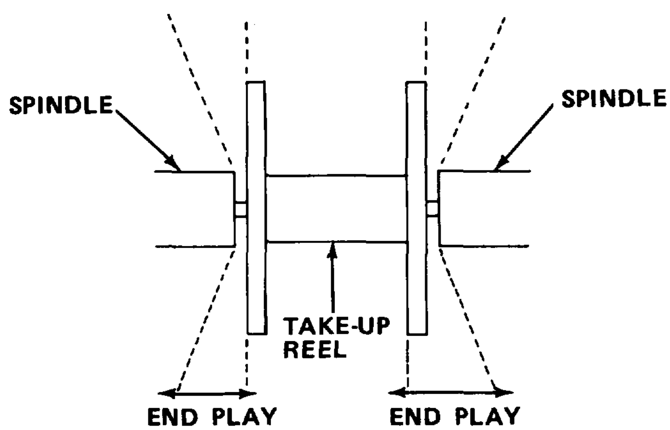
NOTE

In the following steps, 7.0 cm and 5 in. (12.7 cm) film is mounted. If 9.5 in. (24.13 cm) film reels are used, center idler bracket is removed and film reel spool is mounted between crank handles.



(1) Move all four aluminum spindle locking knobs upward to detent position.

(2) Insert film supply reel on lower idler spindle and slide lower crank spindle toward center until crank spindle engages supply reel. Allow for slight end play.



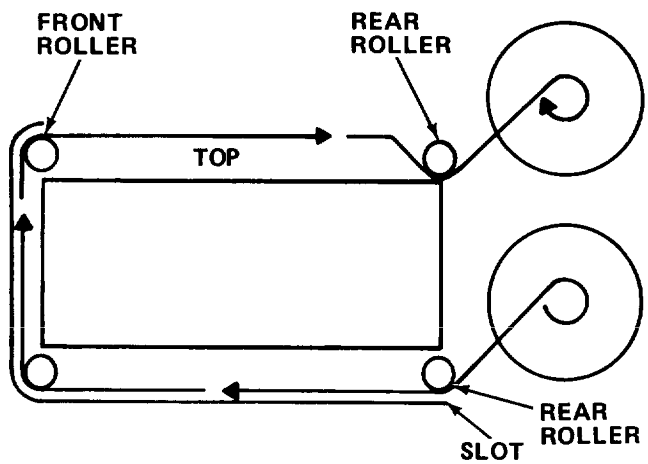
(3) Place take-up reel on upper idler spindle. Then slide upper crank spindle toward center until crank spindle engages take-up reel.

NOTE

Readjust position of bracket, if required, to have proper end play in both upper and lower reels. Slight end play is required in both upper and lower reels.

(4) If two films are to be mounted, repeat steps (1) through (3) for other side.

b. Thread film.



(1) Bring film under rear roller into slot between bottom cover and rollers. Feed film until end comes out over rollers at front of microscan. Then feed film under rollers at rear of equipment and up to take-up spool.

(2) Wind film on take-up reel and tighten drag brake to adjust film tension.

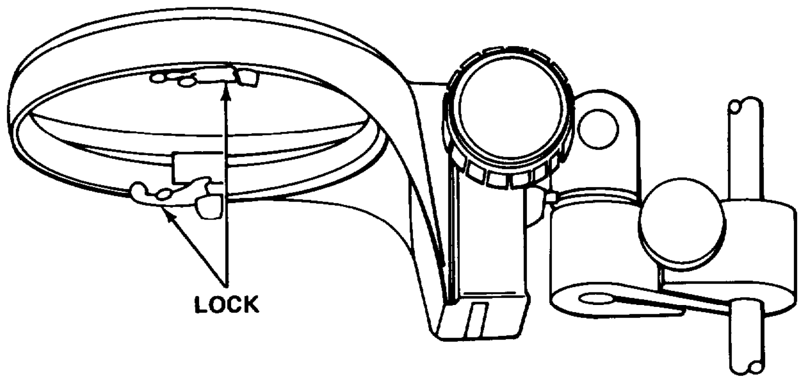
(3) Repeat steps (1) and (2) for second reel.

c. Install stereoscope.

NOTE

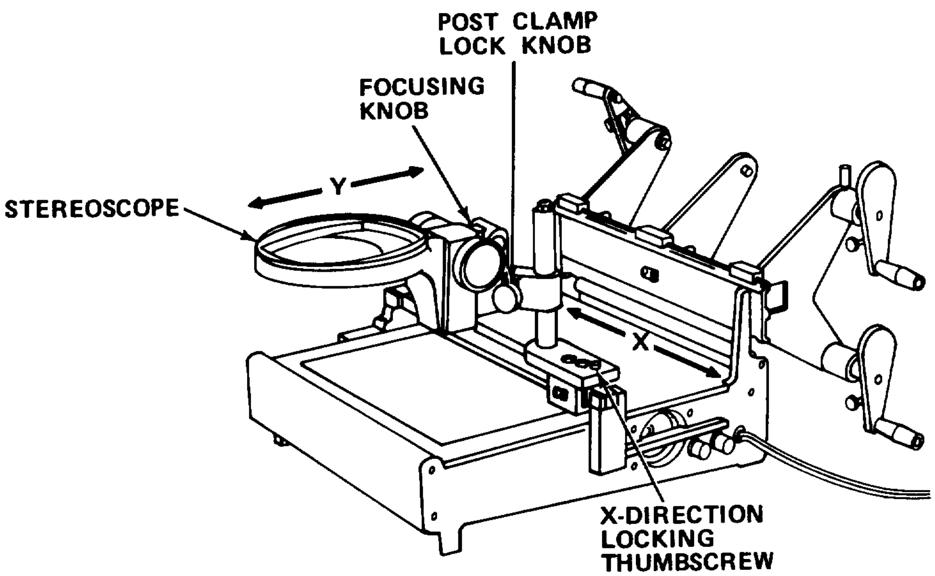
When a higher viewing distance is required, the 8 in. post is available and may be used. The 8 in. post is interchangeable with the 5.25 in. post. The 8 in. viewing post, however, prevents the microscan from being stored inside the desk well.

(1) Mount stereoscope. Follow procedures in Chapter 7 to assemble rhomboid to pod.



(2) Lock clips on bottom of stereoscope mount to hold pod.

d. Position stereoscope.



(1) Move stereoscope to approximate viewing height by loosening post clamp lock knob and raising or lowering stereoscope mount. Rotate stereoscope mount in horizontal plane to desired position. Then tighten post clamp lock knob.

(2) Loosen X-direction locking thumbscrew, and move stereoscope left or right until position is correct. Then tighten X-direction locking thumbscrew.

(3) Loosen Y-direction locking thumbscrew, and move stereoscope forward or backward until correct. Then tighten Y-direction locking thumbscrew.

(4) Focus stereoscope by moving focusing knobs to raise or lower stereoscope.

e. Illuminate viewing stages.

(1) Turn on fan motor control switch.

(2) Turn on left and right illumination controls.

(3) Turn illumination controls fully on (maximum intensity) and allow 15 minutes for lamps to warm up.

f. Completion of task.

(1) Turn illumination controls off.

CAUTION

Wait 2 or 3 minutes before turning fan motor off to prevent damage to equipment.

(2) Fully rewind film on supply reel and remove reel from microscan.

(3) Place one hand under empty film reels, and release spindle locking knobs with other hand to release spindle.

(4) Remove and empty film reels for reuse as take-up reels.

(5) Turn fan motor control switch off.

(6) Unplug power cord.

(7) Cover microscan with dust cover.

(8) Unlock door lock to lower table into well and close door.

5-6.3 Preparation For Movement.

a. Raise leaf and lock onto door.

b. Remove dust cover.

c. Remove reel brackets and store in container.

d. Remove stereoscope and store in container.

e. Lift microscan from turntable and store in container.

5-7. OPERATION UNDER UNUSUAL CONDITIONS. This equipment is designed for operation only in a controlled environment.

