Errata

Title & Document Type: **5089A Power Supply Operating and Service Manual**

Manual Part Number: **05089-90001**

Revision Date: **November 1985**

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HP References in this Manual

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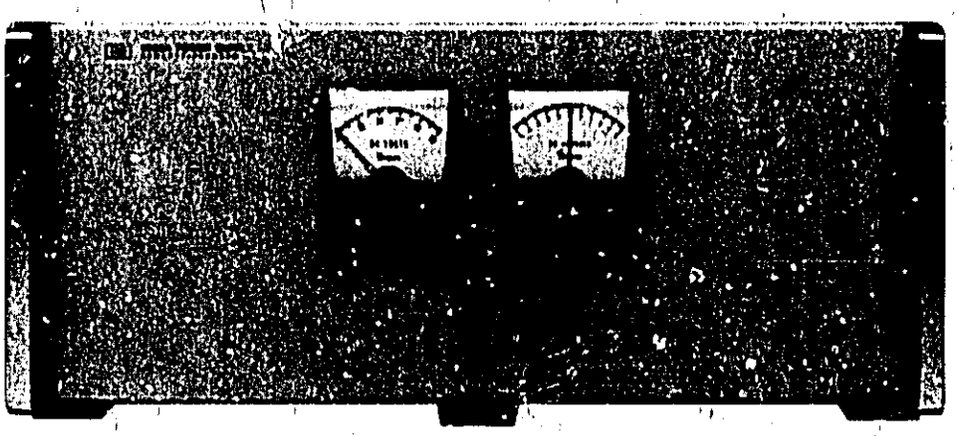
Agilent Technologies

HP5089A

OPERATING AND SERVICE MANUAL

5089A
Power Supply



HEWLETT PACKARD

HP5089A

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packa d instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

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HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

5089A
POWER SUPPLY

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2332A, unless accompanied by a Manual Change Sheet indicating otherwise.

For additional information about serial numbers, refer to INSTRUMENT AND MANUAL IDENTIFICATION in Section I.

MANUAL PART NUMBER 05089-90001
Microfiche Part Number 05089-90002

Printed: NOVEMBER 1985

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SAFETY CONSIDERATIONS

GENERAL

The HP 5089A is a Safety Class I instrument provided with a protective earth terminal. The instrument is designed and tested to international standards.

This manual contains information, cautions, and warnings which must be followed by all persons operating or servicing the instrument to ensure safe operation and to retain the instrument in safe condition.

WARNING

BEFORE CONNECTING POWER TO THE INSTRUMENT:

The protective earth terminal must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in an outlet socket provided with a protective earth contact. This protection must not be negated by an extension power cable without a protective grounding (earthing) conductor. Grounding one conductor of a two-conductor outlet is not sufficient.

Ensure that all devices connected to the instrument are connected to the protective (earth) ground.

Make sure the correct fuses with the required current rating, voltage rating, and of the specified type (normal blow, time delay, etc.) are installed. DO NOT USE repaired fuses or short-circuited fuseholders to replace blown fuses.

Whenever it is likely that the protection offered by grounding or fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

LINE VOLTAGE CONNECTION

To reduce the risk of electric shock when connecting the instrument to an ac outlet (mains), the military-type connector of the power cord must be connected to the ac line connector on the rear panel of the instrument before inserting the mains plug in an outlet socket. To detach the power cord, the mains plug must be disconnected from the outlet socket before removing the other end of the cord from the instrument.

If this instrument is to be energized via an autotransformer, make sure the common terminal is connected to the neutral (earthed) pole of the power source.

HIGH VOLTAGE

The HP 5089A Power Supply is less a power switch. The ac power input circuits and unregulated dc output voltages are always on when this instrument is connected to an external power source. Contact with these circuits can cause injury to personnel or damage to equipment. Any adjustment or repair of an opened instrument should be avoided as much as possible. This type of operation should only be done by service-trained personnel who are aware of the electrical and fire hazards involved.

CAUTION

LINE VOLTAGE SELECTION

BEFORE CONNECTING THIS INSTRUMENT TO A POWER SOURCE, make sure that the line voltage selector switch (on the rear panel) is set to the correct range for the ac voltage being applied. Verify that the correct fuses are installed.

BATTERY CHARGING

When charging the HP 5089A, the instrument should not be positioned in such a way that the battery terminals are facing downward (instrument sitting on its rear panel). Charging the batteries in this position may force venting of the electrolyte which may cause instrument damage and possible personal injury. When in use as a power source (batteries discharging), the HP 5089A may be used in any position.

BATTERIES

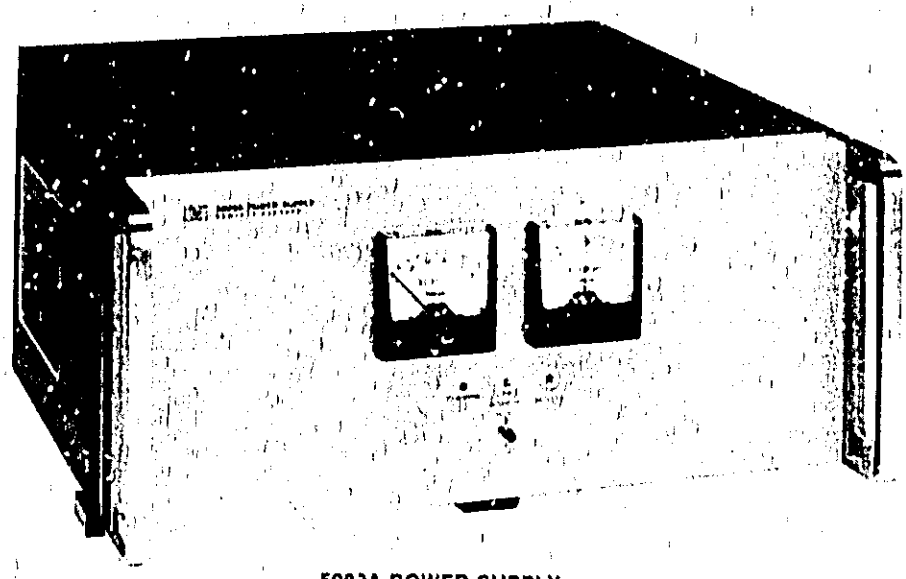
The instrument with batteries installed weighs about 30.5Kg (67 pounds) and can cause injury or damage if accidently dropped. The batteries can also deliver very high output currents that may cause a severe burn if accidently shorted by jewelry such as a ring or a metal watchband. Temporary removal of these items is suggested before starting any service procedure. Use a workbench with an insulated surface to prevent a battery short circuit.

INSTRUMENT STORAGE

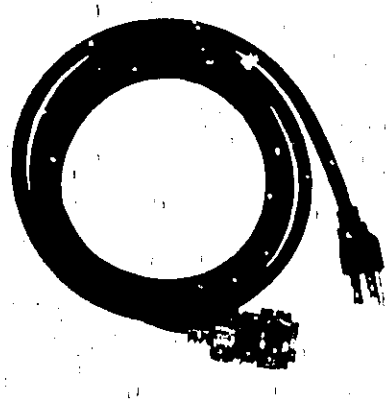
Prolonged storage is not recommended for the HP 5089A unless the battery is fully charged and, if possible, connected to an ac power source to maintain the float voltage. If storage without power input is necessary, be sure the battery is fully charged and the internal BATTERY switch S1 is set to OFF before placing the instrument in storage. Lead-acid batteries deteriorate rapidly if stored in a discharged state.

⚠ ATTENTION ⚠

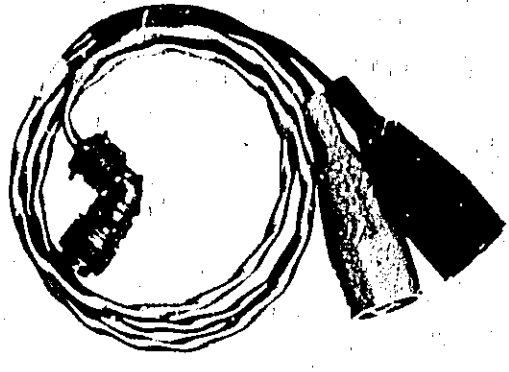
This symbol: ⚠ , when it appears on an instrument means: Read the instruction manual before operating the instrument. The first three sections of the manual are particularly important. If the instrument is operated without reading the instructions, the instrument may not operate correctly.



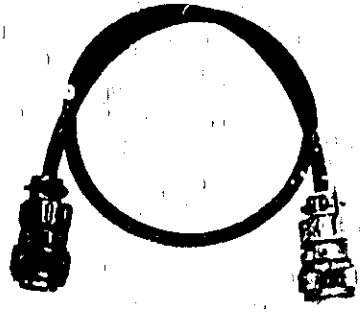
5089A POWER SUPPLY



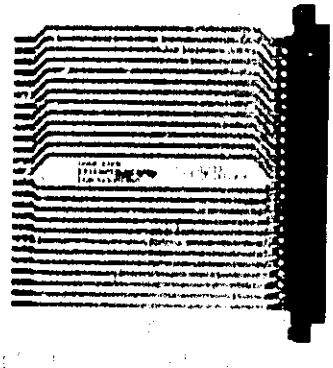
85-255 VAC POWER INPUT CABLE (W1)



+11 TO +20 VDC POWER INPUT CABLE (W2)



+22 TO +28 VDC OUTPUT CABLE (W3)



EXTENDER BOARD FOR A1 BOARD ASSEMBLY (MP1)

Figure 1-1. HP Model 5089A Standby Power Supply and Accessories Supplied

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual contains the information necessary to install, operate, and service the Hewlett-Packard Model 5089A Standby Power Supply. The Power Supply, with its supplied accessories, is shown in *Figure 1-1*.

1-3. MANUAL SUMMARY

1-4. This manual is divided into eight sections, each covering a particular topic of the operation and servicing of the Model 5089A. The topics by section number are:

SECTION I, GENERAL INFORMATION: Provides the instrument specifications, instrument identification, accessories, safety considerations, and recommended test equipment.

SECTION II, INSTALLATION: Provides information about initial inspection, preparation for use, storage, and shipment.

SECTION III, OPERATION: Provides information about operating characteristics, panel features, operator's maintenance and operating instructions.

SECTION IV, OPERATION VERIFICATION: Provides abbreviated procedures for operation verification, which give the operator a high degree of confidence that the Model 5089A is operating properly.

SECTION V, ADJUSTMENTS: Provides the procedures and adjustment locations to properly maintain the instrument operating characteristics within specifications.

SECTION VI, REPLACEABLE PARTS: Provides ordering information for all replaceable assemblies and parts within the instrument.

SECTION VII, MANUAL CHANGES: This section is reserved for manual change information for adapting the manual to instruments for which the content of the manual does not apply directly.

SECTION VIII, SERVICE: This section provides the instrument theory of operation, troubleshooting information, repair techniques, and schematic diagrams.

1-5. SPECIFICATIONS

1-6. The specifications for the Model 5089A are listed in *Table 1-1*. These specifications are the performance standards or limits against which the Model 5089A can be tested.

Table 1-1. HP Model 5089A Specifications

INPUT VOLTAGE:
AC Charging: 85V AC to 130V AC rms, 48 to 440 Hz, 300VA max
85V AC to 255V AC rms, 48 to 66 Hz, 300VA max

DC Charging: 11V min to 30V DC, 110W max.

OUTPUT VOLTAGE: 22V to 28V DC (nominal), 2A maximum.

STANDBY CAPACITY: 15AH at +25°C when fully charged.

RECHARGE: 90% recharge in 24 hours, 100% recharge in 72 hours (with no external load).

PANEL INDICATORS:
Green LED: ON indicates battery is CHARGING.
Yellow LED: ON indicates CHARGE INTERRUPT.
Red LED: ON indicates BATTERY LOW.
Meters: Center-scale dc ammeter plus dc voltmeter.

BATTERY: Two 12V series-connected sealed lead-acid.

EXTERNAL LOW BATTERY VOLTAGE ALARM: Floating contact closure at rear panel block for low voltage visible or audible "low battery" warning. Contact rating is 30V dc at 2 amperes.

OPERATING ENVIRONMENT:
Temperature: 0° to 50°Celius
Humidity: up to 95% at 40° Celsius (with no internal condensation)
Altitude: up to 12,180 metres (40,000 feet).

STORAGE ENVIRONMENT:
Temperature: -40° to +65° Celius
Humidity: Up to 95% noncondensing
Altitude: 15,240 metres (50,000 feet)

DIMENSIONS: 177mmH × 425mmW × 416mmD (7" × 16.7" × 16.4")

WEIGHT: Net weight 30.5Kg (67 pounds)

ACCESSORIES SUPPLIED:
AC Power Input Cable Assembly: HP Part No. 05061-6091
DC Power Input Cable Assembly: HP Part No. 05089-60102, (11V to 20V input)
DC Output Cable Assembly: HP Part No. 05089-60101
Extender Board Assembly (Dual 25 Pin): HP Part No. 5060-0169

ACCESSORIES AVAILABLE:
Spare A1 Board Assembly (05089-60001): Option 001
Rack Mounting Adapter Kit: Option 908

1-7. DESCRIPTION

1-8. The HP Model 5089A Standby Power Supply furnishes dc power to keep frequency and time standard systems operating during extended interruptions of ac line power. It is designed both as a standby supply for stationary applications and as a portable power supply for use in portable frequency and time standard systems such as the HP "Flying Clock." The Power Supply will provide dc operating power for instruments such as the HP Model 5061A Cesium Beam Frequency Standard or the Model 5065A Rubidium Vapor Frequency Standard. The sealed rechargeable lead-acid batteries provide up to a 15 ampere-hour output (depending upon battery charge) to the frequency standard in the event primary power is disconnected or interrupted. Battery recharging and maintenance of a float voltage is automatically controlled.

1-9. Two front-panel meters and three LED indicators supply all necessary information to monitor operation of the power supply. Provisions are supplied for external alarm circuits when the power supply approaches a fully discharged state.

1-10. Primary power for the HP 5089A can be from an 85V to 255V rms (48 to 66 Hz) ac power source (300V max), an 85V to 130V rms (48 to 440 Hz) ac power source (300VA max), or a +11V to +30V dc power source (110W max). The HP 5089A Power Supply is always operating when connected to a primary power source.

1-11. ACCESSORIES SUPPLIED

1-12. The accessories supplied with the Model 5089A are shown in *Figure 1-1*. Their description and part number are given below:

a. The ac power input cable assembly (W1) is the HP Part No. 05061-6091 with a hard-wired male NEMA connector on one end and a female type MS military connector on the other end.

b. A HP Part No. 05089-60102 dc power input cable assembly (W2) is supplied for connecting an external stand-by power source to DC INPUT connector J2. This cable assembly has a dual-pin female type MS military connector on one end and color coded and insulated battery clips on the other end; red for positive and black for negative. The W2 cable assembly is used for the 11-20 V dc input connector only. No cable is supplied for the 20-30 V dc connector.

c. A HP Part No. 05089-60101 dc power output cable assembly (W3) is supplied for connecting DC OUTPUT connector J3 to the external load. This cable assembly has five-pin type MS military connectors on each end. One end has a male connector; the other a female connector.

d. A HP Part No. 5060-0169 extender board assembly (MP1) is supplied to elevate circuit board A1 above the instrument for service. This board has a 50-pin edge connector on each end. One end is male to plug into the A1 socket inside the instrument and the other end has a female socket to accept the A1 Board.

1-13. INSTRUMENT AND MANUAL IDENTIFICATION

1-14. The instrument serial number is located in the upper right corner of the rear panel. The serial number is in the form; 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

1-15. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from those described in this manual. The manual for this newer instrument is accompanied by a yellow Manual Changes supplement. This supplement contains "change information" that explains how to adapt the manual to the newer instruments.

1-16. In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-17. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-18. SAFETY CONSIDERATIONS

1-19. The Model 5089A is a Safety Class I instrument provided with a protective earth terminal. The instrument is designed and tested to international standards. Safety information pertinent to the operation and servicing of this instrument is included in appropriate sections of this manual.

1-20. SAFETY SYMBOLS

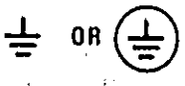
NOTE

The symbol ⚠ (ATTENTION) which appears on the panel of the instrument indicates that the user should refer to the instruction manual before operating, in order to avoid possible instrument damage. Within the manual, information relating to the ATTENTION symbol will be identified with a ⚠ symbol in the margin.

1-21. The following safety symbols are used on equipment and in manuals:

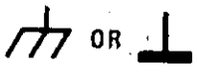
Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to prevent damage to the instrument.

Indicates dangerous voltage at input or output terminals that may exceed 1000 volts.



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating the equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for signal common as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground as described in Section II Installation in this manual before operating the equipment.



Frame and chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current.

Direct current.

WARNING

The WARNING signal denotes a hazard. It calls attention to a procedure, practice, or the like which could result in personal injury if not adhered to or correctly performed.

CAUTION

The CAUTION signal denotes a hazard. It calls attention to an operating procedure, practice, or the like which could result in damage to or destruction to part of or all of the product if not adhered to or correctly performed.

1-22. RECOMMENDED TEST EQUIPMENT

1-23. Equipment required to maintain the Model 5089A is listed in *Table 1-2*. Other equipment can be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-2. Recommended Test Equipment

Instrument	Required Characteristics	Recommended Model
Power Supply	Voltage output of +30V Current capability of 10A	HP Model 6267B
Digital Multimeter or equivalent DC Voltmeter	30V range, 0.01V resolution, ±0.03% accuracy	HP Model 3466A
Clip-on Milliammeter or equivalent	Measures 2A with ±5% accuracy	HP Model 428B
Oscilloscope	50 MHz bandwidth, dual-trace	HP Model 1740A
25 ohm Load	35 Watts dissipation	HP P/N 0819-0022 50 ohm, 20W Resistor (2 in parallel)

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information for unpacking, inspection, installation, and storage of the Hewlett-Packard Model 5089A Standby Power Supply.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, inspect the instrument for visible damage (scratches, dents, etc.). If the instrument is damaged, notify the carrier and the nearest Hewlett-Packard Sales and Service Office immediately (offices are listed at the back of this manual.) Keep the shipping carton and packing material for the carrier's inspection. The Hewlett-Packard Sales and Service Office will arrange for repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

⚠ 2-5. PREPARATION FOR USE

2-6. The HP 5089A requires a single phase ac power source or a dc standby power source if the ac power source is not available or fails. For ac operation, an 85V to 255V rms (48 to 66 Hz) or 85V to 130V rms (85 to 440 Hz) power source is required. A +11V to +30V dc power source is required for dc operation. The HP 5089A does not have an ac line on-off switch and is always operating when connected to a power source.

2-7. Line (Mains) Voltage Selection

2-8. The HP 5089A Power Supply has two ac input voltage ranges. A switch on the rear panel is provided for selecting either an 85-170V ac or 170-255V ac input. No fuse changes are required to use either ac input range.

WARNING

BEFORE CONNECTING POWER TO THE HP 5089A, THE PROTECTIVE EARTH TERMINAL MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR OF THE (MAINS) POWER CORD. THE MAINS PLUG SHALL ONLY BE INSERTED IN AN OUTLET SOCKET WITH A PROTECTIVE EARTH CONTACT. THIS PROTECTION MUST NOT BE NEGATED BY AN EXTENSION POWER CABLE WITHOUT A PROTECTIVE GROUNDING (EARTHING) CONDUCTOR. GROUNDING ONE CONDUCTOR OF A TWO-CONDUCTOR OUTLET IS NOT SUFFICIENT.

CAUTION

Before connecting the instrument to an ac power line (mains), be sure that the rear panel line voltage switch is set to the correct range for the ac input being applied, and that the correct fuses are installed in the fuseholders on the rear panel. Only fuses with the required rated current and voltage ratings and specified type (normal blow, time delay, etc.) should be used for replacement. Do not use repaired fuses or short-circuited fuse holders.

2-9. Selection and Replacement of Fuses

2-10. The HP 5089A is shipped with the correct fuses installed in all fuseholders (F1 through F6). Fuse F1 is inside the instrument and is not a user-replaceable fuse. To replace fuses F2, F3, F4, F5, and F6, use a small, flat-blade screwdriver to remove the fuse carrier from the fuseholder. Press in slightly and turn counterclockwise, until the fuse carrier springs free. Replace the fuse in the fuse carrier and reinstall by inserting and turning clockwise. Be sure to install the correct fuse type and value. Use normal (fast) blow fuses for F2, F4, and F6. Fuses F3 and F5 require a time delay (slow-blow) fuse. Refer to *Table 6-4* Replaceable Chassis Parts for fuse descriptions and part numbers.

2-11. AC Power Input Cable (Power Cord)

2-12. The HP 5089A is shipped with a three-wire ac power input cable (power cord). When the power cord (W1) is connected to an appropriate ac source, it connects the instrument chassis to earth ground.

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN CONNECTING THE HP 5089A TO AN AC OUTLET (MAINS), THE MILITARY-TYPE CONNECTOR OF THE POWER CORD MUST BE CONNECTED TO THE AC LINE CONNECTOR (J1) ON THE REAR PANEL OF THE INSTRUMENT BEFORE INSERTING THE MAINS PLUG IN AN OUTLET SOCKET. TO DETACH THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE CORD FROM THE INSTRUMENT.

2-13. OPERATING ENVIRONMENT

2-14. TEMPERATURE. The HP 5089A may be operated in temperatures from 0 to +50°C.

2-15. HUMIDITY. The HP 5089A may typically be operated in environments with humidity up to 95% at +40°C. However, the HP 5089A should be protected from extreme temperatures which cause condensation in the power supply.

2-16. ALTITUDE. The HP 5089A may be typically operated at altitudes up to 12,180 metres (40,000 feet).

