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SERVICE MANUAL

MULTIPLE OUTPUT LINEAR SYSTEM DC POWER SUPPLIES Agilent MODELS 6621A, 6622A, 6623A, 6624A, and 6627A

Agilent Part No 5957-6379

Agilent Model 6621A, Serial 3737A-03086 through 03145
US37370101 and up

Agilent Model 6622A, Serial 3736A-04021 through 04040
US37360101 and up

Agilent Model 6623A, Serial 3736A-05451 through 05530
US37360101 and up

Agilent Model 6624A, Serial 3735A-13801 through 14200
US37350101 and up

Agilent Model 6627A, Serial 3735A-02356 through 02510
US37350101 and up

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



Agilent Technologies

Microfiche Part No. 5957-6380 **Printed in Malaysia: September, 2001**

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CERTIFICATION

Agilent Technologies certifies that this product met its published specifications at time of shipment from the factory. Agilent Technologies 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.

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This Agilent Technologies hardware product is warranted against defects in material and workmanship for a period of three years from date of delivery. Agilent software and firmware products, which are designated by Agilent for use with a hardware product and when properly installed on that hardware product, are warranted not to fail to execute their programming instructions due to defects in material and workmanship for a period of 90 days from date of delivery. During the warranty period Agilent Technologies will, at its option, either repair or replace products which prove to be defective. Agilent does not warrant that the operation for the software, firmware, or hardware shall be uninterrupted or error free.

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

BEFORE APPLYING POWER.
Verify that the product is set to match the available line voltage and the correct fuse is installed.

GROUND THE INSTRUMENT.
This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the ac power supply mains through a three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the ac power lines (supply mains), connect the protective earth terminal to a protective conductor before any other connection is made. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury. If the instrument is to be energized via an external autotransformer for voltage reduction, be certain that the autotransformer common terminal is connected to the neutral (earthed pole) of the ac power lines (supply mains).

FUSES.
Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.
Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS.
Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

DO NOT SERVICE OR ADJUST ALONE.
Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT EXCEED INPUT RATINGS.
This instrument may be equipped with a line filter to reduce electromagnetic interference and must be connected to a properly grounded receptacle to minimize electric shock hazard. Operation at line voltages or frequencies in excess of those stated on the data plate may cause leakage currents in excess of 5.0 mA peak.

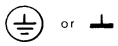
SAFETY SYMBOLS.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents) .



Indicates hazardous voltages.



Indicate earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.
Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

Instruments which appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel

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SAFETY SUMMARY (continued)

GENERAL

Any LEDs used in this product are Class 1 LEDs as per IEC 825-1.

ENVIRONMENTAL CONDITIONS

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

SAFETY SYMBOL DEFINITIONS

Symbol	Description	Symbol	Description
	Direct current		Terminal for Line conductor on permanently installed equipment
	Alternating current		Caution, risk of electric shock
	Both direct and alternating current		Caution, hot surface
	Three-phase alternating current		Caution (refer to accompanying documents)
	Earth (ground) terminal		In position of a bi-stable push control
	Protective earth (ground) terminal		Out position of a bi-stable push control
	Frame or chassis terminal		On (supply)
N	Terminal for Neutral conductor on permanently installed equipment		Off (supply)
	Terminal is at earth potential (Used for measurement and control circuits designed to be operated with one terminal at earth potential.)		Standby (supply) Units with this symbol are not completely disconnected from ac mains when this switch is off. To completely disconnect the unit from ac mains, either disconnect the power cord or have a qualified electrician install an external switch.

Herstellerbescheinigung

Diese Information steht im Zusammenhang mit den Anforderungen der Maschinenläminformationsverordnung vom 18 Januar 1991.

* Schalldruckpegel Lp <70 dB(A) * Am Arbeitsplatz * Normaler Betrieb
* Nach EN 27779 (Typprüfung).

Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991.

* Sound Pressure Lp <70 dB(A) * At Operator Position * Normal Operation
* According to EN 27779 (Type Test).

Edition 2 September, 2001
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Section I
INTRODUCTION

1-1 SCOPE

This manual contains principles of operation, verification, and troubleshooting information for the power supply. Replaceable parts lists and circuit diagrams are also provided. Installation, operation, programming, and calibration procedures as well as detailed specifications are given in a separate Operating Manual, Agilent Part No. 5957-6377.

Wherever applicable, the service instructions given in this manual refer to pertinent information provided in the Operating Manual. The information in each manual covers all five models, 6621A-6624A and 6627A. The main differences between the models are the number and type of outputs each model contains. These differences are specified in each of the manuals.

The following is a listing of the information contained in this manual with a brief description concerning its scope and purpose.

Principles of Operation: Section II provides block diagram level descriptions of the supply's circuits. The GPIB interface (digital circuits), the power control (analog and digital circuits), and power output (analog circuits) are described. These descriptions are intended as an aid in troubleshooting.

Verification: Section III contains test procedures that check the operation of the supply to ensure that it meets the specifications given in Section I of the Operating manual.

Troubleshooting: Section IV contains board level troubleshooting procedures to isolate a malfunction to a defective board (GPIB or output board) or assembly (front panel, power transformer, or cable assembly). Additional troubleshooting procedures are provided to isolate the fault to a defective component on the board. Board and assembly level removal and replacement procedures are also given in this section.

NOTE

Calibration is generally required after a repair is made. Software calibration procedures are given in Appendix A of the Operating Manual. After calibration is completed, perform the applicable test(s) given in Section III of this manual to ensure that the supply meets all specifications.

