



**RELAY ACCESSORIES
HP MODELS 59510A, 59511A**

HP Part No. 5957-6382
Microfiche Part No. 5957-6383

**Operating and Service Manual for
HP Model 59510A, Serials 2811-00101 and Above*
HP Model 59511A, Serials 2811-00101 and Above***

***For instruments with higher Serial Numbers,
a change page may be included.**

Section I GENERAL INFORMATION

1-1 INTRODUCTION

This manual contains instructions for installing, operating, and troubleshooting the HP Model 59510A and 59511A Relay Accessories. Each of these models is designed for use with the HP 6030A, 6032A, 6033A, and 6038A models in the HP 603XA series of system power supplies. The HP 59510A and HP 59511A Relay Accessories can be used with HP 603XA supplies that have the following serial numbers:

HP Model	Serial Numbers *
6030A	2811A-00815 and above
6031A**	2817A-00983 and above
6032A	2818A-03121 and above
6033A	2817A-03452 and above
6038A	2817A-05426 and above

* Models with lower serial numbers can be modified to operate with the HP 595XA Relay Accessory. Consult HP regarding a retrofit kit for these models.

**When the HP 5951XA Relay Accessory is to be used with the HP 6031A System DC Power Supply, care must be taken to set the HP 6031A's current limit to 60 A or less. The HP 6031A power supply is capable of delivering an output current in excess of HP 5951XA's rating of 60 A, which could cause damage to the Relay Accessory.

Wherever applicable, the instructions given in this manual refer to pertinent information provided in the Operating and Service manual for the appropriate HP 603XA power supply as follows:

HP Model	Manual HP P/N
6030A	06030-90003
6031A	06031-90003
6032A	06032-90005
6033A	06033-90010
6038A	06038-90003

The Relay Link Supplement, Appendix F (HP Part No. 5957-6388) to the above manuals, describes circuit changes to the HP 603X supplies which allow use of the supplies with the HP 59510A/59511A. The HP 59510A/59511A Relay Accessory has a logic control input (TTL levels) that allows it to be used with power supplies or devices other than the supplies specified above. Instructions for using the logic control input in a general purpose configuration are given in Section III of this manual.

1-2 DESCRIPTION (FIGURE 1-1)

The HP 59510A and 59511A Relay Accessories are intended for use in power supply applications where either or both load isolation (connect/disconnect) and polarity reversal are required.

The HP 59510A Relay Accessory provides for load connect/disconnect for both the power output and sense leads of the power supply. The HP 59511A Relay Accessory provides for polarity reversal as well as for load connect/disconnect for both power output and sense leads. In addition, each model includes a fault (FLT) output line and a remote inhibit (INH) input line. The FLT output line provides a fault reporting capability that is independent of the HP-IB service request (SRQ) function. The INH input line provides a way to remotely disconnect (also independent of HP-IB computer control) the power supply output.

Figure 1-1A shows the HP 59510A/59511A Relay Accessory configured with a HP 603XA power supply. An HP-IB interface in the HP 603XA power supply recognizes relay commands from the computer and provides serial data to the HP 59510A/59511A via a special connection labeled RLY LINK. The HP 5951XA converts the serial data into relay control signals.

The computer can control the connect/disconnect and polarity reversal (HP 59511A only) functions via the HP 603XA supply's serial data link to the HP 59510A/59511A. The closing and opening of the relays in the HP 59510A/59511A can be coordinated with the enabling and disabling of the power supply output to allow switching the relays when the power supply output is disabled in order to prolong relay life. The microprocessor within the HP 59510A/59511A Relay Accessory properly sequences the power and sense relays to minimize overshoots at the power supply output.

Figure 1-1B shows the HP 59510A/59511A Relay Accessory configured in a general purpose application. This configuration allows the HP 59510A/59511A to be used with power supplies or devices other than HP 603XA power supplies. Logic control inputs are provided that allow TTL logic levels to control the connect/disconnect and polarity reversal (HP 59511A) functions. The logic control inputs have pull-up resistors which allow them to accept signals from relays or open-collector devices.

The HP 59510A/59511A Relay Accessory is designed to fit in a rack height of 5¼ inches and is approximately 7¼ inches wide and 8 inches deep. All necessary connections are made at the front panel.

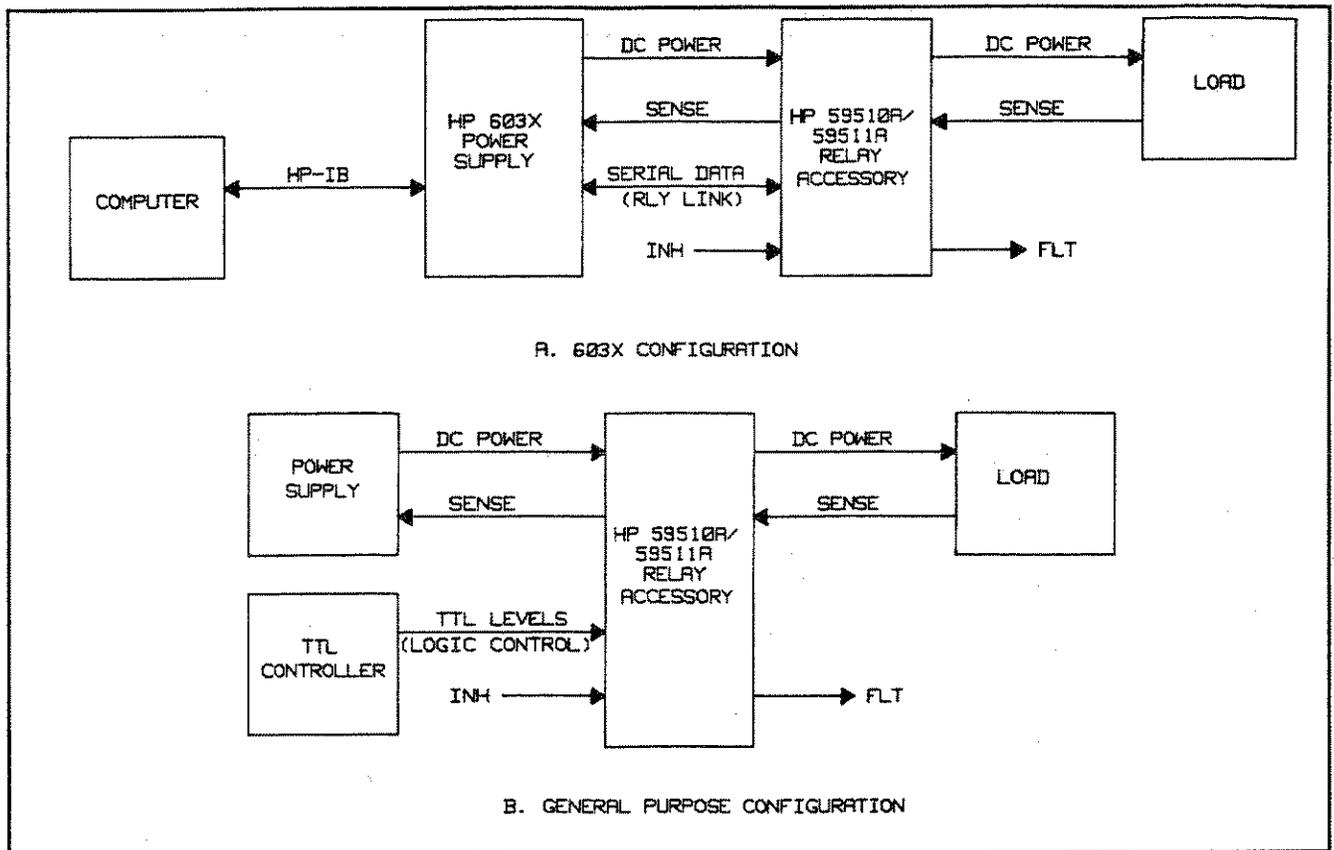


Figure 1-1. HP 59501A/59511A Configurations

1-3 SPECIFICATIONS

Table 1-1 lists the specifications for the HP 59510A/59511A Relay Accessories. The 603XA power supply specifications are listed in the applicable manual (see paragraph 1-1).

1-4 SAFETY CONSIDERATIONS

This product is a Safety Class 1 instrument, which means that it is provided with a protective earth terminal. The instrument and this manual should be reviewed for safety markings and instructions before operation. Refer to the Safety Summary page at the beginning of this manual for a summary of general safety information. Safety information for specific procedures is located at appropriate places in the manual.

The HP 5951XA Relay Accessory contains mercury displacement relays. Because mercury is a hazardous material, defective relays must be disposed of properly (refer to paragraph 5-11 in this manual).

Hewlett-Packard power supplies are designed to comply with the following regulatory standards: IEC 348, VDE 0411, CSA 556B, VDE 0871/6.78 level B (FTZ 1046/84), UL1244.

1-5 INSTRUMENT AND MANUAL IDENTIFICATION

Hewlett-Packard instruments are identified by a two-part serial number, i.e. 2701A-00101. The first part of the serial

number (prefix) is a number/letter combination that denotes either the date of manufacture or the date of a significant design change. It also indicates the country of manufacture. The first two digits indicate the year (26 = 1986, 27 = 1987, etc.), the second two digits indicate the week, and the "A" designates the U.S.A. The second part of the serial number is a different sequential number assigned to each instrument.

If the serial number prefix on your Relay Accessory differs from that shown on the title page of this manual, a yellow Manual Change sheet that is supplied with the manual defines the differences between your unit and the unit described in this manual. The yellow change sheet may also contain information for correcting errors in the manual.

1-6 OPTIONS

Options 100, 120, 220, and 240 simply determine which line voltage is selected at the factory.

100: Input Power, 100 Vac, 48-63 Hz

120: Input Power, 120 Vac, 48-63 Hz

220: Input Power, 220 Vac, 48-63 Hz

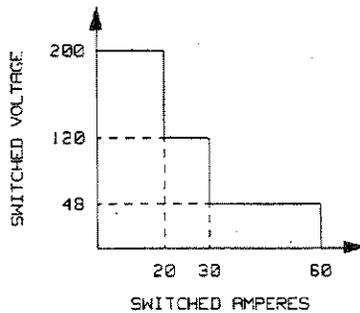
240: Input Power, 240 Vac, 48-63 Hz

850: One rack mount kit

910: One extra operating and service manual shipped with each Relay Accessory.

W30: 2 year additional Return-to-HP Service

Table 1-1. HP Model 59510A and 59511A Specifications

Operating Range: (Both Models)**Inductive Load: 10 mH maximum**

Note that switching of inductive loads places stresses on the HP 5951XA power relay contacts which can significantly degrade relay life. It is advisable to switch these loads under low or zero output conditions, e.g. with the power supply output disabled. In general, switching any load under zero output conditions maximizes relay life.

WARNING

For applications with > 10 mH inductance, consult Hewlett-Packard for applicability and safety. Using the HP 5951XA relays to interrupt high currents through highly inductive loads will cause high levels of energy to discharge across the relay contacts. The resulting rise in temperature and pressure may cause a breach in the hermeticity of the seals in the mercury-filled cylinders of the power relays. Since mercury is a toxic substance, this is a potentially hazardous condition.

Care should be taken in all applications not to exceed the operating range specifications in order to avoid compromising the reliability or the physical integrity of the mercury-displacement relays in the HP 5951XA.

FOR THESE REASONS, THE HP 5951XA SHOULD NOT BE USED WITH THE HP 603XA HIGH INDUCTANCE OPTIONS J01, J02, AND J07.

AC Input: A line select switch on the front panel permits either 100/120 Vac or 220/240 Vac operation (-13%, +6% 48-63 Hz).

Maximum input power: 60 VA

PARD: The HP 5951XA Relay Accessory incorporates a filter which, when used with certain models of the HP 603XA power supply family, yields improved output noise performance at the AOUT/BOU terminals of the HP 5951XA.

HP Model	PARD (mVp-p max.)
6032A	20
6033A	20
6038A	20

Isolation:

A IN/B IN to A OUT/B OUT: 200 Vdc max.
 A IN/B IN/A OUT/B OUT to Ground: ± 500 Vdc max.
 HP 603X LINK to Ground: ± 42 Vdc max.
 *LOGIC CONTROL/INH to Ground: ± 240 Vdc max.
 *FLT to Ground: ± 240 Vdc max.
 FLT to LOGIC CONTROL/INH: ± 42 Vdc max.

*** CAUTION**

The HP 603X LINK, LOGIC CONTROL, and INH signals on the control connector J101 are referenced to the same common. This means that if the HP 5951XA relay accessory is being used in the HP 603XA configuration (see paragraph 3-7), these signals on the control connector J101 must be restricted to ± 42 Vdc from ground, in accordance with the restrictions of the HP 603XA FLT/INH port float voltage specification (refer to appropriate HP 603XA Operating and Service Manual). The FLT signal on J101 has its own common which may float ± 42 Vdc from the other signal common on J101 and up to ± 240 Vdc from ground. The LOGIC CONTROL, INH, and FLT signals may be floated up to ± 240 Vdc from ground ONLY if they are not driven by or driving signals of the FLT/INH port of a Hewlett-Packard instrument AND the HP 603X LINK signals are left disconnected.

As a general rule, if a connection is made from any point on control connector J101 to any point on the FLT/INH port of a Hewlett-Packard instrument, all signals on J101 must be restricted to no greater than ± 42 Vdc from ground.

Settling Time (TTL Control):

Connect: 440 mS
 Disconnect: 160 mS
 Polarity Reversal: 600 mS

DC Voltage Drop (at 60 A): DC voltage drop of 0.5 V maximum between A IN and A OUT and 0.5 V maximum between B IN and B OUT.

Table 1-1. HP Model 59510A and 59511A Specifications (continued)

<p>Control Signals Timing:</p> <p>$\overline{\text{INH}}$ input signal hold time: 1.5 ms minimum</p> <p>LOGIC CONTROL inputs (TTL levels) hold time: 1.5 ms minimum.</p> <p>$\overline{\text{INH}}$ to $\overline{\text{FLT}}$ propagation: 1.5 ms maximum</p> <p>Temperature:</p> <p>Operating: 0 to +55 degrees Celsius Storage: -40 to +75 degrees Celsius</p>	<p>Dimensions: (Both Models)</p> <table border="1"> <thead> <tr> <th>Width</th> <th>Height</th> <th>Depth</th> </tr> </thead> <tbody> <tr> <td>7.35 in.</td> <td>5.14 in.</td> <td>7.82 in.</td> </tr> <tr> <td>186.8 mm</td> <td>130.6 mm</td> <td>198.6 mm</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Weight (lbs):</th> <th>59510A</th> <th>59511A</th> </tr> </thead> <tbody> <tr> <td>Net Weight:</td> <td>5</td> <td>8</td> </tr> <tr> <td>Shipping Weight:</td> <td>8</td> <td>11</td> </tr> <tr> <td>Shipping Weight with Option 850:</td> <td>9</td> <td>12</td> </tr> </tbody> </table> <p>Mounting Orientation: $\pm 10^\circ$ from vertical</p>	Width	Height	Depth	7.35 in.	5.14 in.	7.82 in.	186.8 mm	130.6 mm	198.6 mm	Weight (lbs):	59510A	59511A	Net Weight:	5	8	Shipping Weight:	8	11	Shipping Weight with Option 850:	9	12
Width	Height	Depth																				
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Shipping Weight:	8	11																				
Shipping Weight with Option 850:	9	12																				

Section II INSTALLATION

2-1 INTRODUCTION

This section contains instructions for inspecting and mounting the Relay Accessory, and connecting it to ac power.

2-2 INITIAL INSPECTION

This accessory was thoroughly inspected and tested before it left the factory. As soon as you receive it, remove it from its packing case and check to make sure that it has not been damaged in shipment. Check that there are no broken connectors, etc., and that the unit is free from dents and scratches.

If any damage is found, you should file a claim with the carrier immediately and notify the Hewlett-Packard Sales and Service office nearest you. Keep the original packing materials for the carrier's inspection or in the event the unit has to be returned to Hewlett-Packard. Warranty information is printed on the inside cover of this manual. Your Hewlett-Packard Sales and Service office will furnish the address of the nearest service office to which the unit can be shipped.

2-3 MOUNTING

CAUTION

The Relay Accessory units utilize mercury displacement relays. Consequently, the units must be vertically mounted (or oriented) to ensure proper operation and avoid damage to equipment (See Table 1-1 Specifications).

The Relay Accessory unit is convection cooled and can operate without loss of performance within the temperature range of 0 to 55 degrees C. If the unit is to be used on a bench or any flat surface, attach the four adhesive backed rubber feet to the bottom of the HP 5951XA unit. The feet are shipped in a plastic bag along with two quick disconnect plugs and spare fuses.

The unit can also be mounted in a standard 19 inch rack panel or enclosure. It can be rack mounted in either of two ways:

1. Drilling two/four holes in the mounting surface and using screws to engage the threaded inserts in the bottom/sides of the HP 5951XA.
2. Using the Option 850 Rack Mounting Kit.

CAUTION

Ventilation holes are located on both sides of the HP 5951XA as well as in the back. Make sure that the back and at least one side is left unobstructed. Failure to do so could cause overheating and damage.

2-4 Surface Mounting

The HP 5951XA can be mounted against surfaces by means of machine screws. There are two threaded inserts on the bottom and four threaded inserts on each of the left and right sides of the HP 5951XA (see Figure 2-1). The user must drill two or four holes in the surface against which the HP 5951XA is to be mounted and pass M4 screws (10 mm long) through these holes to engage the threaded inserts within the HP 5951XA. Remember to keep the HP 5951XA oriented vertically (see Mounting Orientation in Table 1-1) for proper operation.

2-5 Option 850 Mounting

Rack mount kit Option 850 can be used to mount a single HP 5951XA unit on the left or right side of the rack as shown in Figure 2-2. Two units can be mounted side by side in the rack using two Option 850 kits.

The HP 5951XA unit rests on the Option 850 rack as shown in Figure 2-2. Two threaded inserts, located on the bottom of the HP 5951XA, line up with holes in the rack. Use two flat head M4 screws (10 mm long) to secure the unit in the rack.

2-6 INPUT POWER REQUIREMENTS

You can operate the unit from a nominal 100 V, 120 V, 220 V, or 240 V single phase power source at 48 to 63 Hz. You can check the line voltage setting of the unit by examining the LINE SELECT switch S101 setting (see Figure 2-3). You can change the unit to accept 100, 120, 220, or 240 Vac by setting S101 to the 100/120 V or 220/240 V position. The same rating fuse (0.5A) is used for a 110, 120, 220, or 240 Vac input. The fuse, designated F1, is located inside the unit near the LINE SELECT switch.