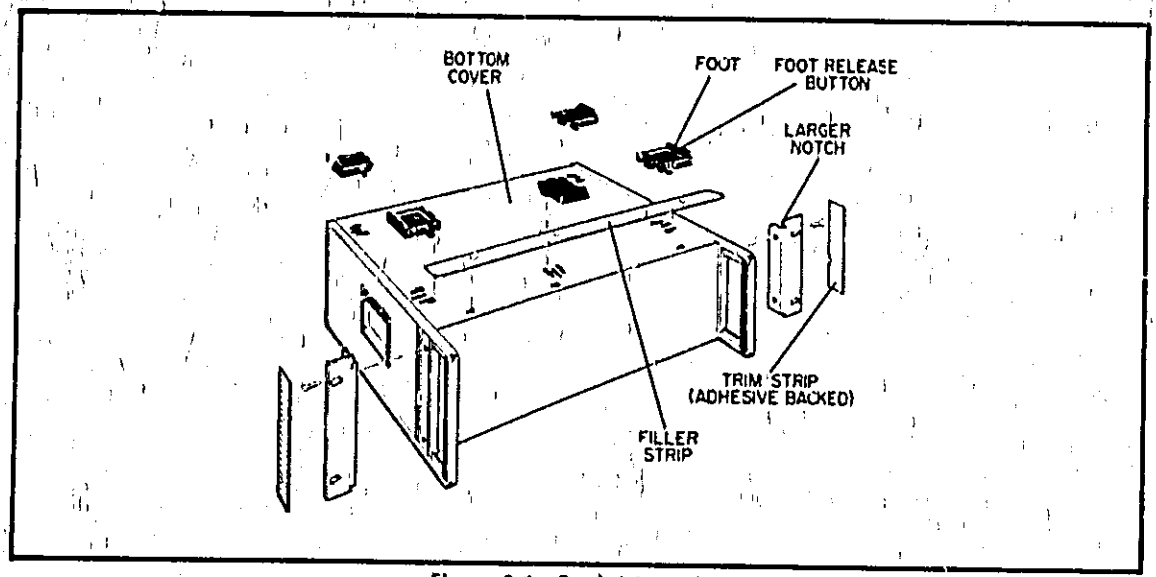


Figure 2-1. Rack Mounting

Table 2-1. Connectors on Cables Supplied with HP 5089A

Function	Model 5089A Power Supply Mfr/HP Part No.	Mating Cable Connector Mfr./HP Part No.	Cable Connector On Opposite End Mfr./HP Part No.	Connection On Opposite End Mfr./HP Part No.
AC LINE J1	MS3102A18-22PW 1251-2458	MS3106A18-22SW 1251-2457	MOLDED 3-PIN POLARIZED PLUG	AC SOURCE
DC INPUT J2	MS3102A16-11P 1251-7962	MS3106A16-11S 1251-7961	RED AND BLACK BATTERY CLAMPS	BATTERY TERMINAL
DC OUTPUT J3	MS3102R14S-5S 1251-0130	MS3106E14S-5P 1251-0129	MS3106E14S-5S 1251-0126	MS3102R14S-5P 1251-0111

2-17. RACK MOUNTING PROCEDURE

2-18. If not shipped as part of a frequency and time standard system, the power supply is ready for bench operation when received. The power supply can be ordered with rack mounting brackets by requesting Option 908 at the time of the original order. To rack mount the HP 5089A at a later date, order the parts listed in *Table 6-4* Replaceable Chassis Parts, Option 908. Use the following procedure and refer to *Figure 2-1* to install the rack mounting parts:

a. Remove mounting feet by pressing the foot release button and slide the feet toward the center of the HP 5089A.

b. Remove adhesive-backed trim strips on sides behind handles.

c. Attach filler strip along the bottom edge of front panel.

d. Attach mounting brackets on each side of power supply. The brackets must be attached with the larger corner notch in each bracket toward the bottom of the instrument.

⚠ 2-19. INSTALLATION PROCEDURE

2-20. The HP 5089A is an automatic instrument with a simple installation procedure and requires little maintenance after being placed in operation. The battery is fully charged and the BATTERY switch is set to OFF when the instrument is first shipped from the factory. If rack mounting is to be used, refer to the Rack Mounting Procedure in the preceding paragraph.

2-21. Before starting the installation, refer to the Section III Operation which will explain steps in the following procedure. The installation of the HP 5089A should be done only by qualified personnel who are aware of the electrical and fire hazards involved.

WARNING

THE HP 5089A POWER SUPPLY IS LESS A POWER SWITCH. THE AC POWER CIRCUITS TO TRANSFORMER T1 AND UNREGULATED DC OUTPUT VOLTAGES ARE ALWAYS ON WHEN THE HP 5089A IS CONNECTED TO AN EXTERNAL POWER SOURCE. CONTACT WITH THESE CIRCUITS CAN CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. ANY ADJUSTMENT OR REPAIR OF AN OPENED INSTRUMENT, WITH POWER CONNECTED, SHOULD BE AVOIDED AS MUCH AS POSSIBLE. THIS TYPE OF OPERATION SHOULD ONLY BE DONE BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED.

a. Be sure the HP 5089A is not connected to an external power source. The power cord will be connected later in this procedure. The BATTERY ON-OFF switch (S1) is located under the front edge of the top cover. Remove screws holding top cover in place and push the cover back. Push BATTERY switch to ON. Moving the switch handle toward the left turns the battery OFF and moving the handle toward the right turns the battery ON. The chassis is marked to show the ON and OFF positions of S1. Replace top cover and screws. The front-panel LED indicators should remain off and both meters should indicate zero.

b. Set the rear panel line voltage switch to the input range which matches the voltage source to be used. Note that the HP 5089A is fused in such a way that no fuse change is required when switching between voltage ranges.

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN CONNECTING THE HP 5089A TO AN AC OUTLET (MAINS), THE MILITARY-TYPE CONNECTOR OF THE POWER CORD MUST BE CONNECTED TO THE AC LINE CONNECTOR (J1) ON THE REAR PANEL OF THE INSTRUMENT BEFORE INSERTING THE MAINS PLUG IN AN OUTLET SOCKET. TO DETACH THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE CORD FROM THE INSTRUMENT.

THE PROTECTIVE EARTH TERMINAL MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR OF THE (MAINS) POWER CORD. THE MAINS PLUG SHALL ONLY BE INSERTED IN AN AC OUTLET SOCKET WITH A PROTECTIVE EARTH CONTACT. THIS PROTECTION MUST NOT BE NEGATED BY AN EXTENSION POWER CABLE LESS THE PROTECTIVE THIRD CONDUCTOR.

CAUTION

When charging the HP 5089A, the instrument should not be positioned in such a way that the battery terminals are facing downward (instrument sitting on its rear panel). Charging the battery in this position may force venting of the electrolyte which may cause instrument damage and possible personal injury. When in use as a power source (battery discharging), the HP 5089A may be used in any position.

c. Connect ac power cord to the HP 5089A AC LINE connector J1. Connect the ac cord to an external 85V to 255V rms (48 to 66 Hz) or an 85V to 130V rms (48 to 440 Hz) single phase power source. The front-panel green and yellow indicators will turn on. The voltmeter will show less than about 27 volts and the ammeter will show a positive charging current of approximately 2.0A.

d. Continue to charge battery. Both meters will start showing a rapid change as the battery approaches full charge. The battery is almost fully charged when the voltage is at least 27 volts and the charging current is less than 0.5 amperes.

e. Attach DC OUTPUT connector to instrument for which the HP 5089A is to supply standby power. If the instrument is not connected to a separate power source and draws power from the HP 5089A, the power supply ammeter will indicate a decrease in charging current and the voltmeter indication will drop. If the output current is more than about two amperes, the ammeter indication will be negative, showing that the battery is being discharged.

f. The ammeter indication shows current flow to and from the battery. A positive meter reading indicates that the battery is charging, and a negative reading indicates that the battery is discharging.

g. Connect external dc power source (if used) to the DC INPUT connector (J2 or J5/J6) which has the correct input range to accept the dc level of the external source. A dc source capable of supplying from +11V up to +30V and a maximum current up to approximately 10 amperes can be used.

h. Push RESET/START switch to turn off the yellow CHARGE INTERRUPT light. This switch serves two functions as explained in the operating section of this manual.

i. Attach a low voltage (30Vdc at 2A max) external alarm circuit to rear panel LOW BATTERY WARNING terminals, if desired. The external alarm should actuate by contact closure which occurs when the battery output voltage drops to a preset value.

2-22. STORAGE AND SHIPMENT ENVIRONMENT

2-23. The instrument may be stored or shipped in environments within the following temperature, humidity, and altitude limitations. The instrument should also be protected from temperature and humidity extremes which cause condensation within the instrument.

a. Temperature: −40 to +65°C.

b. Humidity: up to 95% noncondensing.

c. Altitude: 15,240 metres (50,000 feet).

2-24. PACKAGING

2-25. ORIGINAL PACKAGING. Containers and materials identical to those used in the factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-26. OTHER PACKAGING. The following general instructions should be used for repacking with commercially available materials.

a. Wrap instrument in heavy paper or plastic. If shipping to Hewlett-Packard office or service center, attach tag indicating type of service required, return address, model number, and full serial number.

b. Use strong shipping container. A double-wall carton made of 350-pound test material is adequate.

c. Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inches) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

OPERATION

PERFORMANCE CHECK

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section gives complete operating information for the HP 5089A. Descriptions of the front and rear panel features, as well as an operator's check, operating instructions, and maintenance, are provided.

3-3. OPERATING CHARACTERISTICS

3-4. The HP 5089A is a portable power supply with a nominal output of +22V to +28V dc and, if the battery is fully charged, a 15 ampere-hour output capacity. Maximum output current is 2 amperes.

3-5. The HP 5089A has two series-connected 12V sealed lead-acid batteries. This combination of two batteries will be considered as one single "24V" battery in this manual.

3-6. Front Panel Indicators and Control

3-7. Operation is fully automatic except for manual reset after interruption of the external power source. Three LED indicators plus a dc voltmeter, center-scale dc ammeter, and RESET/START switch are the only front-panel controls and indicators. An on-off switch is not supplied so the HP 5089A is always ON when connected to a power source.

3-8. AC Operation

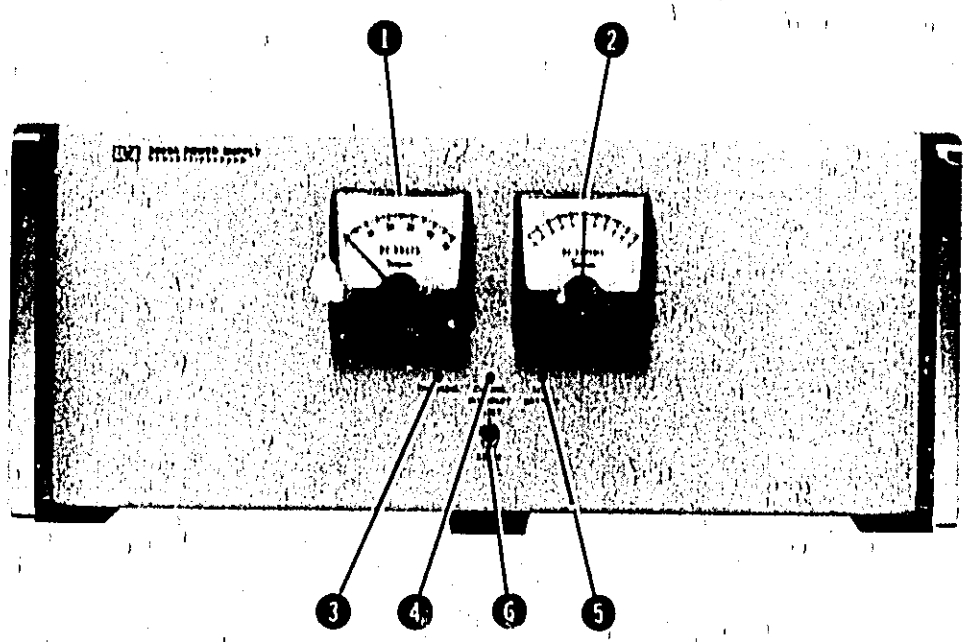
3-9. For ac operation, an 85V to 255V rms (48 to 66 Hz) or an 85V to 130V rms (48 to 440 Hz) power source is required (300VA maximum).

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN CONNECTING THE HP 5089A TO AN AC OUTLET (MAINS), THE MILITARY-TYPE CONNECTOR OF THE POWER CORD MUST BE CONNECTED TO THE AC LINE CONNECTOR (J1) ON THE REAR PANEL OF THE INSTRUMENT BEFORE INSERTING THE MAINS PLUG IN AN OUTLET SOCKET. TO DETACH THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE CORD FROM THE INSTRUMENT.

CAUTION

Before connecting the instrument to an ac power line (MAINS), be sure that the rear panel line voltage switch is set to the correct range for the ac input being applied, and that the correct fuses are installed in the fuseholders on the rear panel. Only fuses with the required rated current and voltage ratings and specified type (normal blow, time delay, etc.) should be used for replacement. Do not use repaired fuses or short-circuited fuse holders.



1. DC VOLTMETER (M1) – Indicates battery voltage when internal BATTERY switch is set to ON. Shows output voltage to any external load attached to DC OUTPUT connector (J3).

2. CENTER-SCALE DC AMMETER (M2) – Shows battery current when BATTERY switch is set to ON by a positive indication when charging and a negative indication when discharging.

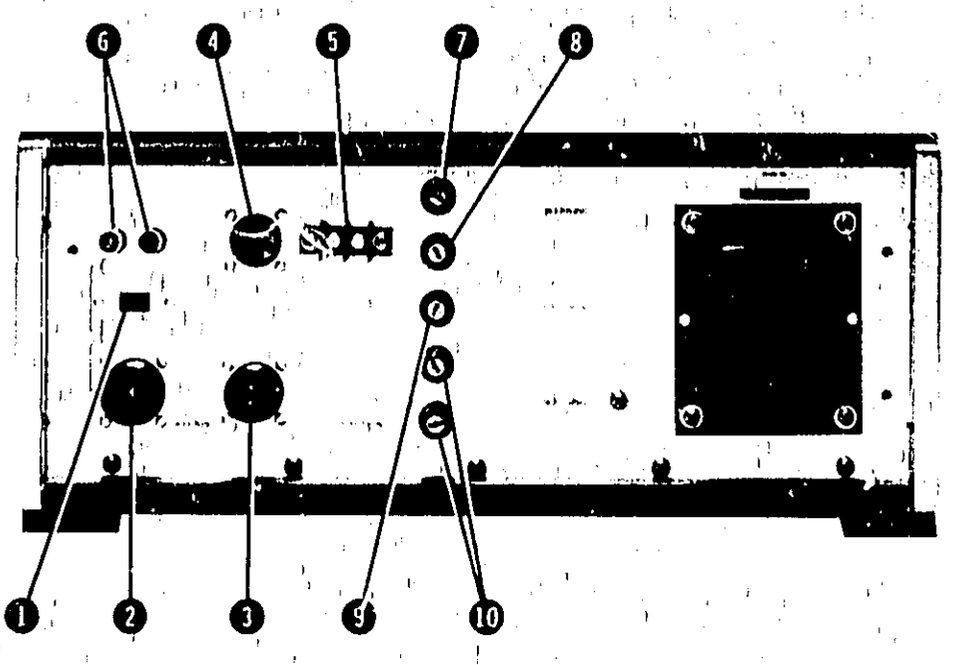
3. CHARGING (A2DS1) – Green LED turns ON to indicate battery CHARGING and normal instrument operation. This LED turns OFF if input power is removed and stays off until the power source is restored.

4. CHARGE INTERRUPT (A2DS2) – Yellow LED turns ON to indicate that the power input has been interrupted. After power is restored, the RESET/START button must be pushed to turn OFF the CHARGE INTERRUPT light.

5. BATTERY LOW (A2DS3) – Red LED turns ON to indicate that the battery has discharged to a voltage level of approximately +23 volts.

6. RESET/START (A2S1) – Pushbutton switch used to RESET the HP 5089A after an interruption of the external power input to the instrument. Also used to activate (START) the HP 5089A after the internal BATTERY switch (S1) has been switched OFF then back ON, when no external power source is present.

Figure 3-1. HP 5089A Front Panel Features



1. ~ (AC) LINE SELECTOR (S2) – Selects voltage range for ac input, either 85V-170V (48-66 Hz), 85V-130V (48-440 Hz) rms or 170V-255V (48-66 Hz) rms.

2. ~ (AC) LINE INPUT (J1) – 3-pin connector accepts ac input power from an 85V-130V rms, 48-440 Hz, or an 85V-255V rms, 48-66 Hz source (300 VA max).

3. DC INPUT 11V-20V (J2) - 2-pin connector accepts a +11V to +20V dc input (110 Watts max).

4. DC OUTPUT 22V-28V (J3) – 5-pin connector outputs a +22V to +28V dc voltage to an external load (2 amperes max).

5. LOW BATTERY WARNING (J4) – 2-terminal barrier block provides floating contact closure for connecting an external audible or visible low battery voltage warning.

6. DC INPUT 20V-30V (J5/J6) – Two terminal binding posts accept a +20V to +30V dc input (110 Watts max).

7. FUSE, DC OUTPUT (F4) – 5 ampere, 250 volt, normal (fast) blow fuse connected in series with DC OUTPUT connector J3.

8. FUSE, DC INPUT (F3) – 10 ampere, 250 volt time-delay (slow-blow) fuse connected in series with DC INPUT connector J5 (red binding post, 20-30VDC).

9. FUSE, DC INPUT (F5) – 10 ampere, 250 volt time-delay (slow-blow) fuse connected in series with DC INPUT connector J2 (11-20VDC).

10. FUSES, ~ (AC) LINE (F2,F6) - 1 ampere, 250 volt normal (fast) blow fuses connected in series with AC LINE connector J1.

Figure 3-2. HP 5089A Rear Panel Features

3-10. DC Operation

3-11. For dc operation, a +11V to +30V dc power source is required. The HP 5089A can be connected to a dc power source while at the same time being connected to an ac power source. No power will be drawn from the external dc source unless the ac source for the HP 5089A is interrupted or fails.

3-12. FRONT PANEL FEATURES

3-13. Two front-panel meters and three LED indicators (see *Figure 3-1*) supply all necessary information to monitor operation of the power supply. The dc voltmeter (M1) indicates the voltage of the battery when the internal BATTERY ON-OFF switch (S1) is set to ON. If an external load is attached, the voltmeter indicates the output voltage to the load, and the ammeter (M2) indicates the battery output current to the external load. The two meters show battery discharge by a negative indication on the ammeter and a declining indication on the voltmeter as the battery discharges.

3-14. The green LED turns on to indicate battery CHARGING and normal instrument operation. This light turns off if input power is removed and stays off until the power source is restored.

3-15. The yellow CHARGE INTERRUPT light turns on to indicate that the input power has been interrupted. When power returns, the battery automatically begins recharging. The RESET/START button must be pushed to turn the CHARGE INTERRUPT light off.

3-16. The red BATTERY LOW light turns on to indicate that the battery has discharged to a voltage level of approximately +23 volts. The battery will continue to supply power after the BATTERY LOW light turns on.

3-17. The RESET/START pushbutton is used to RESET the HP 5089A if input power has been interrupted and then restored. The RESET/START pushbutton is also used for a special operating mode under emergency conditions as explained in Paragraphs 3-33 Emergency Battery Operation.

3-18. REAR PANEL FEATURES

3-19. All input and output connections for the HP 5089A are provided on the rear panel (see *Figure 3-2*). In addition, five user-replaceable fuses and a connection for an external alarm are supplied.

3-20. The HP 5089A accepts an ac line input at a 3-pin military-type connector (J1). The Line Selector switch (S2) can be set for either an 85V to 170V rms (48 to 66 Hz), 85V to 130V rms (48 to 440 Hz) input, or 170V to 255V rms (48 to 66 Hz) input.

3-21. Two input connections for an external dc power source are provided on the rear panel of the HP 5089A. A two-pin type MS male connector (J2) is provided for a +11V to +20V input, and two terminal binding posts (J5/J6) are provided for a +20V to +30V input.

3-22. A 5-pin military-type connector (J3) outputs a +22V to +28V dc voltage to an external load. The maximum output current is 2 amperes.

3-23. A connection for an optional, external LOW BATTERY WARNING alarm is provided at a two-terminal barrier block (J4). The internal contact closure circuit has no connection to the HP 5089A electrical circuits or to the chassis ground.

3-24. Five user-replaceable fuses (F2-F6) are provided on the rear panel. Refer to Operator's Maintenance, Paragraph 3-38, Fuses for fuse descriptions.

3-25. Battery WARNING and DROP OUT

3-26. The battery will supply power to an external load until discharged to a voltage level of approximately +23 volts. At this time, a preset internal WARNING relay actuates, turning on the front-panel BATTERY LOW light and closing the connection at the rear-panel LOW BATTERY WARNING terminals.

3-27. The battery will continue to supply power until the battery voltage drops to +22 volts. An internal DROP OUT relay then deactivates to disconnect both ends of the battery from the internal circuits and external load. The relay contacts for the external alarm remain closed.

3-28. Automatic Recharge and Manual Reset

3-29. When external power returns, the HP 5089A battery automatically starts recharging (charge current shown by ammeter). The external alarm contacts open and the green CHARGING light turns on. The yellow CHARGE INTERRUPT light will turn on to show that the battery has been used and may not be fully charged. Pushing the RESET/START pushbutton turns the CHARGE INTERRUPT light off and arms the charge interrupt indicator circuit.

3-30. BATTERY ON-OFF SWITCH

3-31. BATTERY ON-OFF switch S1 (located inside the instrument) can be used to turn the battery ON or OFF when connecting external equipment or to prevent battery discharge by an external load. The BATTERY switch should be turned OFF so the WARNING and DROP OUT control circuits will not discharge the battery when the HP 5089A is not in use and not connected to an external power source. The BATTERY switch must be ON to recharge the battery or to obtain output power from the battery.

WARNING

THE HP 5089A POWER SUPPLY IS LESS A POWER SWITCH. THE AC POWER CIRCUITS TO TRANSFORMER T1 AND UNREGULATED DC OUTPUT VOLTAGES ARE ALWAYS ON WHEN THE HP 5089A IS CONNECTED TO AN EXTERNAL POWER SOURCE. CONTACT WITH THESE CIRCUITS CAN CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. ANY ADJUSTMENT OR REPAIR OF AN OPENED INSTRUMENT SHOULD BE AVOIDED AS MUCH AS POSSIBLE. THIS TYPE OF OPERATION SHOULD ONLY BE DONE BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED.

3-32. BATTERY ON-OFF switch S1 is located under the front edge of the top cover. Disconnect power input from external power source and remove screws holding the top cover to gain access to S1. Slide cover back to expose the switch handle. Move handle to the left to turn battery OFF or to the right to turn battery ON. The chassis is marked to show the ON and OFF positions of S1. Replace cover and screws before attaching external power input source.

3-33. EMERGENCY BATTERY OPERATION

3-34. A battery that is not fully discharged can be used in an emergency even if the HP 5089A is not connected to an external power source. To use the remaining charge in a partially discharged battery, turn the BATTERY switch ON. All three of the front-panel lights will remain off and both meters will indicate "0" until the RESET/START switch is pushed. The voltmeter will then indicate battery voltage and the ammeter will show the discharge current to any external load connected to

the HP 5089A. The three LED indicators will not turn on. The battery can be used until the WARNING and DROP OUT circuits are activated and the battery is disconnected from the load but not the control circuits.

3-35. Reconnect the power supply to an external power source to recharge the battery. The battery should be recharged as soon as possible to avoid possible battery damage.