Replaceable Parts: Section V provides a listing of replaceable parts for all electronic components and mechanical assemblies.

Circuit Diagrams: Section VI contains functional schematics and component location diagrams. The names that appear on the functional schematics also appear on the block diagrams in Section II. Thus, the descriptions in Section II can be correlated with both the block diagrams and the schematics.

Logic Symbology: Appendix A gives a brief description of the logic symbols used on the functional schematics.

Fault Indicator (FLT) and Remote inhibit (INH): A fault indicator and remote inhibit circuit, which provide additional shutdown protection should either the GPIB and/or controller fail, are available optionally. See a separate document entitled, "Appendix E Option 750 Operating Instructions" for the Multiple Output Linear System DC Power Supply Agilent Models 6621A-6624A and 6627A (Agilent P/N 5957-6372).

Computer Interface Intermediate Language (CIIL): Control Interface Intermediate Language (CIIL) programming capabilities (Option 700) are also available as an option. A separate document entitled, Supplies Option 700" (Agilent P/N 5957-6371)" describes the CIIL option.

1-2 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.

1-3 INSTRUMENT AND MANUAL IDENTIFICATION

Agilent Technologies instruments are identified by a two-part serial number, i.e. 2601A-00101. The first part of the serial number (the 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 (25 =1985, 26 =1986, etc), the second two digits indicate the

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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 power supply differs from that shown on the title page of this manual, a yellow Manual Change sheet, supplied with the manual, defines the differences between your supply and the supply described in this manual. The yellow change sheet may also contain information for correcting errors in the manual.

1-4 FIRMWARE REVISIONS

The Read Only Memory (ROM) chip inside of your supply is identified with a label that specifies the revision of the supply's firmware, see paragraph 4-24.

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Section II
PRINCIPLES OF OPERATION

2-1 INTRODUCTION

The following paragraphs provide block diagram level descriptions of the power supply. Differences between the models are given as required. The descriptions provide a basic understanding of circuit operation and are intended as an aid in troubleshooting. It is assumed in the following discussions that you are familiar with the operating and programming instructions presented in the Operating Manual (Agilent Part No. 5957-6377).

2-2 OVERALL BLOCK DIAGRAM DESCRIPTION (FIGURE 2-1)

Figure 2-1 is a block diagram that illustrates the major assemblies contained within the power supply. As shown in the figure, each supply includes ac input circuits, an GPIB board, front panel display and keyboard, and two or more output boards.

2-3 AC Input Circuit

The ac input circuit consists of a line module on the rear panel of the supply, front panel ON/OFF switch S1, power transformer (T1), located in the front of the chassis, and a cooling fan located in the rear of the chassis. The line module contains a voltage selector card that selects the applicable ac input voltage: 100 Vac, 120 Vac, 220 Vac, or 240 Vac. The voltage card selection must match the nominal line voltage that is connected to the unit. The line module also contains the main fuse F1. An 8 A fuse (normal blow) must be installed for a 100/120 VAC input; a 4 A fuse (normal blow) must be installed for a 220/240 Vac input. The ac input is applied to the power transformer when S1 is ON. Depending on the line module setting, the 120 VAC cooling fan either runs directly from the line or from the appropriate transformer tap. The power transformer provides the main ac inputs to the output boards and also provides the ac inputs for the bias voltage supplies located on the GPIB board and each output board. Ac power distribution is shown in detail in figure 6-1 in the rear of this manual.

2-4 GPIB Board

The GPIB board contains the GPIB interface, system microcomputer, output boards interface, and front panel interface. These circuits provide the interface between the user and the multiple outputs of the power supply. Each output board is actually an output channel that can be individually selected and controlled over the GPIB or from the supply's front panel. The GPIB board interprets commands from the GPIB or from the front panel to control the selected output. The GPIB board also processes measurement and status data received from the output boards. This data may be read back to the controller over the GPIB and/or displayed on the supply's front panel. Also, each output board can be individually calibrated over the GPIB using calibration commands (See Appendix A in Operating Manual). Correction factors are calculated during calibration and are stored in non-volatile memory on the GPIB board. The GPIB board is described in greater detail in paragraph 2-7.

2-5 Front Panel

Most of the remote operations that can be performed via the GPIB can also be performed from the supply's front panel. In addition to the ON/OFF switch already mentioned, the front panel contains an LCD display and a keypad. The LCD display consists of an alphanumeric display and status annunciators. The LCD normally displays the measured output voltage and current of the selected output. When programming an output from the front panel keypad, the selected output channel, the function being programmed, and the present value will be displayed. The annunciators indicate which output channel has been selected and give GPIB power supply status information. The keypad allows control of the supply's system functions as well as individual control of each output channel. Detailed instructions on using the front panel's display and keypad are given in the Operating Manual.

2-6 Output Boards

Each power supply model contains two or more (up to four) output boards. The output combinations that correspond to each model are shown in Figure 2-1. Each isolated output can supply power in two ranges as shown in Figure 2-2. This flexibility allows you to use the same output to power loads with different voltage and current requirements. The output ranges and operating characteristics of each output are described in greater detail in Section IV of the Operating Manual.

As shown in Figure 2-1, each output board contains a rectifier/filter, power module, control circuit, secondary interface circuit, and bias supplies. Note that each 80 W output board has two power modules connected in parallel.