NOTE

The HP 5951XA has no on/off switch. To turn the unit on/off, you must connect/disconnect the power cord.

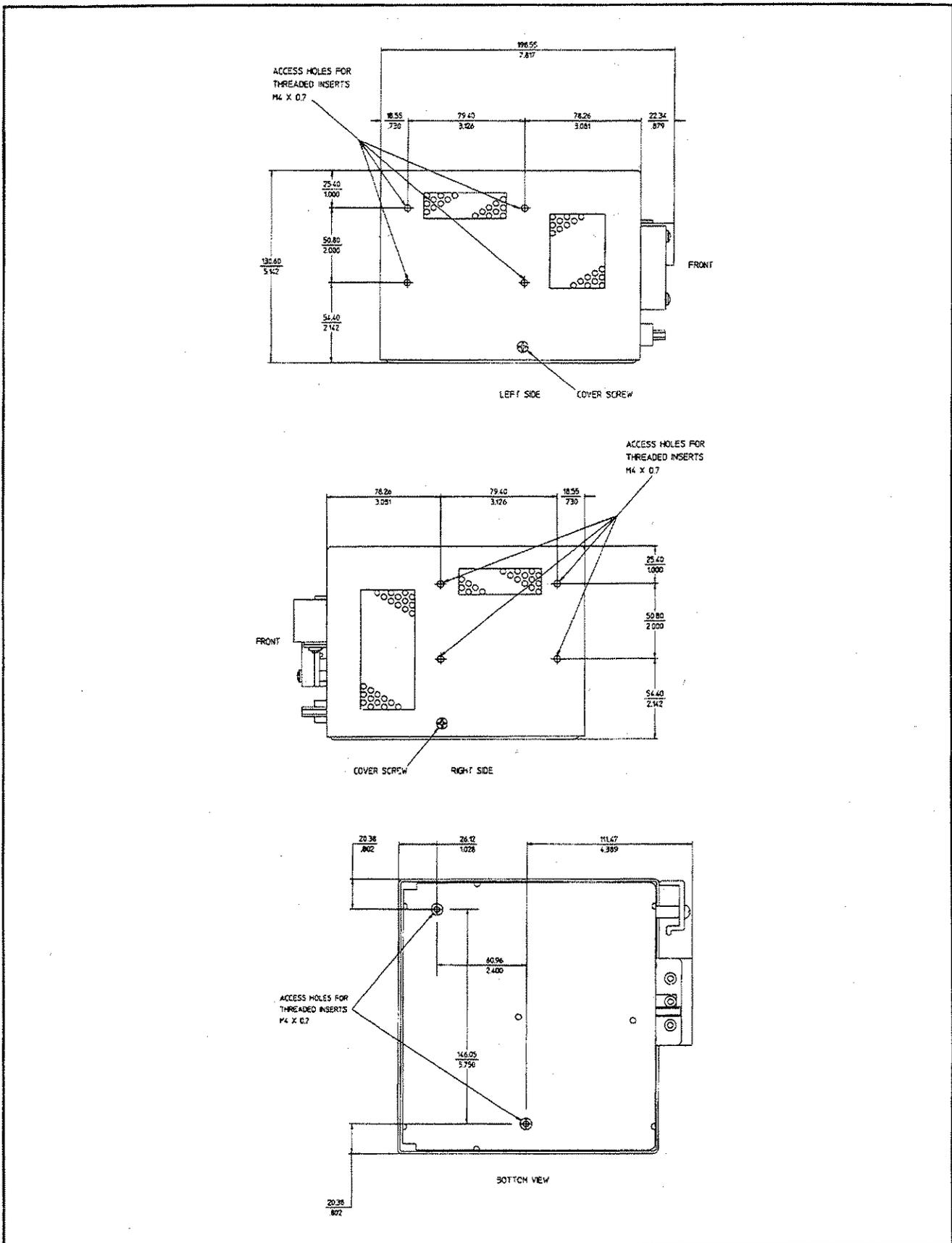


Figure 2-1. Threaded Insert Locations for Surface Mounting

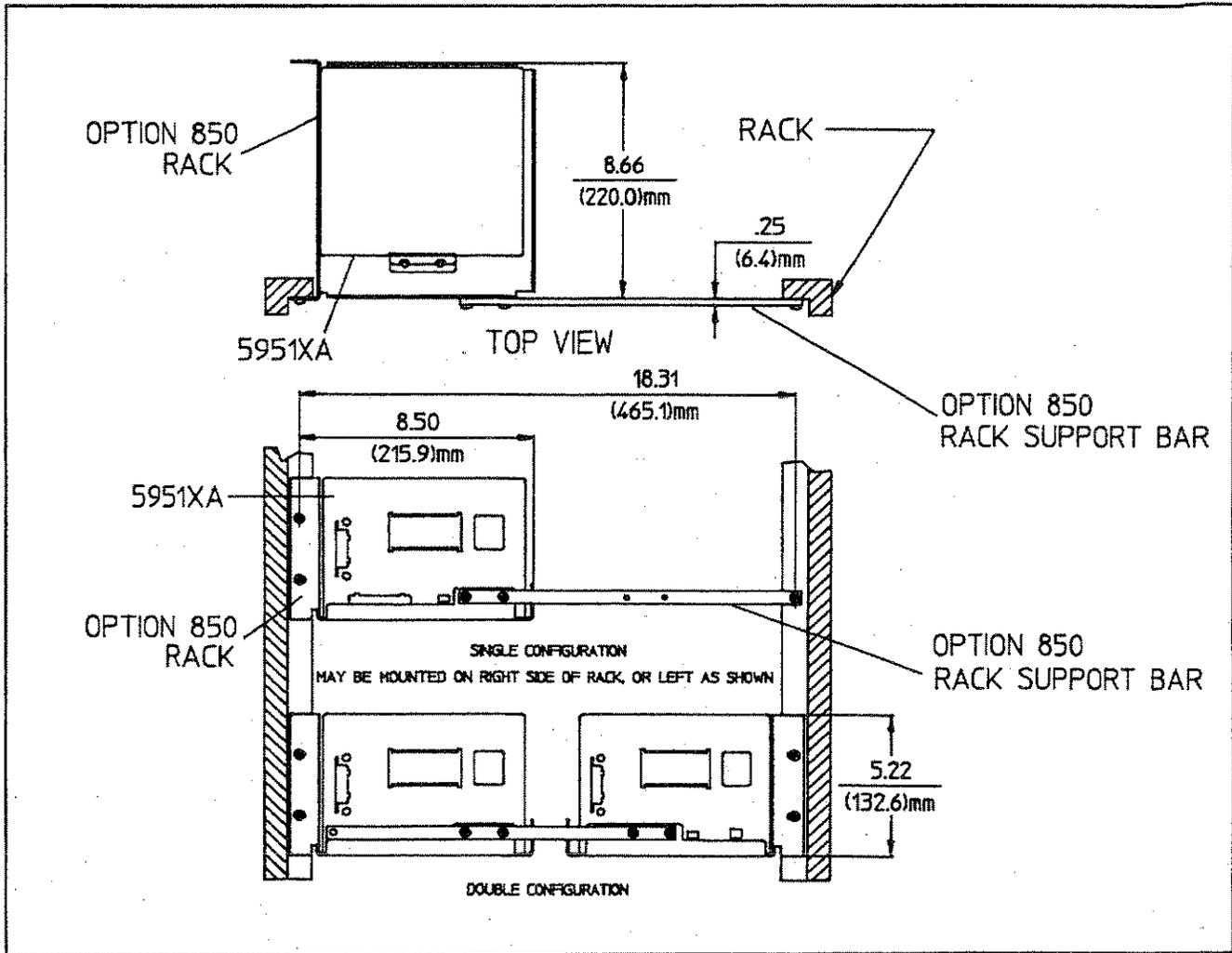


Figure 2-2. Option 850 Rack Mounting

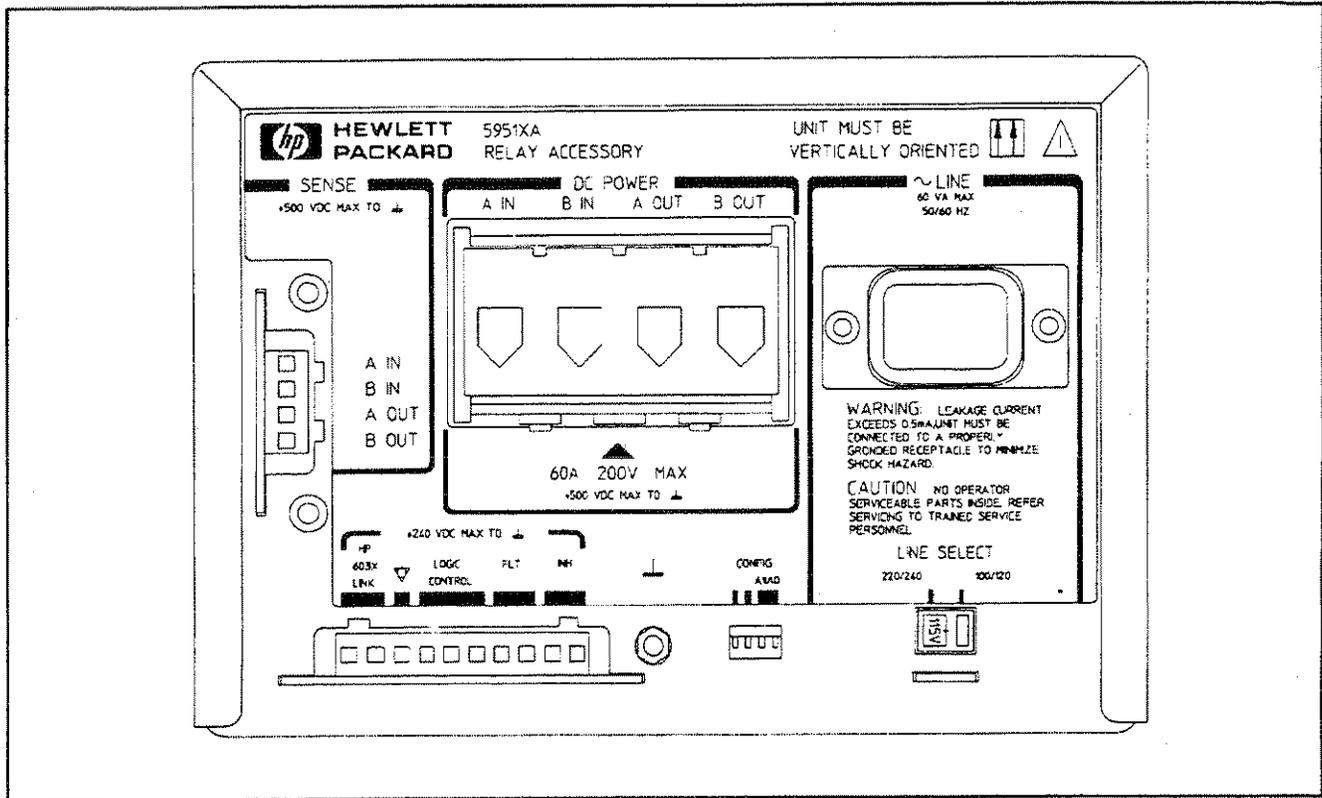


Figure 2-3. Relay Accessory Front Panel

2-7 POWER CORD

The unit is shipped from the factory with a power cord that has a plug appropriate for your location. Figure 2-4 shows the standard configuration of plugs used by Hewlett-Packard. Below each drawing is the HP part number for the replacement power cord equipped with a plug of that

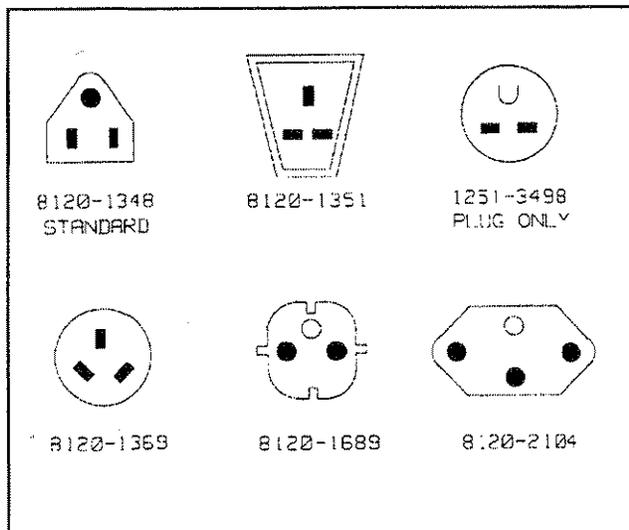


Figure 2-4. Available Power Cords

configuration. If a different power cord is required, contact the nearest Hewlett-Packard Sales and Service office.

For your protection, the National Electrical Manufacturer's Association (NEMA) recommends that the unit's panel and cabinet be grounded. This unit is equipped with a three-conductor power cord; the third conductor being ground. The unit is grounded only when the power cord is plugged into the appropriate receptacle. Do not operate this unit without an adequate cabinet ground connection.

WARNING SHOCK HAZARD

Connect the power cord to a grounded receptacle before you connect any external floating voltages to the Relay Accessory.

The offset pin on the standard three-prong power cord connector is the ground connection. If a two contact receptacle is encountered, it must be replaced with a properly grounded three-contact receptacle in accordance with the National Electrical Code, local codes and ordinances. The work should be done by a qualified electrician.

Section III CONNECTIONS AND OPERATING INFORMATION

3-1 INTRODUCTION

WARNING

HAZARDOUS MATERIAL

The DC power relay(s) in the HP 5951XA have a maximum current rating of 60 amps. The relays contain mercury which is sealed in a steel tube. The tubes may rupture if the current rating is exceeded. Do not connect the HP 5951XA to a power supply capable of delivering more than 60 amps.

This section explains how to make connections and set switches in order to operate the HP 5951XA Relay Accessory in a HP 603XA configuration and in a general purpose configuration. The following main discussions are provided:

- HP 5951XA Front Panel
- DC Power Connections
- Sense Lead Connections
- HP 603XA Configuration
- General Purpose Configuration

3-2 HP 5951XA FRONT PANEL

Figure 3-1 illustrates the front panel of the HP 5951XA where connections and switch selections are made.

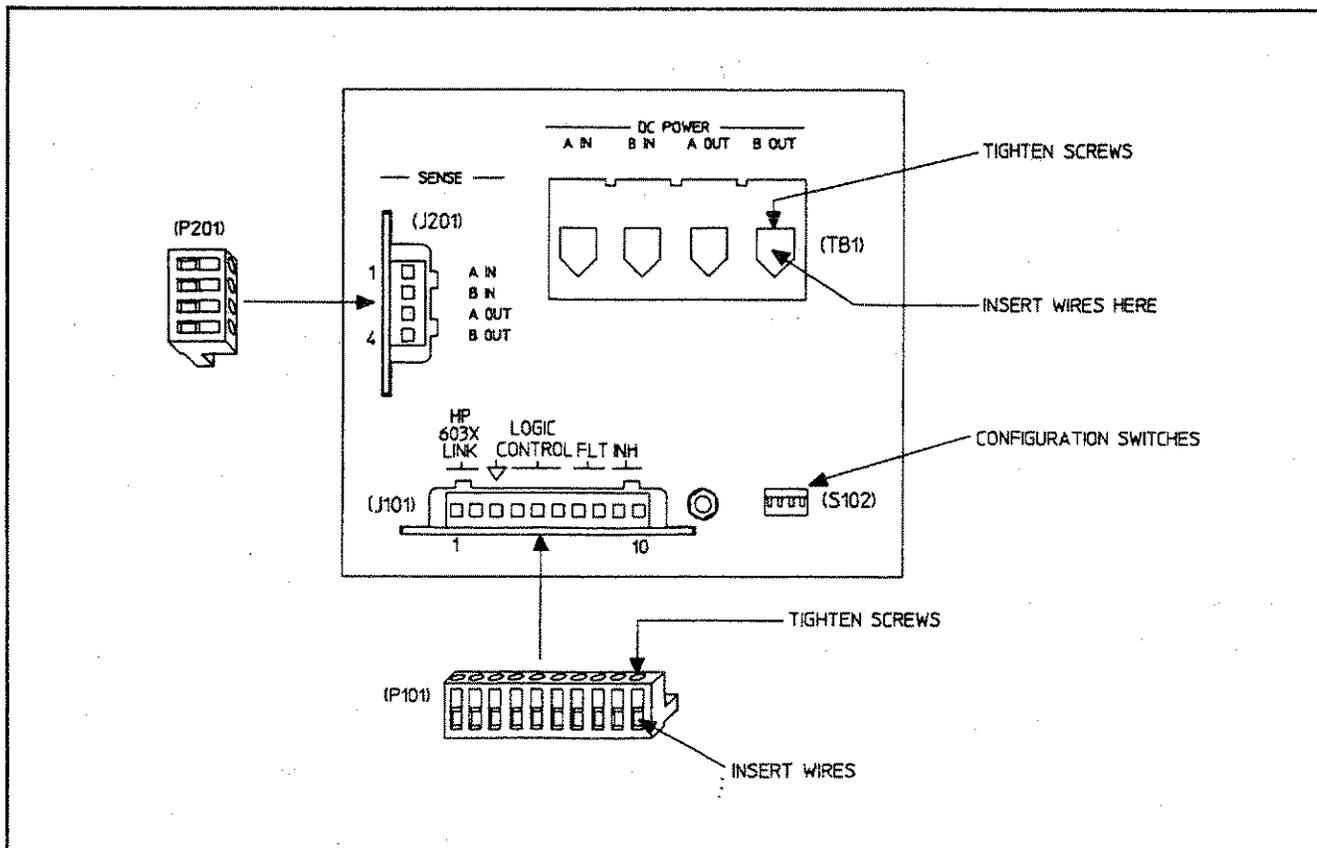
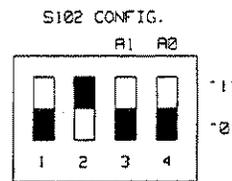


Figure 3-1. HP 59510A/59511A Front Panel Connections

- DC POWER Connections** — A barrier block (TB1) with four screw-down type terminals connects the input and output dc power wires. The A IN and B IN terminals are used to connect the Relay Accessory to the power supply's + and output terminals, respectively. The A OUT and B OUT terminals are used to connect the Relay Accessory to the load. See paragraph 3-3.
- SENSE Connections** — A four pin connector J201 (quick disconnect mating plug P201 supplied) connects the input and output sense leads. The A IN and B IN pins (1 and 2) are used to connect the Relay Accessory to the power supply's +S and -S terminals, respectively. The A OUT and B OUT pins (3 and 4) are used to connect the Relay Accessory to the load's + and -sense leads, respectively. See paragraphs 3-4 to 3-6.
- Control Connections** — A ten pin connector J101 (quick disconnect mating plug P101 supplied) is provided for making the following connections:
- HP 603X LINK(pins 1-2): These two pins provide the serial data link with the HP 603XA supply to control the Relay Accessory (see paragraph 3-11).
- ▽ common (pin 3): provides the common connection for the serial data link or the logic control input.
- LOGIC CONTROL (pins 4-6): These three pins are used for connecting TTL compatible signals to control the Relay Accessory when it is used in a general purpose configuration (see paragraph 3-19).
- FLT (pins 7 and 8): These two pins are used to connect the fault output line. See paragraph 3-13 (HP 603X configuration) or 3-27 (general purpose configuration). Pin 7 is the FLT output signal, pin 8 is its common.
- INH (pins 9 and 10): These two pins are used to connect the inhibit input line. See paragraph 3-13 (HP 603X configuration) or 3-23 (general purpose configuration). Pin 9 is the INH input signal; pin 10 is its common.
- CONFIG Switches** — Four switches (S102-1 to 4), each of which can be set to "1" or "0", make the following selections:



(SHOWN SET TO 0, 1, 0, 0)

Listen Enable On/Off (S102-1): This switch is meaningful only in the LOGIC CONTROL mode. With S102-1 set to "0", the Relay Accessory will always respond to the LOGIC CONTROL lines. With S102-1 set to "1", the Relay Accessory will only respond to the LOGIC CONTROL lines when the LISTEN ENABLE input (J101-6) is a TTL low level. S102-1 is factory set to "0".