Section III OPERATOR MAINTENANCE

5-8. LUBRICATION INSTRUCTIONS.

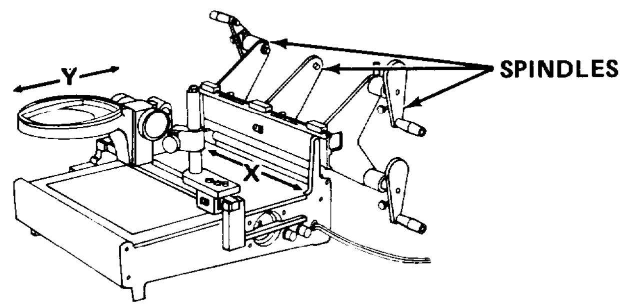
NOTE

These lubrication instructions are mandatory.

5-8.1 Lubricate Microscan. Clean and lubricate bearing surfaces monthly with bearing cleaner (Item 5, Appendix E) and general purpose oil, (Item 14, Appendix E) as follows:

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.



a. Unplug power cord.

b. Wipe all exposed surfaces to remove dirt from microscan.

c. Loosen X- and Y-axis thumbscrews.

d. Clean bearing surfaces with bearing cleaner.

e. Apply small amount of oil to bearing surfaces.

f. Move carriage in X- and Y-directions to distribute oil evenly.

g. Clean optical mount track with bearing cleaner.

h. Apply small amount of oil to track on optical mount.

i. Raise and lower optical mount to distribute oil by turning focusing knobs.

j. Clean spindles with bearing cleaner.

k. Apply small amount of oil to spindles.

l. Rotate spindles to distribute oil.

m. Wipe all surfaces clean of excess oil.

n. Reclean all surfaces that contact film.

5-9. TROUBLESHOOTING PROCEDURES.

a. The table lists the common malfunctions which you may find during operation or maintenance of the microscan light table. You should perform the test/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all test or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

Table 5-2. TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. LIGHT GRIDS AND FAN DO NOT OPERATE.

Step 1. Check that microscan power cord is plugged in.

(a) If plugged in, proceed to step 2.

(b) Plug in power cord.

Step 2. Check that photointerpreter desk power cord is plugged in.

(a) Plug in photointerpreter desk power cord.

(b) Refer to organizational maintenance.

2. FAN OPERATES. ONE OR BOTH LIGHT GRIDS DO NOT OPERATE.

Visually check fuse(s) for broken filament.

(a) If fuse(s) are defective, replace fuse(s) (paragraph 5-10.1).

(b) Refer to organizational maintenance.

5-10. MAINTENANCE PROCEDURES .

a. This section contains instructions covering operator maintenance functions for the microscan light table. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

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5-10.1 Replace Fuse.

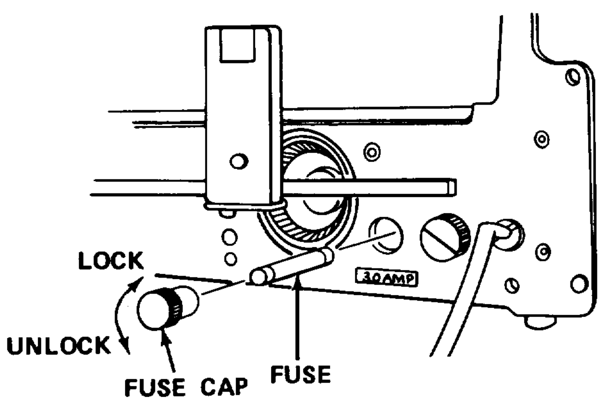
MOS: 81Q, Terrain Analyst

SUPPLIES: Fuse(s) 3 amp.

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.



b. Turn fuse cap left to unlock.

c. Withdraw fuse cap and defect fuse.

d. Install new fuse.

e. Push cap and fuse inward and turn right to lock.

f. Plug in power cord.

Section IV ORGANIZATIONAL MAINTENANCE

5-11. LUBRICATION INSTRUCTIONS. This equipment does not require lubrication at this level of maintenance.

5-12. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT.

5-12.1 Common Tools and Equipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

5-12.2 Special Tools: Test, Measurement, and Diagnostic Equipment: and Support Equipment. Special Tools, TMDE, and Support Equipment is listed in the applicable repair parts and special tools list and in Apppendix B of this manual.

5-12.3 Repair Parts. Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 5-6675-323-24P covering organizational maintenance for this equipment.

5-13. SERVICE UPON RECEIPT.

5-13.1 Checking Unpacked Equipment.

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6, Packing Improvement Report.

b. Check the equipment against the packing list to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.

c. Check to see whether the equipment has been modified.

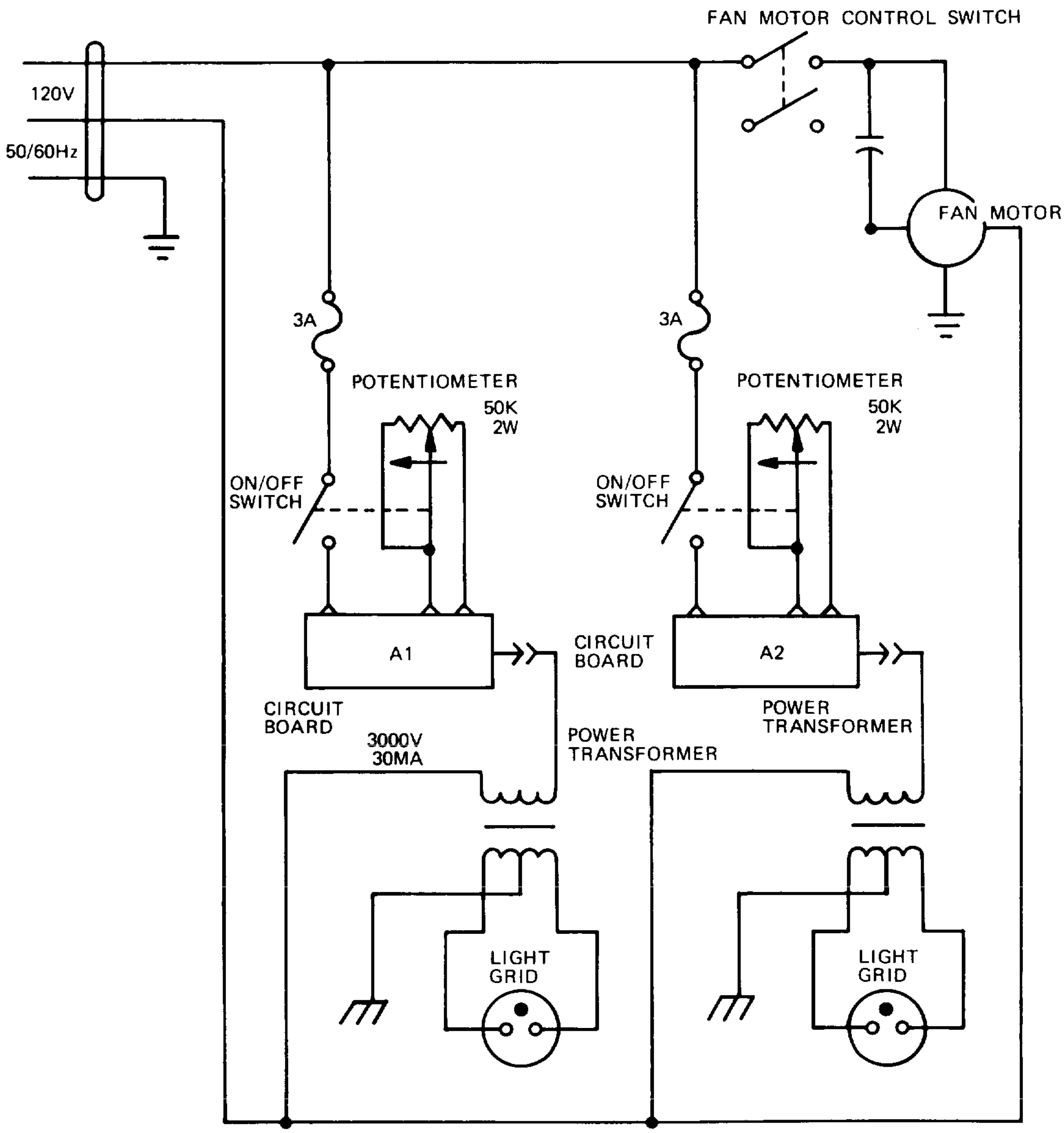
5-14. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES. There are no organizational PMCS assigned for this equipment.