3-36. OPERATOR'S MAINTENANCE

3-37. The only maintenance the operator should normally perform is the replacement of the fuses as described in Paragraph 2-9 Selection and Replacement of Fuses.

CAUTION

Use fuses which are exact equivalents of the original fuses for replacement. See Table 6-4 for fuse descriptions. Make sure that only fuses with the required rated current and voltage ratings and specified type (normal blow, time delay, etc.) are used for replacement. Do not use repaired fuses or short-circuited fuse holders.

3-38. Fuses (Rear-Panel and Internal)

3-39. The six fuses (F1-F6) listed below are all user-replaceable except for F1 which is inside the instrument and should be replaced only by service personnel. Fuses F2 through F6 are installed in fuseholders mounted on the rear panel. The part number and description for all replacement fuses can be found in Section VI Replaceable Parts, Table 6-4 Replaceable Chassis Parts.

3-40. Fuse F1 is located inside the instrument (under front of top cover) and is connected in series with the battery to prevent instrument damage or injury to service personnel if the battery is accidently shorted. F1 is a 5A, 250V normal (fast) blow fuse.

3-41. The rear-panel ac input fuses, F2 and F6, are connected in series with AC LINE connector J1 to protect the power input circuitry. F2 and F6 are 1A, 250V normal (fast) blow fuses.

3-42. Fuse F3 is connected in series with DC INPUT connecter J5 (+20V to +30V) to protect any external dc power source connected to J5/J6. F3 is a 10A, 250V time delay (slow-blow) fuse.

3-43. Fuse F4 is in series with DC OUTPUT connector J3 to protect the battery output circuit. F4 is a 5A, 250V normal (fast) blow fuse.

3-44. Fuse F5 is connected in series with DC INPUT connector J2 (+11 to +20V) to protect any external dc power source connected to J2. F5 is a 10A, 250V time delay (slow-blow) fuse.

3-45. METER INDICATIONS

3-46. The float voltage for the battery is adjustable and is set to +28.20 volts. The indication on the voltmeter can be used to estimate how well the battery is charged. Charging current for the trickle charge is 60 mA and will cause a very slight positive indication on the ammeter.

3-47. PERMANENT TEST RECORD

3-48. The meter indications should be noted in a permanent Test Record when the HP 5089A is first placed in service and should be checked at least once a week. A change in the indications such

as a voltage decrease shown by the voltmeter or an increase in the ammeter current could be an indication of pending trouble in the HP 5089A battery or in the external equipment connected to the DC OUTPUT jack. If a charge interrupt occurs, the green CHARGING light and the yellow CHARGE INTERRUPT light will both turn on when power returns. Press the RESET/START button to turn the CHARGE INTERRUPT light off. Check meter indications frequently until the battery voltage and current return to the original indications as noted in the Test Record.

3-49. BATTERY RECHARGING TIME

3-50. The HP 5089A charging circuit is current limited for a maximum output of about two amperes for battery recharging. The charging current gradually decreases as battery terminal voltage rises. When the float voltage is reached, the charging current reduces to a trickle charge.

3-51. If the HP 5089A internal battery is completely discharged and power is restored, the battery will recharge to at least 90% of full capacity in approximately 24 hours. A battery which has gone through a number of full discharge/24 hour recharge cycles must be recharged for an extended period of time (at least 72 hours) to maintain the battery's ability to accept a full charge.

CAUTION

When charging the HP 5089A, the instrument should not be positioned in such a way that the battery terminals are facing downward (instrument sitting on its rear panel). Charging the battery in this position may force venting of the electrolyte which may cause instrument damage and possible personal injury. When in use as a power source (battery discharging), the HP 5089A may be used in any position.

3-52. Recharging With External Load

3-53. If the battery is recharged while an external load is connected to the HP 5089A output, the load may draw power from the recharging circuit and reduce recharging current to the battery. The time required to recharge the battery will increase and become a variable factor determined by current drain for the load. As long as an external load does not draw more current than the output of the current limiter, the battery will be recharged and will not remain in a discharged state.

3-54. PRECHARGING REPLACEMENT BATTERIES

3-55. New batteries from the factory being used as replacements must be precharged before being used in the HP 5089A to insure that the voltages of the two 12V batteries are balanced. In normal instrument use, the two batteries are charged in series. If the battery voltages are not in balance, the charging current will reduce to a trickle charge when the float voltage of the higher voltage battery is reached, preventing the lower voltage battery from reaching a full charge. To ensure proper charging during normal use, each 12V battery should be individually precharged to the same voltage level before being installed in the HP 5089A. A precharge should also be done on any battery which has been stored for an extended period of time (approximately four months) without being charged or discharged. Refer to Section VIII Service, Paragraph 8-93 Battery Replacement.

3-56. OPERATION WITH HP FREQUENCY STANDARDS

3-57. If the HP 5089A DC OUTPUT is connected to a HP Frequency Standard for standby power, no power will be drawn from the HP 5089A when ac power is supplied to both the Power Supply and

the Frequency Standard. If the Frequency Standard remains connected to an ac power source when ac power input to the HP 5089A is interrupted, the Frequency Standard will not draw power from the HP 5089A.

3-58. *Figure 3-3* shows the cable arrangement between the HP 5089A Standby Power Supply and a frequency standard (in this example, the HP 5061A Cesium Beam Frequency Standard.)

3-59. Option 001 Spare A1 Board Assembly

3-60. If the HP 5089A has been ordered with Option 001, a spare A1 Assembly is provided with the instrument. This spare board has been preadjusted at the factory and can be used as a backup board in the event of an A1 Assembly failure which cannot be immediately repaired. Refer to Section VIII Service, paragraph 8-26 Removal of A1 Assembly if the spare board is to be used. Note that replacing the original A1 Assembly with the spare board will cause the front-panel meter readings to be inaccurate. Refer to Section V Adjustments for calibration procedures.

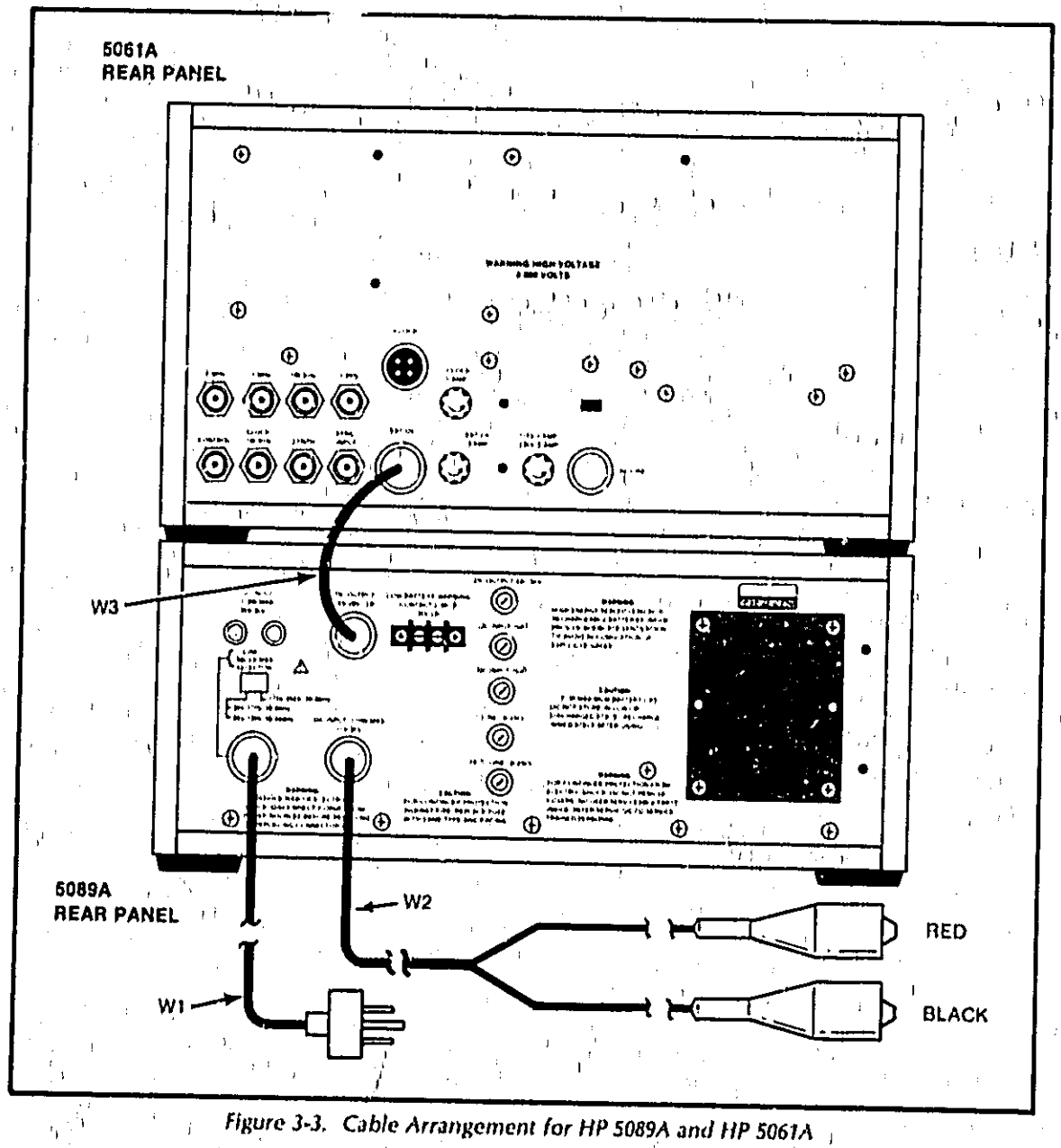


Figure 3-3. Cable Arrangement for HP 5089A and HP 5061A

SECTION IV
OPERATION VERIFICATION

4-1. INTRODUCTION

4-2. The procedure in this section provides a method of verifying the basic operation of the HP 5089A. The test can be performed to give a high degree of confidence that the HP 5089A is operating properly.

4-3. EQUIPMENT REQUIRED

4-4. Equipment required for the Operation Verification procedure is a fixed resistor with a power rating of at least 35 watts and a value of 25 ohms.

4-5. CALIBRATION CYCLE

4-6. The HP 5089A requires periodic verification of operation. Depending on the use and environmental conditions, the HP 5089A should be checked using the Operation Verification procedure at least twice a year.

4-7. An Operation Verification should also be performed after instrument repair. If new batteries were installed in the instrument, they should be precharged before testing the HP 5089A. Refer to Section VIII Service, Paragraph 8-93 Battery Replacement for battery precharging procedure before performing the Operation Verification.

4-8. TEST RECORD

4-9. The front-panel meter indications should be noted in a permanent test record when the HP 5089A is first placed in service and should be checked at least once a week. An unexplained change in a meter reading could be an indication of pending trouble in the HP 5089A battery or in the external equipment connected to the DC OUTPUT jack. If a charge interrupt occurs, the meter readings will change from the values noted in the test record until power is returned and the battery is fully charged. Press RESET/START switch to turn CHARGE INTERRUPT indicator off and check meter indications frequently until battery voltage and current return to the original values noted in the test record.

4-10. A suitable Test Record is given in *Table 4-1* at the end of this manual section.

4-11. OPERATION VERIFICATION PROCEDURE

4-12. Operation verification is recommended every four to six months and at least twice a year. The verification consists of discharging the battery until DROP OUT occurs and then completely recharging to the float voltage. Operation verification should be performed only by qualified personnel who are aware of the electrical and fire hazards involved. The following procedure is suggested:

a. Turn BATTERY switch S1 to OFF.

b. Disconnect all rear-panel connections. (An external alarm may be connected to the barrier block terminals to check the alarm circuit.)

c. Connect a power resistor with a rating of at least 35 Watts and a value of 25 ohms between terminals A and C of DC OUTPUT Jack J3. Considerable heat will be dissipated by the resistor over a period of time. The resistor must be mounted in a manner that will not cause a fire hazard.

d. Turn BATTERY switch S1 to ON and momentarily apply external ac or dc power. Momentary power input activates the WARNING and DROP OUT relay circuits and checks that the green and yellow front-panel lights operate.

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN CONNECTING THE HP 5089A TO AN AC OUTLET (MAINS), THE MILITARY-TYPE CONNECTOR OF THE POWER CORD MUST BE CONNECTED TO THE AC LINE CONNECTOR (J1) ON THE REAR PANEL OF THE INSTRUMENT BEFORE INSERTING THE MAINS PLUG IN AN OUTLET SOCKET. TO DETACH THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE CORD FROM THE INSTRUMENT.

e. When external power is removed, the ammeter should indicate battery discharge by showing a negative current determined by the resistor value and output voltage. The 25 ohm resistor load will result in a current reading of about 1 ampere.

f. The battery will discharge through the load resistor until the voltmeter indication drops to about +23V. At this time, the red LED indicating BATTERY LOW will turn on and the external alarm, if connected, will be actuated.

g. After a total period of at least 15 hours, DROP OUT will occur and the red LED will turn off. The external alarm will still be on.

i. Turn BATTERY switch to OFF and disconnect the load resistor.

j. Turn BATTERY switch back to ON. Connect the instrument to an ac source (Refer to Section II Installation, Paragraph 2-21, Steps b and c).

k. The battery should begin charging as shown by the meters. The green and yellow LED's should turn on. Pressing the RESET/START switch should turn the yellow LED off. The external alarm circuit should be off.

l. The battery should finish charging in not more than 24 hours as indicated by the two meters. Refer to Section III Operation, Paragraph 3-45 Meter Indications and 3-49 Battery Recharging Time. After a 24 hour charge, the HP 5089A is ready for normal operation.

Table 4-1. Power Supply Meter Test Record

Date	Voltmeter	Ammeter	Tested By	Notes

ADJUSTMENTS

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section describes the adjustments required to maintain the HP 5089A operating characteristics within specifications. Adjustments should be made when required, such as after battery replacement or component replacements that may affect an adjustment. Adjustment is also needed if the instrument does not meet any part of the Operation Verification Test in Section IV.

5-3. EQUIPMENT REQUIRED

5-4. Test equipment required for the adjustment procedure is listed in *Table 1-2*, Recommended Test Equipment. Substitute instruments may be used if they meet the requirements as given in the table.

5-5. ADJUSTMENT PROCEDURE

5-6. The following procedure describes operations required for adjustment of the four controls on the A1 Power Supply/Regulator Assembly. The four controls are located on the top of the circuit board with their functions described by adjacent markings on the board. The adjustments should be performed in the sequence that follows:

a. Disconnect power connectors and all other connections on the rear of the instrument.

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN DETACHING THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE POWER CORD FROM THE INSTRUMENT.

b. Remove top instrument cover. Leave BATTERY switch at ON. Pull plug-on battery connectors off of the positive and negative ends of the battery. The jumper between the two batteries can remain connected. Insulate exposed battery terminals with tape to prevent any short circuits while performing the following steps.

WARNING

THE HP 5089A POWER SUPPLY IS LESS A POWER SWITCH. THE AC POWER CIRCUITS TO TRANSFORMER T1 AND UNREGULATED DC OUTPUT VOLTAGES ARE ALWAYS ON WHEN THE HP 5089A IS CONNECTED TO AN EXTERNAL POWER SOURCE. CONTACT WITH THESE CIRCUITS CAN CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. ANY ADJUSTMENT OR REPAIR OF AN OPENED INSTRUMENT SHOULD BE AVOIDED AS MUCH AS POSSIBLE. THIS TYPE OF OPERATION SHOULD ONLY BE DONE BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED.

c. Connect positive output terminal of external dc power supply to battery positive lead (wht/red)) and negative output terminal to chassis ground. Connect digital voltmeter across external dc power supply and set output for an indication of +27.00 volts.

d. Remove four plug buttons in top cover of compartment for circuit board A1. The controls marked DROP OUT, WARNING, VOLTAGE SET, and METER can all be reached by a small screwdriver. Set A1R30 (DROP OUT) and A1R32 (WARNING) maximum counterclockwise.

e. Reduce dc power supply voltage to +22.00 volts. Move digital voltmeter positive test lead to pin A of DC OUTPUT connector J3. The negative voltmeter test lead should remain connected to chassis ground.

f. The voltmeter should indicate +22.00 volts. Slowly turn A1R30 clockwise until a relay click is heard. The voltmeter should now indicate 0 volts.

g. Move digital voltmeter positive test lead to the external power supply and set the output for an indication of +27.00 volts. The sound of a relay click will be heard as the voltage is adjusted upwards. Next, reduce the external power supply output to +23.00 volts.

h. The BATTERY LOW lamp should now be OFF. Slowly turn A1R32 (WARNING) clockwise until a relay click is heard and the BATTERY LOW light turns ON.

i. Disconnect external dc power supply and digital voltmeter.

j. Set output of the external power supply to zero. Connect the positive side of the external supply to the positive battery connector (wht/red wire). Connect the negative side to the negative battery connector (wht/blk/yel wire).

k. Connect a 25 ohm resistor (35 watts or higher) to the rear terminal of the fuseholder for the DC OUTPUT line (F4). This fuseholder is the one nearest the top of the instrument on the rear panel. The connection should be made to the red wire coming from the fuseholder. Connect the other side of the resistor to chassis ground. Use clip leads for connections and a clip-on dc milliammeter or an ammeter connected in series with the resistor to monitor the resistor current.

l. Increase power supply output to +24.00 volts. Indications will appear on the two front-panel meters. The BATTERY switch must be ON.

m. Adjust power supply output until the current monitor for the 25 ohm resistor indicates 1 ampere. Adjust METER control (A1R23) for an indication of −1.0 ampere on the front-panel ammeter.

n. Disconnect the power supply and the current monitor. Leave the 25 ohm resistor connected between the red wire of F4 and chassis ground.

o. Set the HP 5089A ac voltage switch on the rear panel to the 85V to 170V (48 to 66 Hz) range. Connect the HP 5089A to a 115 volt ac power source. The front-panel dc voltmeter will show an indication. Monitor the output voltage at pin A of DC OUTPUT connector J3 with the digital voltmeter at the F4 fuseholder (red wire).

p. Adjust VOLTAGE SET control (A1R19) for a digital voltmeter indication of +28.20 volts. Check this voltage by connecting the digital voltmeter to the battery positive (wht/red) lead and to chassis ground.

q. Disconnect external power source and all test equipment. Replace plug buttons in A1 top cover. Set BATTERY switch to OFF.

r. Connect battery by re-attaching two push-on connectors. Attach the connector with the wht-red wire to the positive terminal. The connector with the wht-blk-yel wire goes to the negative terminal.

s. Turn the BATTERY switch ON. All three of the front-panel lights will remain off and both meters will indicate "0" until the RESET/START switch is pushed. The voltmeter will then indicate battery voltage and the ammeter will show the very low discharge current drawn by the battery control circuits. The three LED indicators will not turn on. If no indications are shown by the meters, the battery must be charged sufficiently to obtain meter readings before this test is completed.

t. Replace top instrument cover. Return the HP 5089A to standby operation by following the INSTALLATION procedure in Section II of this manual. If the power supply is not to be used for standby service, follow the INSTALLATION procedure to connect the power supply to a power source to charge the battery. When fully charged, the battery is maintained by the float voltage.

CAUTION

Prolonged storage is not recommended for the HP 5089A unless the battery is fully charged and, if possible, connected to an ac power source to maintain the float voltage. If storage without power input is necessary, be sure the battery is fully charged and internal BATTERY switch S1 is set to OFF before placing the instrument in storage. Lead-acid batteries deteriorate rapidly if stored in a discharged state.

PARTS LIST

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. *Tables 6-2* through *6-4* list replaceable electrical and mechanical parts for circuit boards A1 and A2 plus those parts which are mounted on or are a part of the chassis. *Table 6-5* contains the names and addresses that correspond with the manufacturer's code numbers given in the parts lists.

6-3. ABBREVIATIONS AND REFERENCE DESIGNATIONS

6-4. *Table 6-1* lists abbreviations and reference designations used in the parts list, schematic diagrams, and throughout this manual. In some cases, two forms of the abbreviations are used, one all in capital letters, and one with partial or no capital letters. This occurs because the abbreviations in the parts lists are in capital letters only. However, in the schematic diagrams and other parts of the manual, other forms of abbreviation are used with both lower case and upper case letters.

6-5. REPLACEABLE PARTS LIST

6-6. *Tables 6-2* through *6-4* are lists of replaceable parts organized in the following sequence:

a. Electrical assemblies (usually circuit boards) and their components in alphanumeric order by circuit reference designations.

b. Chassis-mounted parts in alphanumeric order by reference designations.

c. Chassis parts in alphanumeric sequence by the "H" and "MP" designations assigned to the parts.

6-7. The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. The part number check digit (CD).

c. Total quantity (Qty) used in each individual assembly.

d. The description of the part.

e. A typical manufacturer of the part in a five-digit code.

f. The manufacturer's number for the part.

6-8. The total quantity of each part used within an assembly is given only once at the first appearance of the part number in the list for that assembly.