HP 603X LINK or LOGIC CONTROL (S102-2): This switch selects either HP 603X LINK (serial data) or LOGIC CONTROL (TTL levels) as the controlling input. The "1" position selects the HP 603X LINK and the "0" position selects LOGIC CONTROL. S102-2 is factory set to "1".

Addresses A1 and A0 (S102-3 and 4): These switches are meaningful only in the HP 603X LINK mode to select the address of the Relay Accessory. S102-3 and S102-4 are both factory set to "0". The HP 603X power supplies currently will only communicate with a Relay Accessory at address "0". Addresses 1-3 are provided for possible future use.

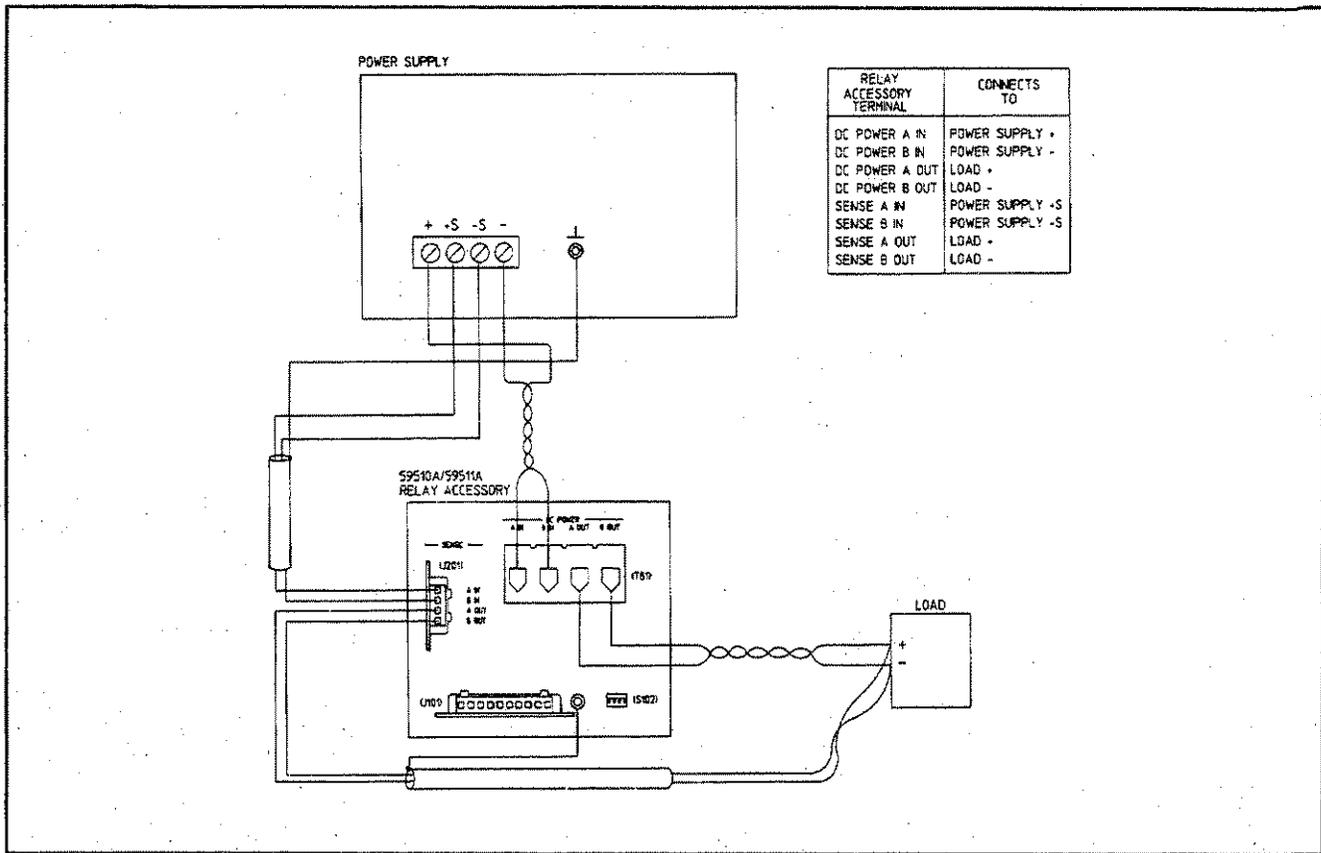


Figure 3-2. DC Power and Sense Lead Connections Remote Sensing

WARNING

SHOCK HAZARD

Turn off input ac power at the power supply and disconnect the Relay Accessory's line cord before changing any connections. Make certain that all wires are properly connected, screws are tightened, and connectors securely installed before reapplying power.

3-3 DC POWER CONNECTIONS

The dc power connections between the power supply and the Relay Accessory and between the load and the Relay Accessory are shown in Figure 3-2. The power supply's output terminals are connected to the Relay Accessory's DC POWER input terminals and the load leads are connected to the Relay Accessory's DC POWER output terminals as follows:

Relay Accessory DC POWER Terminal	Connects To
A IN	Power Supply +
B IN	Power Supply -
A OUT	Load +
B OUT	Load -

The dc power wires are connected to the screw-down

terminals on the DC POWER barrier block TB1 as specified above. Each wire is inserted into the appropriate terminal and the corresponding screw is tightened until the wire is securely fastened (see Figure 3-1).

To satisfy safety requirements, the wires that connect the power supply output voltage to the Relay Accessory and to the load should at least be heavy enough not to overheat while carrying the power supply output current that would flow if the load were shorted. Stranded AWG# 6 copper wire is rated for 50 amps at 105 degrees C conductor temperature. (The maximum allowable conductor temperature is based on +60 degrees C ambient temperature plus 45 degrees C temperature rise because of continuous dc current). This is based on use of a twisted pair to connect the load to the power supply output. Refer to Section III in the applicable HP 603XA Operating and Service Manual (see paragraph 1-1) to help you select the proper wire size.

3-4 SENSE LEAD CONNECTIONS

NOTE

A plastic safety cover for SENSE connector J201 is provided. When the quick disconnect plug P201 is installed in J201, the plastic safety cover need not be used.

WARNING**SHOCK HAZARD**

The safety cover should be installed over J201 to prevent accidentally touching J201 pins when P201 is not installed. Harmful voltages may be present at these pins when power is applied.

3-5 Remote Sensing

The sense lead connections shown in Figure 3-2 are for remote sensing. Remote sensing allows the power supply to automatically increase the output voltage and compensate for the voltage drop in the DC POWER leads. Thus, remote sensing will help to provide the best possible regulation at the load. This is especially useful for CV operation with loads that vary and have significant load-lead resistance. For remote sensing, *make sure* that the straps between the supply's + and +S terminals and between the - and -S terminals are disconnected. The power supply's sense terminals are then connected to the Relay Accessory's input SENSE connector pins and the load sense leads are connected to the Relay Accessory's output SENSE connector pins as follows:

Relay Accessory SENSE Connector	Connects To
A IN (J201-1)	Power Supply +S
B IN (J201-2)	Power Supply -S
A OUT (J201-3)	Load + Sense
B OUT (J201-4)	Load - Sense

The sense wires are connected to the pins of the SENSE connector mating plug P201 as specified above. Each wire is inserted into the appropriate pin and the corresponding screw is tightened until the wire is securely fastened (see Figure 3-1). The plug is then installed in the SENSE connector (J201).

NOTE

When the HP 5951XA Relay Accessory is in the power off state, the SENSE A IN and SENSE B IN terminals are not connected to any points internally. This means that if there is no other path between the power supply's +S/-S Sense terminals and its +/- output terminals, respectively, the supply's output may overshoot. All Hewlett-Packard power supplies with the remote sense feature have internal resistors which provide a moderately high impedance path between the output and sense terminals, and therefore will not overshoot under these conditions. If the power supply being used is not an HP supply and does not have these internal sense resistors, it is recommended that a resistor of approximately 1 K Ω be connected between the supply's + and +S terminals and between the - and -S terminals.

CAUTION

Incorrect wiring of the sense leads or failure to remove the power supply's own sense straps when using remote sensing may cause internal protection fuses F201 and F202 to blow requiring fuse replacement (see Section V). To avoid nuisance blowing, check all connections before applying power. Also, test the sensing setup with a low value of power supply output voltage before applying full output voltage.

Because the sensing leads carry only a few milliamperes, the wires used for sensing can be much lighter than the load leads. The sense leads should be a shielded, twisted pair to minimize noise pickup of external noise. Any noise picked up on the sensing leads will appear at the supply's output, and CV load regulation may be adversely affected. The shield should be grounded at the power supply end only, and should not be used as one of the conductors. The sensing leads should be connected as close to the load as possible. The shield around these leads should also be grounded at one end only. Refer to Section III in the applicable HP 603XA Operating and Service Manual (see paragraph 1-1) for more information concerning remote sensing.

CAUTION

Inadvertent shorting of sense terminals may cause internal (inside HP 5951XA) local sense protection resistors R205 and R206 to open, necessitating replacement. Again, verify connections and test the sensing setup at a low output voltage before applying full output.

3-6 Local Sensing (Figure 3-3)

You can use the DC POWER connect/disconnect and reversing (HP 59511A only) features of the Relay Accessory without using remote sensing connections between the HP 5951XA and the load. For local sensing, connect jumpers between the power supply's + and +S terminals and between the - and -S terminals as shown in Figure 3-3. In this configuration, SENSE connector J201 on the HP 5951XA is not used.

3-7 HP 603XA CONFIGURATION

Before you program the HP 603XA/5951XA configuration, complete the general steps outlined below. Each step is described in greater detail in the referenced paragraph (s). Figure 3-4 illustrates the connections and switch settings required for the HP 603XA/5951XA configuration.

1. Connect the DC POWER and SENSE leads (paragraphs 3-3 to 3-6).

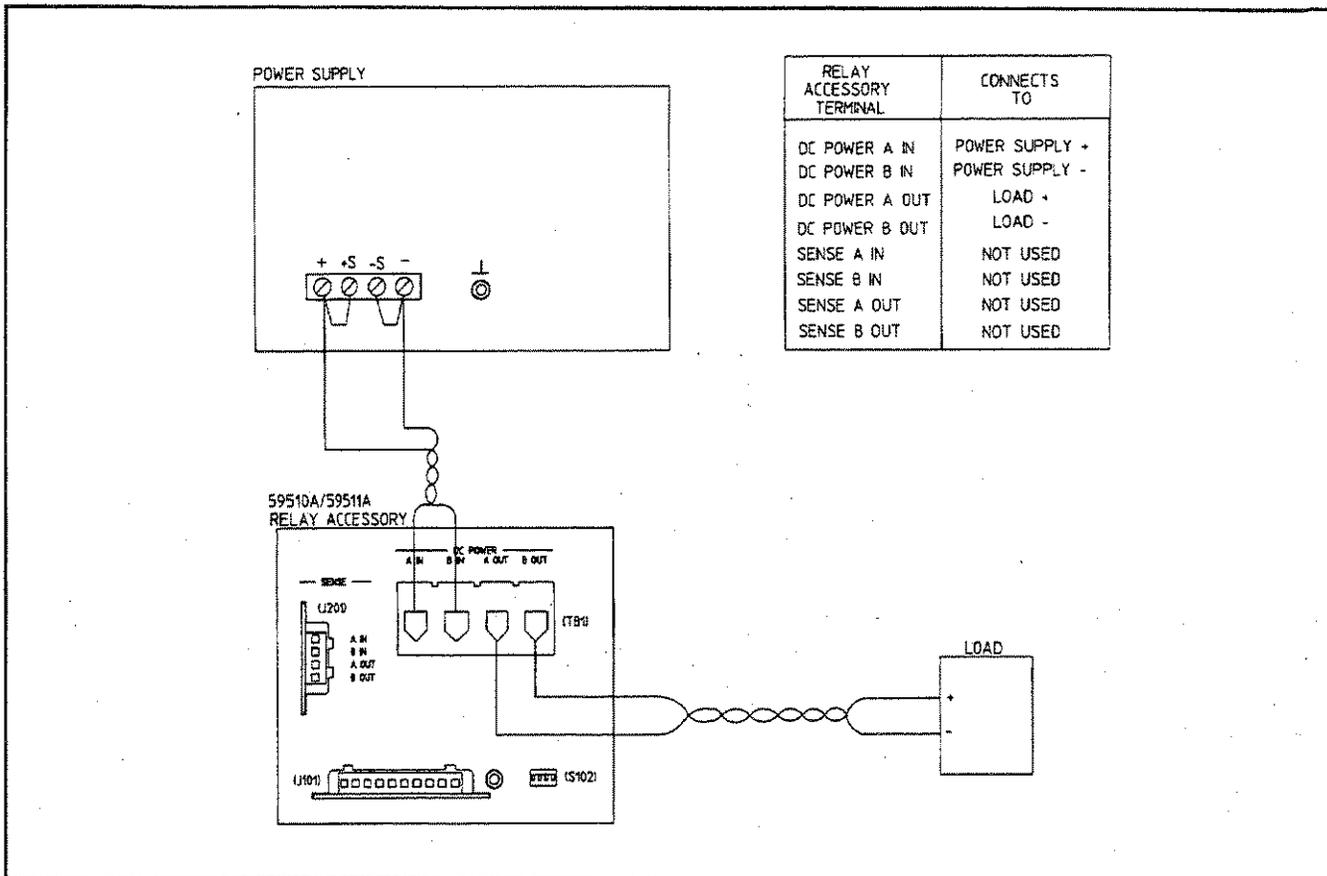


Figure 3-3. DC Power and Sense Lead Connections, Local Sensing

2. Ensure that the CONFIG switches on the HP 5951XA are selecting HP 603X LINK and address 0 (paragraph 3-9).
3. Ensure that the RLY LINK/ INH FLT switch on the HP 603XA is selecting RLY LINK (paragraph 3-10).
4. Make the serial data connection between the HP 603XA and the HP 5951XA (see paragraph 3-11).
5. If desired, you can connect the INH and FLT lines. The remote inhibit (INH) and fault (FLT) lines are described in detail in paragraph 3-13 to 3-16.
6. Apply AC power to the HP 5951XA and the HP 603XA (see paragraph 3-18).
7. Verify the wiring and switch settings by checking the configuration with a low power supply output voltage before applying full output voltage.

NOTE

A switch inside the HP 603XA is factory set so that, at power on, the HP 603XA/5951XA configuration "wakes-up" with the power supply output enabled and disconnected (relay opened) from the load. See paragraph 3-12.

3-8 Switch Settings

In order to program the HP 603XA/5951XA configuration, switches on the HP 603XA and the HP 5951XA must be set to the positions shown in Figure 3-4. A small screw driver or ball point pen will be helpful in setting the switches.

3-9 CONFIG Switches. These switches (S102-1 to S102-4) are located on the rear panel of the HP 5951XA as shown in Figure 3-1. In order to program the HP 603XA/5951XA configuration, switches S102-3 and S102-4 must select address 0, and switch S102-2 must be set to the HP 603X LINK position ("1").