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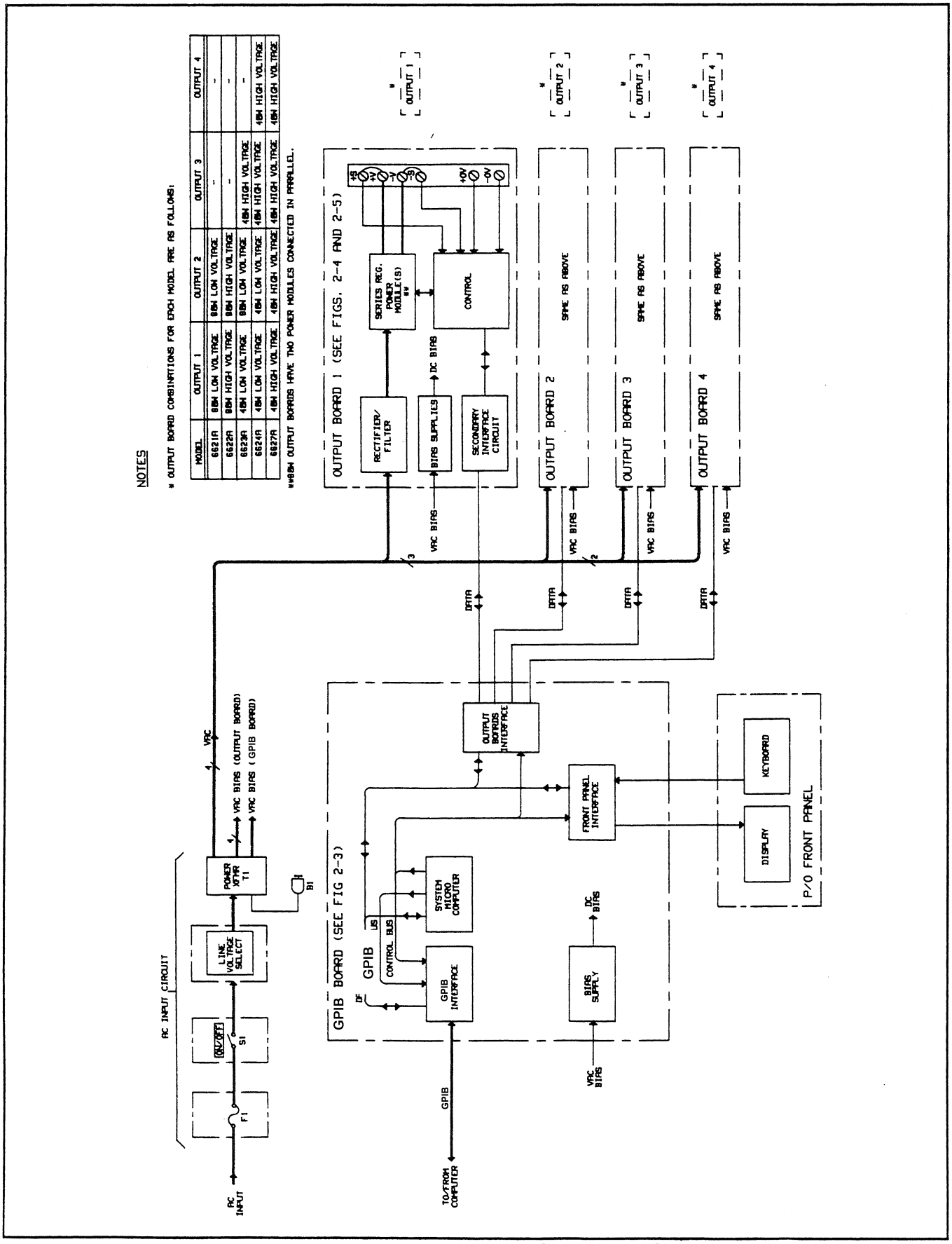
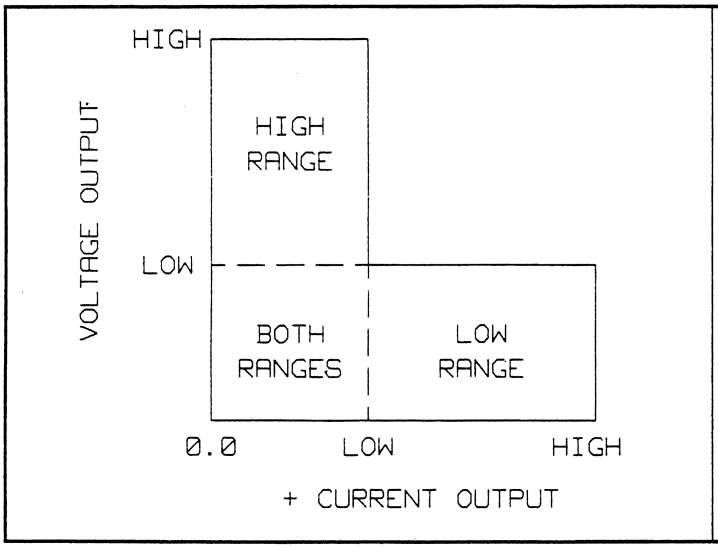


Figure 2-1. Agilent 6621A-6624A and 6627A Multiple Output Power Supplies, Block Diagram

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Output	Low Range Rated Values	High Range Rated Values
80WLV	7 V @ 10 A	20 V @ 4 A
80WHV	20 V @ 4 A	50 V @ 2 A
40WLV	7 V @ 5 A	20 V @ 2 A
40WHV	20 V @ 2 A	50 V @ 0.8 A

Figure 2-2. Output Operating Ranges for the Agilent Models 6621A-6624A and 6627A

The ac input to each output board is rectified, filtered, and applied to the power module regulator. Each output board employs series regulation techniques. The regulator element is connected in series with the load and operates in the linear region (between saturation and cutoff) of the transistor characteristic curve. Regulation is achieved by varying the conduction of the series element in response to changes in the line voltage or the load. The constant voltage CV control circuit compares the voltage at the output with a reference voltage and generates a control signal which varies the conduction of the series regulator to raise or lower the output voltage as required. The constant current CC control circuit compares the voltage at the current monitor resistor with a reference and likewise varies the conduction of the series regulator.