Table 6-1. Abbreviations and Reference Designations

REFERENCE DESIGNATIONS

A	= assembly
AT	= attenuator, isolator, termination
B	= fan; motor
BT	= battery
C	= capacitor
CP	= coupler
CR	= diode, diode thyristor, varactor
DC	= directional coupler
DL	= delay line
DS	= annunciator; signaling device (audible or visual); lamp; LED
E	= miscellaneous electrical part
F	= fuse
FL	= filter
H	= hardware
HY	= circulator
J	= electrical connector (stationary portion); jack
K	= relay
L	= coil, inductor
M	= metre
MP	= miscellaneous mechanical part
P	= electrical connector (movable portion); plug
Q	= transistor; SCR, triode thyristor
R	= resistor
RT	= thermistor
S	= switch
T	= transformer
TB	= terminal board
TC	= thermocouple
TP	= test point
U	= integrated circuit, microcircuit
V	= electron tube
VR	= voltage regulator, breakdown diode
W	= cable, transmission path, wire
X	= socket
Y	= crystal unit-piezo-electric
Z	= tuned cavity, tuned circuit

ABBREVIATIONS

A	= ampere
ac	= alternating current
ACCESS	= accessory
ADJ	= adjustment
A/D	= analog-to-digital
AF	= audio frequency
AFC	= automatic frequency control
AGC	= automatic gain control
AL	= aluminum
ALC	= automatic level control
AM	= amplitude modulation
AMPL	= amplifier
APC	= automatic phase control
ASSY	= assembly
AUX	= auxiliary
AVG	= average
AWG	= american wire gauge
BAL	= balance
BCD	= binary coded decimal
BD	= board
BE CU	= beryllium copper
BFO	= beat frequency oscillator
BH	= binder head
BKDN	= breakdown
BP	= bandpass
BPF	= bandpass filter
BRS	= brass
BWO	= backward-wave oscillator
CAL	= calibrate
CCW	= counterclockwise
CER	= ceramic
CHAN	= channel
cm	= centimeter
CMO	= coaxial
COEF	= coefficient
COM	= common
COMP	= composition
COMPL	= complete
CONN	= connector
CP	= cadmium plate
CRT	= cathode-ray tube
CTL	= complementary transistor logic
CW	= continuous wave
cw	= clockwise
D/A	= digital-to-analog
dB	= decibel
dBm	= decibel referred to 1 mW
dc	= direct current
deg	= degree (temperature interval or difference)
°	= degree (plane angle)
°C	= degree Celsius (centrigrade)
°F	= degree Fahrenheit
°K	= degree Kelvin
DEPC	= deposited carbon
DET	= detector
diam	= diameter
DIA	= diameter (used in parts list)
DIFF AMPL	= differential amplifier
div	= division
DPDT	= double-pole, double-throw
DR	= drive
DSB	= double sideband
DTL	= diode transistor logic
DVM	= digital voltmeter
ECL	= emitter coupled logic
EMF	= electromotive force
EDP	= electronic data processing
ELECT	= electrolytic
ENCAP	= encapsulated
EXT	= external
F	= farad
FET	= field-effect transistor
F/F	= flip-flop
FH	= flat head
FIL H	= filister head
FM	= frequency modulation
FP	= front panel
FREQ	= frequency
FXD	= fixed
g	= gram
GE	= germanium
GHz	= gigahertz
GL	= glass
GND	= ground(ed)
H	= henry
h	= hour
HET	= heterodyne
HEX	= hexagonal
HD	= head
HDW	= hardware
HF	= high frequency
HG	= mercury
HI	= high
HP	= Hewlett-Packard
HPF	= high pass filter
HR	= hour (used in parts list)
HV	= high voltage
Hz	= hertz
IC	= integrated circuit
ID	= inside diameter
IF	= intermediate frequency
IMPG	= impregnated
in	= inch
INCD	= incandescent
INCL	= included(s)
INP	= input
INS	= insulation
INT	= internal
kg	= kilogram
kHz	= kilohertz
kΩ	= kilohm
kV	= kilovolt
lb	= pound
LC	= inductance capacitance
LED	= light-emitting diode
LF	= low frequency
LG	= long
LH	= left hand
LIM	= limit
LIN	= linear taper (used in parts list)
lin	= linear
LK WASH	= lockwasher
LO	= low, local oscillator
LOG	= logarithmic taper (used in parts list)
log	= logarithmic
LPF	= low pass filter
LV	= low voltage
m	= metre (distance)
mA	= milliampere
MAX	= maximum
MΩ	= megohm
MEG	= meg (10⁶) (used in parts list)
MET FLM	= metal film
MET OX	= metal oxide
MF	= medium frequency, microfarad (used in parts list)
MFR	= manufacturer
mg	= milligram
MHz	= megahertz
mH	= millihenry
mho	= conductance
MIN	= minimum
min	= minute (time)
′	= minute (plane angle)
MINAT	= miniature
mm	= millimetre
MOD	= modulator
MOM	= momentary
MOS	= metal-oxide semiconductor
ms	= millisecond
MTG	= mounting
MTR	= meter (indicating device)
mV	= millivolt
mVac	= millivolt, ac
mVdc	= millivolt, dc
mVpk	= millivolt, peak
mVp-p	= millivolt, peak-to-peak
mVrms	= millivolt, rms
mW	= milliwatt
MUX	= multiplex
MY	= mylar
μA	= microampere
μF	= microfarad
μH	= microhenry
μmho	= micromho
μs	= microsecond
μV	= microvolt
μVac	= microvolt, ac
μVdc	= microvolt, dc
μVpk	= microvolt, peak
μVp-p	= microvolt, peak-to-peak
μVrms	= microvolt, rms
μW	= microwatt
nA	= nanoampere
NC	= no connection
N/C	= normally closed
NE	= neon
NEG	= negative
nF	= nanofarad
NI PL	= nickel plate
N/O	= normally open
NOM	= nominal
NORM	= normal
NPN	= negative-positive-negative
NPO	= negative-positive-zero (zero temperature coefficient)
NRFR	= not recommended for field replacement
ns	= nanosecond
NSR	= not separately replaceable
nW	= nanowatt
OBD	= order by description
OD	= outside diameter
OH	= oval head
OP AMPL	= operational amplifier
OPT	= option
OSC	= oscillator
OX	= oxide
oz	= ounce
Ω	= ohm
P	= peak (used in parts list)
PAM	= pulse-amplitude modulation
PC	= printed circuit
PCM	= pulse-code modulation, pulse-count modulation
PDM	= pulse-duration modulation
pF	= picofarad
PH BRZ	= phosphor bronze
PHL	= phillips
PIN	= positive-intrinsic-negative
PIV	= peak inverse voltage
pk	= peak
PL	= phase lock
PLO	= phase lock oscillator
PM	= phase modulation
PNP	= positive-negative-positive
P/O	= part of
POLY	= polystyrene
PORC	= porcelain
POS	= positive; position(s) (used in parts list)
POSN	= position
POT	= potentiometer
p-p	= peak-to-peak
PP	= peak-to-peak (used in parts list)
PPM	= pulse-position modulation
PREAMPL	= preamplifier
PRF	= pulse-repetition frequency
PRR	= pulse repetition rate
ps	= picosecond
PT	= point
PTM	= pulse-time modulation
PWM	= pulse-width modulation
PWV	= peak working voltage
RC	= resistance-capacitance
RECT	= rectifier
REF	= reference
REG	= regulated
REPL	= replaceable
RF	= radio frequency
RFI	= radio frequency interference
RH	= round head, right hand
RLC	= resistance-inductance-capacitance
RMO	= rack mount only
rms	= root-mean-square
RND	= round
ROM	= read-only memory
R&P	= rack and panel
RWV	= reverse working voltage
S	= scattering parameter
s	= second (time)
″	= second (plane angle)
S-B	= slow-blow fuse (used in parts list)
SCR	= silicon controlled rectifier, screw
SE	= selenium
SECT	= sections
SEMICON	= semiconductor
SHF	= superhigh frequency
SI	= silicon
SIL	= silver
SL	= slide
SNR	= signal-to-noise ratio
SPDT	= single-pole, double-throw
SPG	= spring
SR	= split ring
SPST	= single-pole, single-throw
SSB	= single sideband
SST	= stainless steel
STL	= steel
SQ	= square
SWR	= standing-wave ratio
SYNC	= synchronize
T	= timed (slow-blow fuse)
TA	= tantalum
TC	= temperature compensating
TD	= time delay
TERM	= terminal
TFT	= thin-film transistor
TGL	= toggle
THD	= thread
THRU	= through
TI	= titanium
TOL	= tolerance
TRIM	= trimmer
TSTR	= transistor
TTL	= transistor-transistor logic
TV	= television
TVI	= television interference
TWT	= traveling wave tube
U	= micro (10⁻⁶) (used in parts list)
UF	= microfarad (used in parts list)
UHF	= ultrahigh frequency
UNREG	= unregulated
V	= volt
VA	= voltampere
Vac	= volts ac
VAR	= variable
VCO	= voltage-controlled oscillator
Vdc	= volts dc
VDCW	= volts, dc, working (used in parts list)
VF	= volts, filtered
VFO	= variable-frequency oscillator
VHF	= very-high frequency
Vpk	= volts peak
Vp-p	= volts peak-to-peak
Vrms	= volts rms
VSWR	= voltage standing wave ratio
VTO	= voltage-tuned oscillator
VTVM	= vacuum-tube voltmeter
VX	= volts, switched
W	= watt
W/	= with
WIV	= working inverse voltage
WW	= wirewound
W/O	= without
YIG	= yttrium-iron-garnet
Zo	= characteristic impedance

NOTE

All abbreviations in the parts list will be in upper case

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10^{1}
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

6-9. ORDERING INFORMATION

6-10. To order a part listed in the replaceable parts tables, give the Hewlett-Packard part number, check digit, description, and total number required. Send the order to the nearest Hewlett-Packard office.

6-11. To order a part that is not listed in the replaceable parts table, include the instrument model number, complete serial number, the description and function of the part, and the number of parts required. Send the order to the nearest Hewlett-Packard office.

6-12. DIRECT MAIL ORDER SYSTEM

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order. (There is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing).

c. Prepaid transportation. (There is a small handling charge for each order).

d. No invoices — to provide these advantages, a check or money order must accompany each new order.

6-14. Mail order forms and specific ordering information is available through your local HP office. Addresses and phone numbers appear in the back of this manual.

Table 6-2. A1 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	05089-60001	B	1	POWER SUPPLY/REGULATOR BOARD ASSEMBLY	28480	05089-60001
A1C1	0160-0342	3	P	CAPACITOR-FXD 680PF +-1% 300VDC MICA	28480	0160-0342
A1C2	0180-2015	1	4	CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2015
A1C3	0160-0342	3		CAPACITOR-FXD 680PF +-1% 300VDC MICA	28480	0160-0342
A1C4	0180-0230	0	P	CAPACITOR-FXD 1UF +-20% 50VDC TA	56289	150D105X9050A2
A1C5	0180-0230	0		CAPACITOR-FXD 1UF+-20% 50VDC TA	56289	150D105X9050A2
A1C6	0160-0127	2	3	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A1C7	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A1C8	0160-0576	5	P	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C9	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C10	0180-0097	7	1	CAPACITOR-FXD 47UF+-10% 35VDC TA	56289	150D476X9035B2
A1C11	0180-2015	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2015
A1C12	0180-2015	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2015
A1C13	0180-2015	1		CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2015
A1C14	0160-4004	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4004
A1C15	0180-1956	9	P	CAPACITOR-FXD 5600UF+75-10% 50VDC AL	28480	0180-1956
A1C16	0160-0161	1	1	CAPACITOR-FXD .1UF +-10% 200VDC POLYE	28480	0160-0161
A1C17	0180-1956	9		CAPACITOR-FXD 5600UF+75-10% 50VDC AL	28480	0180-1956
A1C18	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A1C19	0180-0291	9	1	CAPACITOR-FXD 220UF+-20% 35VDC TA	28480	0180-0291
A1C20	0180-0291	9		CAPACITOR-FXD 220UF+-20% 35VDC TA	28480	0180-0291
A1CR1	0160-2221	1	1	CAPACITOR-FXD 1300PF +-5% 300VDC MICA	28480	0160-2221
A1CR2	0160-2227	7	P	CAPACITOR-FXD 2400PF +-5% 300VDC MICA	28480	0160-2227
A1CR3	0160-2227	7		CAPACITOR-FXD 2400PF +-5% 300VDC MICA	28480	0160-2227
A1C24	0180-2698	8	1	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	28480	0180-2698
A1C25	0180-0291	9		CAPACITOR-FXD 220UF+-20% 35VDC TA	28480	0180-0291
A1CR1	1906-0079	6	1	DIODE-FW BRDG 100V 10A	18546	VJ10BX
A1CR2	1901-0050	3	17	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR4	1902-0558	8	1	DIODE-ZNR 12V 5% DO-15 PD=1W IZ=*.074%	28480	1902-0558
A1CR5	1901-0020	5	P	DIODE-PWR RECT 400V 750MA DO P7	28480	1901-0020
A1CR6	1901-0020	5		DIODE-PWR RECT 400V 750MA DO P7	28480	1901-0020
A1CR7	1902-0522	6	P	DIODE-ZNR 1N5348B 6V 5% PD=5W IR=10UA	04713	1N5348B
A1CR8	1902-0522	6		DIODE-ZNR 1N5348B 6V 5% PD=5W IR=10UA	04713	1N5348B
A1CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR14	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR15	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR17	1902-3203	6	3	DIODE-ZNR 14.7V 5% DO-35 PD=.4W	28480	1902-3203
A1CR18	1902-3203	6		DIODE-ZNR 14.7V 5% DO-35 PD=.4W	28480	1902-3203
A1CR19	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR20	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR21	1902-3203	6		DIODE-ZNR 14.7V 5% DO-35 PD=.4W	28480	1902-3203
A1CR22	1902-0554	4	1	DIODE-ZNR 10V 5% PD=1W IR=10UA	28480	1902-0554
A1CR23	1902-0556	6	1	DIODE-ZNR 20V 5% PD=1W IR=50A	28480	1902-0556
A1CR24	1901-0662	3	1	DIODE-PWR RECT 100V 6A	04713	MR751
A1CR25	1902-0810	5	1	DIODE-ZNR 1N941 11.7V 5% DO-7 PD=.5W	04713	1N941
A1CR26	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR27	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR28	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR29	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR30	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1K1	0490-0739	1	P	RELAY PC 24VDC COIL 2A 30VDC	28480	0490-0739
A1K2	0490-0739	1		RELAY PC 24VDC COIL 2A 30VDC	28480	0490-0739
A1L1	9140-0249	6	1	INDUCTOR 30UH +-10% 0.075 DIA	28480	9140-0249
A1L2	9100-3065	6	1	INDUCTOR 200H +-5%	28480	9100-3065
A1Q1	1854-0477	7	3	TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A1Q2	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A1Q3	1853-0281	9	3	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q4	1854-0574	5	P	TRANSISTOR NPN SI PD=500MW FT=125MHZ	28480	1854-0574
A1Q5	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q6	1854-0574	5		TRANSISTOR NPN SI PD=500MW FT=125MHZ	28480	1854-0574
A1Q7	1854-0746	3	P	TRANSISTOR NPN 2N6339 SI TO-3 PD=200W	04713	2N6339
A1Q8	1854-0746	3		TRANSISTOR NPN 2N6339 SI TO-3 PD=200W	04713	2N6339
A1Q9	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A1Q10	1854-0839	7	2	TRANSISTOR NPN 2N30535 SI TO-39 PD=1W	3E605	2N30535

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. A1 Replaceable Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1Q11	1854-0037	7		TRANSISTOR NPN PN3053G GI TO-39 PD=5W	31585	PN3053G
A1Q12	1854-0477	7		TRANSISTOR NPN PN2222A GI TO-18 PD=500MW	04713	PN2222A
A1Q13	1855-0327	8	1	TRANSISTOR J-FET PN4416 N-CHAN D MODE	01295	PN4416
A1Q14	1853-0036	2	1	TRANSISTOR PNP GI PD=310MW FT=250MHZ	28480	1853-0036
A1R1	0683-1035	1	3	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R2	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R3	0683-1025	9	3	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R4	0683-2015	9	2	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A1R5	0683-2015	9		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A1R6	0698-7236	7	2	RESISTOR 1K 1% .05W F TC=0+-100	24546	C4 1/8-TC-1001-F
A1R7	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C4 1/8-TC-1001-F
A1R8	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R9	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R10	0698-0810	3	2	RESISTOR 3.16 1% .125W F TC=0+-100	28480	0698-0810
A1R11	0698-0810	3		RESISTOR 3.16 1% .125W F TC=0+-100	28480	0698-0810
A1R12	0698-3266	5	2	RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-TC-2373-F
A1R13	0683-3355	2	3	RESISTOR 3.3M 5% .25W FC TC=-900/+1100	01121	CB3355
A1R14	0698-3150	6	3	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-TC-2371-F
A1R15	0698-3155	1	3	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-TC-4641-F
A1R16	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-TC-2371-F
A1R17	0698-0812	7	1	RESISTOR 1 1% .125W F TC=0+-100	28480	0698-0812
A1R18	0757-0260	3	2	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TC-1001-F
A1R19	2100-1759	4	1	RESISTOR-TRMR 2K 5% 5W SIDE-ADJ 1-TRN	28480	2100-1759
A1R20	0812-0017	2	1	RESISTOR .05 5% 3W PW TC=0+-90	28480	0812-0017
A1R21	0683-1015	7	2	RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A1R22	05089-80001	8	1	RESISTOR 0.010 OHM 5W ANNEALED MANGANIN	28480	05089-80001
A1R23	2100-1756	1	1	RESISTOR-TRMR 200 5% 5W SIDE-ADJ 1-TRN	28480	2100-1756
A1R24	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+600	01121	CB1015
A1R25	0757-0814	9	2	RESISTOR 511 1% .5W F TC=0+-100	28480	0757-0814
A1R26	0757-0814	9		RESISTOR 511 1% .5W F TC=0+-100	28480	0757-0814
A1R27	0698-3157	3	1	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4 1/8-TC-1962-F
A1R28	0757-0443	0	2	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4 1/8-TC-1102-F
A1R29	0757-0443	0		RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-TC-1102-F
A1R30	2100-2021	0	2	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	30983	T1500X202
A1R31	0757-0437	4	1	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4 1/8-TC-6811-F
A1R32	2100-2021	0		RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	30983	T1500X202
A1R33	0683-3355	2		RESISTOR 3.3M 5% .25W FC TC=-900/+1100	01121	CB3355
A1R34	0683-4725	2	2	RESISTOR 4.7M 5% .25W FC TC=-400/+700	01121	CB4725
A1R35	0683-3355	2		RESISTOR 3.3M 5% .25W FC TC=-900/+1100	01121	CB3355
A1R36	0683-4725	2		RESISTOR 4.7M 5% .25W FC TC=-400/+700	01121	CB4725
A1R37	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4 1/8-TC-2371-F
A1R38	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4 1/8-TC-4641-F
A1R39	0698-3266	5		RESISTOR 237K 1% .125W F TC=0+-100	24546	C4 1/8-TC-2373-F
A1R40	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4 1/8-TC-4641-F
A1R41	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4 1/8-TC-1001-F
A1R42	0698-3151	7	1	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4 1/8-TC-2871-F
A1R43	0698-0820	7	2	RESISTOR 4.64 1% .125W F TC=0+-100	28480	0698-0820
A1R44	0698-0820	7		RESISTOR 4.64 1% .125W F TC=0+-100	28480	0698-0820
A1R45	0757-0204	7	4	RESISTOR 150 1% .125W F TC=0+-100	24546	C4 1/8-TC-151-F
A1R46	0757-0284	7		RESISTOR 150 1% .125W F TC=0+-100	24546	C4 1/8-TC-151-F
A1R47	0683-5225	6	1	RESISTOR 5.2K 5% .25W FC TC=-400/+	01121	CB5225
A1R48	0683-5125	8	1	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A1R49	0698-7215	7	2	RESISTOR 82.5 1% .05W F TC=0+-100	24546	C4 1/8-TC-82R5-F
A1R50	0698-7100	0	2	RESISTOR 10 1% .05W F TC=0+-100	24546	C4 1/8-TC-10R0-F
A1R51	0698-7224	3	2	RESISTOR 316 1% .05W F TC=0+-100	24546	C4 1/8-TC-3160-F
A1R52	0698-0817	2	2	RESISTOR 2.61 1% .125W F TC=0+-100	28480	0698-0817
A1R53	0698-7210	7		RESISTOR 82.5 1% .05W F TC=0+-100	24546	C4 1/8-TC-82R5-F
A1R54	0698-7224	3		RESISTOR 316 1% .05W F TC=0+-100	24546	C4-1/8-TC-3160-F
A1R55	0698-0817	2		RESISTOR 2.61 1% .125W F TC=0+-100	28480	0698-0817
A1R56	0698-7100	0		RESISTOR 10 1% .05W F TC=0+-100	24546	C4 1/8-TC-10R0-F
A1R57	0757-0401	8	1	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TC-101-F
A1R58	0757-0284	7		RESISTOR 150 1% .125W F TC=0+-100	24546	C4 1/8-TC-151-F
A1R59	0757-0204	7		RESISTOR 150 1% .125W F TC=0+-100	24546	C4 1/8-TC-151-F
A1R60	0698-8027	4	1	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8027
A1R61	0699-0069	2	1	RESISTOR 2.15M 1% .125W F TC=0+-100	28480	0699-0069
A1R62	0757-0463	4	1	RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4 1/8-TC-8252-F
A1R63	0757-0446	3	1	RESISTOR 15K 1% .125W F TC=0+-100	24546	C4 1/8-TC-1502-F
A1R64	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1T1	9100-2688	7	2	TRANSFORMER-PULSE INDUCTANCE: 30.1MH	28480	9100-2688
A1T2	9100-2688	7		TRANSFORMER-PULSE INDUCTANCE: 30.1MH	28480	9100-2688
A1T3	9100-2690	1	1	TRANSFORMER SWITCHING; PRI IND: 5.04MH	28480	9100-2690
A1U1	1820-2230	3	1	IC MV CMOS MONO/ASTBL	3L535	CD4047BF
A1U2	1826-0146	0	2	IC OP AMP GP DUAL 8-DIP-P PKG	27014	LM358N
A1U3	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P PKG	06665	UPC311C
A1U4	1820-0639	1	1	IC DCD TTL NAND QUAD 2-INP	01295	SN7437N
A1U5	1826-0430	1	1	IC 309 V REGTR TO-3	07263	LM309K

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. A1 Replaceable Parts (Continued)

Reference Designation	HP Part Number	c d	Qty	Description	Mfr Code	Mfr Part Number
A1U6	1826-0346	8		IC OP AMP GP DUAL 8 DIP-P PKG	P2014	LM358N
A1XU1	1200-0474	9	2	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A1XU2	1200-0471	6	3	SOCKET-IC 8-CONT DBL STRP DIP-SLDR	28480	1200-0471
A1XU3	1200-0471	6		SOCKET-IC 8-CONT DBL STRP DIP-SLDR	28480	1200-0471
A1XU4	1200-0474	9		SOCKET-IC 14 CONT DIP-SLDR	28480	1200-0474
A1XU5				NOT ASSIGNED		
A1XU6	1200-0471	6		SOCKET-IC 8-CONT DBL STRP DIP SLDR	28480	1200-0471
				A1 MISCELLANEOUS PARTS		
A1MP1	5000-9043	6	2	PIN CKT BD EXTRACTOR	28480	5000-9043
A1MP2	5040-6043	2	2	HANDLE CKT BD EXTRACTOR	28480	5040-6043
A1MP3	05089-00001	2	1	BRACKET CKT-BD MOUNTING	28480	05089-00001
A1MP4	1205-0021	2	2	HEAT SINK (FOR A1Q7 AND A1Q8)	28480	1205-0021
A1MP5	0380-0342	9	4	STANDOFF-TVT-ON .125 IN-LG 6-32THD	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-3. A2 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	05089-60002	9	1	INDICATOR BOARD ASSEMBLY	28480	05089-60002
A2C1	0180-0238	0	1	CAPACITOR-FXD 10UF+20% 50VDC TA	56289	150D106X9050A2
A2D61	1990-0405	5	1	LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4581
A2D62	1990-0407	7	1	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4584
A2D63	1990-0406	6	1	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4584
A2R1	0683-4725	2	6	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R2	0683-2035	3	1	RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A2R3	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R4	0683-2735	0	2	RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A2R5	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R6	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R7	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R8	0683-2735	0		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A2R9	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2S1	3101-2686	1	1	SWITCH-PB DPDT NON 1A 115AC	28480	3101-2686
A2U1	1826-0346	0	1	IC OP AMP GP DUAL 8-DIP-P PKG	27014	LM358N
A2XU1	1200-0471	6	1	SOCKET-IC 8-CONT DIL STRP DIP SLDR	28480	1200-0471
				A2 MISCELLANEOUS PARTS		
A2MP1	05000-20017	7	3	SPACER-INSULATING LED STANDOFF	28480	05000-20017
A2MP2	3101-0051	8	1	KNOB PUSH BUTTON BLACK	28480	3101-0051