The address (S102-3, S102-4) must be set to 0 in order for the HP 603XA to communicate with the HP 5951XA (addresses 1-3 are provided for possible future use). If S102-2 is not set to the HP 603X LINK position, the HP 603XA power supply will generate "error 9" when it receives a relay command (e.g. RELAY ON) and it will not attempt to send serial data to the HP 5951XA. Also, if the HP 603XA expects to send data to the Relay Accessory but does not receive any response to its communications over the serial data cable,

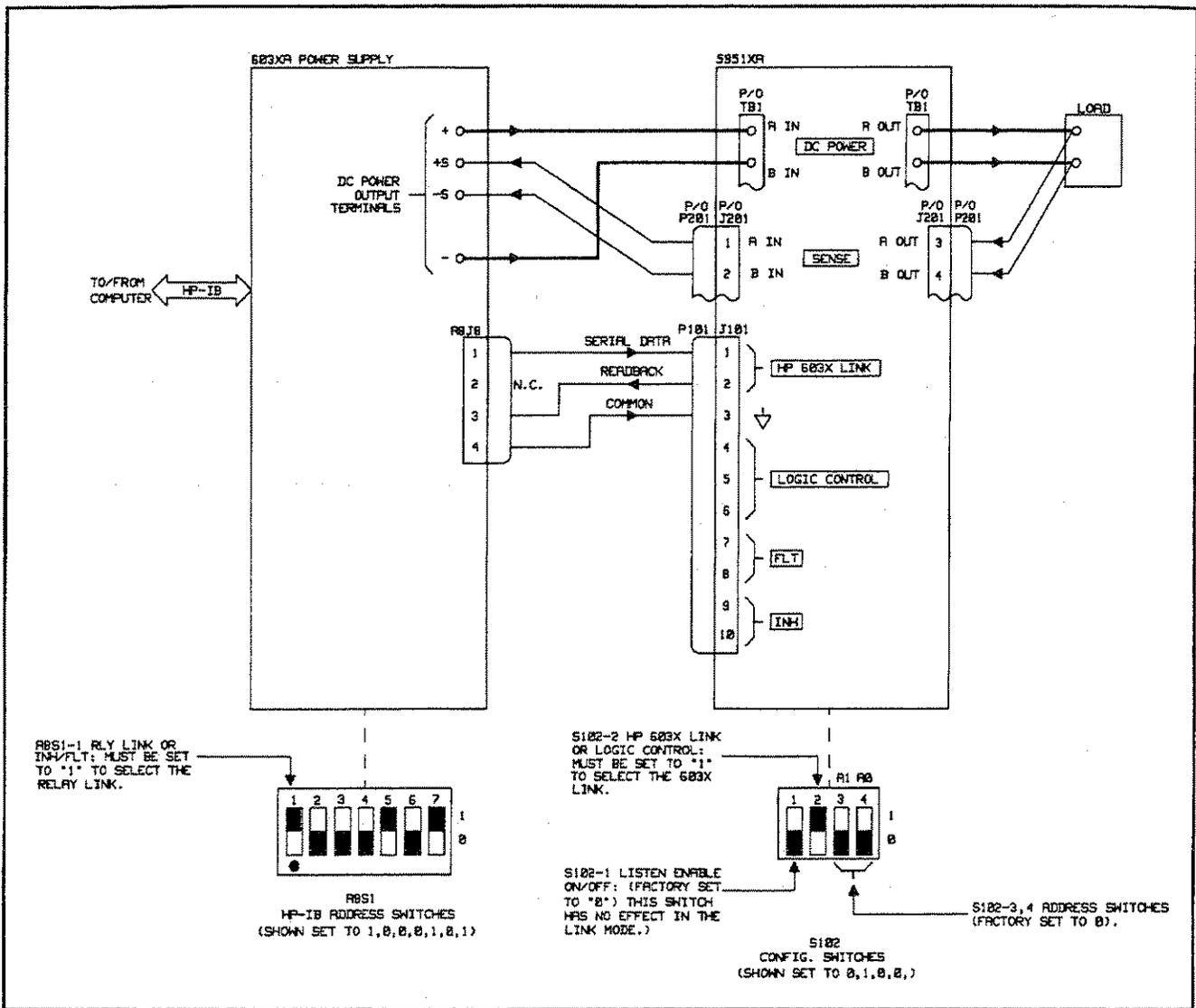


Figure 3-4. HP 603X Configuration

it will also generate "error 9". The switches S102-2 to S102-4 are read by the HP 5951XA only at power-on. Switch S102-1 is only active in the Logic Control (TTL) mode. For safety considerations, it is recommended that the HP 5951XA be unplugged before any of the S102 switches are manipulated.

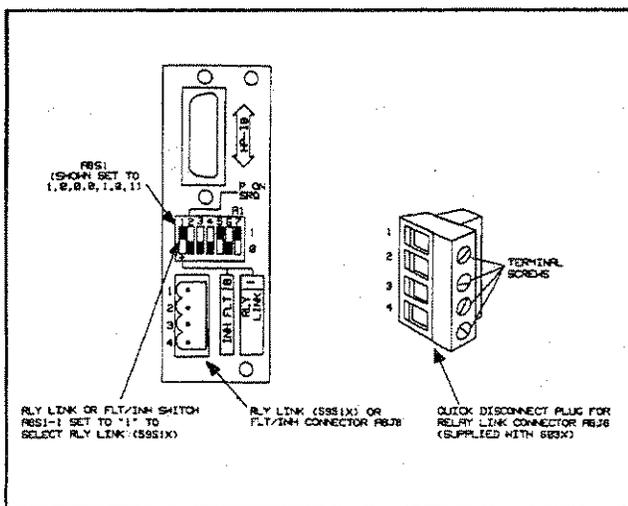


Figure 3-5. Relay Link Connector and Selector Switch on HP 603X Rear Panel

3-10 RLY LINK or INH/FLT Switch. This switch (A8S1-1), is one of 7 DIP switches located below the HP-IB connector on the rear of the HP 603XA supply as shown in Figure 3-5. In order to program the HP 603XA/5951XA configuration, switch A8S1-1 must be set to the RLY LINK position (see Fig. 3-4). With A8S1-1 set to RLY LINK, connector A8J8 (RLY LINK or INH/FLT) functions as a serial data link for relay control instead of as a connector for the remote inhibit (INH) input line and the fault (FLT) output line. If switch A8S1-1 is not set to the RLY LINK position, the HP 603XA will generate error 9 when it receives a relay command (e.g. RELAY ON) and will not attempt to communicate with the HP 5951X Relay Accessory via the serial data cable. The functions performed by the remaining DIP switches A8S1-2 through A8S1-7 are described in the HP 603XA Operating and Service Manual(see paragraph 1-1).

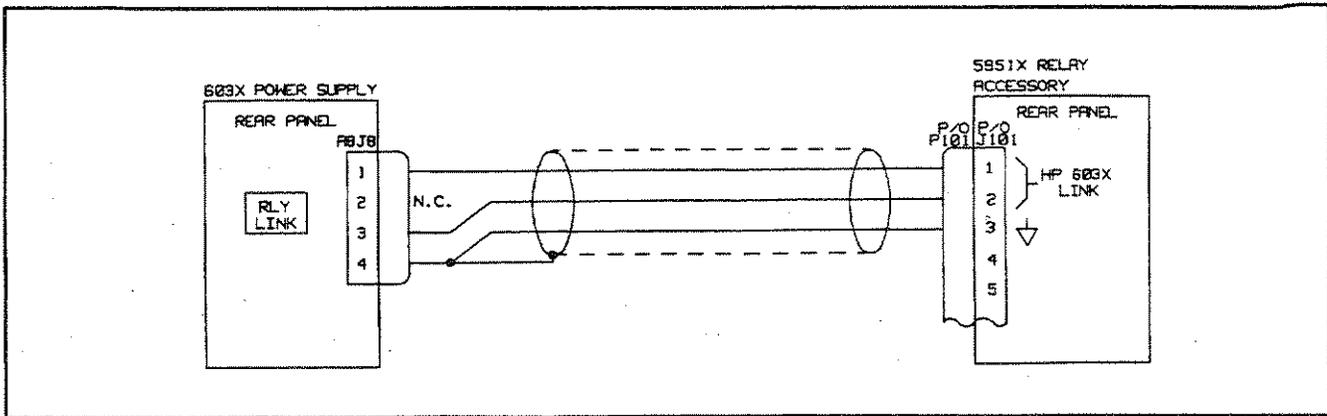


Figure 3-6. Serial Data Link Cable Connection

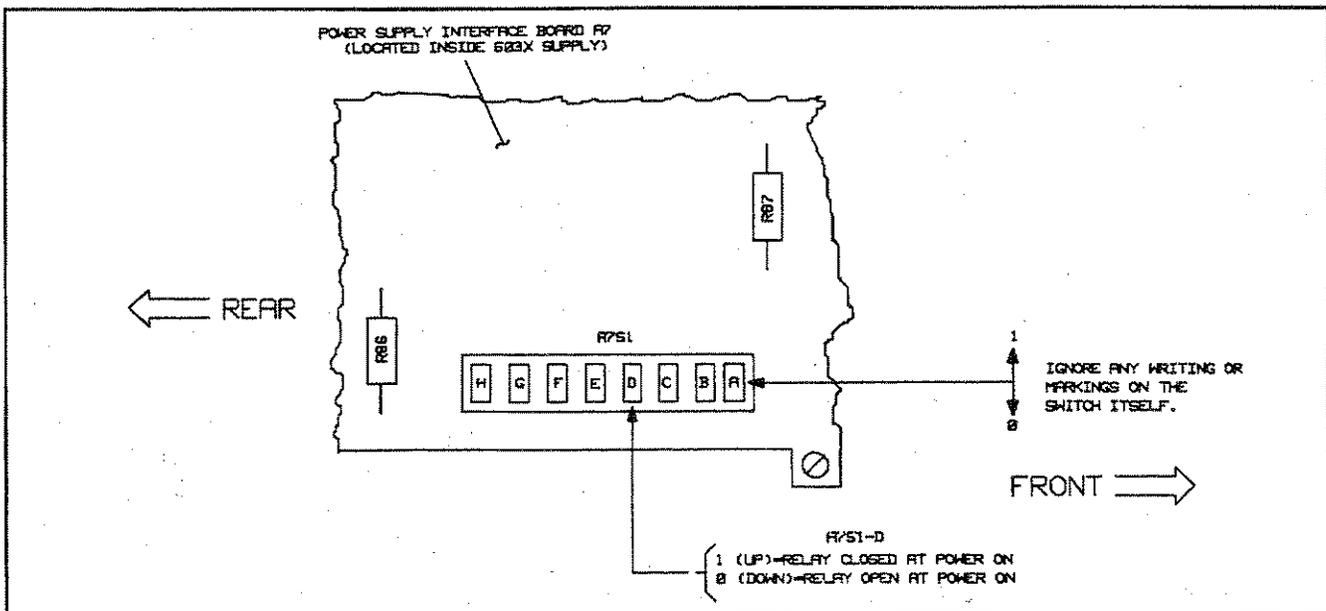


Figure 3-7. Switch A7S1 (Located inside the HP 603X Supply)

3-11 HP 603XA/5951XA Serial Data Connection

The serial data connection is made between connector A8J8 on the rear of the HP 603XA supply and the HP 603X LINK connector pins (J101-1 to 3) on the front of the HP 5951XA using a shielded cable as shown in Figure 3-6.

The serial data output (A8J8-1) from the HP 603XA is connected to the input (J101-1) of the HP 5951XA. The serial data readback (J101-2) from the HP 5951XA is connected to the input (A8J8-3) of the HP 603XA. Note that pin A8J8-2 is left unconnected. The common connection is made between A8J8-4 and J101-3. The cable shield should only be grounded (connected to common) at the power supply end (A8J8-4) as shown in Figure 3-6.

A 4-pin quick disconnect mating plug for A8J8 is supplied with the HP 603XA supply and a 10-pin quick disconnect mating plug (P101) for J101 is supplied with the HP 5951XA. Each cable wire is inserted into the appropriate mating plug pins (see Figures 3-5 and 3-6) and the corresponding screw is tightened until the wire is securely fastened.

3-12 HP 603XA/5951XA Configuration Wake-Up State

A switch (inside the HP 603XA supply) is factory set so that at power-on, the HP 603XA/5951XA configuration "wakes-up" with the power supply output enabled and disconnected (relay open) from the load. The switch (A7S1) is located on the power supply's interface board and can be set to the

alternate position in which the HP 603X/5951XA configuration "wakes-up" with the power supply output enabled but connected (relay closed) to the load. Refer to Figure 7-7 and paragraph 5-77 in the HP 603XA Operating and Service Manual if you want to gain access to the power supply interface board A7 in order to change the setting of switch A7S1.

WARNING

SHOCK HAZARD

Changing the setting of switch A7S1-D requires the removal of protective covers. To avoid the possibility of personal injury, remove the power supply from operation before opening the cabinet. Turn off ac power and disconnect the line cord, HP-IB plug, load, remote sense leads, and INH/FLT connector before removing protective covers. Refer to the Maintenance section of the appropriate HP603XA Operating and Service Manual for procedures for accessing the A7 PSI Board of the power supply. Observe all precautions in this section to avoid personal injury or damage to equipment.

As shown in Figure 3-7, A7S1 is comprised of eight separate switches. Switch A7S1-D determines the "wake-up" state of the Relay Accessory. With A7S1-D set to "0", the "wake-up" state is relay open. With A7S1-D set to "1", the wake-up state is relay closed. The remaining A7S1 switches are described in the HP 603X manual. Note that if you do change switch A7S1-D, make sure that you do not disturb any of the other A7S1 switch settings. Switches A7S1-E to H are set at the factory for each particular model and must not be changed.

3-13 Remote Inhibit (INH) and Fault (FLT) Lines

The remote inhibit ($\overline{\text{INH}}$) input (J101-9 and 10) and the fault (FLT) output (J101-7 and 8) on the Relay Accessory (see Figure 3-1) are used in place of the $\overline{\text{INH}}$ input and FLT output on the HP 603XA power supply in a HP 603XA/5951XA configuration. The FLT line provides the user with a means of knowing the status of any unmasked fault register bit, independently of the service request (SRQ) function available through the HP-IB. The $\overline{\text{INH}}$ line controls the remote inhibit (RI) bit in the power supply's fault register and provides a way to disconnect the power supply output from the load. The fault registers are described in detail in the applicable HP 603XA Operating and Service Manual (see paragraph 1-1). Both $\overline{\text{INH}}$ and FLT are negative true, i.e., they are active when they are low levels. Pins 8 and 10 are the commons for the FLT and $\overline{\text{INH}}$ signals, respectively. Both FLT and $\overline{\text{INH}}$ may be floated relative to ground and to each other. Refer to Table 1-1 for details.

3-14 INH Input Line. When $\overline{\text{INH}}$ is Low, the Relay Accessory will execute the equivalent of a RELAY OFF

command which opens the DC power relay (normal or reverse) disconnecting the load from the HP 603XA output. Also, with $\overline{\text{INH}}$ Low, the Relay Accessory is in the local sense state, that is, the HP 603XA's +S and -S sense terminals are connected to the HP 603XA's + and - output terminals via the LOCAL SENSE relay contacts inside the Relay Accessory.

The Relay Accessory will not respond to the RELAY ON or $\overline{\text{OUT}}$ ON commands while the $\overline{\text{INH}}$ line is held Low. When $\overline{\text{INH}}$ goes High, the Relay Accessory will not return to the state previous to the $\overline{\text{INH}}$ Low condition but will remain in the off state.

While $\overline{\text{INH}}$ is Low, the Relay Accessory will respond to the routine status poll request (see paragraph 3-17) from the HP 603XA by setting a bit in its status response to indicate that a remote inhibit condition exists. The HP 603XA will disable its output upon detection of this condition. The HP 603XA output can be enabled again by means of the HP 603XA standard command RST (see Section III in the HP 603XA Operating and Service Manual). The RST command should be issued only after the Relay Accessory is no longer remote inhibited (after $\overline{\text{INH}}$ goes High). If RST is issued when the Relay Accessory is remote inhibited ($\overline{\text{INH}}$ is Low), the HP 603XA and the HP 5951XA will remain inhibited.

3-15 FLT Output Line. The $\overline{\text{FLT}}$ output line of the Relay Accessory is turned on (Low level) when any unmasked bit in the HP 603XA's fault register is set. For example, $\overline{\text{FLT}}$ is turned on if the $\overline{\text{INH}}$ input line is turned on and the remote inhibit (RI) bit in the fault register is unmasked. The RI bit is unmasked using the UNMASK RI command as described in Section III of the HP 603XA Operating and Service Manual. If RI was the only fault bit set, the FLT line will go High (off) upon reading the HP 603XA fault register (FAULT?). The other power supply conditions that can turn on the FLT line are discussed in the HP 603XA manual.

3-16 Using $\overline{\text{INH}}$ and FLT with Multiple HP 603XA/5951XA's. Figure 3-8 illustrates three HP 5951XA's (A, B, and C) in which the FLT output of one is connected to the $\overline{\text{INH}}$ input of the next. Also, the RI bit must be unmasked in each of the HP 603XA supplies. A fault condition in any one supply will cause all of the power supply outputs to be disconnected from their respective loads without computer involvement or any external circuitry.

WARNING

SHOCK HAZARD

Float voltage restrictions for the $\overline{\text{INH}}$ and FLT signals must be observed to avoid risk of personal injury or damage to equipment. Refer to the Isolation Specification listed in Table 1-1.

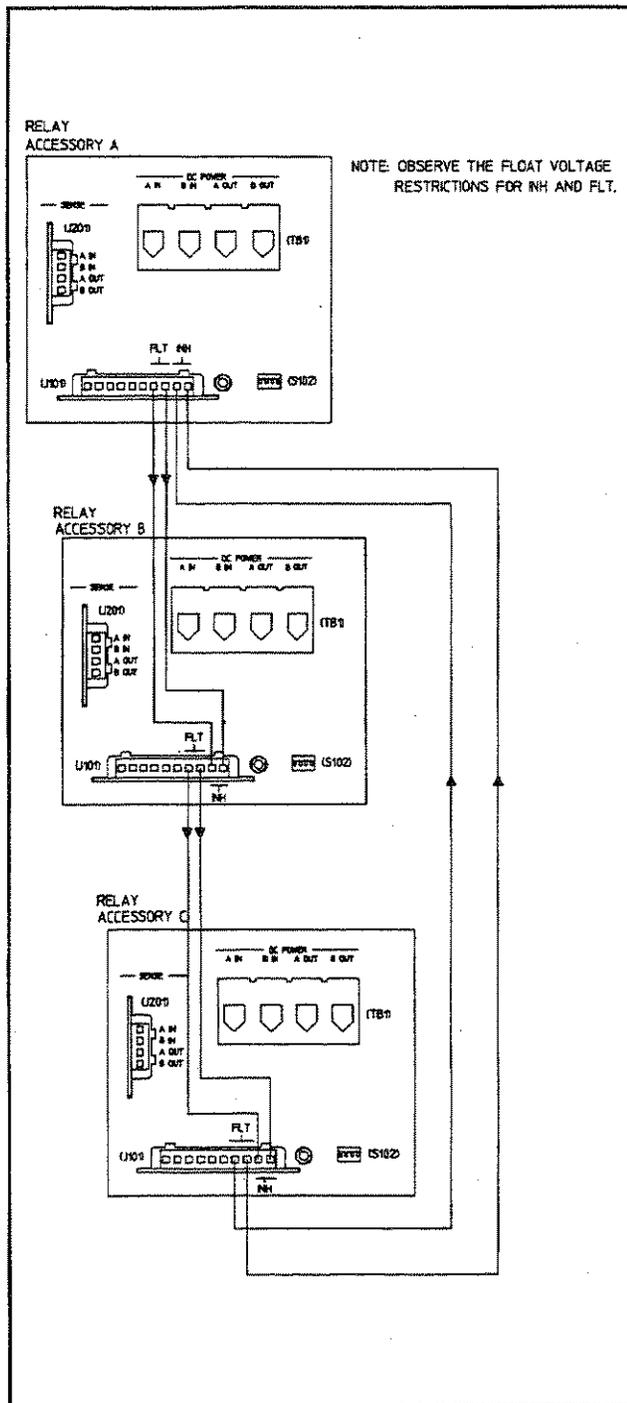


Figure 3-8. FLT/INH Connections

3-17 HP 603XA Status Poll

The HP 603XA queries the status of the Relay Accessory at regular intervals. The state of the RI (remote inhibit) mask is encoded within the status query. When it receives the status query, the Relay Accessory will be updated according

to the information encoded within the status query. The Relay Accessory will then respond by echoing the status query command back to the HP 603XA with the INH input line state encoded within this echo. The HP 603XA may then disable its output depending upon the remote inhibit information received.