The interface circuit on the output board receives digital signals from the GPIB board and converts them to analog signals (reference voltages) which are sent to the control circuit to program the output voltage and current.

The output boards can be commanded to send measurement and status data back to the GPIB controller and/or to the display on the front panel. The data is sent back via the secondary interface circuit and the appropriate circuits on the GPIB board.

The output board is able to sink current as well as source current. Current sink limits are fixed at values approximately ten percent higher than the maximum current source limit for the particular output voltage operating point. See Figure 2-7 for typical current source and sink characteristics. The output board circuits are described in greater detail in paragraph 2-24.

2-7 GPIB BOARD (FIGURE 2-3)

Figure 2-3 illustrates the major circuits and signal flow on the GPIB board. Complete circuit details are shown on the functional schematic, Figure 6-2, in the rear of this manual.

The functional names on the block diagram correspond with those on the schematic so that the diagrams can be correlated. As shown in Figure 2-3, the major circuits consist of the GPIB interface, the system micro-computer, the output boards interface, and the front panel interface circuit.

2-8 GPIB Interface

These circuits consist of the GPIB bus connector (J201), transceivers (U203) for the 8 data lines and 8 control lines, and the GPIB talker/listener chip (U202). All GPIB (IEEE-488) functions are implemented by the GPIB chip which handles data transfer between the microprocessor and the GPIB, handshake protocol, and talker/listener addressing procedures. The GPIB talker/listener chip is connected to the data bus and appears as memory locations to the microprocessor.

The eight data lines (DI01-DI08) of the GPIB are reserved for for the transfer of data and other messages in a byte serial, bit parallel manner. Data and message transfer is asynchronous, coordinated by the three handshake lines (DAV, NRFD, and NDAC). The power supply can be a talker or a listener on the GPIB. The controller dictates the role of an GPIB device by setting the ATN (attention) line true and sending talk or listen addresses on the data lines (DI01-DI08). The power supply's GPIB address is stored in the EEPROM (electrically erasable programmable memory) chip along with other system variables. You can find out your supply's GPIB address by using the front panel ADDR key as described in the operating manual. As shipped from the factory, the power supply's address is set to 5. Any address from 0 through 30 is a valid address.

There are five GPIB control lines: ATN, IFC, REN, SRQ, and EOI (IEEE-488). When the controller sets the ATN line true, all devices on the bus must "listen" to the addresses and universal commands placed on the bus. When ATN is false, only devices that are addressed will actively send or receive data. All unaddressed devices will ignore the data lines when ATN is false.

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2-9 System Micro-Computer

The system micro-computer decodes and executes all instructions, and controls all data transfers. It consists of a microprocessor, an address decoder, RAM and ROM memories, data buffers/latches, and a real time clock as shown in Figure 2-3.

2-10 Microprocessor and Clock Circuits. These circuits contain a high performance 8-bit microprocessor (U201) and associated clock circuits. The microprocessor operates on a 1 MHz cycle, which it derives from a 4 MHz ceramic resonator oscillator(Y201).The 1 MHz $\overline{Q}$ signal is generated by the microprocessor for use by the other circuits.

A 4 millisecond (approximately) clock signal, applied to the microprocessor interrupt input, enables the microprocessor to keep track of real time. This allows the microprocessor to perform necessary tasks on a regular basis. The real time clock signal is also used to keep track of the time that has elapsed since the output was last changed. This enables the microprocessor to determine if a CV/CC mode change occurred before the selected time delay (see Reprogramming Delay discussion in Section V of the Operating Manual). The microprocessor inhibits the OCP function until the delay is over.

The microprocessor also uses the 4 millisecond clock to determine when to refresh the front panel display and to perform other regularly scheduled jobs.

The R/ $\overline{W}$ (read/write) output from the microprocessor indicates the direction of flow on the data bus, either to or from the microprocessor. A low level R/ $\overline{W}$ signal indicates that the microprocessor is writing data onto the data bus. A high level R/ $\overline{W}$ signal indicates that the microprocessor is reading data that was placed on the bus by the addressed circuit. The microprocessor uses the address decoder circuit and the address bus to specify the data transfer locations. Addresses are valid on the rising edge of the Q signal.

2-11 Data Bus Latches (U217) and Buffers (U216). The timing sequence of the microprocessor is such that the circuits providing data for the microprocessor are de-selected (address disappears) before the microprocessor can read the data. The data bus latches (U217) latch the data to be read by the microprocessor. The data is updated on every falling Q pulse. Data put on the data bus by the microprocessor goes around the latches through buffers (U216).