5-15. ORGANIZATIONAL TROUBLESHOOTING PROCEDURES.

a. Organizational troubleshooting procedures cover the most common malfunctions that may be repaired at the organizational level. Repair or adjustment requiring specialized equipment is not authorized unless such equipment is available. Troubleshooting procedures used by the operator should be conducted in addition to the organizational troubleshooting procedures.

b. This manual cannot list all the possible malfunctions or every possible test/ inspection and corrective action. If a malfunction is not listed or is not corrected by a listed corrective action, notify your supervisor.

c. For unidentified malfunctions, use the following schematic or the foldout located at the end of this manual for further fault analysis.



d. If the microscan light table does not power up when turned on, verify that 120 V ac is present at the receptacle. If voltage is not present, plug equipment into receptacle with power available and proceed with equipment troubleshooting. Perform no-power procedures for dead receptacle (Table 1-4).

Table 5-3. ORGANIZATIONAL TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. LIGHT GRIDS OPERATE. FAN DOES NOT OPERATE .

Test fan motor control switch for continuity.

(a) If there is no continuity when switch is on, replace fan motor control switch (paragraph 5-16.3).

(b) If there is continuity through switch, replace fan motor (paragraph 5-16.1).

2. FAN OPERATES. ONE OR BOTH LIGHT GRIDS DO NOT OPERATE.

Step 1. Check continuity of dimmer switch(es).

(a) If continuity exists, proceed to step 2.

(b) If continuity does not exist, replace dimmer switch(es) (paragraph 5-16.2).

Step 2. Check continuity of power cord.

(a) If no continuity exists, replace power cord (paragraph 5-16.5).

(b) Refer to direct/general support maintenance.

5-16. MAINTENANCE PROCEDURES.

a. This section contains instructions covering organizational maintenance functions for the microscan light table. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

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5-16.1 Replace Fan Motor.

MOS: 41B, Topographic Instrument Repair Specialist

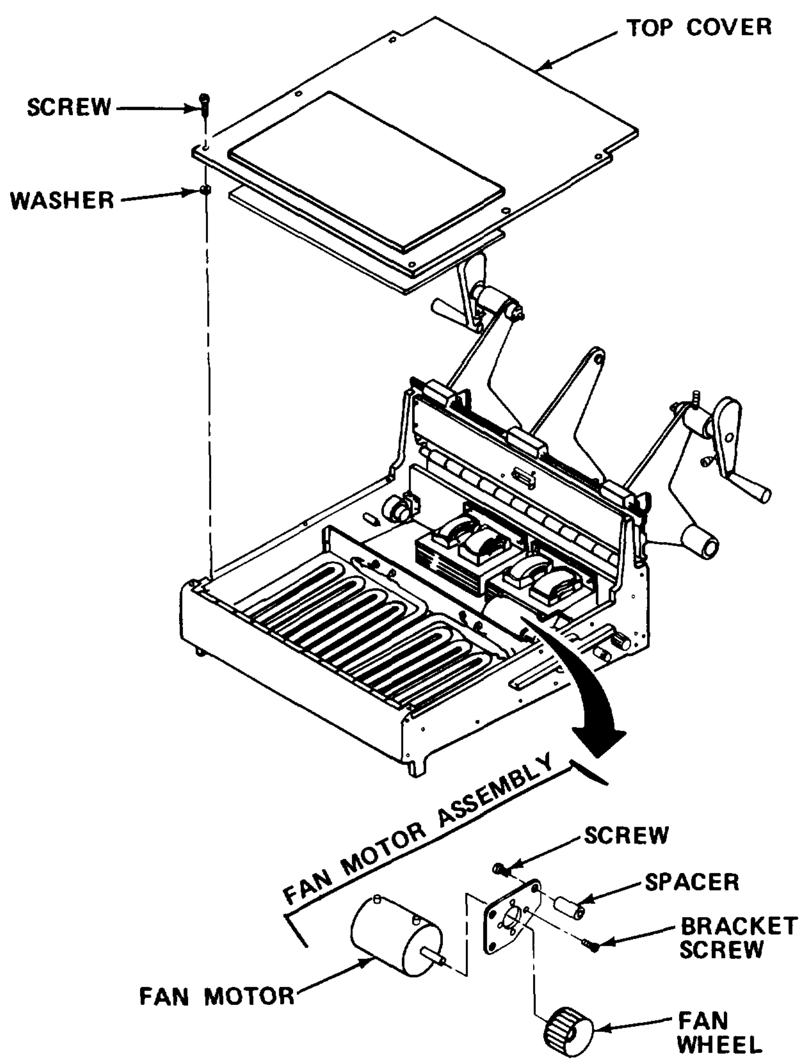
TOOLS: Soldering Iron
5/32 in. Hex Head Key Wrench
9/64 in. Hex Head Key Wrench

SUPPLIES: Solder (Item 24, Appendix E)
Fan Motor

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.



b. Remove optical mount.

c. Remove six screws and top cover.

d. Tag and desolder wires from fan motor.

e. Remove three screws, spacers, and defective motor.

f. Remove fan wheel from shaft and install on new motor.

g. Remove four screws from bracket mounting.

h. Install new fan motor and fan wheel. Secure with four screws.

i. Install fan motor assembly. Secure with three spacers and screws.

j. Solder wires to new fan motor.

k. Reinstall washers, top cover, and secure with six screws.

1. Plug in power cord.

5-16.2 Replace Dimmer Switch.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: .050 in. Hex Head Key Wrench
5/32 in. Hex Head Key Wrench
1/2 in. Socket, 3/8 in. Drive
3/8 in. Drive Ratchet
Soldering Iron