3-18 HP 603XA/5951XA Turn-On Sequence

The HP 603XA queries the status of the HP 5951XA at regular intervals as described above. If communications are broken (e.g., serial data link cable is disconnected) between the HP 603XA and the HP 5951XA, the HP 5951XA will assume a safe state (relay opened), the HP 603XA will generate "error code 9", and the ERROR indicator on the HP 603XA front panel will light. The HP 5951XA will resume normal operation when communications are re-established. The HP 603XA ERROR indicator will remain on until the error query (ERR?) is received.

It is recommended that you apply AC power to the HP 5951XA first and then turn on the HP 603XA power supply. If the HP 603XA is turned on before the 5951XA, "error 9" will be generated. Normal communication between the HP 603XA and the HP 5951XA will be established after the HP 5951XA is turned on. The "error 9" generated by the HP 603XA is cleared by sending the error query "ERR?". If both the HP 603XA and the HP 5951XA are powered up simultaneously, e.g. via the same rack power switch, no error will be generated.

3-19 GENERAL PURPOSE CONFIGURATION

Figure 3-9 illustrates a general purpose configuration that consists of a power supply, a TTL level control device, the Relay Accessory, and the load. In order to control the Relay Accessory in this configuration, follow the general steps outlined below. Each step is described in greater detail in the referenced paragraph(s).

1. Connect the DC POWER and SENSE leads (paragraphs 3-3 to 3-6).
2. Ensure that the CONFIG switches (S102) on the HP 5951XA are selecting LOGIC CONTROL (TTL input) and the desired LISTEN ENABLE position (see paragraphs 3-20 to 3-22).
3. Make the LOGIC CONTROL (TTL levels) connections (see paragraph 3-23).
4. If desired, you can connect the INH and FLT lines (see paragraph 3-27).
5. Apply AC power to the HP 5951XA unit, the power supply, and the TTL control device.
6. Verify the wiring and switch settings by checking the configuration with a low power supply output voltage before applying full output voltage.

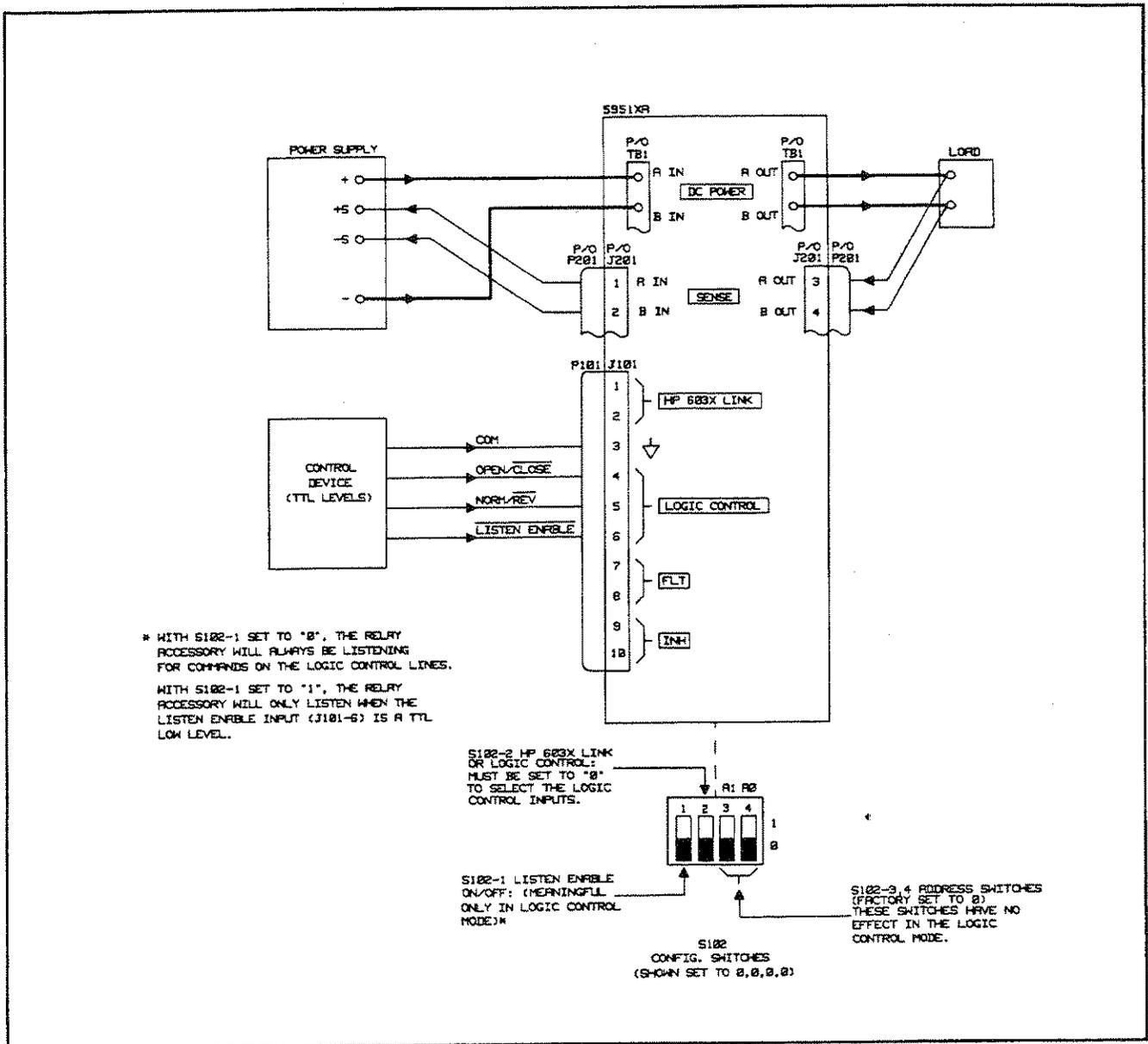


Figure 3-9. General Purpose Configuration

NOTE

At power on, the Relay Accessory "wakes-up" with its DC power and remote sense relays open, the local sense relay closed, and with the normal polarity mode in effect. After power is on, the Relay Accessory goes to the state specified by the the LOGIC CONTROL (TTL levels) inputs. If no inputs are connected, the HP 5951XA will remain with the "wake-up" conditions in effect.

3-20 Switch Settings

In order to control the general purpose configuration, set the CONFIG switches (S102) on the HP 5951XA as follows:

3-21 HP 603X LINK or LOGIC CONTROL Switch. Set switch S102-2 to the LOGIC CONTROL position as shown in Figure 3-9. In this position, the HP 5951XA will respond to the TTL inputs (see paragraphs 3-23 to 3-26) and ignore any commands sent via the HP 603XA LINK input.

3-22 Listen Enable Switch. With S102-1 set to the "0" position, the Relay Accessory will continuously respond to signals on the LOGIC CONTROL input lines. With S102-1 set to "1", the LISTEN ENABLE input (J101-6) determines when the Relay Accessory will respond to signals on the LOGIC CONTROL lines (see paragraph 3-24).

3-23 TTL Input Connections

The TTL control inputs are connected to the LOGIC CONTROL pins J101-3 through J101-6 as shown in Figure 3-9. The TTL input signals are: OPEN/CLOSE (J101-4), NORMAL/REVERSE (J101-5), and LISTEN ENABLE (J101-6). The TTL common connection is made to J101-3.

WARNING

The LOGIC CONTROL, INH, and FLT signals must be restricted to no greater than ± 42 Vdc from ground unless specific requirements are fulfilled. Refer to the Isolation Specifications in Table 1-1 for details. Failure to observe these requirements may result in damage to equipment and/or personal injury.

3-24 LISTEN ENABLE Input. This input determines if the microprocessor in the Relay Accessory will respond to changes on the TTL input lines. If LISTEN ENABLE is false (High level), the Relay Accessory will remain in its current state regardless of the state of the OPEN/CLOSE and NORM/REV inputs. When LISTEN ENABLE is held true (Low level), the Relay Accessory will respond to these inputs.

Switch S102-1 on the rear of the HP 5951XA allows the LISTEN ENABLE input to be held Low (true) or to float High (false). The Relay Accessory is shipped from the factory with S102-1 set to "0" so that LISTEN ENABLE is held Low.

If you want the Relay Accessory to continuously "listen" for commands on the TTL input lines, leave S102-1 set to the "0" position. If you want to use the LISTEN ENABLE input to select when the Relay Accessory will "listen" to the TTL input lines, set S102-1 to "1". With S102-1 set to "1", the Relay Accessory will listen only when LISTEN ENABLE (J101-6) is true (Low). This line can be used to control any one of a number of Relay Accessories. Figure 3-10 illustrates the connections required to control three units. The TTL control device selects the unit by setting the applicable LISTEN ENABLE line (LE1, LE2, or LE3) Low.

3-25 OPEN/CLOSE Signal. As long as the OPEN/CLOSE input is held Low, the DC power and remote sense relays will be closed. Releasing the line (floats High) will open these relays and return the the Relay Accessory to the local sense state. (This is assuming that LISTEN ENABLE is low. If LISTEN ENABLE is high, the HP 5951XA will not respond

to changes on the OPEN/CLOSE input, but will remain in its original state.)

3-26 NORM/REV Input (Applies only to HP Model 59511A). If the normal polarity power relay K1 and remote sense normal relay K202 are closed, a Low level at this input causes the relays to go through the open state before they end up in the reverse polarity state (reverse polarity power relay K2 and remote sense reverse relay K203 both closed). Remember that the NORM/REV input is level sensitive and must be held Low in order to keep Relay Accessory in the reverse polarity state. Releasing the line will return the Relay Accessory to the normal polarity state. (This is assuming LISTEN ENABLE is low. If LISTEN ENABLE is high, the HP 59511A will not respond to changes on the NORM/REV input, but will remain in its original state.)

NOTE

HP 662X series of HP-IB Multiple Output DC Power Supplies equipped with Option 750 provide four open collector outputs which can provide Low true TTL compatible levels to control the HP 5951XA. Up to four HP 59510A's can be controlled by connecting to the OPEN/CLOSE input on each HP 59510A. Up to two HP 59511A's can be controlled by connecting to the OPEN/CLOSE and NORM/REV inputs on each HP 59511A. Refer to the Operating Instructions for the 662XA Option 750 (APPENDIX E, HP Part No. 5957-6372).

3-27 Remote Inhibit (INH) and Fault (FLT) Lines

In the LOGIC CONTROL (TTL input) mode, a Low level INH signal will always disconnect the power supply output from the load and cause the FLT line to go true (Low). FLT will go false (High) when INH goes false (High).

A Low level on the INH line will also override the OPEN/CLOSE line. When the INH line is released (High), the Relay Accessory will again respond to the OPEN/CLOSE input provided that the LISTEN ENABLE line is true. Consequently, it is recommended that the INH input be driven by a latching type circuit. Activity on the NORM/REV line while INH is true (Low) will not affect the Relay Accessory since polarity has no meaning when the DC power relay is opened.

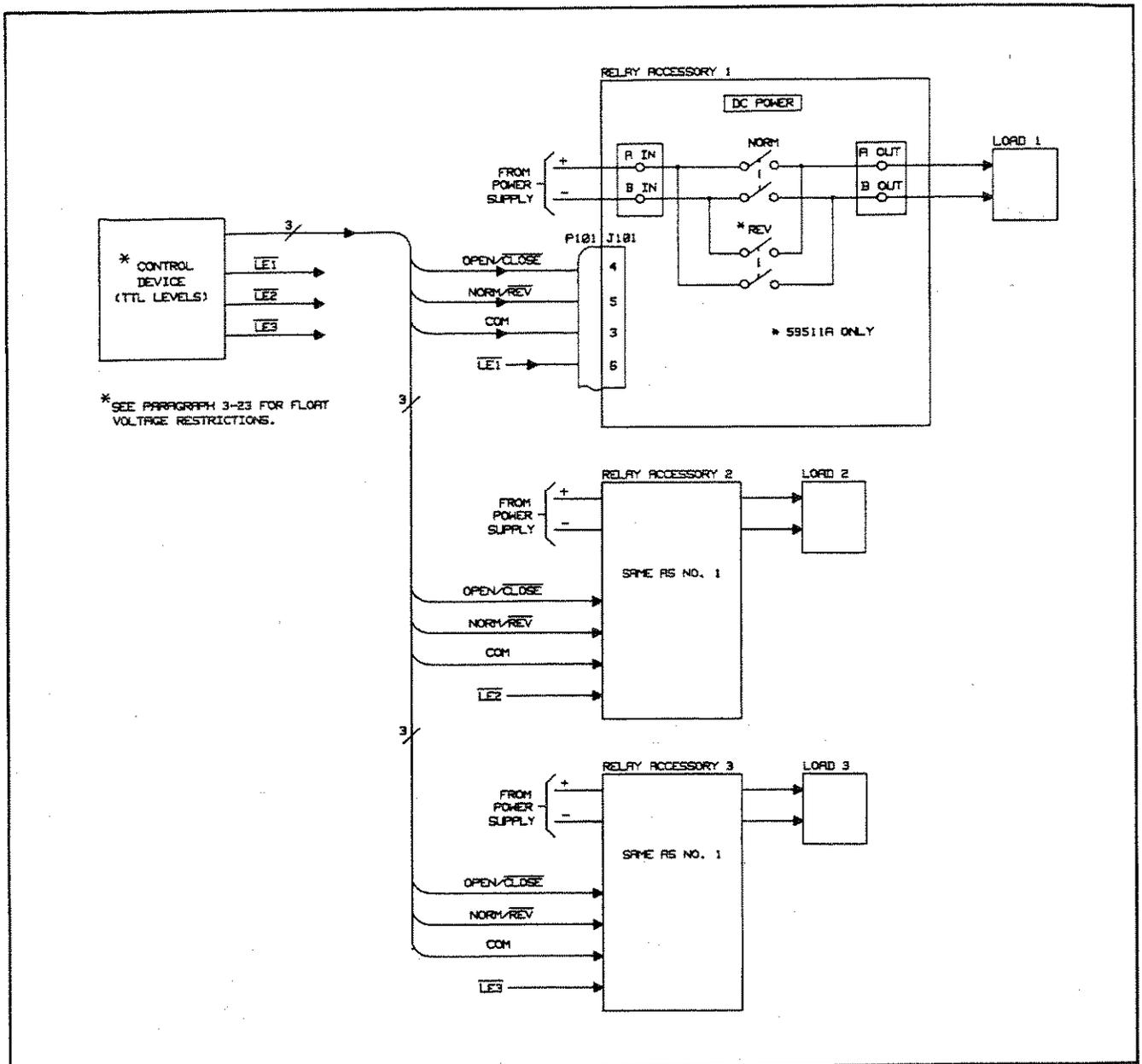


Figure 3-10. Logic Control of Multiple Relay Accessories

Section IV HP 603XA PROGRAMMING COMMANDS

4-1 INTRODUCTION

This section describes the commands that have been changed or added to the HP 603XA standard commands to permit programming the HP 5951XA/603XA configuration from an HP-IB controller. The programming syntax for all of the commands is described in Section III of the HP 603XA Operating and Service Manual (see paragraph 1-1).

presently available only in the standard programming language as described in this section.

The commands are received by the HP 5951XA from the HP 603XA via the serial data link described in paragraph 3-11. Table 4-1 lists and briefly describes each of the changed and added commands. Each command is described in greater detail in subsequent paragraphs.

NOTE

The current HP 603XA Option 700 CIIL (control interface intermediate language) programming capability does not include relay (HP 59510A/59511A) control. Control of the HP 59510A/59511A is

Figure 4-1 illustrates how the power supply's output and sense leads are connected or disconnected from the load and how polarity reversal is accomplished. A tabulation is included on Figure 4-1 that specifies how the HP 603XA LINK commands and the LOGIC CONTROL inputs control the DC POWER and SENSE relays in the Relay Accessory.

Table 4-1. Additional and Changed Commands

Command	Type	Description
OUT <on/off>	Standard (changed)	Programs both the power supply output and the relay. For on/off = 1 or ON, the power supply output is disabled, the relay is closed, and then the output is enabled. For on/off = 0 or OFF, the output is disabled and then the relay is opened. Having the output off (disabled) when the relay changes state extends the life of the relay.
OUT?	Standard (changed)	Queries the power supply output setting independent of the actual power supply output state or the state of the relay. The response is either OUT 1 (setting = output enabled) or OUT 0 (setting = output disabled).
POL <norm/rev>	Standard (added)	Instructs the Relay Accessory (HP 59511A only) to provide either normal polarity (norm/rev = NORM or 1) or reverse polarity (norm/rev = REV or 0) at the load.
POL?	Standard (added)	Queries the relay polarity setting (HP 59511A only). The response is either POL 0 (setting = polarity reversed) or POL 1 (setting = polarity normal).
DC <on/off>	Standard (added)	On/off = 0 or OFF turns off the power supply output (disables the power mesh). On/off = 1 or ON turns on the power supply output (enables the power mesh). The DC <on/off> command does not affect the state of the relay.
DC?	Standard (added)	Queries the power supply output setting. The response is either DC 0 (setting = output disabled) or DC 1 (setting = output enabled).
RELAY <on/off>	Standard (added)	Opens (on/off = OFF or 0) or closes (on/off = ON or 1) the relay. The RELAY <on/off> does not affect (turn on/off) the power supply output.
RELAY?	Standard (added)	Queries the relay setting. The response is either RELAY 0 (setting = opened) or RELAY 1 (setting = closed).