2-**12 Free-Run and Signature Analysis Jumpers.** The data bus is connected to the microprocessor through a jumper pack (W202). For some signature analysis tests of the microprocessor kernel (microprocessor, RAM, ROM), the data bus is broken by moving W202 from the NORMAL position to the NOP position (see paragraph 4-23). This connects a NOP (no operation) code (free run) to the microprocessor data inputs. The NOP code does not contain an address for the next instruction so the microprocessor goes to the next highest address. Therefore, the address bus looks like a 16-bit counter that continuously rolls over and starts at zero. The contents of each address appear sequentially on the data bus (other side of the break).In addition, for all signature analysis tests, jumper W201 must be moved from the NORM RUN position to the SIG ANALYSIS position (see paragraph 4-23).

2-13 Address Bus and Address Decoder. The microprocessor has 16 address lines (A0-A15) allowing it to address 65,536 locations. The address decoder (U208) allows each addressable circuit to look at a shorter address. The chip select signals ($\overline{CS0}$ - $\overline{CS8}$)are decoded from the higher order address lines (A12-A15). When a data buffer's CS is decoded, it places its data on the data bus lines. When a data latch's CS is decoded, the output of each latch will be set to the logic state that is present on the associated data bus line. If the chip select for the RAM (random access memory), ROM (read only memory), or talker/listener chip is decoded, the selected circuit will decode the lower order address bits supplied to it on the address bus.

2-14 Memory(ROM and RAM). The system microcomputer contains both ROM (U206) and RAM (U207) devices. The 16 K non-volatile ROM contains the operating program and parameters. The 2 K static RAM stores variables voltage to be programmed, output current readback, etc. A third memory chip, shown in the output boards interface block of Figure 2-3,is the EEPROM (electrically erasable programmable memory). The EEPROM (U221) stores all of the system constants including calibration constants, the supply's GPIB address, and model number (see paragraph 2-19).

2-15 Real Time Clock. The real time clock (U209) consists of a 14-stage ripple counter that divides the 1 MHz Q clock signal from the microprocessor to produce a pulse every 4 milliseconds. The real-time clock is used by the microprocessor to schedule regular jobs as described previously. The $\overline{\text{TIMER ENABLE}}$ signal resets the counter to zero.

2-16 Output Boards Interface This circuit provides the interface between the system microcomputer and each of the output boards (up to 4) in the power supply. Data is transferred serially one bit at a time between latches/buffers on the GPIB board and opto-isolators on the output boards. As shown in Figure 2-3, the latches/buffers use data bus lines D0-D3 to send/receive data from the applicable output. Data Line D0 is used for output board 1, D1 for output board 2, D2 for output board 3 (if present), and D3 for output board 4 (if present). A controlled and regulated 5 volt line is also generated on the GPIB board to operate part of the opto-isolators on the output boards. In addition to interfacing with the output boards, the latches/buffers interface with the 1 K bit serial EEPRO in which system constants are stored.

2-17 Data Buffers. These 3-state buffers (U212) place the serial data from each output board and the EEPROM on the supply's system microcomputer data bus lines when chip select $\overline{CS3}$ is decoded. Serial data from output boards 1-4

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appears on data bus lines D0-D3, respectively, and EEPROM serial output data appears on data bus line D7. Logic 0's will always appear on data bus lines D4-D6 when CS3 is decoded because these buffer inputs are connected to COMMON. All buffer outputs are held in the high impedance state when CS3 is not decoded.

2-18 Data Latches. These stages (U213) are edge-triggered D-type flip-flops. On the rising edge of the CS2 chip select, the output of each stage will be set to the logic state that is present on the associated data bus line. Data bus lines D0-D3 are the serial data input lines for output boards 1-4, respectively. Data bus line D4 controls the TIMER ENABLE signal line to the real time clock circuit; D5 is the chip select line for the EEPROM; D6 is the clock signal for the EEPROM; and D7 is the data input line for the EEPROM.

The data that is transferred between the GPIB board and the output boards (up to 4) passes through optical isolators located on each output board.

2-19 EEPROM. This 1 K bit serial EEPROM (electrically erasable programmable memory) stores the power supply's GPIB address and model number as well as the constants used in calibrating the supply. The EEPROM (U221) is non-volatile allowing it to retain the stored information after power is cycled off and on.

Because the RAM operates faster than the EEPROM, at power on, the stored serial data is read into RAM in the system microcomputer via data bus line D7, the associated buffer state, and the data output pin of the EEPROM.

The EEPROM's 1024 bits of read/write memory are divided into 64 registers of 16 bits each. Each register can be serially read from or written to using data bus line D7. Input data is received via a data latch and output data is sent via a data buffer.

Data written to the EEPROM is stored in a location until it is updated by an erase and write cycle. The CHIP SELECT and CLOCK signals are used by the microprocessor to control the EEPROM's programming modes. At power on, the EEPON signal holds the EEPROM's CLOCK signal off to protect against accidental data writes when power is initially applied.

2-20 Front Panel Interface

These circuits provide the interface between the supply's system microcomputer and the front panel (keyboard and LCD display). The microprocessor uses the data latches (U210) and data buffers (U214) to transfer data between the supply's system microcomputer and the front panel.

2-21 Data Latches. On the rising edge of the $\overline{CS5}$ chip select these D-type flip-flops will be set to the logic states that are present on the data bus lines.

Data bus lines D2-D7 are fed directly to the front panel display to indicate power supply conditions. The LCD display may indicate the output voltage and current for a selected output board, the present function being programmed, a programmed message, or an error message. The annunciators provide operating and status information. The microprocessor uses the real time clock to determine when to update/refresh the display.