SUPPLIES: Solder (Item 24, Appendix E)
Dimmer Switch

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

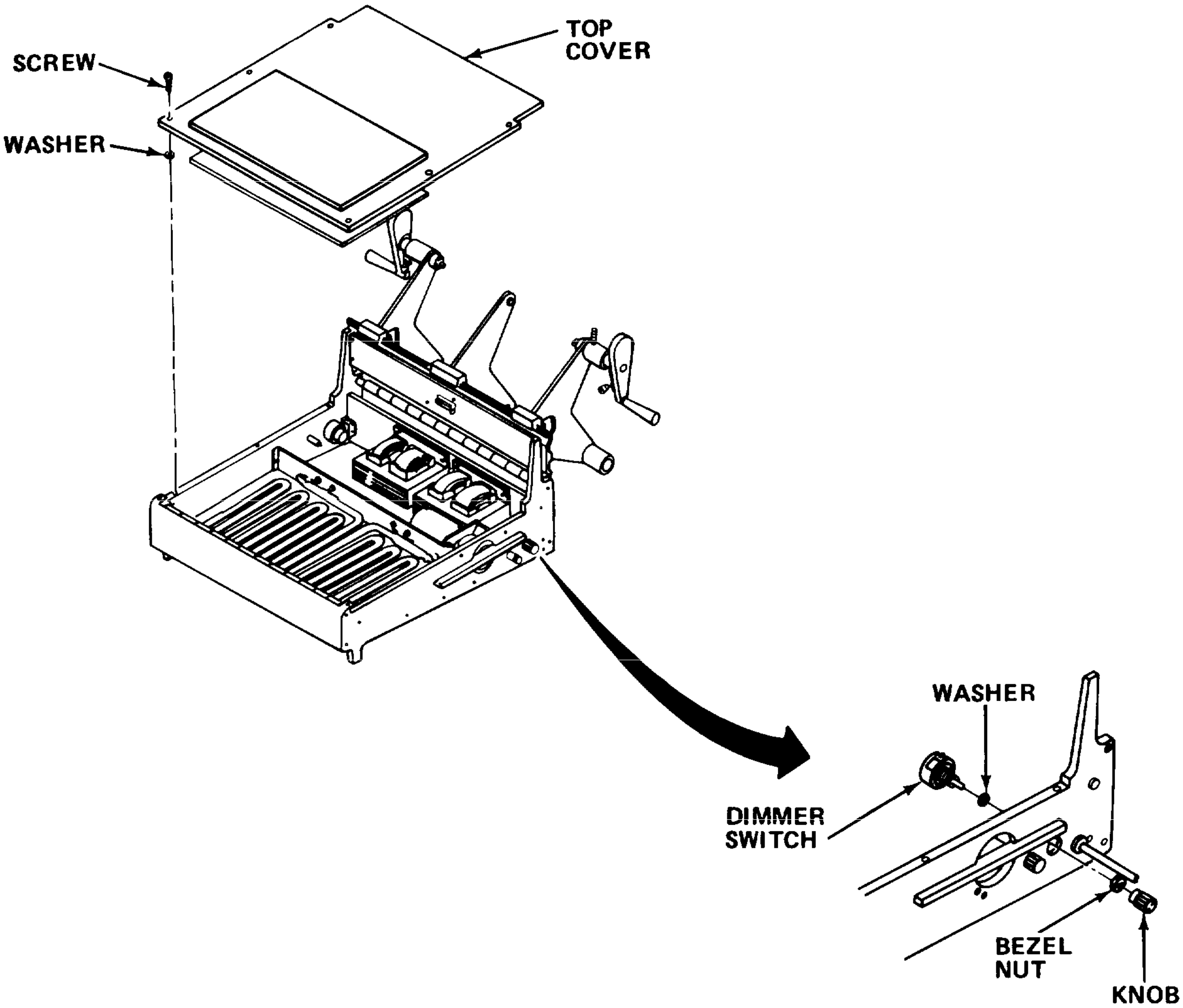
b. Remove optical mount.

c. Remove six screws and top cover.

d. Loosen hex head screw and pull knob from shaft.

e. Remove bezel nut.

f. Withdraw dimmer switch from hole.



g. Tag and desolder wires from defective dimmer switch.

h. Remove defective dimmer switch.

i. Install new dimmer switch and secure with bezel nut.

j. Solder wires to new switch.

k. Reinstall knob and tighten screw.

l. Reinstall cover and secure with six screws.

m. Plug in power cord.

5-16.3 Replace Fan Motor Control Switch.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: 5/32 in. Hex Head Key Wrench
9/16 in. Socket, 3/8 in. Drive
3/8 in. Drive Ratchet
Soldering Iron

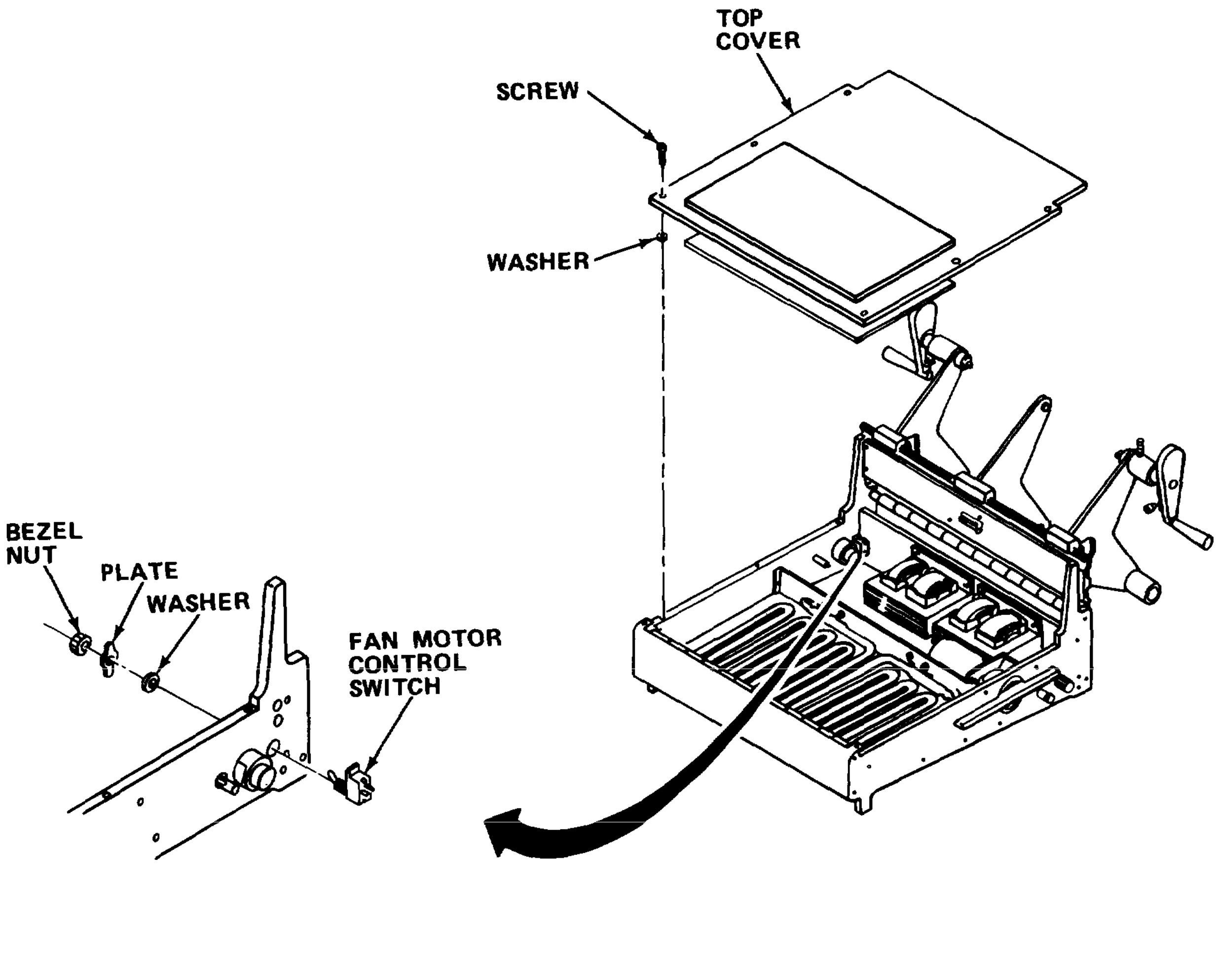
SUPPLIES: Fan Motor Control Switch
Solder (Item 24, Appendix E)

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Remove optical mount.



c. Remove six screws and top cover.

d. Remove bezel nut, washer, and plate.

e. Withdraw defective fan motor control switch into light box.

f. Tag and desolder wires from defective fan motor control switch.

g. Install new switch and secure with washer, plate, and bezel nut.

h. Solder wires to new switch.

i. Reinstall top cover and secure with six screws.

j. Plug in power cord.