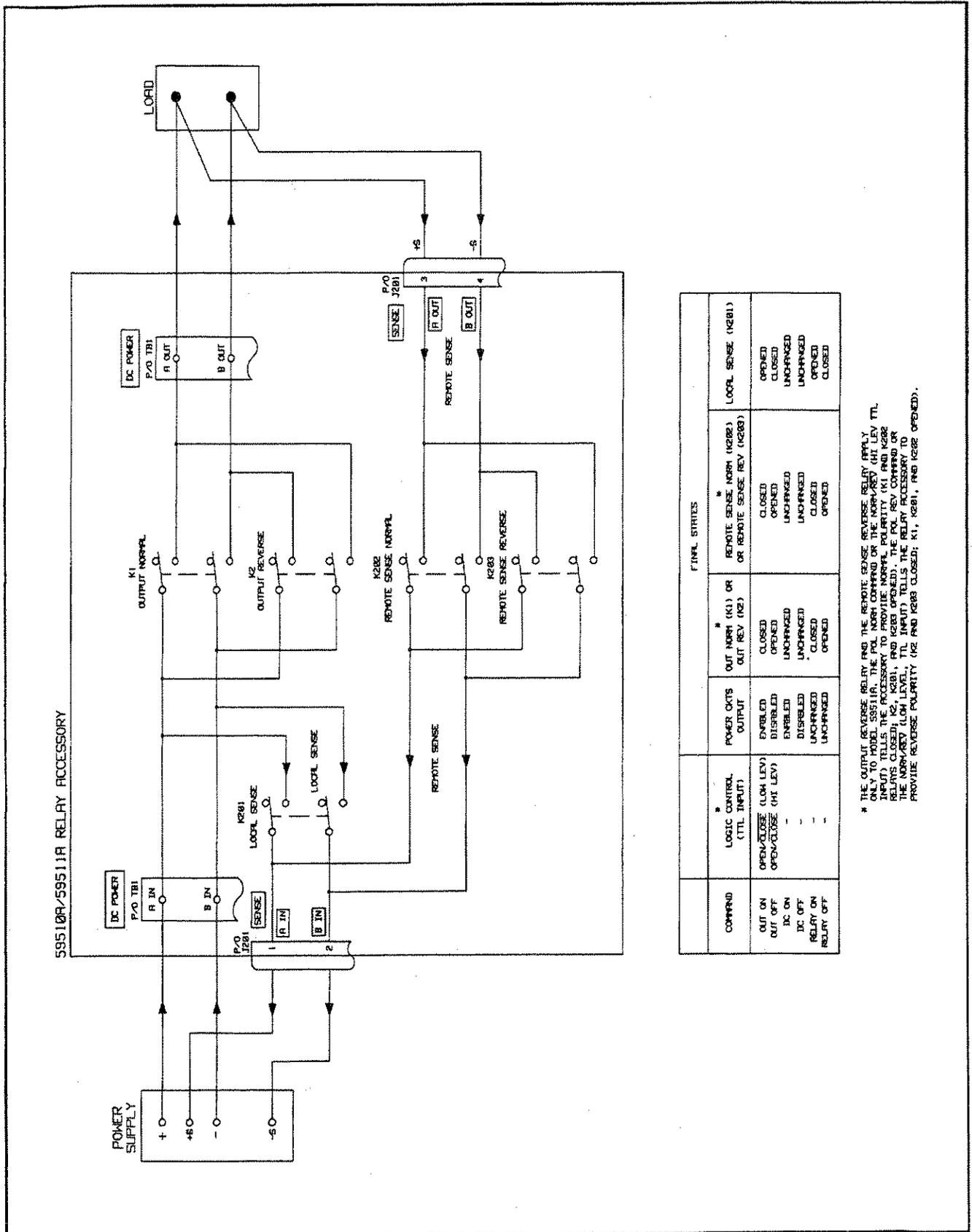


Figure 4-1. Relay Accessory/Power Supply Output Control

4-2 CHANGED COMMAND

The actions performed by the Output on/off command (see Table 3-7 in the HP 603X Operating and Service Manual) have changed. The Output on/off and the added commands (e.g., Relay on/off) described later can be used to control the Relay Accessory provided that the RLY LINK—INH/FLT switch A8S1-1 is in the RLY LINK position. Using the Output command is the preferred method because it disables the power supply's output while the relays are switched, thus prolonging relay life.

NOTE

When the RLY LINK—INH/FLT switch A8S1-1 on the HP 603X power supply is in the INH/FLT position, the functions of the Output command and the other standard commands are same as described in Table 3-7 of the HP 603X Operating and Service Manual. The added commands (DC on/off, Relay on/off, and Polarity norm/rev) will generate error 9 if sent with A8S1 in the INH/FLT position.

4-3 Output On/Off

The power supply output is enabled/disabled and the relay closed/opened using the OUT command:

OUT ON or OUT 1

This command first disables the power supply output, delays to permit the output to downprogram sufficiently, then closes the power relay, and finally, after a delay to guarantee relay settling, enables the power supply output. The downprogramming delay depends upon the model as specified below. The OUT ON (or OUT 1) command also places the HP 603XA/5951XA configuration in the remote sense state. In the remote sense state, the power supply's sense terminals are connected to the load's sense leads via the remote sense relay contacts in the HP 5951XA.

HP Model	Delay
6030	600 mS
6031	500 mS
6032	400 mS
6033	200 mS
6038	400 mS

OUT OFF or OUT 0

This command first disables the power supply output and then opens the relay after the specified delay. The OUT OFF (or OUT 0) command also places the HP 603XA/5951XA configuration in the local sense state. In the local sense state, the power supply's sense terminals are connected to the supply's output terminals via local sense relay contacts in the 5951XA.

NOTE

The delays between disabling the output of the power supply and the closure or opening of the relay contacts do not guarantee that the current is zero during relay closure or opening. The delays were chosen to provide reasonable reduction in output before relay contact activity in order to prolong relay life. In applications where it is necessary to guarantee zero output conditions, e.g. when using highly inductive loads, it is advisable to use the DC On/Off and RELAY On/Off commands with a suitable WAIT between them. In general, to extend relay life, it is advisable to switch the relays under low or zero output conditions.

The state of the output on/off setting may be read by sending:

OUT?

and addressing the power supply to talk. The response from the power supply is in the format:

OUT 0 or OUT 1

in which 0 indicates the power supply output setting is disabled; and 1 indicates that the supply output setting is enabled. Note that the actual output state may not be reflected. For example, if the setting is output enabled, but an overvoltage condition has caused the output to be disabled, an OUT? query will return OUT 1.

4-4 ADDED COMMANDS

Relay on/off, DC on/off, and Polarity on/off commands have been added to the HP 603XA standard programming commands in order to control the HP 5951XA/603XA configuration. The DC on/off and Relay on/off commands allow independent control of the power supply output and the relays. An Output command, issued after a Relay and/or DC command(s), will supersede these command(s) and restore both the power supply output and the relays to the same state (e.g. power supply output enabled and relay closed).

At power-on, the default states are power supply output enabled (DC ON) and relay opened (RELAY OFF). These default states can be reconfigured on HP 603XA supplies by changing one of the A7S1 identification switches on the power supply interface board (see paragraph 3-12). The alternate power-on default setting is power supply output enabled (DC ON) and the relay closed (RELAY ON).

The power-on default state for the Polarity on/off command is normal polarity (POL NORM). The POL command only applies to HP Model 59511A. If it is used to program a HP 603XA/59510A configuration, programming error 9 will be generated by the HP 603XA supply when it attempts to execute the POL command.

4-5 DC On/Off

The power supply output is enabled/disabled without affecting the state of the Relay Accessory using the DC command:

DC ON or DC 1

The DC ON command enables the power supply output.

DC OFF or DC 0

The DC OFF command disables the power supply output. When disabled the output is approximately zero volts.

The state of the DC on/off setting may be read by sending:

DC?

and addressing the power supply to talk. The response from the power supply is in the format:

DC 0 or DC 1

in which 0 indicates that the power supply output setting is disabled, and 1 indicates that the power supply output setting is enabled. Note that the DC ? command returns the state of the power supply output setting as controlled by the DC or OUT commands.

4-6 Relay On/Off

The relay is closed/opened using the RELAY command:

RELAY ON or RELAY 1

The RELAY ON command closes the relay connecting the power supply's output to the load. It also places the supply in the remote sense state.

RELAY OFF or RELAY 0

The RELAY OFF command opens the relay disconnecting the power supply's output from the load. It also places the supply in the local sense state.

The state of the Relay on/off setting may be read by sending:

RELAY?

and addressing the power supply to talk. The response from the power supply is in the format:

RELAY 0 or RELAY 1

in which 0 indicates that the relay setting is opened, and 1 indicates that the setting is closed. Note that the RELAY? command returns the setting of the relay as controlled by the RELAY and/or OUT commands. A relay opened due to

the remote inhibit (INH) signal will not affect the response to RELAY?. A low level inhibit (INH) signal will always cause the relay to open. For example, if a RELAY ON command has been sent to close the relay and then an INH signal opens the relay, a subsequent RELAY? command will result in a response of RELAY 1 indicating that the relay is programmed to be closed, although it is actually open.

4-7 Polarity Normal/Reverse (Model 59511A only)

The polarity of the power supply output voltage at the load is changed using the POL command:

POL NORM or POL 1

POL NORM disables the power supply output, changes the output polarity setting to normal (opens the reverse polarity relays and closes the normal polarity relays), and then enables the power supply output.

POL REV or POL 0

POL REV disables the power supply output, changes the output polarity setting to reverse (opens the normal polarity relays and closes the reverse polarity relays), and then enables the power supply output.

NOTE

If the polarity is already that which is called for by the POL command, there will be no change in the power supply output or the state of the relay.

The power-on default is normal polarity. If the 603XA power supply's output is enabled and one of the relays (normal or reverse) is closed when the 603XA receives a POL command to reverse polarity, the 603XA will do the following:

1. Disable its output.
2. Wait for the output to decay (the delay is model dependent, see paragraph 4-3).
3. Open the relay.

The above sequence places the 603XA/59511A configuration in the OUT OFF state (power supply output off and relays opened). Immediately after the relays have settled in the opened state, the sequence is reversed until the resultant state is OUT ON, with the output enabled and the relay for the opposite polarity closed.

The state of the POL (normal/reverse) setting may be read by sending:

POL?

and addressing the power supply to talk. The response from the power supply is in the format:

POL 0 or POL 1

in which 0 indicates that the polarity setting is reversed, and 1 indicates that the polarity setting is normal.

Section V MAINTENANCE

5-1 INTRODUCTION

This section provides verification, circuit operation, and troubleshooting information for the HP Model 59511A and 59510A Relay Accessories. Before you attempt to troubleshoot the Relay Accessory, ensure that the fault is with the HP 5951XA itself and not with the HP-IB controller, HP 603XA supply, or power line. The verification tests that follow in paragraph 5-9 enable this to be determined without having to remove the covers from the Relay Accessory.

It is recommended that you read the circuit descriptions in paragraphs 5-2 through 5-7 as well as the operating information and programming instructions in Sections III and IV before you troubleshoot the unit.

This section also contains a replaceable parts list, functional schematic, and a component location diagrams.

5-2 CIRCUIT OPERATION

The HP 59510A and 59511A Relay Accessories can be used in power supply applications where either or both load connect/disconnect and polarity reversal are required. The HP 59510A provides for load connect/disconnect for both the power output and the sense leads of the supply. The HP 59511A provides for polarity reversal as well as for load connect/disconnect for both power output and sense leads.

Figure 5-7 at the back of this manual is a functional schematic diagram that illustrates the circuits contained on the main circuit board, the relay board, and on the chassis of the HP 59510A/59511A Relay Accessory.

5-3 Main Circuit Board

The main circuit board contains the circuits which control the sense and power relays. A power-on circuit and bias supply which provide power to operate the control circuits and the relays are also located on the main circuit board.

5-4 Control Circuits. Microcomputer chip U101 is the primary component. It includes a microprocessor unit (MPU), ROM, and RAM. These internal circuits process all relay commands that are received via the serial data input or the general purpose TTL input. Ceramic resonator Y101 provides a 4 MHz clock signal for the microprocessor. The jumper across J103-5 and J103-6 identifies the unit as HP Model 59510A. No jumper connected identifies the unit as HP Model 59510A.

When CONFIG switch S102-2 is set to "1", it selects the HP 603X LINK (serial data) input and allows the microprocessor

to respond to serial data from the HP 603X and ignore the TTL input.

Comparator U103D is used as a level sense amplifier for the serial data which represents commands from the HP-IB controller. Microprocessor U101 converts the serial data into signals to open or close the DC power and sense relays via high current driver circuits U104 and U105. Quad driver U104 controls the normal output polarity (drivers A and B), remote sense reverse (driver C), and local sense (driver D) relays. Quad driver U105 controls the reverse output polarity (drivers A and B) and remote sense normal (driver C) relays. Driver D of U105 is used for the FLT output line. The normal and reverse polarity DC power relays each have two drivers because of their higher current requirements. Optical isolator U108 transfers the FLT signal to connector pins J101-7 and 8. The microprocessor's FLT output and INH input lines are described in Section III of this manual.

Comparator U103C is used as a level sense amplifier to readback serial data which represents Relay Accessory status. As described in paragraph 3-17, the HP 603XA queries the status of the Relay Accessory at regular intervals. If the microprocessor does not receive any communication within this interval, it will reset and the HP 5951XA will assume a safe state (relay open). Counter U109 divides the microprocessor clock to a rate used by the serial communications circuitry inside U101.

With CONFIG switch S102-2 set to the LOGIC CONTROL (TTL levels) input ("0" position), the microprocessor will respond to the TTL inputs, OPEN/CLOSE and NORM/REV (HP 59511A only), and ignore any commands received on the serial data input. Each TTL input line has a pull-up resistor to make the default input a logic High causing the microprocessor to open the DC power and remote sense relays and close the local sense relay. The microprocessor translates the OPEN/CLOSE and NORM/REV TTL inputs into signals that open/close the DC power and remote sense relays as described in paragraphs 3-24 and 3-25.

A third TTL input, LISTEN ENABLE, determines (in the logic control mode) if the microprocessor will respond to OPEN/CLOSE and NORM/REV inputs. If LISTEN ENABLE is false (high level), the microprocessor will keep the relays in their current state regardless of the state of the OPEN/CLOSE and NORM/REV inputs. When LISTEN ENABLE is held true (low level), the microprocessor will respond to the other TTL inputs. CONFIG switch S102-1 allows the LISTEN ENABLE input to be held Low (logic true) or float high (logic false). S102-1 is factory set to "0" (low, logic true).

Switches S102-3 and S102-4 are address switches which are meaningful only in the HP 603X LINK mode (when S102-2 is set to "1"). Switches S102-3 and S102-4 are factory set to "00" because at present, HP 603XA supplies will only communicate with a Relay Accessory at address 0. Addresses 1-3 (selectable by changing S102-3 and S102-4 to "01", "10", or "11") are provided for possible future use.

5-5 Bias Supply. The bias supply is comprised of full-wave bridge rectifier diodes U106, a switching regulated power supply (Q101-Q103 and U102), and a three-pin regulator IC Q104. The ac input power is applied to U106 via line fuse F1, line voltage select switch S101, and transformer T101. Transformer T101 provides 36 Vac nominal across U106. The switching regulated supply generates +11.5 Vdc for the current drivers (U104, U105), comparators (U103), and the relays (K1, K2, K201-K203). A feedback loop containing comparator U102A and driver transistors Q101, Q102 control the conduction of Q103 to keep the 11.5 Vdc bias output constant. The 11.5 Vdc output is feedback to U102A where it is compared with a reference voltage. If the output goes below 11.5 V, Q103's duty cycle is increased to increase the output. Conversely, if the output rises above 11.5 V, Q103's duty cycle is decreased which in turn decreases the output.

The 11.5 V output is also applied to three-pin voltage regulator Q104 and to the power-on (PON) circuit. Voltage regulator IC Q104 generates the +5 V bias which is used by various control circuits on the main circuit board.

5-6 Power-on Circuit. The power-on circuit (U103A, U103B, U107) generates the PON signal when power is initially turned on. The PON signal is held low for approximately 100 ms at power on to initialize microprocessor U101 and counter U109 and to initially inhibit the relay driver circuits (U104, U105). This prevents any erroneous relay control signals from being generated when power is initially applied to the Relay Accessory.

Also, if the line voltage drops after the unit has been turned on, the power-on circuit will again generate the PON Low level signal to initialize the microprocessor and inhibit the relay drivers.

5-7 Relays

As shown in Figure 5-5, the sense relays K201-203 (mercury-wetted) are located on the relay board and the DC power output relays K1, K2 (mercury displacement) are mounted vertically in the chassis.

HP Model 59511A contains five relays: K1 (DC power normal polarity), K2 (DC power reverse polarity), K201 (local sense), K202 (remote sense normal polarity), and K203 (remote sense reverse polarity). The relays are controlled by microprocessor U101 via relay drivers U104 and U105 as shown in Figure 5-6. A summary of the commands that control relay operation is given in Table 4-1.

Normal DC output polarity (NORM) relay K1 connects/disconnects the + and - power supply output terminals to the load and the remote sense normal polarity (RSN) relay K202 connects/disconnects the + and - sense leads from the load to the +S and -S terminals on the power supply. When reverse polarity is programmed, relays K2 and K203 are operated to reverse the polarity of the connections/disconnections described above. Microprocessor U101 sequences the closing/opening of the relays to minimize overshoots at the power supply output. Resistors R301-306 and capacitors C301-3306, mounted on the filter board, provide noise filtering and ESD (electrostatic discharge) protection at the DC POWER terminals.

Note that local sense (LS) relay K201 is closed when the other relays are opened. Fuses F201 and F202 in the remote sense lines prevent excessive current from flowing through the sense path in the event of relay failure or miswiring of sense leads. resistors R205 and R206 provide excess current protection for the local sense relay. Resistors R201-204, 211-224 and capacitors C201-204 provide ESD protection at the sense terminals.

HP Model 59510A is identical to HP Model 59511A except that it does not contain relays K2 and K203. Thus, the reverse polarity functions described above do not apply to HP 59510A. If a command that controls polarity is sent to the HP 59510A, a programming error will be generated by the HP 603XA when it attempts to execute the commands. Figure 5-1 shows the relay timing sequence. This timing sequence insures that the sense signal path remains unbroken when the power relay is switched.