Data bus lines D0-D2 are fed to the 3 to 8 line keyboard decoder (U211). The microprocessor successively drives each of the eight open collector outputs of the decoder and monitors the four readback lines from the keyboard to determine which key was pressed. The readback lines are held high until a depressed key pulls the line low.

2-22 Data Buffers. These 3-state buffers place the keyboard readback data on data bus lines D4-D7 when chip select CS4 is decoded. As stated above, the microprocessor will use this information to determine which key was pressed. In addition to the keyboard readback data on D4-D7, the front panel data buffers provide the following data on bus lines D0-D3 when CS4 is decoded:

D0 - A logic 1 (Jumper W201 is not installed in the Skip Self Test position)--tells the microprocessor to perform the self test at power on;
or
a logic 0 (Jumper W201 is installed in the Skip Self Test position) - tells the microprocessor **not to perform** self test at power on.

D1 - A logic 1 (jumper W201 is not installed in the Cal Lockout position) - tells the microprocessor to respond to calibration commands;
or
a logic 0 (Jumper W201 is installed in the Cal Lockout position) - tells the microprocessor to ignore calibration commands. This jumper provides security against unauthorized calibration.

D2 - A logic 1 (this buffer input is hardwired).

D3 - A logic 0 (this buffer input is hardwired).

All buffer outputs are held in the high impedance state disconnecting it from the data bus when CS4 is not decoded.

2-23 Bias Supply and Start-Up Circuit

The bias supply (U218) provides + 5 V bias power to operate the circuits on the GPIB board. The start-up circuit (U220,U222) generates the OPTO PON signal (delayed + 5 V) which is used to power the optical-isolators on the output boards. The OPTO PON signal is initially held low for approximately 100 ms to prevent the erroneous transfer of data at power on. The start-up circuit also generates PCLR (power clear) and EEPON (EEPROM power on) signals when power is turned on. The PCLR signal is held low at power on to initialize the talker/listener and microprocessor chips. The EEPON signal is held low at power on to disable the EEPROM clock. Thus, the start up circuit delays turning on the microprocessor and optoisolators until the bias voltages have stabilized. If the line voltage drops after the unit has been turned on, the start-up circuit will again generate the low level signals to disable the interface and remove power from the supply's outputs.

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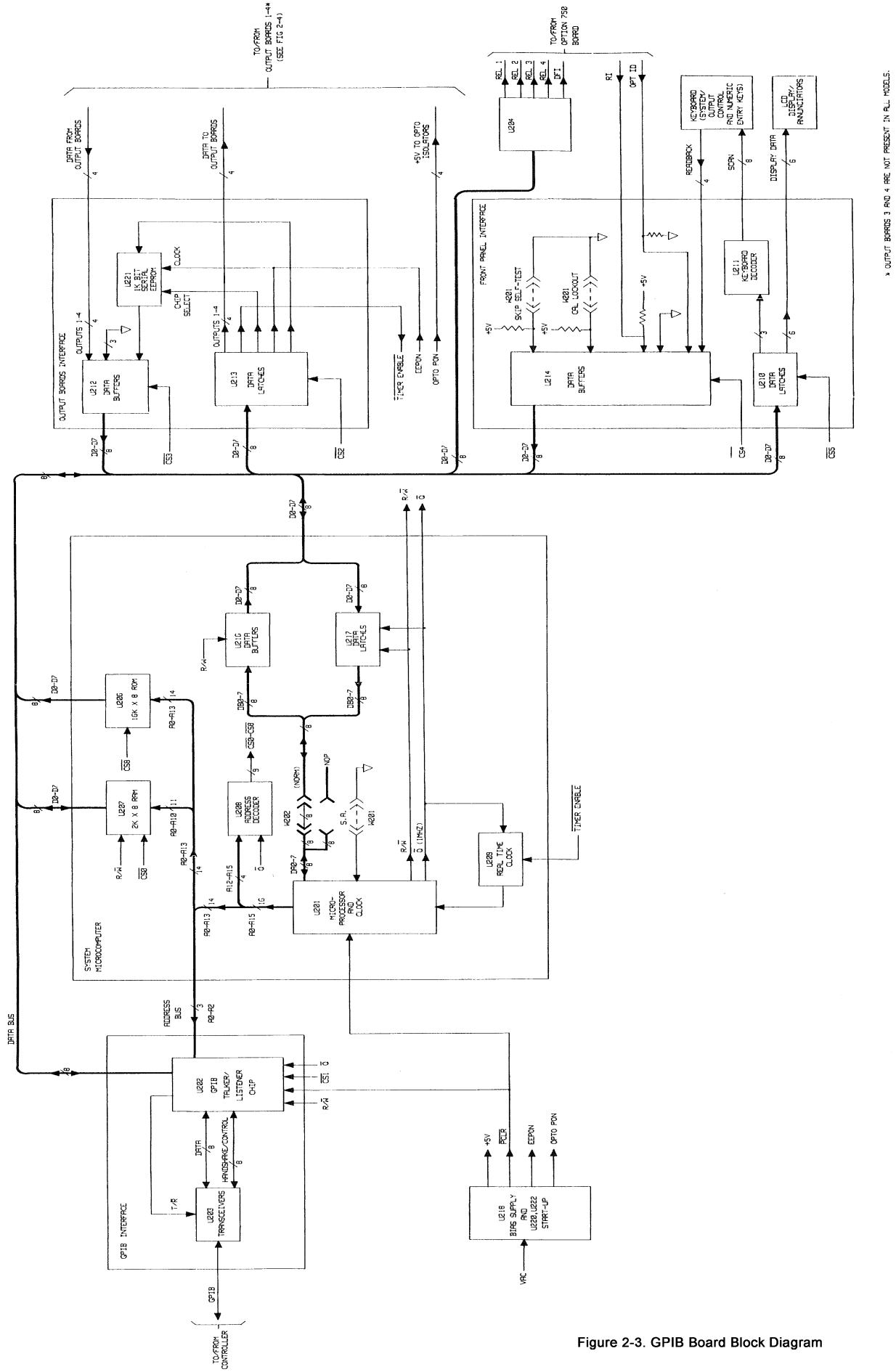