See introduction to this section for ordering information
*Indicates factory selected value

Table 5-4. Replaceable Chassis Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				CHASSIS MOUNTED PARTS		
BT1	1420-0318	8	P	BATTERY LEAD-ACID SEALED 12V 20 AMP HRS	28480	1420-0318
BT2	1420-0318	8		BATTERY LEAD-ACID SEALED 12V 20 AMP HRS	28480	1420-0318
C1	0160-4201	7	P	CAPACITOR-FXD PPOLYE +-20% (250VAC(RMS))	56633	PHCP271X4P2
C2	0160-4201	7		CAPACITOR-FXD PPOLYE +-20% (250VAC(RMS))	56633	PHCP271X4P2
C3	0160-4393	2	1	CAPACITOR-FXD 10UF +-10% 100VDC ELR	51642	400-100-X25-106M
C4	0180-2030	6	P	CAPACITOR-FXD .01UF+75-10% 250VDC AL	28480	0180-2030
C5	0180-2030	6		CAPACITOR-FXD .01UF+75-10% 250VDC AL	28480	0180-2030
CR1	1906-0222	1	1	DIODE FW BRDG 400V 25A	04713	MDA2504
CR2	1901-0032	1	1	DIODE-PWR RECT 1N1209 100V 15A DO 5	03508	1N1209
CR3	1902-0282	9	1	DIODE-ZNR 15V 5% PD=1W IR=5UA	28480	1902-0282
CR4	1902-0554	4	1	DIODE-ZNR 10V 5% PD=1W IR=10UA	28480	1902-0554
CR5	1901-1160	6	1	DIODE-SCHOTTKY 45V 30A	81483	60-45
CR6	1901-0050	3	1	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
F1	2110-0010	9	2	FUSE 5A 250V NTD 1.25X.25 UL	75915	312005
F2	2110-0001	8	2	FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
F3	2110-0395	3	2	FUSE 10A 250V FD 1.25X.25	28480	2110-0351
F4	2110-0010	9		FUSE 5A 250V NTD 1.25X.25 UL	75915	312005
F5	2110-0395	3		FUSE 10A 250V FD 1.25X.25	28480	2110-0395
F6	2110-0001	8		FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
J1	1251-2458	0	1	CONNECTOR 3-PIN M CIRC STANDARD	28480	1251-2458
J2	1251-2962	1	1	CONNECTOR 2 PIN M CIRC STANDARD	28480	1251-2962
J3	1251-0138	1	1	CONNECTOR 5-PIN F CIRC STANDARD	28480	1251-0138
J4	0360-2108	3	1	BARRIER BLOCK 2-TERMINAL	28480	0360-2108
J5	1510-0046	2	1	BINDING POST ASSY SGL SGL-TUR RED	28480	1510-0046
J6	1510-0039	9	1	BINDING POST ASSY SGL SGL-TUR BLK	28480	1510-0039
M1	1120-1597	9	1	METER DC VOLTS 0 TO 50 VOLTS	28480	1120-1597
M2	1120-1596	8	1	METER DC AMPS CENTER SCALE 25 TO 25A	28480	1120-1596
Q1	1854-0469	9	1	TRANSISTOR NPN 2N6057 SI TO 3 PD=150W	04713	2N6057
R1	0757-0816	1	1	RESISTOR 681 1% .5W F TC=0+-100	28480	0757-0816
R2	0757-0278	9	1	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	CB 1781 (B 1781)
S1	3101-2432	4	1	SWITCH-TGL DPDT 6A 250VAC/DC SLDR	28480	3101-2432
S2	3101-2290	1	1	SWITCH-SL DPDT 6A 250VAC SLDR-LUG	28480	3101-2290
T1	9100-2609	8	1	TRANSFORMER-POWER 115V 47-440HZ	28480	9100-2609
W1	05861-6091	9	1	CABLE ASSEMBLY, AC POWER INPUT	28480	05861-6091
W2	05089-60102	8	1	CABLE ASSEMBLY, EXTERNAL DC POWER INPUT	28480	05089-60102
W3	05089-60101	9	1	CABLE ASSEMBLY, DC OUTPUT	28480	05089-60101
W4	05089-60105	3	1	ASSY, WIRE (CA-CS POSITIVE CONNECTION)	28480	05089-60105
W5	05089-60106	4	1	ASSY, WIRE (CR) CHASSIS CONNECTION)	28480	05089-60106
W6	05089-60103	1	1	ASSY, WIRE (POSITIVE BATTERY LEAD)	28480	05089-60103
W7	05089-60104	2	1	ASSY, WIRE (NEGATIVE BATTERY LEAD)	28480	05089-60104
W8	05089-60107	5	1	ASSY, WIRE (BATTERY INTERCONNECT)	28480	05089-60107
XA1	1251-2413	7	1	CONNECTOR-PC EDGE 25-CONT/ROW P-ROWS	28480	1251-2413
XF1-6				FUSEHOLDERS CONSIST OF THE FOLLOWING PARTS:		
	2110-0565	9	6	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
	2110-0564	8	6	FUSEHOLDER BODY 12A MAX FOR UL	09922	031-1657
	2110-0569	3	6	FUSEHOLDER COMPONENT NUT; THREAD MTP.7	28480	2110-0569
	0362-0107	2	5	TUBING-INS .5 D/.25 RCVD .04 WALL POLYO	28480	0362-0107
				MISCELLANEOUS CHASSIS PARTS		
H1	P510 5137	9	4	SCREW MACH 6-32 .25 IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H2	2360-0125	6	2	SCREW-MACH 6-32 .75-IN-LG PAN-HZ-POZI	0000	ORDER BY DESCRIPTION
H3	3050-0071	5	10	WASHER FL MTLC NO. 8 .362 IN-ID	28480	3050-0071
H4	3050-0017	9	2	WASHER FL MTLC 1/4 IN .26 IN-ID	28480	3050-0017
H5	0360-0007	1	5	TERMINAL SLDR LUG PL-NTC FOR #10 SCR	28480	0360-0007
H6	0360-0040	2	5	TERMINAL-SLDR LUG LK-NTC FOR #1/4-SCR	28480	0360-0040
H7	0360-0042	4	2	TERMINAL SLDR LUG PL-NTC FOR-#6-SCR	28480	0360-0042
H8	0360-0053	7	3	TERMINAL-SLDR LUG LK-NTC FOR-#10-SCR	28480	0360-0053
H9	1400-0017	0	3	CLAMP-CABLE .312 DIA .375-WD NYL	28480	1400-0017
H10	2190-0006	1	2	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
H11	2190-0011	0	38	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0011
H12	2190-0010	7	1	WASHER-LK EXT T NO. 8 .168-IN-ID	28480	2190-0010
H13	2190-0017	4	4	WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
H14	2190-0047	0	3	WASHER-LK ID CTSK EXT T NO. 6 .142-IN-ID	28480	2190-0047
H15	2190-0102	8	2	WASHER-LK INTL T 15/32 IN .472-IN-ID	28480	2190-0102

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-4. Replaceable Chassis Parts (Continued)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
H16	2200-0103	2	P	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
H17	2260-0869	3	8	NUT-HEX-W/LKW 4-40-THD .094 IN THK	00000	ORDER BY DESCRIPTION
H18	2360-0115	4	2	SCREW-MACH 6-32 .312-IN-LG PAN-HD POZI	00000	ORDER BY DESCRIPTION
H19	2360-0210	0	1	SCREW-MACH 6-32 .625-IN-LG OF DEG	00000	ORDER BY DESCRIPTION
H20	2420-0001	5	5	NUT-HEX-W/LKW 6-32-THD .109-IN-THK	00000	ORDER BY DESCRIPTION
H21	0510-0046	9	50	SCREW-MACH 8-32 .375-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
H22	2510-0045	0	54	SCREW-MACH 8-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H23	2510-0051	6	2	SCREW-MACH 8-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H24	2510-0113	1	1	SCREW-MACH 8-32 .025-IN-LG PAN-HD POZI	00000	ORDER BY DESCRIPTION
H25	2500-0003	5	9	NUT-HEX-W/LKW 8-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
H26	2200-0103	0	35	SCREW-MACH 10-32 .5-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H27	2200-0128	0	4	SCREW-MACH 10-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H28	0740-0002	4	1	NUT-HEX-DBL-CHAM 10-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
H29	2950-0051	8	1	NUT-HEX-DBL-CHAM 1/4-20-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
H30	2950-0052	9	2	NUT-HEX-DBL-CHAM 1/4-40 THD .062-IN-THK	00000	ORDER BY DESCRIPTION
H31	3050-0002	2	22	WASHER-FL MTLC NO. 10 .203-IN-ID	28480	3050-0002
H32	3050-0010	2	2	WASHER-FL MTLC NO. 6 .142 IN-ID	28480	3050-0010
H33	3050-0066	8	2	WASHER-FL MTLC NO. 6 .142-IN-ID	28480	3050-0066
H34	3050-0001	1	50	WASHER-FL MTLC NO. 8.172-IN-ID	28480	3050-0001
H35	2420-0002	6	2	NUT-HEX-DBL-CHAM 6-32-THD .109-IN-THK	28480	2420-0002
MP1	5060-0162	5	1	EXTENDER BOARD 95-PIN	28480	5060-0162
MP2	5060-0734	0	2	FRAME SIDE	28480	5060-0734
MP3	05089-00004	5	1	CHASSIS	28480	05089-00004
MP4	05089-00002	3	1	PANEL FRONT	28480	05089-00002
MP5	05089-00003	4	1	PANEL REAR	28480	05089-00003
MP6	5060-0707	3	1	COVER TOP	28480	5060-0707
MP7	5060-0719	7	1	COVER BOTTOM	28480	5060-0719
MP8	5060-0767	9	5	FOOT ASSEMBLY	28480	5060-0767
MP9	5060-0719	1	2	COVER SIDE	28480	5060-0719
MP10	05089-00005	6	1	REAR BULKHEAD (A) COMPARTMENT)	28480	05089-00005
MP11	05089-00006	7	1	FRONT BULKHEAD (A) COMPARTMENT)	28480	05089-00006
MP12	05089-00007	8	2	BOARD MOUNT WITH GUIDES (A) COMPARTMENT SIDE)	28480	05089-00007
MP13	05089-00008	9	1	PLATE-SHIELD TOP COVER (A) COMPARTMENT)	28480	05089-00008
MP14	6960-0001	3	4	PLUG BUTTON 5/8 INCH	28480	6960-0001
MP15	05089-00009	0	1	BATTERY FRAME (END AND SEPARATOR PLATES)	28480	05089-00009
MP16	05089-00010	3	1	BATTERY BRACE FRONT (BATTERY CASE FRONT SIDE)	28480	05089-00010
MP17	05089-00011	4	1	BATTERY COVER (BATTERY CASE TOP COVER)	28480	05089-00011
MP18	05089-00012	5	1	CHASSIS BRACE (UNDER-CHASSIS BATTERY SUPPORT)	28480	05089-00012
MP19	05089-00013	6	1	BATTERY BRACE REAR (BATTERY CASE REAR SIDE)	28480	05089-00013
MP20	05089-00014	7	1	P.C. BOARD FASTENER (BLOCK, A1MP1 BRACKET MTG)	28480	05089-00014
MP21	0590-0513	1	2	SPACER 4-40 INTERNAL-THD (FOR MTG A2 CR2 DD)	28480	0590-0513
MP22	1200-0043	6	1	INSULATOR ANNODIZED ALUMINUM (Q1 MTG)	28480	1200-0043
MP23				NOT ASSIGNED		
MP24	1200-0080	1	2	INSULATOR-DIODE MTG ANNODIZED ALUM (FOR CR2)	28480	1200-0080
MP25	5060-0052	9	2	SIDE TRIM PLATE FLUTED ALUMINUM	28480	5060-0052
MP26	5060-0222	1	2	HANDLE ASSEMBLY 5-INCH SIDE	28480	5060-0222
MP27	5060-0735	2	2	HANDLE RETAINER ASSEMBLY OLIVE GRAY	28480	5060-0735
MP28	4320-0002		1	U-CHANNEL RUBBER 1-FT-LONG	23519	ORDER BY DESCRIPTION
MP29	0360-0023	1	1	TIP LUG SPRIP 3-TERMINAL	28480	0360-0023
MP30	05089-00015	8	2	BATTERY PAD 6 INCH X 6 INCH (BOTTOM)	28480	05089-00015
MP31	05089-00016	9	2	BATTERY PAD 5 INCH X 5 INCH (SIDE)	28480	05089-00016
MP32	05089-00017	0	2	BATTERY PAD 4 INCH X 4 INCH (FRONT)	28480	05089-00017
MP33	0380-0670	4	2	CLAMP-CAP 0.062 DIA GIL	56289	4506-2B
MP34	0362-0561	6	2	CONNECTOR-GEL CONT SOLDER-TEM TAB	28480	0362-0561
MP35	1200-0456	7	1	SOCKET-XSTR P-CONT TO-3	28480	1200-0456
MP36	1200-0000	3	2	INSULATOR-DIO ALUMINUM HD-ANOZ	28480	1200-0000
MP37	5060-0098		1	LABEL-SERIAL NO	28480	5060-0098
				OPTION 908 PARTS FOR POWER SUPPLY RACK MOUNTING		
	05005-2011	6	1	BRACKET MOUNTING LEFT	28480	05005-2011
	05005-2012	0	1	BRACKET MOUNTING RIGHT	28480	05005-2012
	5040-6676	9	1	FILLER STRIP BOTTOM	28480	5040-6676
	2510-0107	5	8	SCREW-MACH 8-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information
*Indicates factory selected value

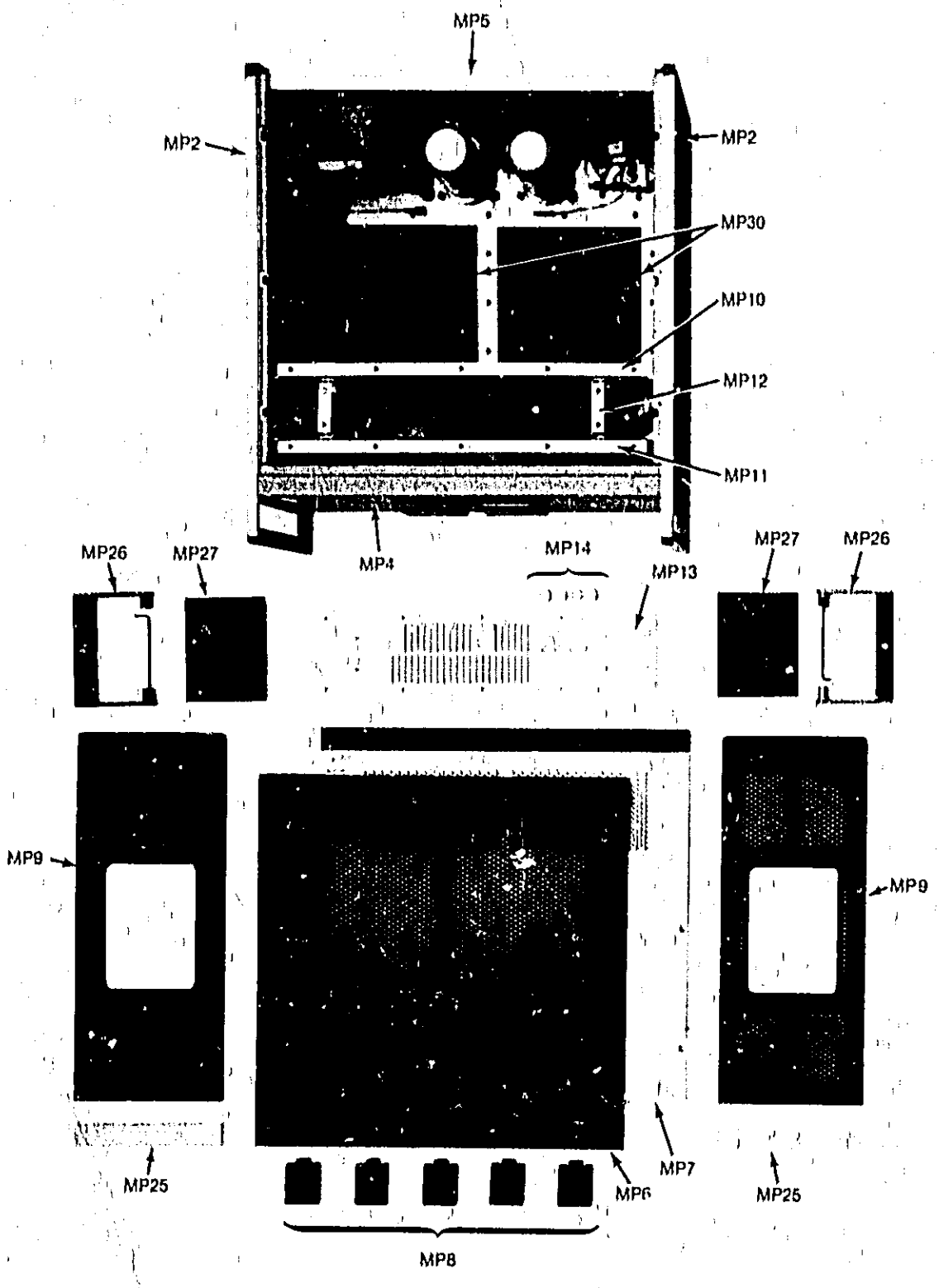


Figure 6-1. Cabinet Parts

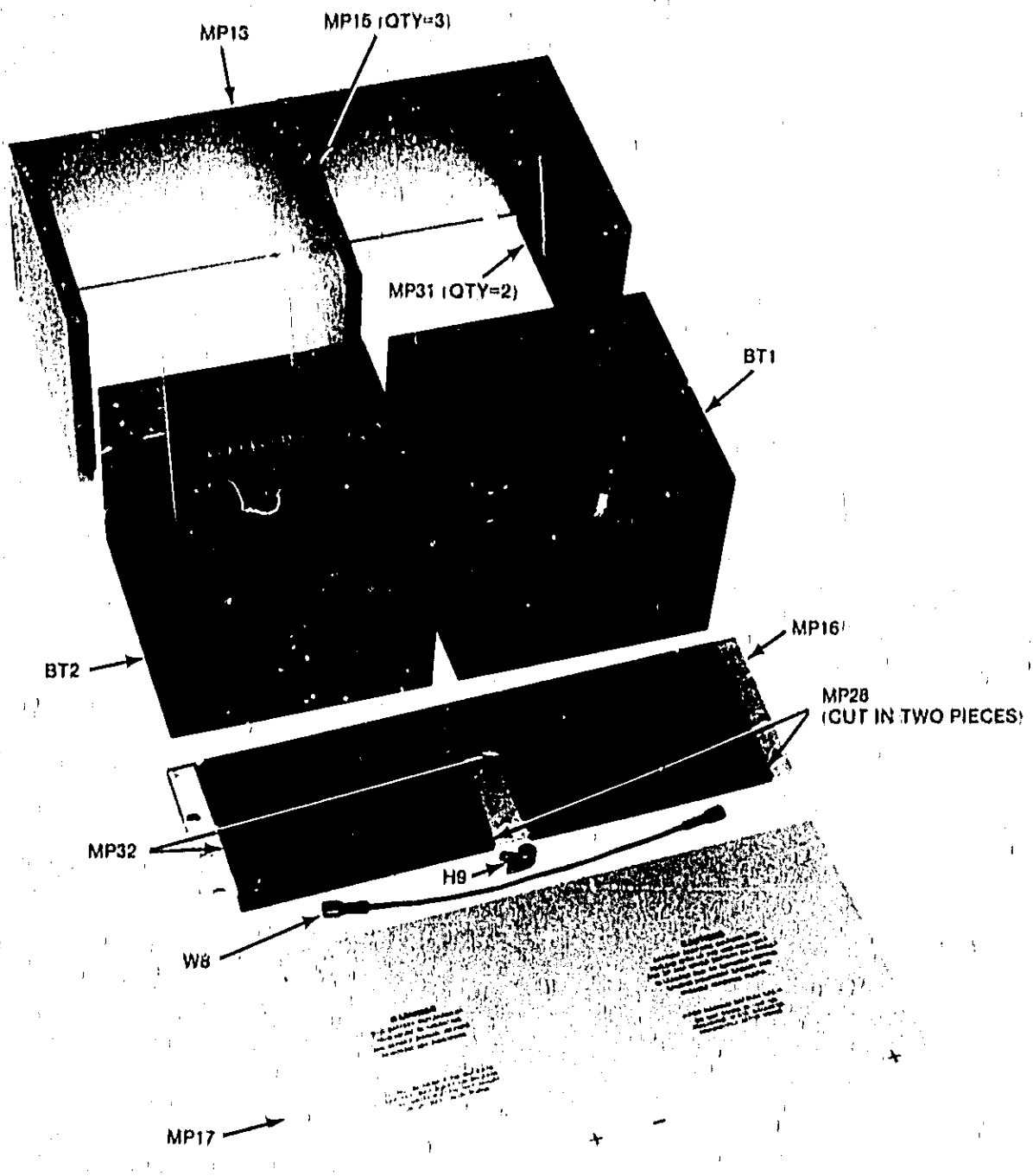


Figure 6-2. Battery Case Parts

Table 6-5. Manufacturers' Code List

Mfr. No.	Manufacturer's Name	Address	Zip Code
C0633	RIFA	BROMMA, SE	
H9027	SCHURTER AGH	LUZERN, SW	
50545	NIPPON ELECTRIC CO	TOKYO, JP	
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO	MILWAUKEE, WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWNDALE, CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS, TX	75222
03508	GE CO SEMICONDUCTOR PROD DEPT	AUBURN, NY	13201
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX, AZ	85008
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW, CA	94042
1B546	VARO SEMICONDUCTOR INC	GARLAND, TX	75040
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD, PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA, CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO, CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE, NI	
30983	MEPCO/ELECTRA CORP	SAN DIEGO, CA	92121
51642	CENTRE ENGINEERING INC	STATE COLLEGE, PA	16801
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS, MA	01247
75915	LITTELFUSE INC	DES PLAINES, IL	60016

BACK DATING MANUAL CHANGES

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains manual change information for adapting this manual to instruments for which the content of the manual does not apply directly.