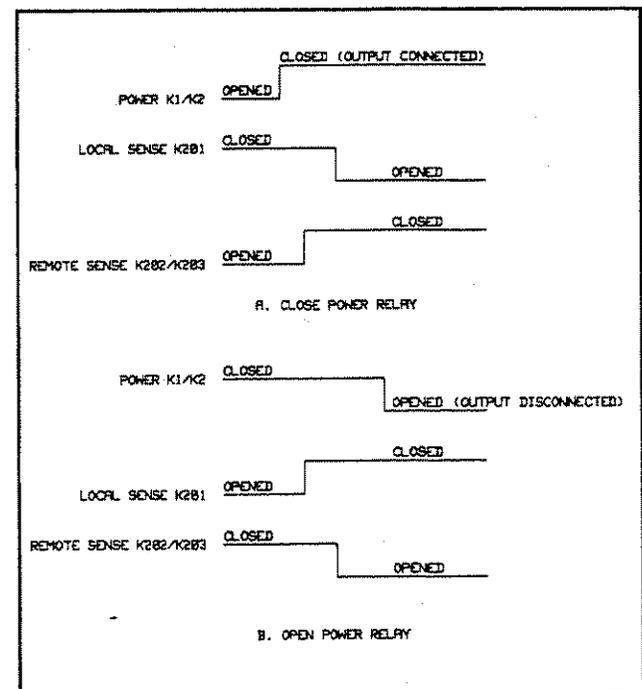


Figure 5-1. Relay Timing

5-8 VERIFICATION

The following paragraphs provide procedures to verify that the Relay Accessory is operating properly.

5-9 Relay Control Verification (TTL Mode)

Connect 5 Vdc, a 100 ohm $\frac{1}{2}$ W resistor, and a dc voltmeter to the Sense connector J201 as shown in Figure 5-2. Set all S102 switches (1 through 4) to logic 0 (down) and proceed as follows:

Relay OPEN/CLOSE

- Turn-on power to the Relay Accessory.
- The dc voltmeter should read 0 volts.
- Short J101-3 (common) to J101-4 (OPEN/CLOSE).
- The dc voltmeter should read 5 volts.
- Disconnect J101-3 (com) from J101-4 (OPEN/CLOSE).
- The dc voltmeter should read 0 volts.

Relay NORMAL/REVERSE (HP Model 59511A Only)

- Short J101-4 (OPEN/CLOSE) TO J101-3 (com).
- The dc voltmeter should read 5 volts.
- Short J101-5 (NORMAL/REVERSE) TO J101-3 (com).
- The dc voltmeter should read -5 volts.
- Disconnect J101-5 (NORMAL/REVERSE) from J101-3 (com).
- the dc voltmeter should read 5 volts.

Relay LISTEN ENABLE

- Set S102-1 to logic 1 (up).
- Short J101-6 (LISTEN ENABLE) to J101-3 (com).
- The dc voltmeter should read 0 volts.
- Short J101-4 (OPEN/CLOSE) to J101-3 (com).
- The dc voltmeter should read 5 volts.
- Disconnect J101-6 (LISTEN ENABLE) from J101-3 (com.)
- The dc voltmeter should read 5 volts.
- Disconnect J101-4 (OPEN/CLOSE) from J101-3 (com).
- The dc voltmeter should read 5 volts.
- Momentarily short J101-6 (LISTEN ENABLE) to J101-3 (com.)
- The dc voltmeter should read 0 volts.

Relay HP 603XA LINK/LOGIC CONTROL

- Set S102-2 to the HP 603XA LINK position (logic 1, up).
- Turn off power to the Relay Accessory for 10 seconds.
- The dc voltmeter should read 0 volts.
- Short J101-4 (OPEN/CLOSE) to J101-3 (com).
- The dc voltmeter should read 0 volts.
- Set S102-2 to the LOGIC CONTROL position (logic 0, down).
- The dc voltmeter should read 0 volts.
- Turn off power to the Relay Accessory for 10 seconds.
- The dc voltmeter should read 5 volts.

5-10 DC Power Relay Verification

Connect 5 Vdc, a 100 ohm $\frac{1}{2}$ W resistor, and a dc voltmeter to the DC Power terminal block TB1 as shown in Figure 5-3. Set all S102 switches (1 through 4) to logic 0 (down) and proceed as follows:

Output Normal Relay

- Turn on power to the Relay Accessory.
- The dc voltmeter should read 0 volts.
- Short J101-3 (com) to J101-4 (OPEN/CLOSE).
- The dc voltmeter should read 5 volts.
- Disconnect J101-3 (com) from J101-4 (OPEN/CLOSE).
- The dc voltmeter should read 0 volts.

Output Reverse Polarity Relay (HP Model 59511A only)

- Short J101-4 (OPEN/CLOSE) to J101-3 (com).
- The dc voltmeter should read 5 volts.
- Short J101-5 (NORMAL/REVERSE) TO J101-3 (com).
- The dc voltmeter should read -5 volts.
- Disconnect J101-5 (NORMAL/REVERSE) from J101-3 (com).
- The dc voltmeter should read 5 volts.

5-11 REMOVAL AND REPLACEMENT PROCEDURES

WARNING

HAZARDOUS MATERIAL

Relays K1 (HP 59510A and HP 59511A) and K2 (HP 59511A only) contain mercury. The mercury is sealed in a stainless steel tube. Defective relays must be disposed in accordance with your local hazardous waste regulations.

If you wish, the relays may be returned to Hewlett-Packard. If the seal has been broken, the relays and liquid mercury must be placed in a leakproof plastic bag. Place the bag in a fiberboard box and return to Hewlett-Packard by surface transportation only. If the seal is not broken, the plastic bag is not necessary. Please ship relays to: Hewlett-Packard

150 Green Pond Rd
Rockaway, N.J. 07866
Attn: Product Support Group

The following paragraphs describe how to remove the assemblies and components within the Relay Accessory. Figure 5-5 illustrates the location of the circuit boards and chassis mounted components. Figure 5-6 illustrates the component locations on each circuit board. Replacement procedures are essentially the reverse of the removal procedures. Unplug the line cord and proceed as follows:

5-12 Cover

To remove the cover:

- Remove the two cover screws, one on each side.
- Lift the cover straight up and off of the unit.

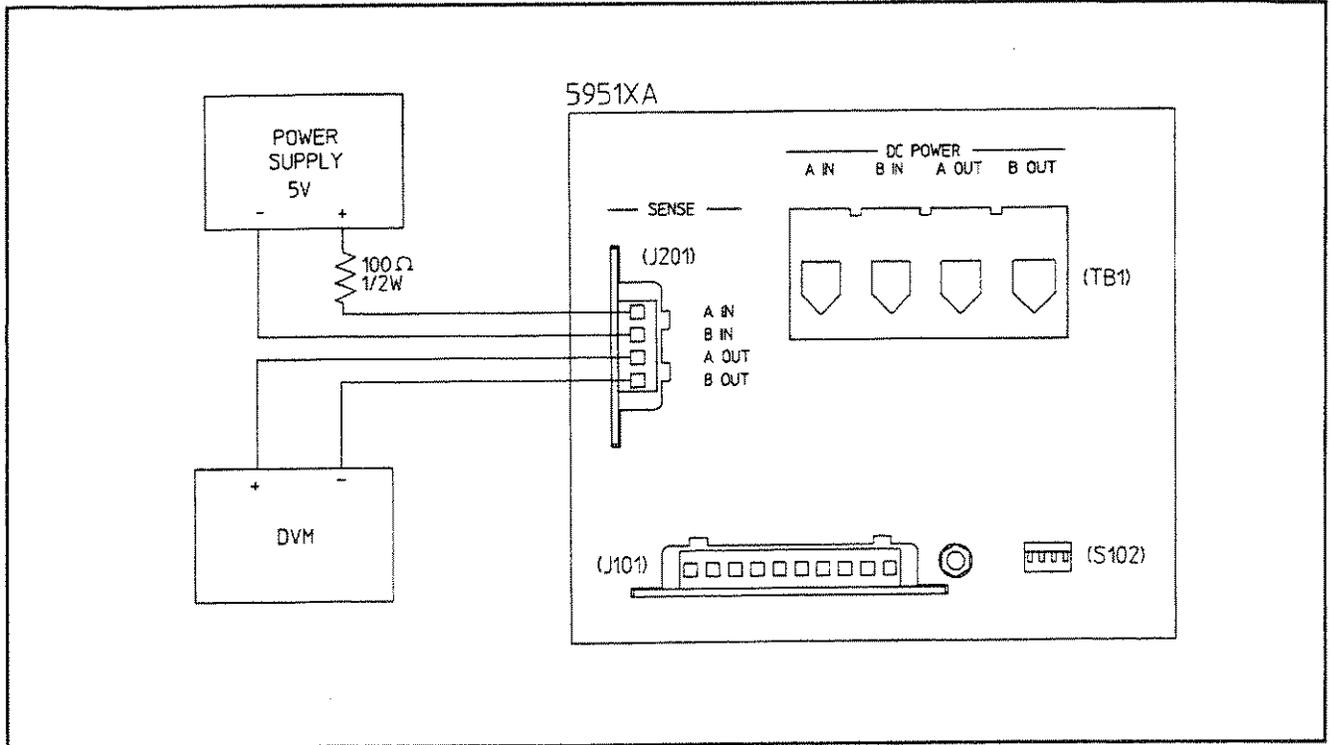


Figure 5-2. Relay Control Verification Test Setup

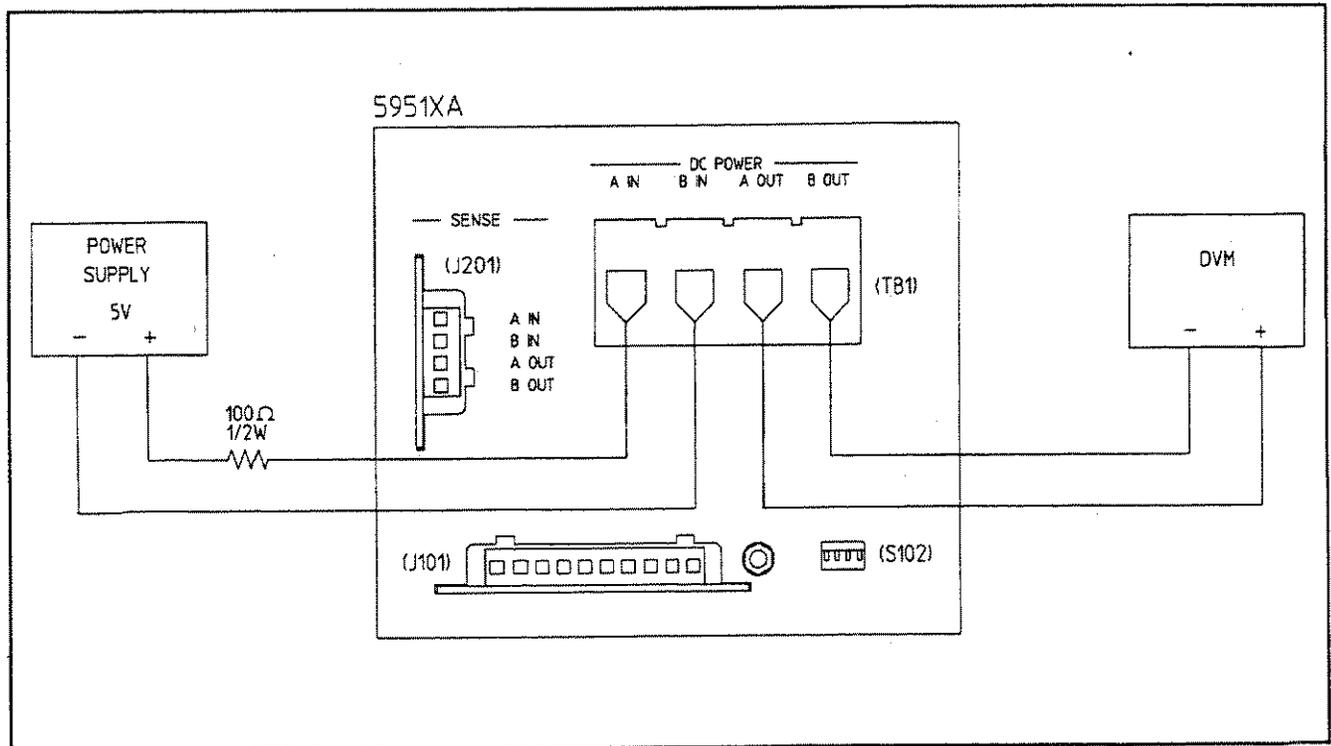


Figure 5-3. DC Power Relay Verification Test Setup

Note

When replacing the cover, put it back on the same way that you removed it in order for the cover screw holes to line up with the chassis screw holes.

5-13 Assembly Removal

To disassemble the unit:

- a. Remove the plastic safety cover and quick disconnect plugs from the front panel connectors.
- b. Disconnect the ribbon cable from J202 on the Sense Relays Board.
- c. Remove two screws securing the DC POWER terminal block (TB1) to the front panel.
- d. Remove two screws securing the 3-sided upper chassis to the front panel. The screws are located on the left and right side top corner.
- e. Remove two screws securing the upper chassis to the lower chassis. The screws are located at the bottom on the rear of the unit.
- f. Push TB1 through the opening in the Front Panel and separate the upper chassis from the front panel and lower chassis which houses the main circuit board. The upper chassis contains the sense relays board, TB1, filter board, and the dc power relay (s).
- g. You can remove individual assemblies (circuit boards) and components (e.g. power relay) from the upper chassis by disconnecting the applicable wires and attaching hardware.

5-14 Main Circuit Board Removal

To remove the main circuit board:

- a. Remove the two screws and nuts that secure the ac input connector/line filter to the front panel.
- b. Remove the two screws that secure the main circuit board to the chassis.
- c. Remove the main circuit board.

5-15 TROUBLESHOOTING PROCEDURES

The troubleshooting procedures provided in the following paragraphs should be performed in the sequence given in order to isolate the defective circuit and/or component. Refer to Figures 5-4 through 5-7 and proceed as described below.

WARNING

SHOCK HAZARD

The troubleshooting procedures given below are performed with power applied and the protective cover removed. Such procedures should be performed only by service-trained personnel who are aware of the hazards (for example, fire and electrical shock).

5-16 Test Setup

To gain access to the circuit boards and components inside the unit:

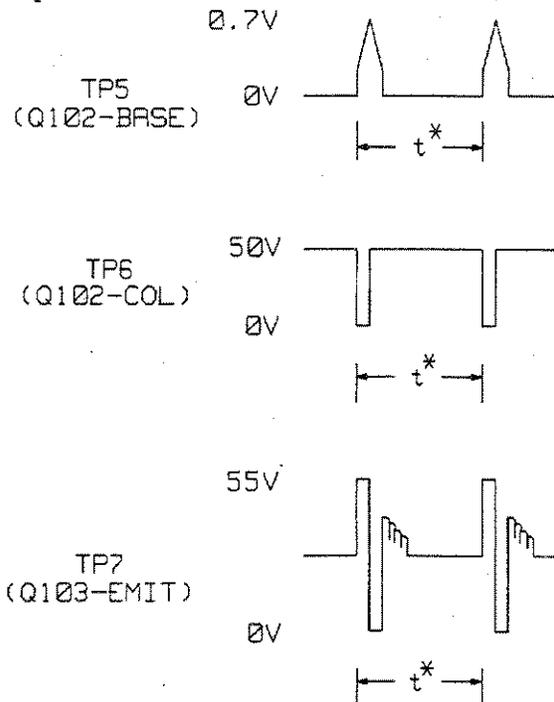
- a. Remove the cover and disassemble the unit as described in paragraphs 5-12 and 5-13.
- b. Place the disassembled unit on a flat surface so that the component side of the main circuit board is accessible. Place the upper chassis so that you can reconnect the ribbon cable.
- c. Reconnect the ribbon cable between J202 on the sense relays board and J102 on the main circuit board.
- d. Reconnect the line cord and turn on power by plugging the line cord into the ac line.

5-17 Bias Supply and Power-On Circuit

- a. Check the ac line fuse F1.
- b. Check the bias voltages at the test points shown on Figure 5-6:

Test Point	Measurement
TP1 (pos) to TP2 (com)	+5Vdc ±0.25 Vdc
TP3 (pos) to TP2 (com)	+11.8 Vdc ±0.5 Vdc
TP4 (pos) to TP2 (com)	+55 Vdc ±10 Vdc

If the bias voltages are incorrect, check the waveforms at test points TP5, TP6, and TP7 (see Figure 5-6) to isolate the faulty components.



- *t = approx. 1.4 ms with sense relays board disconnected
- t = approx. 0.8 ms with sense relays board connected
- t = approx. 0.12 ms with power relay energized

- c. Check the power-on ($\overline{\text{PON}}$) signal. The $\overline{\text{PON}}$ signal is false (high) during normal operation. Check for $\overline{\text{PON}}$ false (high) at U101-6, U109-11, U104-14, and U105-14. If $\overline{\text{PON}}$ is true (low), check U103 and U107, see Figure 5-7.

5-18 Microprocessor U101

- a. Check if the microprocessor passes the power-on self-test by measuring the signal at U101-19:

Measured Signal	Meaning
Low level	Microprocessor U101 passed self test
250 Hz	RAM failure; replace U101
500 Hz	ROM failure; replace U101
1 kHz	Timer failure; replace U101
2 kHz	ID failure; Make sure that the J103 ID connector configuration is correct. For HP Model 59510A, all J103 pins should be open. For HP Model 59511A, pins 5 and 6 should be shorted (see Figure 5-7). If J103 configuration is correct and the signal is 2 kHz, replace U101.

- b. Check the microprocessor clock signals at:

Test Point	Clock Signal
U101-2, 3	4 MHz sine wave
U101-40	1 MHz square wave
U101-10	125 kHz square wave

- c. Turn off power.

5-19 Relay Circuits

NOTE

Check sense protect resistors R205 and R206 and sense protect fuses F201 and F202 before troubleshooting individual sense relay circuits.

The following procedures troubleshoot the relay control circuits and the relays (Figure 5-7). To troubleshoot these circuits, set the CONFIG switches S102-2 to "0" (LOGIC CONTROL) and S102-1 to "0" (LISTEN ENABLE).