5-16.4 Replace Top Cover.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: 5/32 in. Hex Head Key Wrench

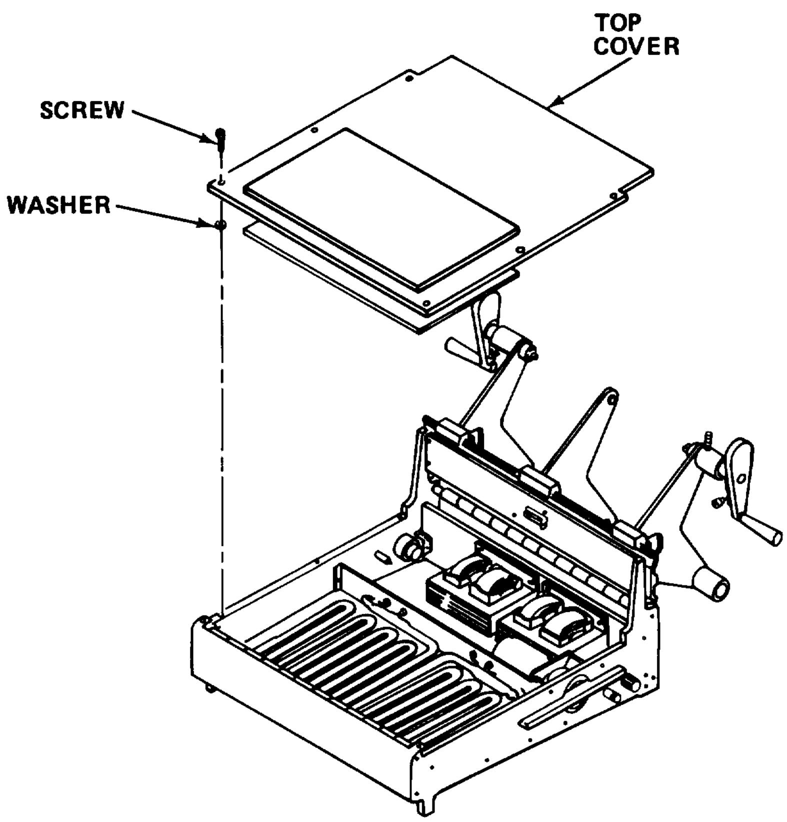
SUPPLIES: Top Cover

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Remove optical mount.



c. Remove six screws and defective top cover.

d. Install new top cover.

e. Secure with six screws.

5-16.5 Replace Power Cord.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: 5/32 in. Hex Head Key Wrench
Soldering Iron

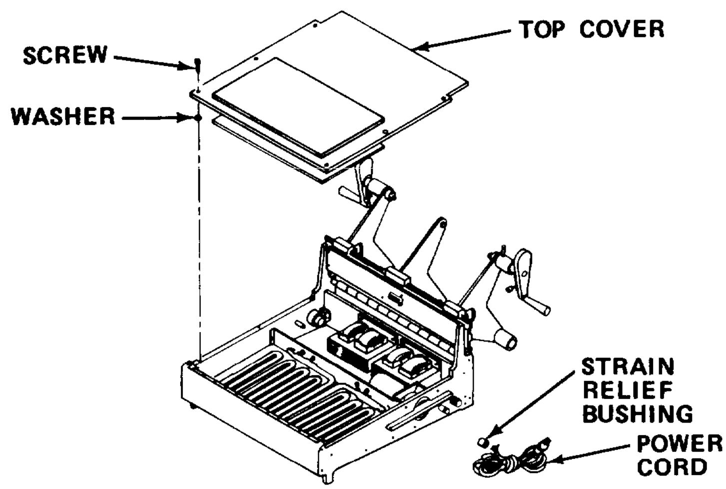
SUPPLIES: Solder (Item 24, Appendix E)
Power Cord

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Remove optical mount.



c. Remove six screws and top cover.

d. Tag and desolder power cord leads.

e. Remove defective power cord and strain relief bushing.

f. Install strain relief bushing on new power cord.

g. Install new power cord into machine.

h. Solder power cord wires to connections.

i. Reinstall top cover and secure with six screws.

j. Reinstall optical mount.

k. Plug in power cord.

5-17. PREPARATION FOR STORAGE OR SHIPMENT. Contact your battalion for packing and shipping instructions.

Section V DIRECT/GENERAL SUPPORT MAINTENANCE

5-18. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT.

5-18.1 Common Tools and Equipment. For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

5-18.2 Special Tools; Test, Measurement. and Diagnostic Equipment; and Support Equipment. Special Tools, TMDE, and Support Equipment is listed in the applicable repair parts and special tools list and in Appendix B of this manual.

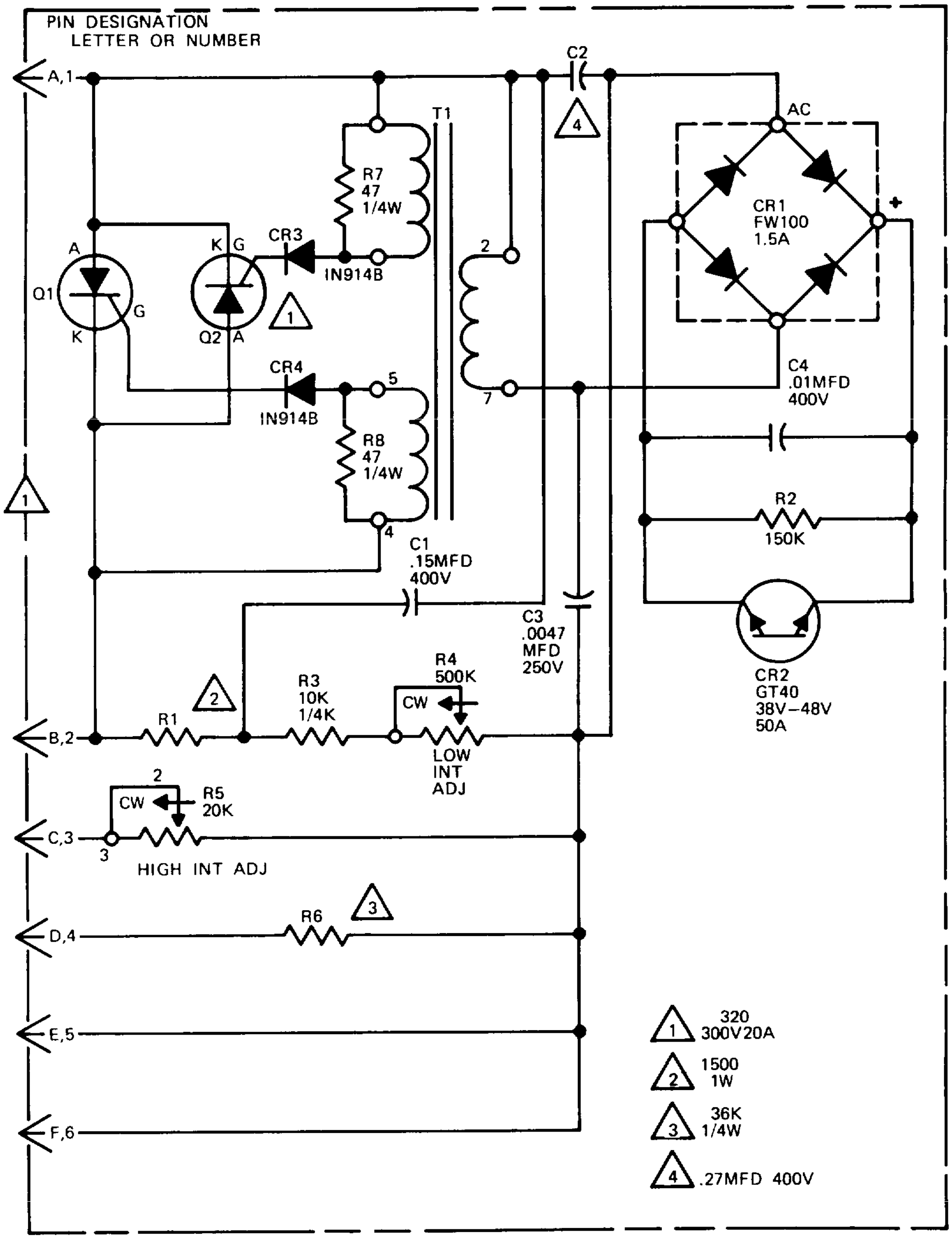
5-18.3 Repair Parts. Repair parts are listed and illustrated in the Repair Parts and Special Tools List, TM 5-6675-323-24P covering direct/general support maintenance for this equipment.