7-3. MANUAL CHANGES

7-4. This manual applies directly to Hewlett-Packard HP 5089A Standby Power Supplies with serial number prefix 2332A.

7-5. As engineering changes are made, newer instruments may have serial prefix numbers higher than 2332A. Manuals for these instruments will be supplied with MANUAL CHANGES sheets, printed on yellow paper, containing the required information. Replace affected pages or modify existing manual information as directed in the MANUAL CHANGES pages. Contact the nearest Hewlett-Packard Sales and Service Office (listed at the back of this manual) if the change information is missing.

SERVICE INFORMATION

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section contains the information required to service the HP 5089A. The information includes theory of operation, troubleshooting, safety considerations, service aids, and a schematic diagram.

WARNING

THE HP 5089A POWER SUPPLY IS LESS A POWER SWITCH. THE AC POWER CIRCUITS TO TRANSFORMER T1 AND UNREGULATED DC OUTPUT VOLTAGES ARE ALWAYS ON WHEN THE HP 5089A IS CONNECTED TO AN EXTERNAL POWER SOURCE. CONTACT WITH THESE CIRCUITS CAN CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT. ANY ADJUSTMENT OR REPAIR OF AN OPENED INSTRUMENT SHOULD BE AVOIDED AS MUCH AS POSSIBLE. THIS TYPE OF OPERATION SHOULD ONLY BE DONE BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED.

8-3. A detailed theory of operation for chassis components and both circuit boards (A1 and A2) begins with paragraph 8-38 and references the schematic diagram in *Figure 8-7.*

8-4. RECOMMENDED TEST EQUIPMENT

8-5. Test equipment required to test the HP 5089A is listed in *Table 1-2.* Equipment other than that listed may be substituted if the substitute meets or exceeds the critical specifications.

8-6. SAFETY CONSIDERATIONS

8-7. Although the HP 5089A has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in safe condition. Service and adjustments should be performed only by service-trained personnel who are aware of the hazards involved.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDING) CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) IS LIKELY TO MAKE THE HP 5089A DANGEROUS TO PERSONNEL. WHENEVER IT IS LIKELY THAT THE PROTECTION OFFERED BY GROUNDING OR FUSES HAS BEEN IMPAIRED, THE INSTRUMENT MUST BE MADE INOPERATIVE AND BE SECURED AGAINST ANY UNINTENDED OPERATION.

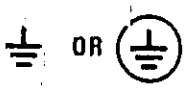
8-8. Opening the HP 5089A while power is connected should be avoided as much as possible, and, when necessary, should be carried out by a skilled person who is aware of the hazards involved. Capacitors inside the HP 5089A may still be charged even if the instrument has been disconnected from an external power supply.

8-9. Make sure that only fuses with the required rated current and of the type specified in *Table 6-4* are used for replacement. The use of repaired fuses or short circuiting of fuseholders MUST be avoided. Whenever it is likely that protection is impaired, the HP 5089A must be rendered inoperative and secured against any operation until repaired.

8-10. The following safety symbols are used on equipment and in manuals:

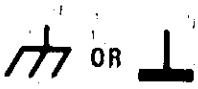
Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to prevent damage to the instrument.

Indicates dangerous voltage at input or output terminals that may exceed 1000 volts.



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating the equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for signal common as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground as described in Section II Installation in this manual before operating the equipment.



Frame and chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current.

Direct current.

The WARNING signal denotes a hazard. It calls attention to a procedure, practice, or the like which could result in personal injury if not adhered to or correctly performed.

The CAUTION signal denotes a hazard. It calls attention to an operating procedure, practice, or the like which could result in damage to or destruction to part of or all of the product if not adhered to or correctly performed.

3-11. SCHEMATIC DIAGRAM NOTES

8-12. *Figure 8-1* shows the symbols used on the schematic diagram. This same figure also shows the method of assigning reference designators, assembly numbers, and subassembly numbers.

SYMBOLS

DANGEROUS VOLTAGE EXCEEDS 1000 VOLTS

FRONT PANEL LABEL

REAR PANEL LABEL

INTERIOR AND PC BOARDS LABEL

WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE

OR PROTECTIVE CONDUCTOR TERMINAL

CIRCUIT COMMON

IDENTIFIED COMMON

OR CHASSIS TERMINAL

KNOB CONTROL

SCREWDRIVER ADJUST

MAIN SIGNAL PATH

FEEDBACK PATH

OR OR TEST POINT

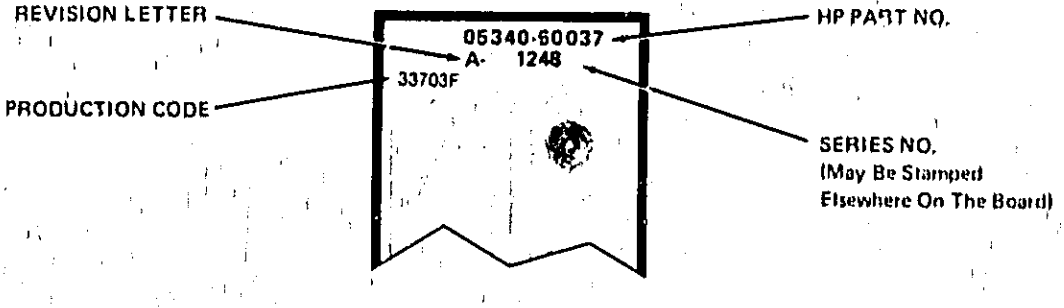
INSTRUCTION MANUAL REFERENCE

ALTERNATING CURRENT

DIRECT CURRENT

ALTERNATING OR DIRECT CURRENT

PRINTED CIRCUIT BOARD IDENTIFICATION



REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION. JACKS ARE THE STATIONARY CONNECTORS AND PLUGS ARE THE MORE MOVEABLE OF TWO CONNECTORS.

ASSEMBLY	ABBREVIATION	COMPLETE DESCRIPTION
A25	C1	A25C1
A25A1	CR1	A25A1CR1
NO PREFIX	J3	J3

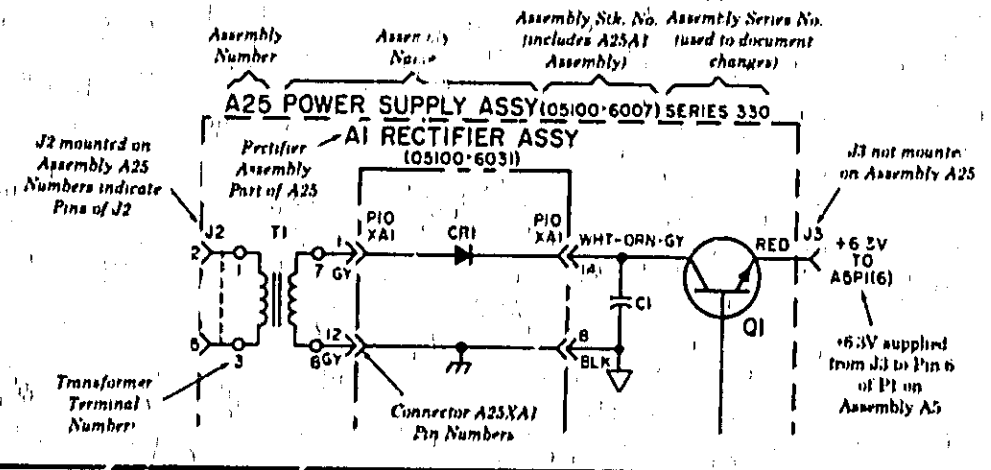


Figure 8-1. Schematic Diagram Notes

8-13. Reference Designations

8-14. Assemblies such as printed circuit boards are assigned numbers in sequence, A1, A2, etc. Reference designators for individual components are determined by adding the assembly number as a prefix for the component number. For example, the complete reference designation for U1 on assembly A1 is A1U1.

8-15. Identification Marks on Printed Circuit Boards

8-16. HP printed circuit boards (see *Figure 8-1*) have four identification numbers; an assembly part number, a series number, a revision letter, and a production code. The assembly part number consists of 10 etched digits (such as 05089-60001) and is the primary identification. All assemblies with the same part number are interchangeable. When a production change is made on an assembly that makes it incompatible with previous assemblies, a change in part number is required.

8-17. The series number (such as 2332) is used to document minor electrical changes. As changes are made, the series number is incremented. When replacement boards are ordered, you may receive a replacement with a different series number. If there is a difference between the series number stamped on the board and the schematic in this manual, a minor electrical difference exists. If the number on the printed circuit board is lower than that on the schematic, refer to Section VII for backdating information. If it is higher, refer to the yellow looseleaf manual change sheets for this manual. If the manual change sheets are missing, contact your local HP Sales and Support Office. Refer to the listing at the back of this manual.

8-18. Revision letters (A, B, etc.) denote changes in printed circuit layout. For example, if a capacitor type is changed (electrical value may remain the same) and requires different spacing for its leads, the printed-circuit board layout is changed and the revision letter is incremented to the next letter. When a revision letter changes, the series number is also usually changed. The production code is the four-digit seven-segment number used for production purposes.

8-19. TROUBLESHOOTING

8-20. Troubleshooting the HP 5089A can be accomplished by using a digital voltmeter or a dual-trace oscilloscope. Refer to *Table 1-2* Recommended Test Equipment. The following procedure is recommended:

WARNING

THE INSTRUMENT WITH BATTERIES INSTALLED WEIGHS ABOUT 30.5Kg (67 POUNDS) AND CAN CAUSE INJURY OR DAMAGE IF ACCIDENTLY DROPPED. THE BATTERIES CAN ALSO DELIVER VERY HIGH OUTPUT CURRENTS THAT MAY CAUSE A SEVERE BURN IF ACCIDENTLY SHORTED BY A RING OR A METAL WATCH BAND. TEMPORARY REMOVAL OF THESE ITEMS IS SUGGESTED BEFORE STARTING ANY SERVICE PROCEDURE. USE A WORKBENCH WITH AN INSULATED SURFACE TO PREVENT A BATTERY SHORT CIRCUIT.

a. A quick check of the switching circuit can be made by setting the ac input line voltage to 90V rms with a variable transformer. Turn the battery switch OFF and remove any external load connected to J3 (DC OUTPUT). Make sure that the rear-panel ac line voltage selector switch is set to the 85V to 170V, 48-66 Hz input range. If the input power circuit is functioning

correctly, a nominal voltage of +12 to +13 volts should be present at the input to A1 (junction of C19, C20, P43, and L1), and the dc voltage measured at the positive terminal of capacitor C17 should be approximately +28 to +30 volts.

b. Use the dual channel oscilloscope as a signal tracer to determine if U1 has the three output waveforms shown in the schematic diagram. Follow the signal paths of the three signals until the defective component is located in the switching circuits that provide input drive to transformer T3.

c. The dc voltmeter can also be used to check the switching circuits and the remaining control circuits. Turn the BATTERY switch to ON. If a dc output of +25 to +28 volts is present at the positive terminal of capacitor C17, the switching circuits are probably functioning correctly.

d. The dc output from Q9 and the voltage at the junction of C13, R14, and R18 should be steady without any sudden fluctuations. These two voltages may slowly drift in a positive direction as the battery approaches a full charge. The BATTERY switch must be ON.

e. An additional test for the battery control circuits can be made if the battery is not completely discharged. Disconnect all input power to the HP 5089A and set the BATTERY switch to OFF. All three of the front-panel lights should be off and both meters should indicate zero.

f. Set the BATTERY switch to ON. There should be no change in the front-panel indications until the RESET/START switch is pushed.

g. The voltmeter will indicate battery voltage and the ammeter a slight discharge after the RESET/START button is pushed. The three front-panel lights should remain off. If the BATTERY LOW light (red LED) turns on, the battery is very close to a fully discharged state and will be disconnected by the DROP-OUT circuit when fully discharged. Any external alarm circuit connected to the LOW BATTERY WARNING terminals on the rear panel will be actuated when the BATTERY LOW light turns on.

h. If the HP 5089A passes all the troubleshooting checks, reconnect the power supply to an external power source to recharge the battery or turn the BATTERY switch to OFF so the control circuits will not discharge the battery.

8-21. SERVICE AIDS

8-22. Screws in the HP 5089A that appear to have Phillips heads all have Pozidrive heads, identifiable by the marks between the four slots in the head of the screw. Use Pozidrive screwdrivers only; Phillips screwdrivers may be damaged or the screws will be damaged if the wrong screwdriver is used.

8-23. Service Aids on Printed Circuit Board

8-24. The A1 Board has two handles to assist when removing the circuit board from the instrument. Two screws in the supporting bracket for A1 must be removed before the circuit board can be pulled out of the instrument. The bracket also serves as a heat sink for diode A1CR1.

8-25. The four controls on A1 are identified by the same names as shown in the schematic diagram. The three transformers on A1 have their terminals identified by letters R and G for red and green, respectively. Transformer T3 also has numbers "18" and "20" to indicate wire size.

8-26. REMOVAL OF A1 ASSEMBLY

8-27. The A1 Assembly is held in place by two screws and a bracket on the rear side of A1 in the approximate center of the circuit board. The two screws attach the bracket to an aluminum block mounted on the chassis bulkhead behind the circuit board. The bracket and aluminum block provide a heat sink for rectifier diode A1CR1.

8-28. The following procedure is recommended for removal of the A1 Power Supply/Regulator Assembly:

a. Detach the power cord from the ac outlet socket (mains).

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN DETACHING THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE POWER CORD FROM THE INSTRUMENT.

b. Disconnect external dc standby supply, if present, at DC INPUT connector J2 or J5/J6.

c. Remove top cover from instrument.

d. Push BATTERY toggle switch to OFF.

e. Remove ventilated top cover (MP13) from the circuit board compartment.

f. Remove the two screws holding the bracket on A1. The screws are visible on the back side of the A1 circuit board.

g. Two handles are supplied on the top edge of the circuit board to assist in circuit board removal. Pull the circuit board straight up out of the chassis socket with a side-to-side rocking motion to free the board from the socket.

8-29. INSTALLING EXTENDER BOARD FOR A1

8-30. The extender board (MP1) plugs into the chassis socket for A1. The circuit board is not polarized and can be fully inserted into the chassis socket in either position. The slot in the top of the circuit board compartment is offset so the A1 Assembly can be plugged into the extender board in only one position (with component side of A1 Assembly facing the front of the instrument).

8-31. The A1 Assembly can be mounted on the extender board and the power supply can be operated when troubleshooting the A1 Assembly or the A2 Assembly.

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN ATTACHING THE POWER CORD TO AN AC OUTLET (MAINS) THE MILITARY-TYPE CONNECTOR OF THE POWER CORD MUST BE CONNECTED TO AC LINE CONNECTOR (J1) ON THE REAR PANEL OF THE HP 5089A BEFORE INSERTING THE MAINS PLUG IN AN OUTLET SOCKET.

8-32. REPLACEMENT OF A1T1, A1T2, AND A1T3 TRANSFORMERS

8-33. If replacing pulse transformers A1T1 or A1T2 or switching transformer A1T3, note the location of the paint dot (usually white) on the original transformer. Install the replacement transformer with the dot in the same relative position. The dot on transformers A1T1 and A1T2 should face the top edge of the circuit board. The dot on A1T3 should be facing to the right (viewing component side of circuit board when the board is held upright).

8-34. REMOVAL OF A2 ASSEMBLY

8-35. The A2 Assembly is located between the circuit board compartment for A1 and the backside of the front panel. The board is held in place by threaded spacers on two of the meter-mounting screws and pushbutton switch A2S1 (RESET/START) on the front panel.

8-36. To gain access to this circuit board, the front panel must be moved from the power supply. The panel is held in place by recesses in the two side frames. To release the panel from the side frames, the screws in one side frame must be loosened sufficiently to permit sideways movement of the panel. The left side frame (instrument viewed from front) is the easiest side frame to loosen. The panel can then be moved to the left far enough to be free from the right side frame. The panel can then be laid forward to expose the A2 circuit board.

8-37. The A2 circuit board can be detached from the back of the panel and the panel can be temporarily put back in place while troubleshooting the A2 Board.

CAUTION

Great care should be taken not to short any terminals on circuit board A2 to chassis ground. Severe instrument damage can occur.

8-38. THEORY OF OPERATION

8-39. The following paragraphs contain a detailed theory of operation for the HP 5089A Standby Power Supply circuitry. The first circuit description, beginning at Paragraph 8-40, is of the chassis-mounted components that make up the power input circuitry. The circuit description of the A1 Power Supply/Regulator Assembly begins at Paragraph 8-49 and the description of the A2 Indicator Assembly begins at Paragraph 8-83. All circuit descriptions are referenced to the schematic diagram, *Figure 8-7*.

8-40. Power Input Circuit Operating Theory (Chassis Mounted Parts)

8-41. Operating power is provided by power transformer T1 which receives a single phase ac input from an 85V to 255V rms (48 to 66 Hz) or an 85V to 130V rms (48 to 440 Hz) power source via AC LINE connector J1. The power transformer T1 has two primary windings which are connected in parallel by rear panel switch S2 for an input voltage range of 85V-170V rms ac. Switching S2 to its alternate setting connects the two primary windings in series for an input voltage range of 170V-255V. Two fuses, F5 and F6, are provided for the primary, one for each winding. An ac on-off switch is not provided, so the HP 5089A is always on when connected to an external ac power source and the line fuses are intact.

8-42. Output from the single secondary winding on T1 is rectified by full-wave bridge rectifier CR1 and filtered by capacitors C4 and C5. The filtered dc output from C4 and C5 is then regulated by Darlington high-power NPN silicon transistor Q1. Bypass capacitors C1, C2, and C3 reduce radiated rf noise from the switching regulator to an insignificant level.

8-43. Resistor R1 and breakdown diodes CR3 and CR4 supply a reference voltage to the base of Q1 for a maximum regulated output of about +25V at the input to circuit board A1. This output voltage varies in direct proportion (approximately) to the ac or dc input from the external ac or dc power sources, up to a maximum of +25V. Transistor Q1 is capable of absorbing input power line surges to prevent possible damage to the HP 5089A.

8-44. An external dc power source can be used as an emergency power source. Two connections are provided for dc input. Connector J2 is for a +11V to +20V dc input and connector J5/J6 is for a +20V to +30V dc input. Diodes CR5 and CR2 prevent reverse current flow to the external dc source when ac line voltage is present. A slow-blow fuse is used for F5 and F3 to prevent fuse burn-out by a current surge if the power supply switches to the dc source. For the lower input range, transistor Q1 is bypassed. For the higher input range, Q1 ensures that the dc input voltage to the A1 Board is not excessive.

8-45. In cases when the rectifier voltage developed by CR1 is not sufficiently high (the worst case is 85V @ 440 Hz), it is necessary to make Q1 saturate in order to obtain a minimum drop. This is done by injecting a current from pin $\overline{13}$ through R2 into the base of Q1. With an input of 85V @ 440 Hz, the rectifier voltage is typically 13 volts. Once the regulator starts up, 29 volts (approximately) is available from pin $\overline{13}$ and this provides enough base current for Q1. The injected current is prevented from flowing back to the source by diode CR6.

8-46. Power input needed for any particular operating level (battery charging and/or dc output) is approximately the same. Input current requirements (ac or dc) are inversely proportional (approximately) to the supply voltage. A high input voltage decreases current through Q1; a low input increases the current. The nominal +10V to +25V dc output from Q1 supplies all operating power for the A1 Power Supply/Regulator Board.

8-47. Five fuses are mounted on the rear panel. Two fuses (F2, F6) protect the input power circuitry. Two more fuses (F3, F5) protect the external dc power source and the fifth fuse (F4) protects the power supply output circuits. A sixth fuse (F1), mounted inside the HP 5089A, is connected in series with the battery.

8-48. Other chassis mounted parts include the two sealed lead-acid batteries BT1, BT2, BATTERY ON-OFF switch S1, dc voltmeter M1, and center-scale dc ammeter M2.

8-49. A1 Power Supply/Regulator Assembly Operating Theory

8-50. In the following discussion, all parts are on circuit board A1 (except Q1 and XA1 in the next paragraph) and have a prefix of A1 such as A1C1. This prefix will not be used in the following text to make the discussion easier to read and follow.

8-51. Output dc from power regulator Q1 enters circuit board A1 through several contacts in circuit board socket XA1, as shown in the schematic diagram, *Figure 8-7*. Capacitors C19 and C20 filter the input dc and bypass any internally generated noise on the input line. This input goes to the turn-on control circuit of transistor Q12 and to the LC filter circuit consisting of L1 and C15.

8-52. Transistor Q12 is biased to turn on whenever the dc input to A1 is first applied. The current through Q12 passes through diode CR5 and supplies input voltage to voltage regulator U5. The regulator delivers a +5 volt output that is filtered by capacitors C2 and C14.

8-53. The +5V supply is used for operating power by transistors Q1 and Q2 and integrated circuits U1 through U4. Consequently, the switching logic circuits are turned on as soon as power is first applied or after a power interruption.

8-54. Filtered dc from L1 and C15 enters the center tap of switching transformer T3 and travels through both sides of T3 and rectifier CR1 to choke L2. This choke has a bifilar winding with a powdered iron core. The two windings are connected in parallel for low dc resistance in the output current path.

8-55. Driver transistors Q7 and Q8 are both off and will not turn on before they receive an input from transformers T1 and T2, respectively. Signal timing and output amplitude from T1 and T2 are controlled by the switching-logic circuits. A dc current flows through T3, CR1, and L2 to the junction of C16, C17, C24, R17, and then through R20 to the VOLTAGE SET control, R19. Transistors Q3 through Q6 also receive power from this junction.

8-56. Occasionally, a large surge may occur at the output of L2 when ac power is first applied. If the surge causes breakdown diodes CR17 and CR18 to conduct, a surge is produced across resistor R41. This surge is amplified by U2B and immediately pulls the DC ERROR FEEDBACK line high through diode CR20.

8-57. When voltage is first applied across diodes CR17 and CR18, capacitor C24 starts to charge through resistor R41 and the two diodes do not conduct until C24 is charged to a point where the voltage across C24 is high enough to cause the diodes to conduct. When C24 first starts to take a charge, input to U2B(5) goes high (limited to +5V by diode CR19) and the output from U2B(7) goes very high. The DC ERROR FEEDBACK line is pulled high through diode CR20. The charging of C24 and conduction by the diodes provides a short time delay and gradually allows the input to U2(5) to go low and the output at U2(7) to go low.

8-58. When the DC ERROR FEEDBACK line is high, output pulses from U3 are narrow and do not drive the switching circuits to a maximum, thus ensuring a "soft turn-on" to prevent damage to transistors Q3 through Q8. After the turn-on surge passes, capacitor C24 is fully charged and diodes CR17 and CR18 turn off so the output from U2B goes low. Diode CR20 is reverse-biased and the DC ERROR FEEDBACK line is disconnected from the output of U2B. Control of the DC ERROR FEEDBACK line, by the feed-back circuit of U2A, is then restored for normal operation. Capacitor C24 has no function when fully charged.