Figure 2-3. GPIB Board Block Diagram

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2-24 OUTPUT BOARD

The following paragraphs provide block diagram level descriptions of the output board. The descriptions cover the four output board types (40WLV, 40WHV, 8OWLV, and 80WHV). Differences between the board types are given as required. Figure 2-1 shows which output board types are used in each model.

The descriptions that follow are divided into two main block diagram discussions: Secondary Interface Circuits and Power Mesh and Control Circuits. The block diagrams illustrate the major circuits and signal flow on an output board. Complete circuit details are shown on the output board functional schematic Figure 6-3 in the rear of the manual. The functional names on the block diagrams correspond with those on the functional schematic.

2-25 Secondary Interface Circuits (Figure 2-4)

These circuits receive digital signals from the GPIB board and convert them to analog signals (voltages) which are sent to the power mesh and control circuits to program the output voltage, output current, and overvoltage.

Measurement and status signals are sent back to the secondary interface circuits from the power mesh and control circuits to be processed before they are sent on to the GPIB board and then to the GPIB controller and/or the front panel. The following paragraphs describe the interface circuits shown in Figure 2-4.

2-26 Microcomputer. This 8-bit microcomputer (U312) contains a CPU, ROM, and RAM. These internal circuits process all data that is transferred between the GPIB board and the power mesh and control circuits on the output board. GPIB board data is transferred serially via optical isolators which connect incoming data to an input port on the microcomputer and outgoing data to an output port on the microcomputer.

On the output board side, the microcomputer uses an 8-bit parallel bidirectional data bus to program DACs which control the output voltage, output current, and overvoltage setting. Various status and operating conditions are read back on the data bus. The microcomputer also generates address and control signals which are used by other interface circuits. The interrupt input to the microcomputer is used in conjunction with analog multiplexer (U323) and DAC (U321) to perform a succesive approximation A/D conversion in order to readback output voltage and current values as well as various test point voltages.

2-27 Address Decoder. This circuit (U320) decodes addresses sent by the microcomputer and generates the appropriate chip select signal ($\overline{CS0}$ - $\overline{CS3}$) to select which circuit sends or receives data. $\overline{CS0}$ selects the status monitor (part of U327) to send status data back to the microcomputer on data bus lines D0-D5. $\overline{CS1}$-$\overline{CS3}$ determine which DAC will receive data. $\overline{CS1}$ selects the CV 12-bit DAC, CS2 selects the + CC/OV dual 8-bit DAC, and $\overline{CS3}$ selects the readback 12-bit DAC.

2-28 CV DAC. The constant voltage (CV) 12-bit DAC (U313) and amplifier (U315A) convert the digital input into an analog signal (CV REF) in the range of 0 to -10 V. This signal is used as a reference voltage and is sent to the voltage control circuits (see paragraph 2-43) to set the output voltage to the programmed value. CV REF is also sent to the analog multiplexer so that it can be measured during power on self test.

The 12-bit DAC internally formulates the 12-bit DAC data from the 8-bit (D0-D7) data bus. Bits D4-D7 are transferred into DAC bit positions 0-3 when the microcomputer sets the DAC $\overline{A}$/B signal low and bits D0-D7 are transferred into DAC bit positions 4-11 when the microcomputer sets the DAC $\overline{A}$/B signal high.

2-29 Current and Overvoltage DACs. These DACs are contained in a dual 8-bit DAC chip (U314). The DAC $\overline{A}$/B signal determines which DAC receives the data on the data bus. Bits D0-D7 are transferred into the current DAC when DAC $\overline{A}$/B is low and into the overvoltage DAC when DAC $\overline{A}$/B is high.

The 8-bit current DAC (part of U314) and amplifier U315B convert the digital input into an analog signal (CL REF) in the range of 0 to -10 V. This signal is used as a reference voltage and is sent to the current control circuit (see paragraph 2-44) to set the output current to the programmed value.

The 8-bit overvoltage DAC (part of U314) and amplifier U315C convert the digital input into an analog signal (OV REF) in the range of 0 to -10 V. This signal is compared with the output voltage and will shut down the output when the output voltage exceeds the programmed OV (see paragraph 2-32).

The CL REF and OV REF signals are also sent to the analog multiplexer so that they can be measured during power on self test.