5-19. DIRECT/GENERAL SUPPORT TROUBLESHOOTING PROCEDURES.

a. Direct/general support troubleshooting procedures cover the most common malfunctions that may be repaired at the direct/general support level. Repair or adjustment requiring specialized equipment is not authorized unless such equipment is available. Troubleshooting procedures used by lower level maintenance should be conducted in addition to the direct/general support troubleshooting procedures.

b. This manual cannot list all the possible malfunctions or every possible test/inspection and corrective action. If a malfunction is not listed or is not corrected by a listed corrective action, notify your supervisor.

c. For unidentified malfunctions, use the facing schematic or the foldout located at the end of this manual for further fault analysis.



A1/A2 CIRCUIT CARD

d. If the microscan light table does not power up when turned on, verify that 120 V ac is present at the receptacle. If voltage is not present, plug equipment into receptacle with power available and proceed with equipment troubleshooting. Perform no-power procedures for dead receptacle (Table 1-4).

Table 5-4. DIRECT/GENERAL SUPPORT TROUBLESHOOTING

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

1. LIGHT INTENSITY IS NOT EQUAL FOR BOTH LIGHT GRIDS.

   Test maximum and minimum light grid intensity. Minimum value is 500 ft lamberts; maximum value is 2000 ft lamberts.

   Adjust dimmer circuit to equal values (paragraph 5-20.1).

2. OPTICAL QUALITY OF IMAGE CHANGES AS STEREOSCOPE IS MOVED OVER ILLUMINATED VIEWING STAGES.

   Orient stereoscope rhomboids to minimum separation in X- and Y-directions.

   If optical quality improves, recollimate optical mount (paragraph 5-20.2).

3. FAN OPERATES. ONE OR BOTH LIGHT GRIDS DO NOT OPERATE.

   Change dimmer circuit card or substitute with good card.

   (a) If lamp lights, adjust dimmer circuit (paragraph 5-20.1).

   (b) Replace grid lamp (paragraph 5-20.4).

4. LIGHT GRID LIGHTS BUT INTENSITY WILL NOT CHANGE.

   Step 1. Check that connector to dimmer card is not reversed.

NOTE

Dimmer card connector is not keyed and may be reversed. If card is reversed, grid lamp will operate at maximum intensity and lamp intensity will not change.

Table 5-4. DIRECT/GENERAL SUPPORT TROUBLESHOOTING - Cont

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

4. LIGHT GRID LIGHTS BUT INTENSITY WILL NOT CHANGE - Cont

Remove connection, mark card and connector to indicate proper connection.

Step 2. Check voltage output at potentiometer.

(a) If no change when knob is turned, replace dimmer switch (paragraph 5-16.2).

(b) Replace dimmer card (paragraph 5-20.3) and adjust dimmer circuit (paragraph 5-20.1).

5-20. MAINTENANCE PROCEDURES.

a. This section contains instructions covering direct/general support maintenance functions for the microscan light table. Personnel required are listed only if the task requires more than one.

b. After completing each maintenance procedure, perform operational check to be sure that equipment is properly functioning.

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5-20.1 Adjust Dimmer Circuit.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Light Meter (LM-150A)
Alinement Tool

WARNING

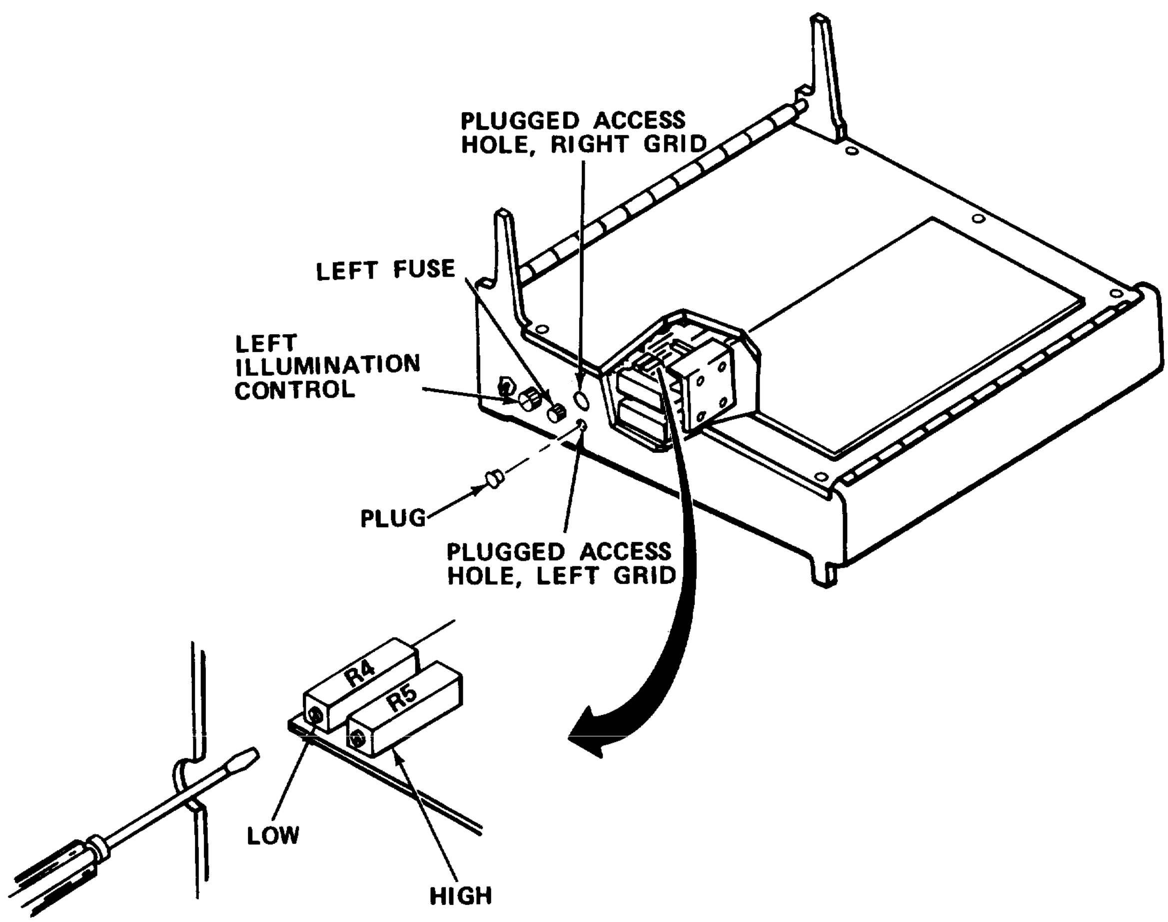
High voltages in light box may cause injury or death. Use insulated alinement tool, proper grounding of power cord, and care in adjustment to prevent injury.

a. Plug in power cord.

b. Turn fan motor control switch on.

c. Turn illumination controls fully right and wait 15 minutes.

d. Place light meter in center of light grid being adjusted. (For right light grid, light meter is placed in center of right illuminated viewing stage.)



e. Locate plugged access hole for right light grid and for left light grid, and remove plug for hole to be used.

f. Insert insulated alinement tool through hole to engage adjusting screw on high level resistor. Turn screw until light output is 2000 ft lamberts.

g. Turn illumination control to left. (Light is still on at minimum intensity.)

h. Turn low resistor adjusting screw until intensity is 500 ft lamberts.

i. Recheck high value (2000 ft lamberts) with illumination control fully right.

j. Readjust high and low values until range of intensity is low, 500 ft lamberts, and high, 2000 ft lamberts. Turn off lights.

k. Reinstall plugs.

l. Turn fan motor control switch to off.

m. Unplug power cord.

5-20.2 Collimate.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Autocollimator
7/16 in. Combination Wrench
1/8 in. Hex Head Key Wrench

SUPPLIES: Cheesecloth (Item 7, Appendix E)

a. Remove stereoscope and store in secure area.

b. Place autocollimator body in optical mount and lock in place.

c. Clean glass illuminated viewing stage.

d. Wipe mirror back clean.

e. Place mirror in center of glass illuminated viewing stages under autocollimator.