8-59. As the dc output voltage from L2 rises to maximum, diodes CR6, CR7, and CR8 conduct to supply an input to pin 1 of the +5V regulator. The voltage supplied by these three diodes exceeds the voltage supplied by Q12 through diode CR5. This places a reverse voltage on diode CR5 and the current through CR5 drops to zero and turns transistor Q12 off. This automatic control takes over when the power supply is first turned on or when input power returns after a charge interrupt occurs.

8-60. The CMOS astable multivibrator U1 has three outputs. The output at U1(13) is an approximate square wave with a nominal frequency of 50 kHz. The RC timing circuit consisting of capacitor C1 and resistor R1 determines the frequency of this signal. The other two outputs, from U1(10,11) are 180° out of phase with each other and are squarewaves with a frequency of 25 kHz (1/2 of the output frequency at pin 13). The phase relationship between the signals is shown by idealized waveforms in the schematic diagram, *Figure 8-7.*

8-61. Resistor R2 and capacitor C3 integrate the 50 kHz output from U1, pin 13. The resulting waveform is similar to a triangular wave with the positive peaks slightly delayed from the positive going edges of the squarewaves from U1(10,11).

8-62. The integrated and delayed 50 kHz signal enters non-inverting input pin 2 of voltage comparator U3. An amplified and filtered dc error signal, from U2(1), enters inverting input pin 3 of U3. The output at U3(7) is a series of positive pulses with a 50 kHz repetition rate.

8-63. The pulse width of the U3(7) output is controlled by the amplitude of the DC ERROR FEEDBACK signal to increase or decrease the drive to the switching circuits. The pulse width is narrowed to reduce the drive to the switching circuits, and is widened to increase the drive to the switching circuits. The DC ERROR FEEDBACK signal is derived from the dc output from choke L2 via error feedback amplifier U2A.

8-64. The current through R19 and breakdown diodes CR21 and CR22 establishes a positive dc voltage at the junction of C13, R14, and R18. This voltage changes with any change in dc output level from L2. The output dc from L2 tends to rise slightly when the battery gets a full charge, and tends to drop if the battery requires a large charging current. The voltage at U2A(3) will rise or fall according to the output from L2. The input to U2A(3) and the +5 volt regulated output from U5 are compared, amplified, and filtered by the U2A circuit to appear as the DC ERROR FEEDBACK signal at U2A(1) in series with resistor R42.

8-65. The DC ERROR FEEDBACK signal average level is approximately +2.5 volts and shifts in level to compensate for errors in the output voltage when the circuit is functioning normally. The DC ERROR FEEDBACK signal line is highly filtered and free from power supply noise. This signal is derived from the output voltage, via U2A, to control voltage regulation, output voltage, and maximum current through current limiter Q9.

8-66. If the DC ERROR FEEDBACK signal to U3(3) is high, the time interval between the points where the triangular wave crosses above and below the level of the DC ERROR FEEDBACK signal is short and U3 outputs narrow pulses. If the error signal is below the average level, the time interval is longer and U3 outputs wider pulses.

8-67. A push-pull input is provided to the switching transformer, T3, by a repetitive cycle which originates at the 25 kHz outputs of U1. The squarewaves from U1(10,11) are buffered by transistors Q2 and Q1 which are alternately turned on and off by the squarewaves. When Q2 conducts, NAND gates U4C and U4D are enabled and Q1 is turned off to disable gates U4A and U4B. A pulse from U4A turns Q3 off and one from U4B turns Q4 on. The pulse from U3 then passes through U4C and U4D to produce negative input pulses at the base of transistors Q5 and Q6.

8-68. Transistor Q5 turns on and Q6 turns off. The current pulse through Q5 induces a current pulse in T2 to turn transistor Q8 on for the duration of the pulse. Capacitor C10 stores the current pulse through Q5 and is partially discharged by Q4 during the half-cycle until Q2 is turned off and Q1 is turned on. The charging of C10 prevents a high dc current flow through T1 and T2. Capacitor C10 remains charged to a nominal average value of +5 volts, but may be as low as +0.5 volts for a low charging current or as high as +14 volts with a high charging current.

8-69. The situation is reversed when the squarewaves from U1 turn on Q1 and turn off Q2. Gates U4A and U4B are enabled and U4C and U4D are disabled. Transistor Q5 is turned off, and at the beginning of the next half-cycle Q3 is turned on. Current through Q3 and T1 induces a current pulse to turn on Q7 for the duration of the pulse. Note that transistor Q4 only turns off when Q3 is turned on, and Q6 only turns off when Q5 is turned on. At all other times, Q4 and Q6 are turned on, providing a current path to ground.

8-70. This completes one cycle which keeps repeating to provide the push-pull input to transformer T3, and the resultant dc output from CR1. Bridge rectifier CR1 is connected for full-wave operation and is not used as a bridge.

8-71. Output current delivered by the rectifier is determined by the width of output pulses from U3. The rectified output is filtered by choke L2 and capacitors C16 and C17. Capacitor C16 bypasses rf noise emerging from switching transformer T3, and capacitor C17 smoothes the dc output. Inductors L1 and L2 keep rf noise confined to the switching transformer circuit.

8-72. Maximum output current for battery charging or an external load is controlled by transistor Q9 and current-sense resistor R20. As the current increases through R20, transistor Q9 gradually turns on until the maximum current reaches about 2 amperes. Collector current through Q9 then begins to pull the reference voltage high through diode CR23. The change in the reference voltage is sensed by U2A, which raises the amplitude of the DC ERROR FEEDBACK LINE to reduce the width of the U3 output pulses just enough to limit additional increase in the output current.

8-73. Current regulator output is divided into three different paths. One path is through A1P1($\overline{13}$) for power input to Indicator Assembly A2 (discussed later). A second path is through series diode CR24 to the front-panel meters and back to the battery discharge control circuits. The second path then continues through the contacts of DROP OUT relay K1 to DC OUTPUT jack J3. The third path goes through CR24 and ammeter shunt resistor R22 to BATTERY switch S1. Reverse current flow into the battery charging circuits of the HP 5089A is prevented by diode CR24.

8-74. When a low dc input voltage (+10V to +11V) is available to the A1 Board, Q3 and Q5 operate at nearly 50% duty cycle after power is turned on. The average dc voltage developed across C10 rises and as a result, the voltages available across the primary windings of T1 and T2 are not sufficiently high. In turn, the available drive for Q7 and Q8 is inadequate and they do not switch. Since the regulator circuit is not switching, there is approximately zero volts applied from CR1 to the gate of Q13. Q13 conducts, causing Q14 to saturate. This raises the voltage on the DC ERROR FEEDBACK line on the cathode side of CR20 which in turn reduces the duty cycle of Q3 and Q5. The average voltage across C10 is thus reduced and gradually more drive becomes available at the bases of Q7 and Q8. When Q7 and Q8 begin switching, a negative voltage is applied to the gate of Q13. Q14 and Q13 are now cut off and normal loop control is resumed.

8-75. When BATTERY ON-OFF switch S1 is ON, charging current passes through shunt resistor R22 and one DPST section of S1 to battery fuse F1 and the positive battery terminal. The second DPST section of S1 is not used. The battery negative terminal is connected to circuit board common by one set of contacts in DROP OUT relay K1.

8-76. The DROP OUT and WARNING circuits consist of operational amplifiers U6A and U6B, transistors Q10 and Q11, and dc relays K1 and K2. With power applied, diode CR25 and capacitor C25 plus resistors R25 and R26 form a regulated power supply of approximately +11V for U6. Resistors R28 and R29 also divide the +11V supply to produce a nominal reference voltage of about +5V for the inverting input of both operational amplifiers. Negative output from the operational amplifiers turns transistors Q10 and Q11 off so DROP OUT and WARNING relays K1 and K2 are not activated.

8-77. The DROP OUT and WARNING circuits can be preset to operate at a certain voltage level by potentiometers R30 and R32, which are part of a voltage divider circuit across the dc input supply to these circuits. The controls are set so the center arms provide a positive voltage to the non-inverting inputs of U6A and U6B. When this input is high enough the outputs the operational amplifiers go positive.

8-78. Potentiometers R30 and R32 are preset so the outputs of U6A and U6B are normally positive, turning on transistors Q10 and Q11. When Q10 and Q11 turn on, relays K1 and K2 actuate and their contacts make the connections shown in the schematic diagram. Relay K1 internally connects the negative side of the battery to the circuit board common and activates the control circuits for relays K1 and K2. Relay K1 also connects the positive side of the battery (from CR24 cathode via XA1) to the DC OUTPUT connector, J3. Relay K2 contacts are open, the BATTERY LOW warning light is off, and an open circuit appears between the rear-panel terminals to which an external alarm circuit may be connected.

8-79. The center-scale dc ammeter shows battery current by a positive indication when charging or a negative indication during discharge when relay K1 is energized. The dc voltmeter shows output voltage to any external load attached to the DC OUTPUT connector.

8-80. Connecting an external power source will turn the HP 5089A on, ready to function as a stand-by power supply. Automatic battery charging starts at a rate determined by the current limiter, the regulated output voltage from the limiter, plus any residual charge in the battery. The maximum charging rate is approximately 2.0A at the start and then tapers to a trickle-charge when the batteries are fully charged.

8-81. If external power fails or is removed, causing the HP 5089A to supply standby power, the battery will discharge to supply power for the external load plus power to the DROP OUT and WARNING circuits until the charge is nearly exhausted. At this point, preset by WARNING control R32, the positive input voltage to U6B(5) is too low for U6B(7) output to remain high so U6B(7) goes low. This turns transistor Q11 off to de-energize relay K2. Contacts of K2 turn on the BATTERY LOW light (red LED) on the front panel and close the circuit between the two LOW BATTERY WARNING terminals on the rear panel.

8-82. The battery will continue to supply stand-by power until output voltage drops approximately 1 volt lower. At this point, preset by DROP OUT control R30, the positive input voltage to U6A(3) is too low for the U6A output to remain high so U6A(1) goes low. Transistor Q10 turns off to de-energize relay K1. The contacts of K1 disconnect the battery from the load and from the DROP OUT and WARNING control circuits. All front-panel lights turn off, but the contacts for the rear-panel LOW BATTERY WARNING terminals (for an external alarm) remain closed.

8-83. A2 Indicator Assembly Operating Theory

8-84. In the following discussion, all parts are on circuit board A2 and have a prefix of A2, such as A2C1. This prefix will not be used in the following text to make the discussion easier to read and follow.

8-85. The A2 Indicator Assembly circuit board is held by the mounting screws for the front-panel meters. Added spacers over the screws plus the RESET/START switch (S1) support the circuit board behind the front panel so the green (DS1), yellow (DS2), and red (DS3) LED lights protrude through the panel to show CHARGING, CHARGE INTERRUPT, and BATTERY LOW warning indications, respectively.

8-86. Operating power for the A2 Assembly comes from the regulated output of the A1 circuit board through XA1 pin $\overline{13}$. The A2 Indicator Assembly has four external connections via four wires soldered into holes in the A2 circuit board.

8-87. A black wire connects circuit board common to the chassis. Power input comes from a pin on XA1 through a wht-red wire. The orn-wht wire from socket XA1 supplies power for the BATTERY LOW warning light. A fourth wire (wht-blk-yel) comes from the negative side of the battery.

8-88. The fourth wire permits the battery to be used for an emergency power source provided the battery is fully or partially charged and able to supply an output for a limited time. If the BATTERY switch (S1) is turned from OFF to ON and the front-panel RESET/START switch (A2S1) is pushed, the negative side of the battery is connected to circuit board common. This is the same switching action as that obtained when DROP OUT relay K1 is actuated. The relay control circuits also receive operating voltage and will control the WARNING and DROP OUT relays until the battery is discharged.

8-89. When the HP 5089A is first connected to an external power source or power returns after an interruption, the green CHARGING and yellow CHARGE INTERRUPT lights turn on. The red BATTERY LOW warning light should be off.

8-90. When power is applied, the flip-flop circuit consisting of U1A and U1B supplies a high output from U1A(1) and a low output from U1B(7). The high level (about +28V) from U1A(1) turns the CHARGE INTERRUPT light on. The voltage from the A1 circuit is divided by R2 and R3 to supply a nominal input of +5 to +7 volts to the noninverting inputs of U1A and U1B. The output from U1A(1) provides a voltage at the inverting inputs of both operational amplifiers. The inverting input at U1B(6) is reduced by resistors R8 and R7 and is positive with respect to the input at pin 5 so the output at U1B(7) remains low (about +.8V).

8-91. Resistors R6 and R4 reduce the positive output from U1A(1), and capacitor C1 introduces a time delay while being charged through resistor R4. This results in delayed input voltage to the inverting input at U1A(2). The delayed voltage is negative with respect to the input at U1A(3) so the flip-flop does not change state.

8-92. The output at U1A(1) remains high so the CHARGE INTERRUPT light remains on. Pushing RESET/START switch S1 pulls the inverting input at U1B(6) low. Output at U1B(7) goes high enough to force the input dc at U1A(2) higher than the positive input at U1A(3). The output at U1A(1) goes low. The yellow light turns off and the inverting input to U1B(6) is held low by the output from U1A.

8-93. BATTERY REPLACEMENT

8-94. Precharging Replacement Batteries

8-95. New batteries from the factory being used as replacements must be precharged before being used in the HP 5089A to ensure that the voltages of the two 12V batteries are balanced. In normal instrument use, the two batteries are charged in series. If the battery voltages are not in balance, the charging current will reduce to a trickle charge when the float voltage of the higher voltage battery is reached, preventing the lower voltage battery from reaching a full charge. To ensure proper charging during normal use, each 12V battery should be precharged to the same voltage level before being installed in the HP 5089A. A precharge should also be done on any battery which has been stored for an extended period of time (approximately four months) without being charged or discharged.

8-96. Before installing new batteries in the HP 5089A, each battery should be precharged for 24 hours from a dc source set at +15.30V ±.01V and current limited to 2.0A ±0.1 A. The two batteries may also be charged in parallel with the current limiting set to 4.0A ±0.2 A. DO NOT precharge the two batteries in series.

CAUTION

The batteries should not be charged in an inverted position (battery terminals facing downward). Charging the batteries in this position may force venting of the electrolyte which may cause workbench damage and possible personal injury. When in use as a power source (battery discharging), the batteries may be used in any position.

SERVICE INFORMATION CON'T

8-97. Battery Replacement Procedure

8-98. The following procedure is recommended when battery replacement becomes necessar . The batteries and battery case are removed as one single assembly before the individual batteries are replaced.

WARNING

THE BATTERIES AND BATTERY CASE WEIGH ABOUT 35 POUNDS AND CAN CAUSE INJURY OR DAMAGE IF ACCIDENTLY DROPPED. THE BATTERIES CAN ALSO DELIVER VERY HIGH OUTPUT CURRENTS THAT MAY CAUSE A SEVERE BURN IF ACCIDENTLY SHORTED BY JEWELRY SUCH AS A RING OR A METAL WATCH BAND. TEMPORARY REMOVAL OF THESE ITEMS IS SUGGESTED BEFORE STARTING ANY SERVICE PROCEDURE. USE A WORKBENCH WITH AN INSULATED SURFACE TO PREVENT A BATTERY SHORT CIRCUIT.

CAUTION

The batteries contain sulfuric acid and are designed for maximum reliability and safety in this instrument. Use exact replacement batteries only. A substitute battery may have electrolyte leakage caused by venting which may cause instrument damage and possible personal injury.

a. Disconnect the power cord from the outlet socket (mains).

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN DETACHING THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE POWER CORD FROM THE INSTRUMENT.

b. Remove top instrument cover and push BATTERY switch to OFF. Disconnect all connectors and connections to the rear of the instrument.

c. Disconnect all four plug-on battery connectors. Dress or temporarily tape wires to hold them out of the way.

d. Invert the HP 5089A on a manual or flat board thick enough to support the instrument on the battery case. Remove bottom cover.

e. The battery case is attached to chassis by 14 screws on the bottom of the chassis. Remove and save all of these screws.

f. Lift instrument up and off of battery case and batteries.

g. Note location of silicon rubber sheets (cemented on chassis) for each battery. These rubber sheets and four others, cemented inside the battery case, compensate for mechanical variations in battery size and must be reused during reassembly of the battery case and batteries.

h. Loosen three screws attaching back cover at each end of battery case (six screws total). DO NOT loosen three screws in center of back cover.

i. Loosen three screws attaching top cover at each end of battery case (six screws total). DO NOT loosen three screws in center of top cover.

j. Remove and save nine screws attaching front cover to battery case. Remove front cover, cable clamp, and short battery jumper wire.

k. Replace batteries in battery case. Be sure the rubber sheets are in place when batteries are installed.

CAUTION

Do not incinerate or mutilate the old batteries as they may burst or release toxic materials. Do not short circuit old batteries; a severe burn or fire could result from a short circuit.

l. Replace front cover, cable clamp, battery jumper wire, and nine screws removed in step j. Tighten the three screws in the center of the cover. Leave the three screws on each end of the cover loose.

m. Stand battery case on end on a thin spacer that is smaller than the end plate and tighten nine screws around the bottom end. Repeat procedure with battery standing on opposite end. The rubber sheets, in battery case, are compressed by this procedure.

n. Place battery and case assembly on a book or flat board in the same position as step d just after lifting the HP 5089A off of battery case and batteries. The silicon rubber sheets must remain attached to the top side of the instrument chassis.

o. Invert the HP 5089A over battery case and batteries. Replace all 14 screws (removed in step e) to hold battery case in place. Install bottom cover.

p. Turn instrument right-side up and reconnect the batteries.

q. Push BATTERY toggle switch to ON and replace top cover. All three front-panel indicator lights should be off.

r. Refer to procedures in Section II Installation and Section III Operation to begin using the instrument.

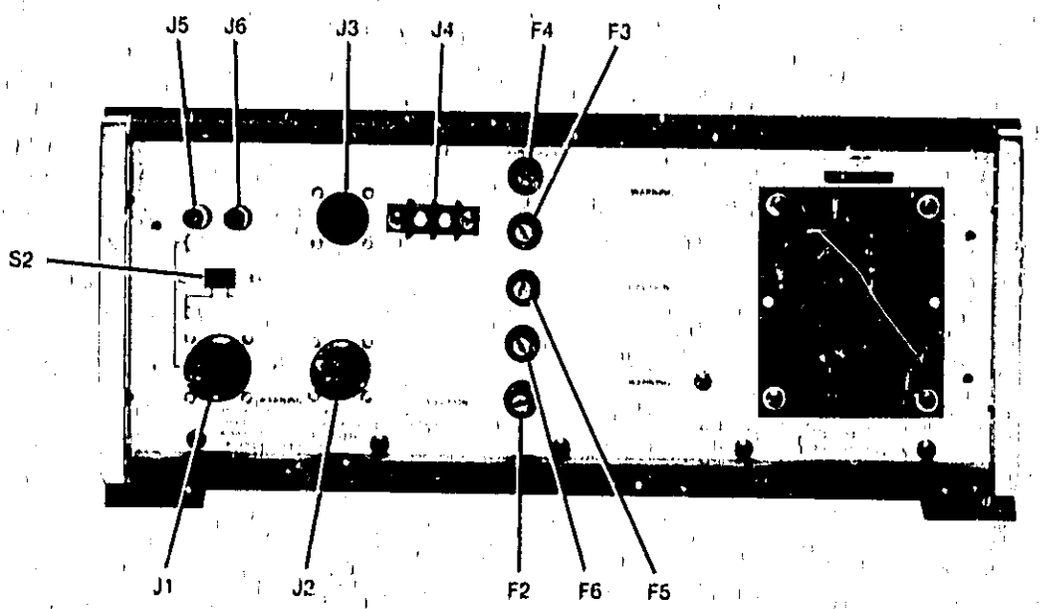
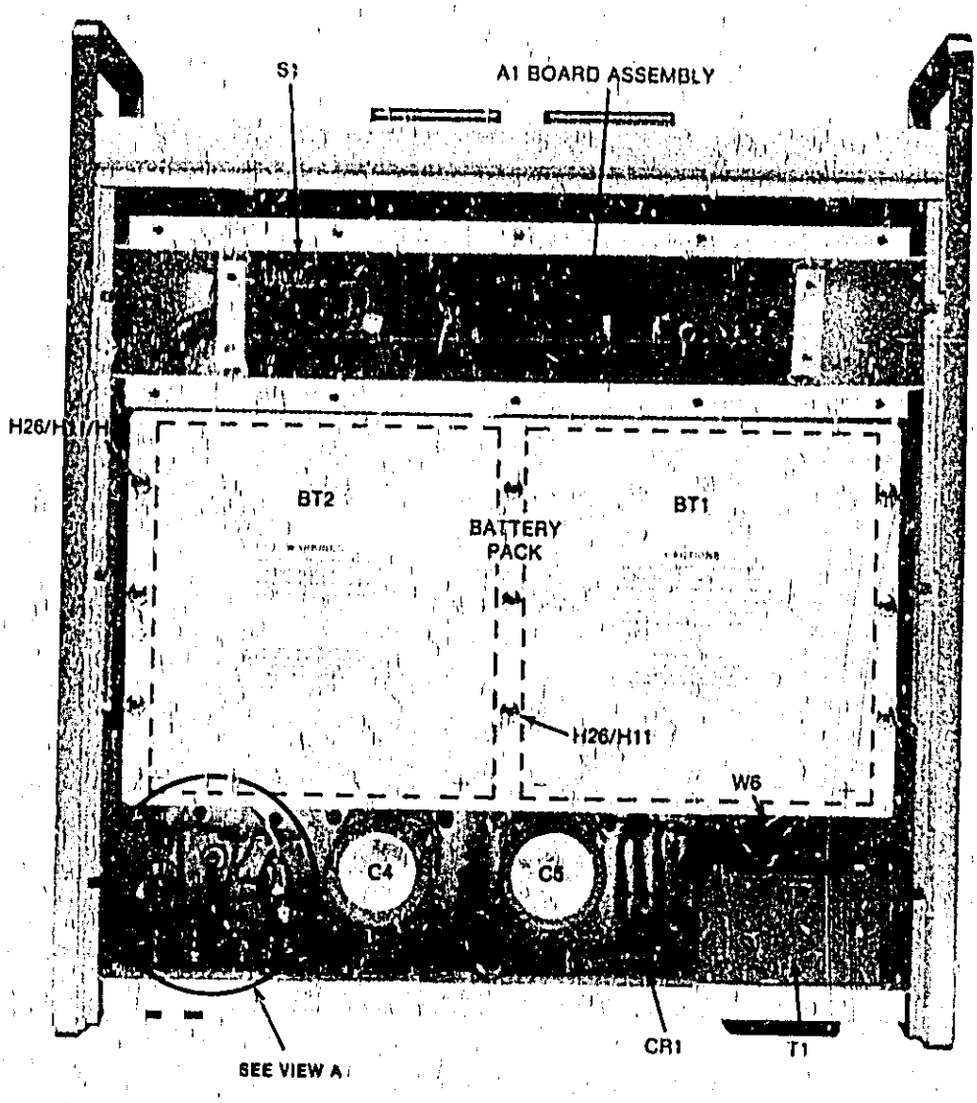
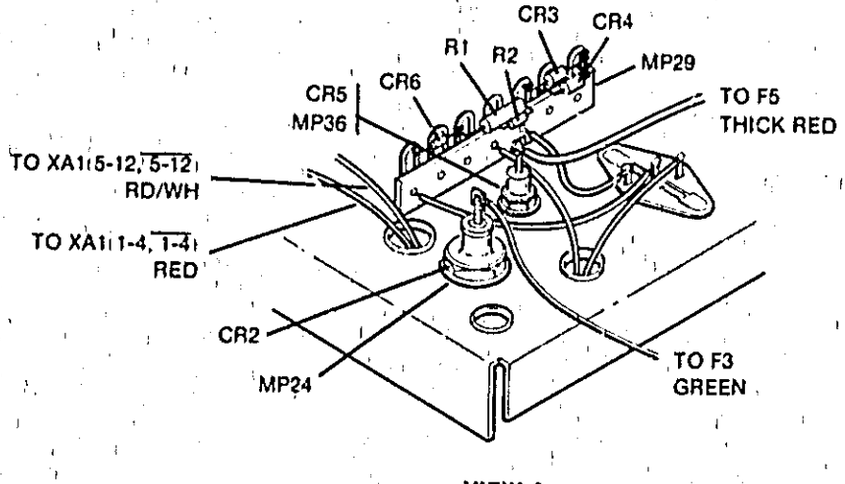