5-20 HP Model 59510A. Proceed as follows:

- a. Turn on power and check that relay K201 is energized (contacts closed) and relays K1 and K202 are deenergized (contacts opened). If the relays are not in the state specified, check if the correct levels are present at the applicable driver output pins are as follows:

Relay	Driver Output Pin	Level
K1 (opened)	U104-1 and 3	11.5 V
K202 (opened)	U105-6	11.5 V
K201 (closed)	U104-8	0 V

- b. Connect the OPEN/ $\overline{\text{CLOSE}}$ input (J101-4) to common (J101-3) and check that relays K1 and K202 are energized (contacts closed) and relay K201 is deenergized (contacts opened). If the relays are not in the state specified, check if the correct levels are present at the applicable driver pins are as follows:

Relay	Driver Output Pin	Level
K1 (closed)	U104-1 and 3	0 V
K202 (closed)	U105-6	0 V
K201 (opened)	U104-8	11.5 V

5-21 HP Model 59511A. Proceed as follows:

- a. Turn on power and check that relay K201 is energized (contacts closed) and relays K1, K2, K202, and K203 are deenergized (contacts opened). If the relays are not as specified, check if the correct levels are present at the applicable driver pins are as follows:

Relay	Driver Output Pin	Level
K1 (opened)	U104-1 and 3	11.5 V
K2 (opened)	U105-1 and 3	11.5 V
K202 (opened)	U105-6	11.5 V
K203 (opened)	U104-6	11.5 V
K201 (closed)	U104-8	0 V

- b. Connect the OPEN/ $\overline{\text{CLOSE}}$ input (J101-4) to common (J101-3) and check that relays K1 and K202 are energized (contacts closed) and relays K2, K201, and K203 are deenergized (opened). If the relays are not as specified, check if the correct levels are present at the applicable driver pins as follows:

Relay	Driver Output Pin	Level
K1 (closed)	U104-1 and 3	0 V
K2 (opened)	U105-1 and 3	11.5 V
K202 (closed)	U105-6	0 V
K203 (opened)	U104-6	11.5 V
K201 (opened)	U104-8	11.5 V

- c. With the OPEN/ $\overline{\text{CLOSE}}$ input J101-4 still connected to J101-3, also connect the NORM/ $\overline{\text{REV}}$ input (J101-5) to common (J101-3). Check that relays K2 and K203 are energized (contacts closed) and relays K1, K201, and K202 are deenergized (contacts opened). If the relays are not as specified, check if the correct levels are present at the applicable driver pins as follows:

Relay	Driver Output Pin	Level
K1 (opened)	U104-1 and 3	11.5 V
K2 (closed)	U105-1 and 3	0 V
K202 (opened)	U105-6	11.5 V
K203 (closed)	U104-6	0 V
K201 (opened)	U104-8	11.5 V

5-22 FLT and INH Circuits

To troubleshoot these circuits, leave the LOGIC CONTROL mode in effect (S102-2 set to "0") and proceed as follows:

- Connect a LED (HP/PN 1990-0486 or equivalent), a 3 K resistor (HP/PN 0686-3025 or equivalent), and an external 5 Vdc supply (HP/PN 6214C or equivalent) to the FLT output pins (J101-7 and 8) as shown in Figure 5-4.
- Set the $\overline{\text{INH}}$ input true by connecting the $\overline{\text{INH}}$ input (J101-9) to common (J101-10). In the LOGIC CONTROL mode, when the INH input goes true (low), the FLT output goes true (Low).

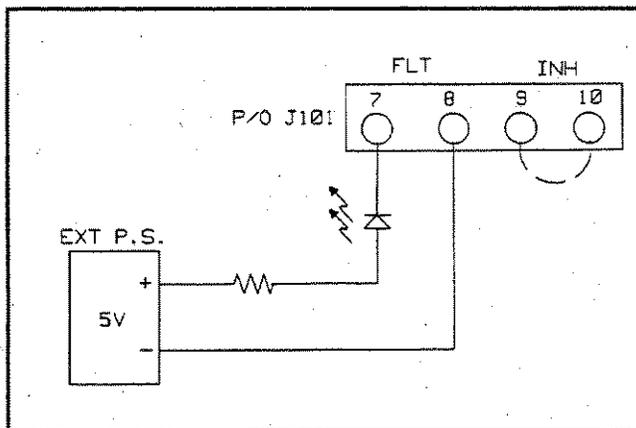


Figure 5-4. FLT/INH Circuit

- Check that the LED is on. If it is on, go to step d. If it is not on, check the level at U105-8. If it is 0 V (approx.), U108 is probably defective. If it is 4 V (approx.), U105 is probably defective.
- Set the $\overline{\text{INH}}$ input false by disconnecting the jumper between J101-9 and J101-10.
- Check that the LED is out. If it is not out, check the level at U105-8. If the level is 4 V (approx.), U108 is probably defective. If it is 0 V (approx.), U105 is probably defective.

5-23 PARTS LIST

Table 5-1 lists all of the electrical and mechanical replaceable parts for the HP 59510A and 59511A Relay Accessories. Figure 5-5 shows the circuit board and relay locations within the unit, Figure 5-6 shows the component locations on each circuit board, and Figure 5-7 is the functional schematics.

You can order parts from your local Hewlett-Packard sales office. Refer to the list of sales offices at the back of the manual for the office nearest you. When ordering parts include the following information:

- The Hewlett-Packard part number.
- A description of the part.
- The quantity needed
- The model HP 59510A or 59511A in which the part is used.

Table 5-1. 59510A/59511A Parts List

Ref. Desig.	HP Part No.	Description
	Main Circuit Board	
C101	0160-4788	Cap, 18 pF 5% 100 V
C102	0160-4833	Cap, 0.022 μ F 10% 100 V
C103	0180-0376	Cap, 0.47 μ F 35 V
C104	0180-2980	Cap, 1000 μ F 35 V
C105, 109	0180-0291	Cap, 1 μ F 10% 35 V
C106	0180-3853	Cap, 1000 μ F 100 V
C107, 108		Not Used
C110-112	0160-4835	Cap, 1 μ F 10% 50 V
C113, 114	0160-4787	Cap, 22pF 5% 100 V
C115, 116	0160-4281	Cap, 2200pF 20%
C117	0180-0405	Cap, 1.8 μ F 10% 20 V
CR101		Not Used
CR102	1901-1087	Diode rectifier
F1	2110-0803	fuse, 0.5 A, 250 V time delay(ac line)
J101	0360-2348	Right angle connector, 10 pins (control)
J102	1251-8542	Connector, header, 7 pins
J103	1251-8736	Connector, header, 6 pins (model ID)
L101	9140-1186	Inductor 680 μ H
Q101	1853-0510	Transistor, PNP
Q102	1854-0575	Transistor, NPN
Q103	1854-0920	Transistor, NPN
Q104	1826-0122	IC Volt Reg UA7805UC
R101	0683-1235	Res, 12 K 5% 1/4 W
R102	0747-0835	Res, 6.81 K 1% 1/2 W
R103	0698-0085	Res, 2.61 K 1%
R104	0698-3382	Res, 5.49 K 1%
R105	0699-0070	Res, 3.16 M 1%
R106, 110, 127, 128	0757-0442	Res, 10 K 1% 1/8 W
R107	0757-0400	Res, 90.9 1% 1/8 W
R108	0757-0280	Res, 1 K 1% 1/8 W
R109	0757-0726	Res, 511 1% 1/8 W
R111	0698-3260	Res, 464 K 1%
R112, 117, 129, 131-134	0757-0401	Res, 100 1% 1/8 W
R113	1810-0316	Resistor network (8 X 10 K)
R114, 115	0757-0472	Res, 200 K 1%
R116, 135	0812-0010	Res, 3 K 5% 3 W
R118	1810-0337	Resistor network (8 X 4.7 K)
R119	0683-1215	Res, 120 5% 1/4 W
R120	0698-3149	Res, 255 K 1%
R121-124	0757-0449	Res, 20 K 1% 1/8 W
R125, 126	0698-6286	Res, 100 M 10%
R130		Not Used
S101	3101-2609	Switch, DPDT
S102	3101-2264	Switch, rocker (4)
T101	9100-4704	Transformer, power
U101	5080-2127	IC, microprocessor unit
U102	1826-0412	IC, comparator
U103	1826-0138	IC, comparator
U104, 105	1820-4185	IC, relay drivers
U106	1906-0006	IC, diodes, FW bridge rect.
U107	1826-1343	IC, voltage reg
U108	1990-0543	IC, optical isolator
U109	1820-3205	IC, clock counter MM74HC193N
VR101	1902-3180	Diode zener 11.8 V 2%
VR102-107	1902-0950	Diode zener 4.7 V 5%
VR108	1902-0556	Diode zener 20 V 5%
Y101	0410-1627	Resonator 4 MHz

Table 5-1. 59510A/59511A Parts List (continued)

Ref. Desig.	HP Part No.	Description
Sense Relays Board		
C201-204	0160-7026	Cap, 2200 pF 200 V
F201,202	2110-0665	Fuse, 1A (remote sense leads)
J201	0360-2312	Connector, 4 pins (sense)
J202	1251-8542	Connector, header, 7 pins
K201, 202, 203*	0490-1656	Relay, sense
K211, 222,233*	0490-1670	Relay, sense (alternate for K201, 202, 203)
R201-204,211-214	0698-6286	Res, 100M 10%
R205, 206		Res, 100 10% 1 W (local sense leads)
R207-210		Not Used
Filter Board		
C301-304	0160-7026	Cap, 2200 pF 200 V
C305-306	0160-4259	Cap, .22 μ F 10%
J301	1252-2618	Connector, header
R301-304,311-314	0698-6286	Res, 100 M 10%
R305,306	0698-8812	Res, 1 1% 1/8 W
R307-310		Not Used
Chassis/Miscellaneous Electrical		
J1		Not Used
J2	9135-0124	Ac line connector/RFI filter
K1,2 *	59510-60001	Relay, power mercury displacement
P1		Not Used
P2	8120-4383	Ac line cord
P101	0360-2345	Terminal block (quick disconnect), 10 terminals, mates with J101
P201	1252-1488	Terminal block (quick disconnect), 4 terminals, mates with J201,
TB1	0360-1663	Barrier block (dc output), 4 terminals
W1	8120-4277	Cable assy, connects between J102 and J202
* Relays K2 and K203 (or K233) are supplied with Model 59511A only.		
Mechanical		
	59510-00001	Main chassis
	59510-00002	Relay chassis
	59510-00003	Instrument cover
	59510-20001	Safety cover (ref J201)
	59511-00001	Bus bar (ref K1 and K2), HP Model 59511A only
	0515-0896	Screw, flat head M4 X 10 mm long Relay K1 to relay chassis (2) Relay K2 to relay chassis (2) * Main board to relay chassis (2) Cover to main and relay chassis (2)
	0515-0911	Screw, mach M3 X 10 mm long Main chassis to ac filter (2)
	0535-0031	Hex nut M3 Main chassis to ac filter (2)
	0515-1114	Screw, pan head, M4 X 10 mm long Main board to main chassis (2) Main board to relay chassis (2) Bus bar wires (2) * Main chas to relay chas rear (2) Safety cover to main chassis (2) Safety ground to main chassis (1)
	0515-1374	Screw, mach M4 X 30 mm long Terminal blk TB1 to filter bd (1) TB1/filter assy to main chassis (2)
	2110-0714	Fuseholder (Ref F1 on main bd.)

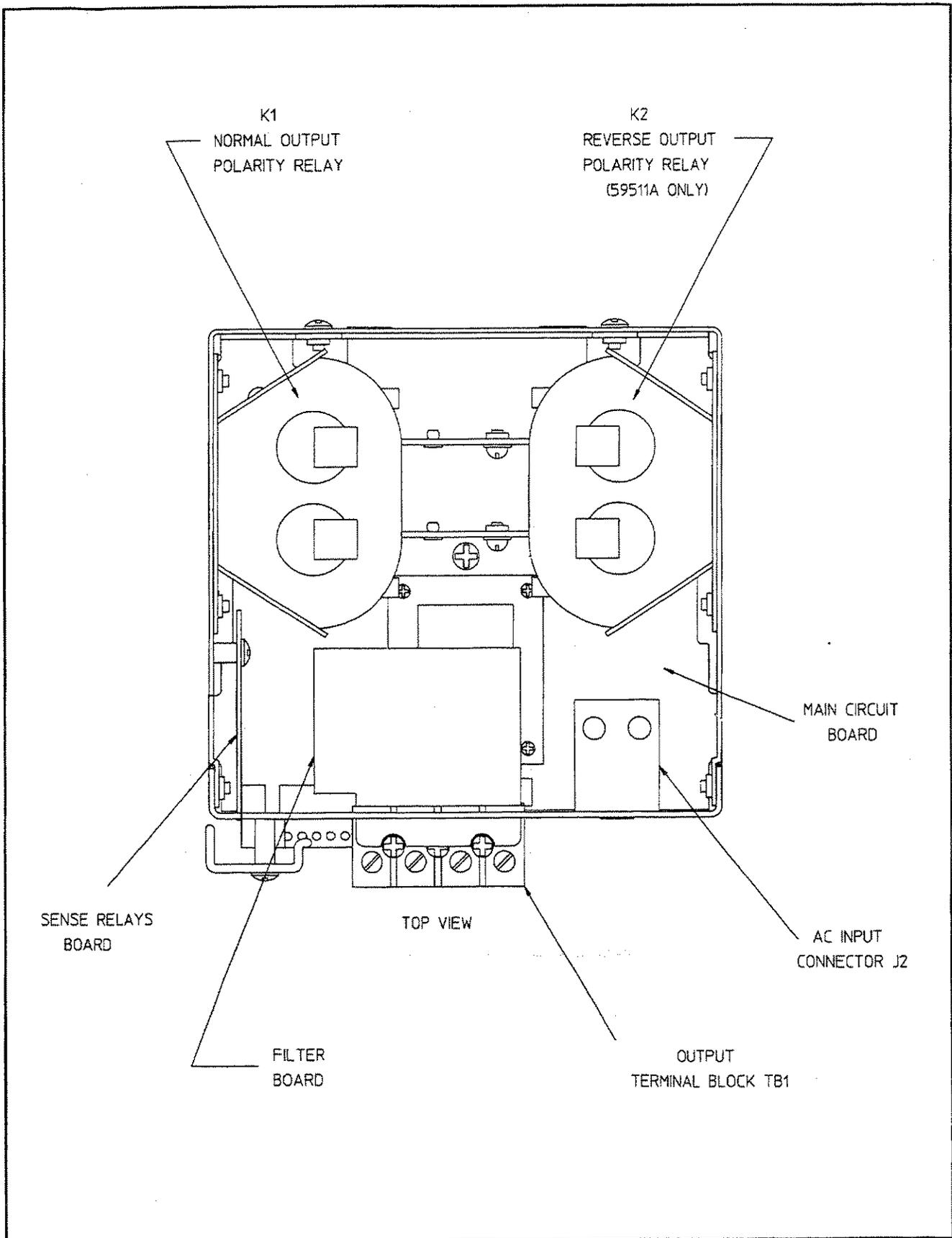
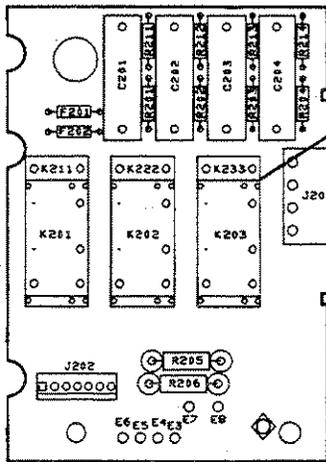
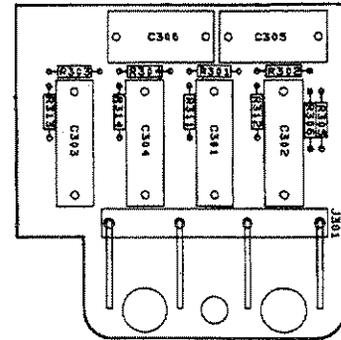


Figure 5-5. 59510A/59511A Assembly Locations

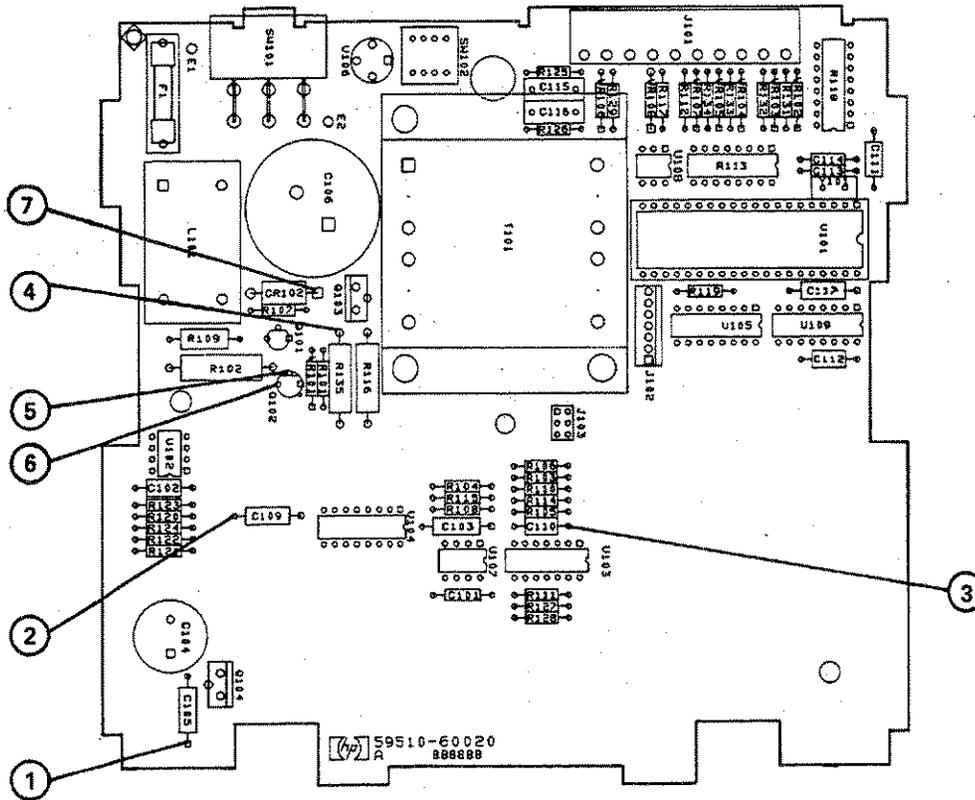


SENSE RELAYS BOARD

K203 (OR K233) IS SUPPLIED
IN HP MODEL 59511A ONLY.
K211, 222, AND 233 ARE
ALTERNATES FOR K201,
202, AND 203, RESPECTIVELY.



FILTER BOARD



MAIN BOARD

Figure 5-6. HP Model 59510A/59511A Relay Accessory, Circuit Board Component Location Diagram