CAUTION

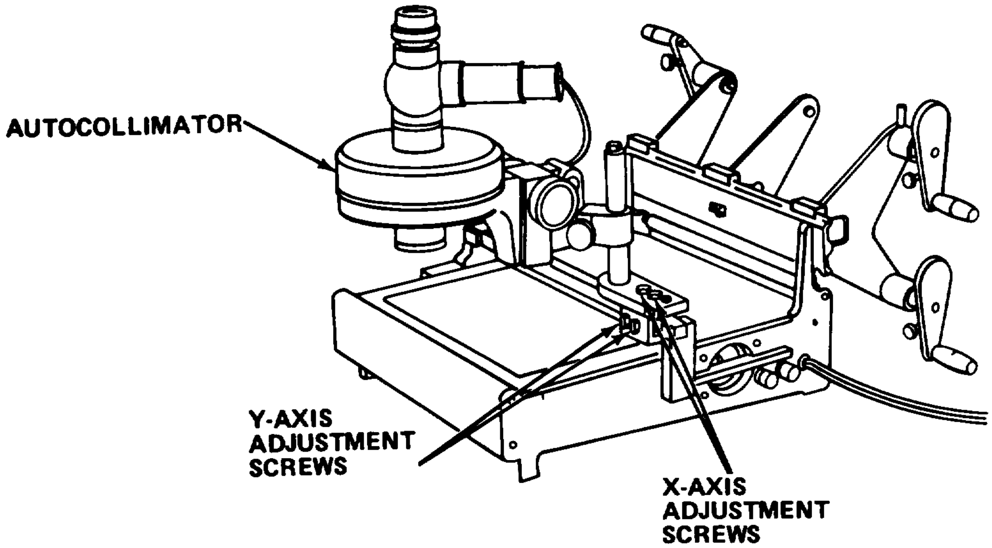
To prevent damage to viewing stage, do not slide mirror over glass illuminated viewing stages. Lift up and reposition mirror when necessary to change position.

f. Plug in autocollimator power cord to power source.

g. Observe reflected cross hairs.

NOTE

One or more reflected images of cross hair may be seen. Dimmer images from glass illuminated viewing stage are not to be used.



h. Rotate autocollimator until virtual and reflected cross hair images are the collimation error. Difference between virtual and reflected vertical line is X-axis error, and difference between virtual and reflected horizontal line is Y-axis error.

i. Loosen locknuts. Then alternately tighten and slacken adjustment screws to remove X-axis error.

j. Loosen locknuts. Then alternately tighten and slacken adjustment screws to remove Y-axis error.

k. Observe X-axis error and readjust screws to obtain closest possible fit between reflected and virtual image.

1. Lift mirror and move to position on edge of view field. At each position, center autocollimator and observe error.

NOTE

Allowable error is ±10 minutes of arc in X- or Y-direction.

m. If error exceeds allowable error, make collimation adjustment at worst point and center point to bring all points as close as possible to specification.

n. Tighten locknuts on adjusting screws without changing adjustment setting.

o. Remove and store mirror.

p. Unplug and secure autocollimator.

q. Reinstall stereoscope.

5-20.3 Replace Dimmer Card.

MOS: 416, Topographic Instrument Repair Specialist

TOOLS: Light Meter
Flat Tip Screwdriver
5/32 in. Hex Head Key Wrench
4 - 14 mm Socket Set, 1/4 in. Drive

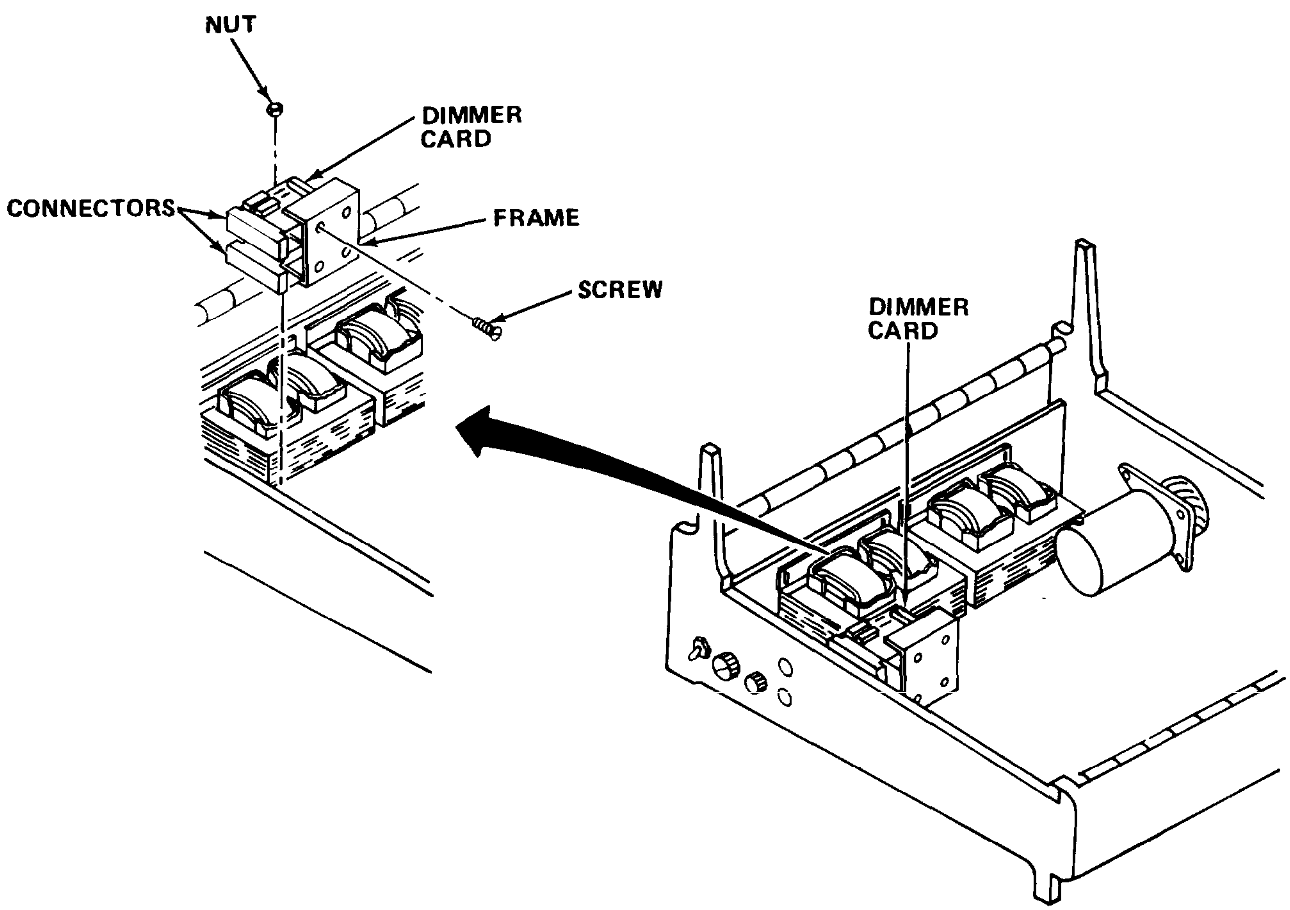
SUPPLIES: Dimmer Card

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Remove optical mount.



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c. Remove top cover.

d. Disconnect electrical connectors.

e. Remove two nuts. Lift cards and bracket from frame.

NOTE

Observe position of card and connector.

f. Remove screws and then pull defective card from bracket.

NOTE

Top card is for right light grid. Bottom card is for left light grid.

g. Install new card on bracket. Secure bracket with nuts.

h. Reconnect electrical connectors.

i. Reinstall top cover.

j. Reinstall optical mount.

k. Plug in power cord.

NOTE

If intensity of light will not change, connector is reversed.

l. Adjust dimmer circuit (paragraph 5-20.1).