Figure 8-2. HP 5089A Rear View





VIEW A

Figure 8-3. HP 5089A Top Internal View (A1 Compartment Cover Removed)

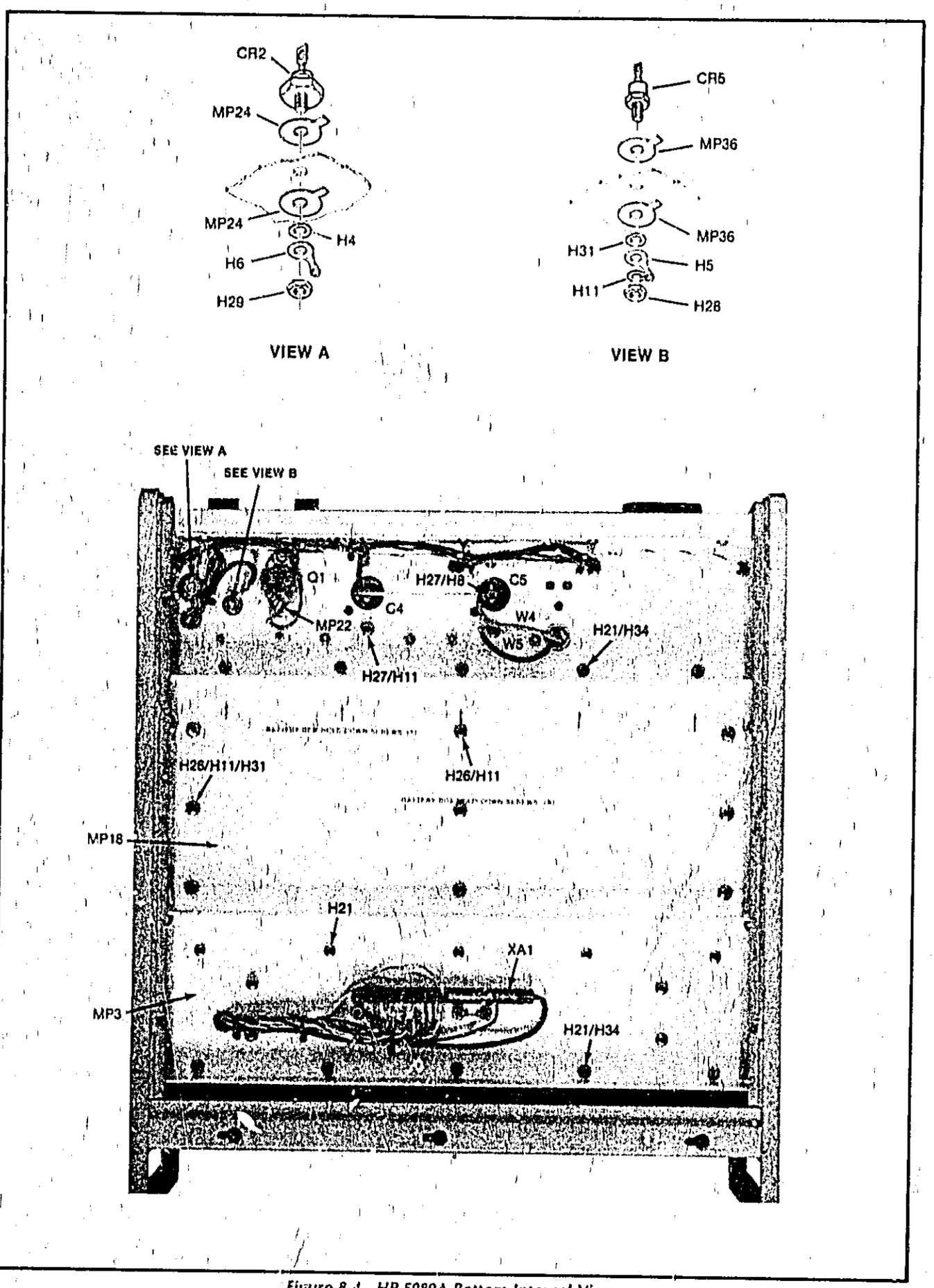
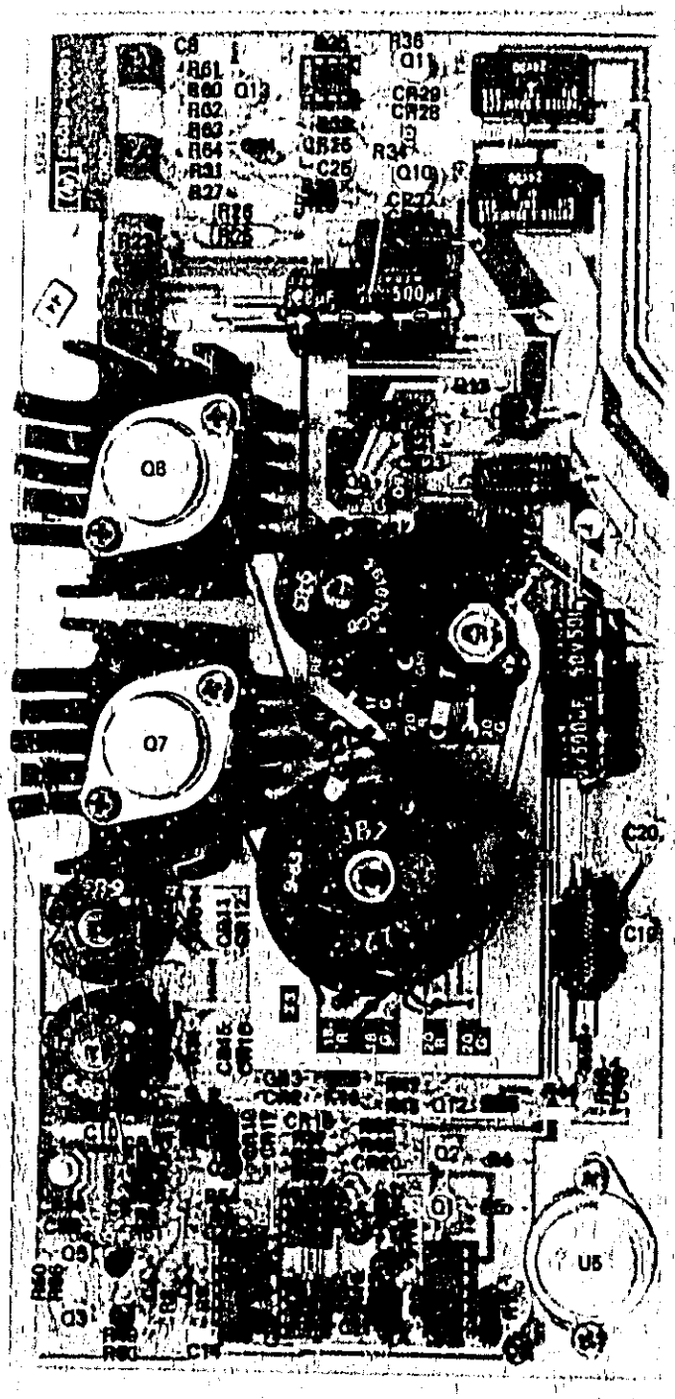
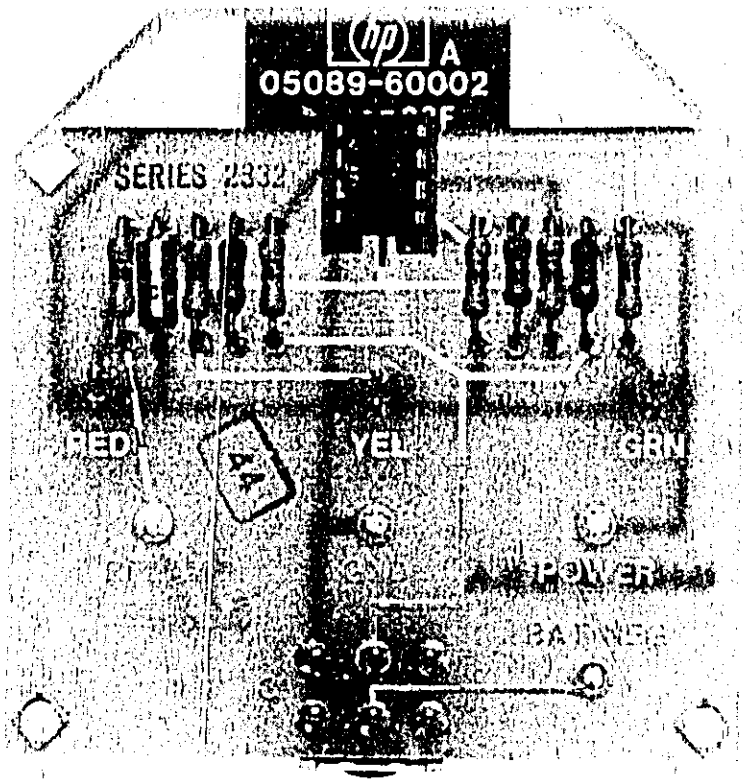


Figure 8-4. HP 5089A Bottom Internal View

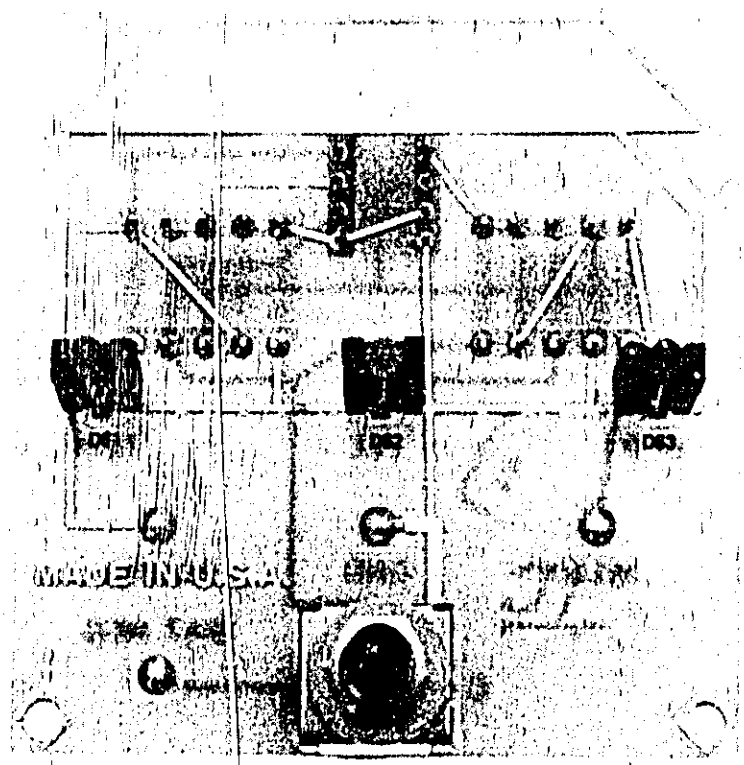


A1

Figure 8-5. A1 Power Supply/Regulator Assembly



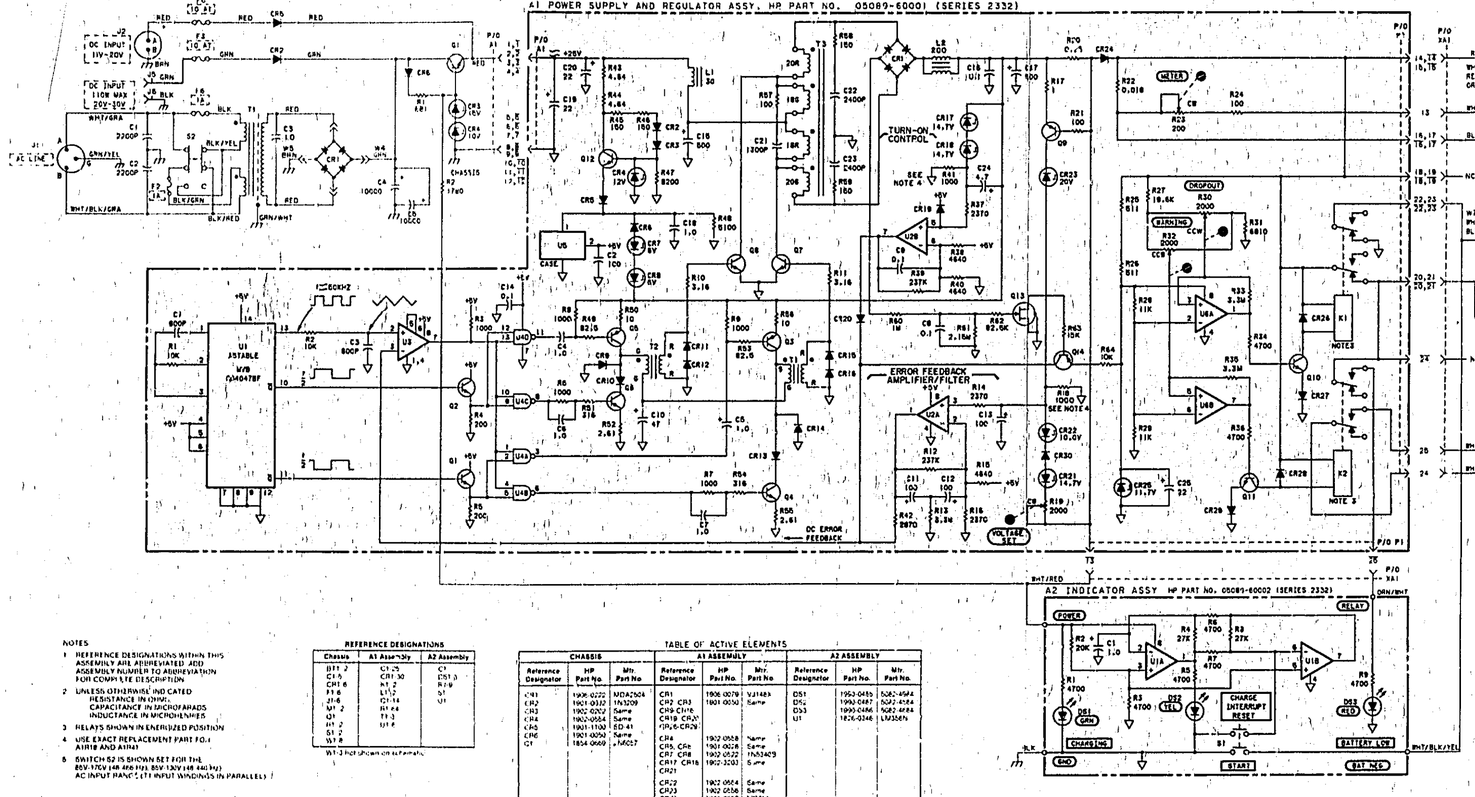
COMPONENT SIDE



CIRCUIT SIDE

A2

Figure 8-6. A2 Indicator Assembly



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS, INDUCTANCE IN MICROHENRIES.
3. RELAYS SHOWN IN ENERGIZED POSITION.
4. USE EXACT REPLACEMENT PART FOR A1R18 AND A1R41.
5. SWITCH S2 IS SHOWN SET FOR THE 85V-125V (48-66 Hz), 85V-130V (48-440 Hz) AC INPUT RANGE (T1 INPUT WINDINGS IN PARALLEL).

REFERENCE DESIGNATIONS

Chassis	A1 Assembly	A2 Assembly
BT1, 2	C1-25	C1
C1-9	CR1-30	CR1-3
CR1-6	R1, 2	R1-9
F1-6	U1, 2	S1
J1-6	Q1-14	U1
M1, 2	R1-64	
Q1	T1-3	
S1, 2	U1-5	
W1-8		

W1-3 not shown on schematic.

TABLE OF ACTIVE ELEMENTS

CHASSIS			A1 ASSEMBLY			A2 ASSEMBLY		
Reference Designator	HP Part No.	Mfr. Part No.	Reference Designator	HP Part No.	Mfr. Part No.	Reference Designator	HP Part No.	Mfr. Part No.
CR1	1906-0222	MDA2504	CR1	1906-0079	V2146A	DS1	1963-0465	5082-4984
CR2	1901-0032	1N3209	CR2, CR3	1901-0050	Same	DS2	1990-0487	5082-4984
CR3	1901-0202	Same	CR9-CR16			DS3	1990-0486	5082-4984
CR4	1902-0064	Same	CR19-CR21			U1	1826-0346	LM358N
CR5	1901-1100	SD-41	(SPLUS-CR29					
CR6	1901-0050	Same	CR4	1902-0858	Same			
C1	1854-0469	2N4057	CR5, CR6	1901-0028	Same			
			CR7, CR8	1902-0522	1N5240B			
			CR17, CR18	1902-3203	Same			
			CR21					
			CR22	1902-0064	Same			
			CR23	1902-0858	Same			
			CR24	1901-0662	MR751			
			CR25	1902-0018	1N941			
			Q1, Q2, Q12	1854-0477	2N2222A			
			Q3, Q5, Q9	1853-0281	2N2907A			
			Q4, Q6	1854-0674	Same			
			Q7, Q8	1854-0744	2N5339			
			Q10, Q11	1854-0023	2N3904S			
			Q13	1855-0327	2N4416			
			Q14	1853-0036	Same			
			U1	1820-2230	CD4047BF			
			U2, U6	1826-0346	LM358N			
			U3	1826-0065	UPC311C			
			U4	1820-0371	SN7437N			
			U5	1820-0430	LM309K			

Figure 8-7. HP 5089A Standby Power Supply (A1, A2 Assemblies and Chassis-Mounted Parts) Schematic Diagram

MANUAL CHANGES

MANUAL UPDATING CHANGES

CHANGE DATE: December 5, 1985

*** * * * MANUAL UPDATING COVERAGE * * * ***

This supplement adapts your manual to instruments with serial numbers prefixed through 2550.

*** * * * MANUAL IDENTIFICATION * * * ***

Instrument: HP 5089A Standby Power Supply Operating & Service Manual

Manual Part No: 05089-90001
Manual Microfiche: 05089-90002
Manual Print Date: November 1985

ABOUT THIS SUPPLEMENT

The information in this supplement is provided to correct manual errors and to update the manual to instruments containing changes after the manual print date.

Change and correction information in this supplement is itemized by page numbers corresponding to the original manual pages. The pages in this supplement are organized in numerical order by manual page number.

HOW TO USE THIS SUPPLEMENT

Insert this title page in front of the title page in your manual.

Perform all changes specified for "All Serials", and all changes through the Series Prefix of your instrument or board.

Insert any copmlete replacement pages provided into your manual in the proper location.

If your manual has been updated according to the last edition of this supplement, you need only perform those changes pertaining to the new series prefix. See List of Effective Pages on the reverse side of this page. New information affecting "All Serials" will be indicated by a "#" in front of the page number.

HEWLETT PACKARD

LIST OF EFFECTIVE PAGES

SERIAL PREFIX OR SERIAL NUMBER	PAGES
All Serials	8-21
2550	2-3, 3-7, 6-8, 6-9, 6-11, 6-17, 8-18

MANUAL CHANGES MODEL 5089A (05089-90001)

SERIAL PREFIX OR SERIES NUMBER	CHANGES

Page 2-4. Installation:

2550 Paragraph 5, CAUTION:
>Delete "(instrument sitting on its rear panel)".

Page 3-7. Operation:

2550 Paragraph 4, CAUTION:
>Delete "(instrument sitting on its rear panel)".

Pages 6-8/6-9, Table 6-4. Replaceable Chassis Parts:

2550
>Change BT1/BT2 from 1420-0310 to 1420-0347 BATTERY LEAD-ACID SEALED 12V 14.4 AMP HRS.
>Change H11 quantity from 38 to 2.
>Change H22 quantity from 54 to 49.
>Change H26 from 2680-0103 to 2680-0301, Qty 36, SCREW-MACH 10-32 .5-IN-LG FLANGED.
>Delete H31, 3050-0002.
>Change MP15 BATTERY FRAME FROM 05089-00009 TO 05089-00020.
>Change MP16 BATTERY BRACE FRONT from 05089-00010 to 05089-00022.
>Change MP19 BATTERY BRACE REAR from 05089-00013 to 05089-00023.
>Delete MP28 4320-0002.

NOTE

A retroft kit (P/N 05089-60004) is available to allow instruments prior to series 2550 to use the new battery.

Page 6-11, Figure 6-2. Battery Case Parts:

2550 >Change MP13 to MP19.

Page 8-18, Figure 8-4. HP 5089A Bottom Internal View

2550
>Delete H21/n34 Battery Hold-Down Screws (5 Ea) in top third of photo.
>Delete H31 Washer and reference designation in top right drawing and in left side of photo.
>H26 Screws, 9 each in center of photo, have been replaced by Hex-Head Screws w/Washer.

SERIAL PREFIX OR SERIES NUMBER	CHANGES

Page 8-21, Figure 8-7. HP 5089A Standby Power Supply:

All Serials	>Add heading, "Table of Active Elements" to table on right of Reference Designations.