5-20.4 Replace Light Grid Assembly,

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: 5/32 in. Hex Head Key Wrench
7/64 in. Hex Head Key Wrench
Soldering Iron

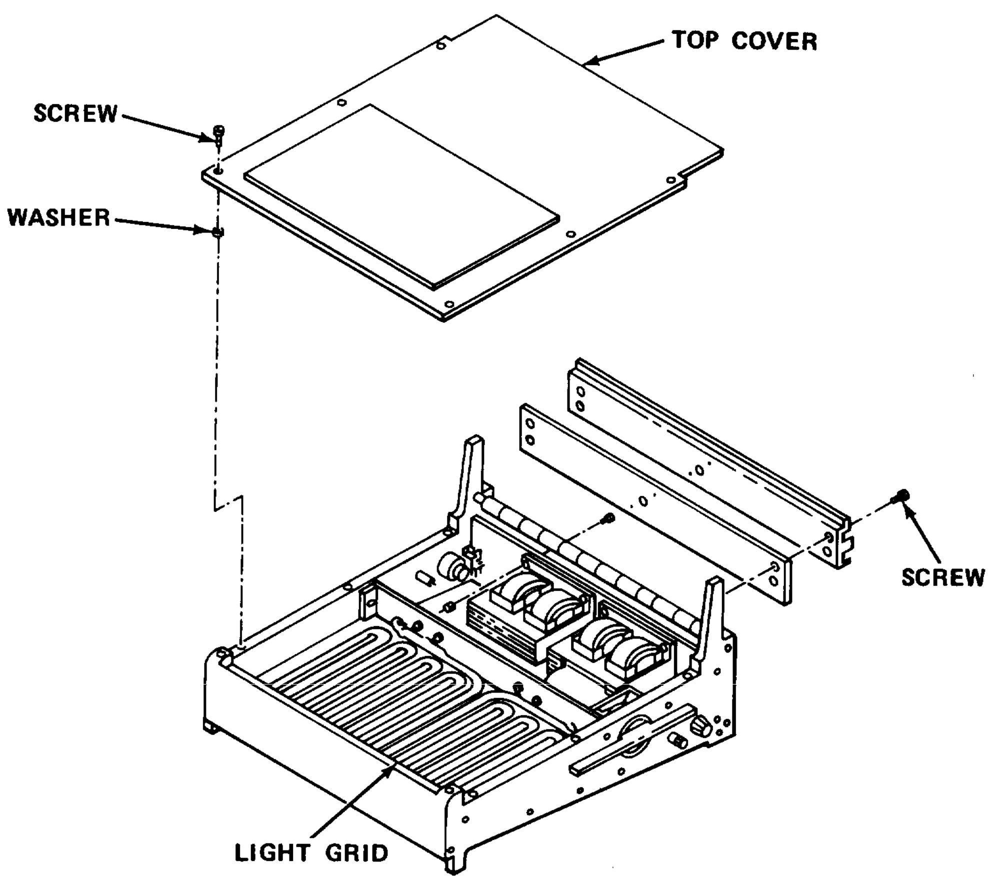
SUPPLIES: Light Grid Assembly
Silicone Sealant (Item 23, Appendix E)
Solder (Item 24, Appendix E)

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Remove optical mount.



c. Remove top cover.

d. Remove silicone sealant.

e. Remove defective grid and pan.

f. Tag and desolder grid lamp leads.

g. Install new grid lamps and pan assembly.

h. Solder grid lamp leads.

i. Aline grid lamps and pan assembly and secure with screws.

j. Cover assembly with silicone sealant and reinstall top cover.

k. Reinstall optical mount

l. Plug in power cord.

5-20.5 Replace High Voltage Transformer.

MOS: 41B, Topographic Instrument Repair Specialist

TOOLS: Flat Tip Screwdriver
5/32 in. Hex Head Key Wrench
7/64 in. Hex Head Key Wrench
4 - 14 mm Socket Set, 1/4 in. Drive
Soldering Iron

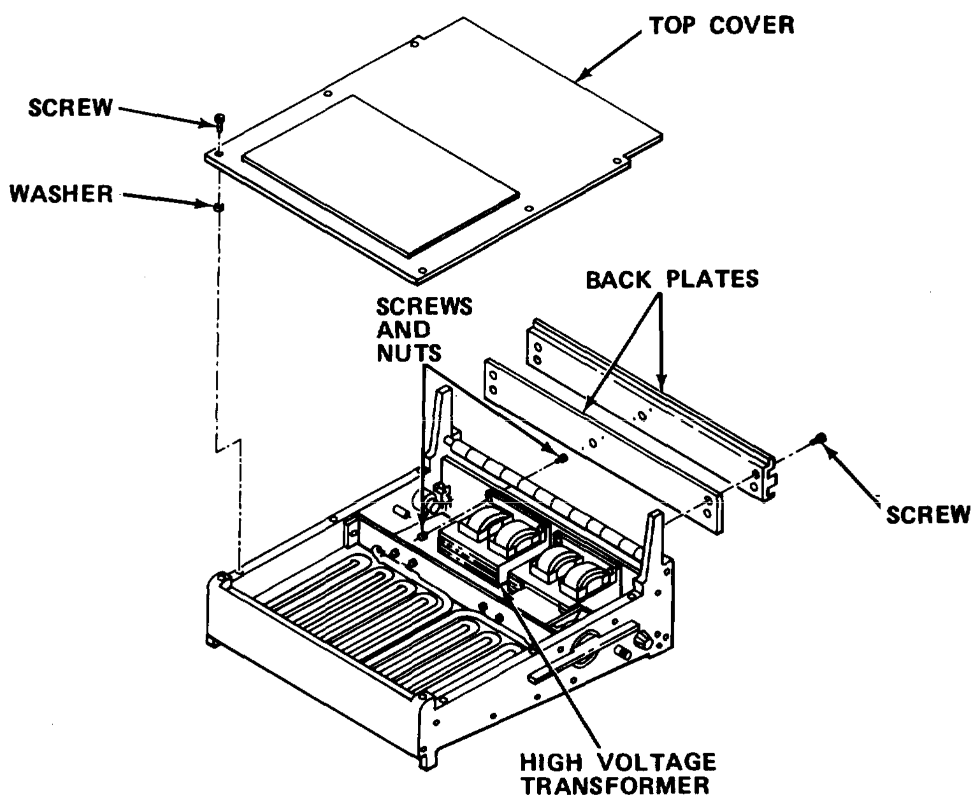
SUPPLIES: Transformer (3000V)
Silicone Sealant (Item 23, Appendix E)
Solder (Item 24, Appendix E)

WARNING

Death or serious injury may occur from electrical shock unless power cord is unplugged before servicing.

a. Unplug power cord.

b. Remove optical mount.



c. Remove top cover.

d. Remove reel brackets.

e. Remove back plates.

f. Remove light grid and pan (paragraph 5-20.4).

g. Tag wires to light grid and remove insulation.

h. Desolder wires.

i. Tag and desolder remaining wires.

j. Remove transformer mounting plate and defective transformer.

k. Remove defective transformer from plate.

l. Install new high voltage transformer.

m. Solder wires to transformer and seal with silicone sealant.

n. Reinstall light grid.

o. Reinstall back plates.

p. Reinstall reel brackets.

q. Reinstall top cover.

r. Reinstall optical mount.

s. Plug in power cord.

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81		4-3		Callout 16 on figure 4-3 is pointing at a bolt. In key to figure 4-3, item 16 is called a shim - Please correct one or the Other.
125	line 20			I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got what I ordered, so the NSN is wrong. Please give me a good NSN

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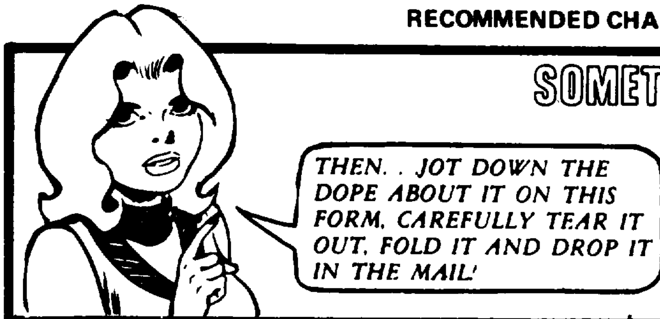

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C