2-30 Analog Multiplexer. The analog multiplexer (U323)selects one of eight inputs (0 to -10 V) to be applied to the readback signal comparator for the A/D converter. The selected signal is determined by address lines (A0-A2) which are received from the microcomputer. The analog inputs to the multiplexer indicate the following:

COM	- hardwired to common to reduce noise when no signals are being sampled.
FUSE	- output board's return fuse status (read back during power-on self test)
V READBACK	- output voltage
-I READBACK	- output current (sink)
+I READBACK	- output current (source)
CV REF	- voltage DAC output
CL REF	- current DAC output
OV REF	- overvoltage DAC output

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The voltage readback buffer (U319C) provides unity gain for the V READBACK signal and isolates the multiplexes circuit from the CV control circuit (see Figure 2-5). The current readback amplifier (U345) provides a gain of approximately 36 for the I-MON signal (0 to 0.25 V approximately) which comes from the current sense resistor (see Figure 2-5). The amplified signal is an input (+ IMON) to the analog multiplexes and to the current readback inverter (P/O U319D). The inverter slightly attenuates the signal and provides the correct polarity to the analog multiplexes so that the current can be monitored (- IMON) when the output is sinking current (- current).

2-31 Readback DAC and Signal Comparator. The readback DAC(U321), amplifier (U315D), readback signal comparator (U324), and analog multiplexes (U323) along with the microcomputer (U312) form an analog-to-digital converter (ADC) which monitors the output board signals sent to the analog multiplexes.

The readback 12-bit DAC (U321) and amplifier (U315D) convert the digital input signal from the microcomputer to an analog signal in the range of 0 to -10 V. The 12-bit DAC internally formulates the 12-bit DAC data from the 8-bit (D0-D7) data bus (same as the CV DAC described above).

The output of the DAC and the output of the analog multiplexes are applied to the signal comparator. The readback DAC, under the control of the microcomputer, successively approximates the value of the multiplexer's output to a 12-bit resolution. Starting from the most significant bit, each bit is successively compared to the multiplexer's output and is kept or discarded depending on whether its value is less than or greater than the multiplexer's output. Each comparison (successive approximation) is evaluated by the microcomputer via its INT input. The microcomputer maintains a running total of the approximations which, when complete, represents the value of the analog multiplexer's output.

2-32 Signal Processor. This special purpose IC (U327) processes both analog and digital signals to interface the microcomputer with the power mesh and control circuits. The circuits can be functionally divided into status monitor, overvoltage detector and driver, and power-on/start-up circuits.

Status Monitor - This circuit consists of comparators to monitor the control loops, logic to decode these input lines, and flip-flops to catch and hold changes. The inputs to the status comparators are the CV LOOP, +CL LOOP, and –CL LOOP signals from the power control circuits (see Figure 2-5). The outputs of the comparators are combined in logic circuits which then go into the set inputs of flip-flops which hold the status of CVO, + CLO, - CLO ,and UNREG outputs. UNREG is decoded if the output is not regulated by a CV or CL control loop.

The flip-flops are set by any transition into a decoded state. This generates a record of whether any of the conditions (CV, + CL, - CL, UNREG) existed since the last time the flip-flops were reset. The STATUS RESET input line from the microcomputer resets the flip-flops.

The status monitor circuit also receives OV SENSE and THERM inputs. The THERM signal is received from the power module(s) in the power mesh (see Figure 2-5) and indicates when an overtemperature condition exists. Note that when the microcomputer senses the overtemperature (OT) condition via data bus line D4, it shuts down the output. This circuit resets automatically and restores the output approximately 30 seconds after the temperature drops sufficiently for safe operation.

The OV SENSE input signal indicates when the output's overvoltage detector circuit has been tripped and the output has been shut-down (see overvoltage detector description below). The THERM and OV SENSE inputs control the OT and OV outputs of the status monitor. Note that the OT and OV status are not held in flip-flops. All of status monitor's outputs (CVO, + CLO, - CLO , OV, OT, and UNREG) are returned to the microcomputer via data bus lines D0-D5 when chip select CSO is decoded.

Overvoltage Detector - This circuit generates the OV DRIVE signal which shorts the output by firing the SCR crowbar (within the power module) on the output if any of the following conditions are present:

1. The output at the + V terminal exceeds the programmed OV trip point (OV REF). Note that the +I READBACK signal provides an offset to compensate for the voltage drop across the current monitor resistor. The POV DISABLE signal inhibits the programmable OV function from affecting the OV DRIVE signal.
2. The voltage from the +V output terminal to the +S terminal or from the -S terminal to the -V output terminal exceeds 1.5 V (applies to remote sensing only).
3. A trip signal is received on the output's OV terminals.
4. The output's fixed overvoltage circuit is activated.

Power-On/Start-Up - At power-on, the output of the turn-on comparator circuit(BIAS TRIP input signal to U327) is initially low which holds the PCLR and ON/OFF signals low. With PCLR low, the microcomputer is held in the reset state. With ON/ OFF low, the power control circuits are held off preventing any power from reaching the output terminals.

The turn-on comparator circuit (part of U325) monitors the unregulated bias supply to determine if it is high enough to guarantee regulation by the three-pin regulators. The medium rail voltage is also monitored to ensure that it is above the minimum level required for proper operation of the power module. When these two conditions are met, the BIAS TRIP line is allowed to go high (approximately 0.7 V). Then, after a delay of approximately 0.3 seconds (provided by an external delay capacitor, C346), the PCLR signal goes high allowing the microcomputer to complete its itialization routine and set the OUTPUT ENABLE line low.This allows ON/OFF signal to go high (+2V) enabling the control circuit and current sources which allow power to reach the output terminals. Note that whenever the OUTPUT ENABLE signal

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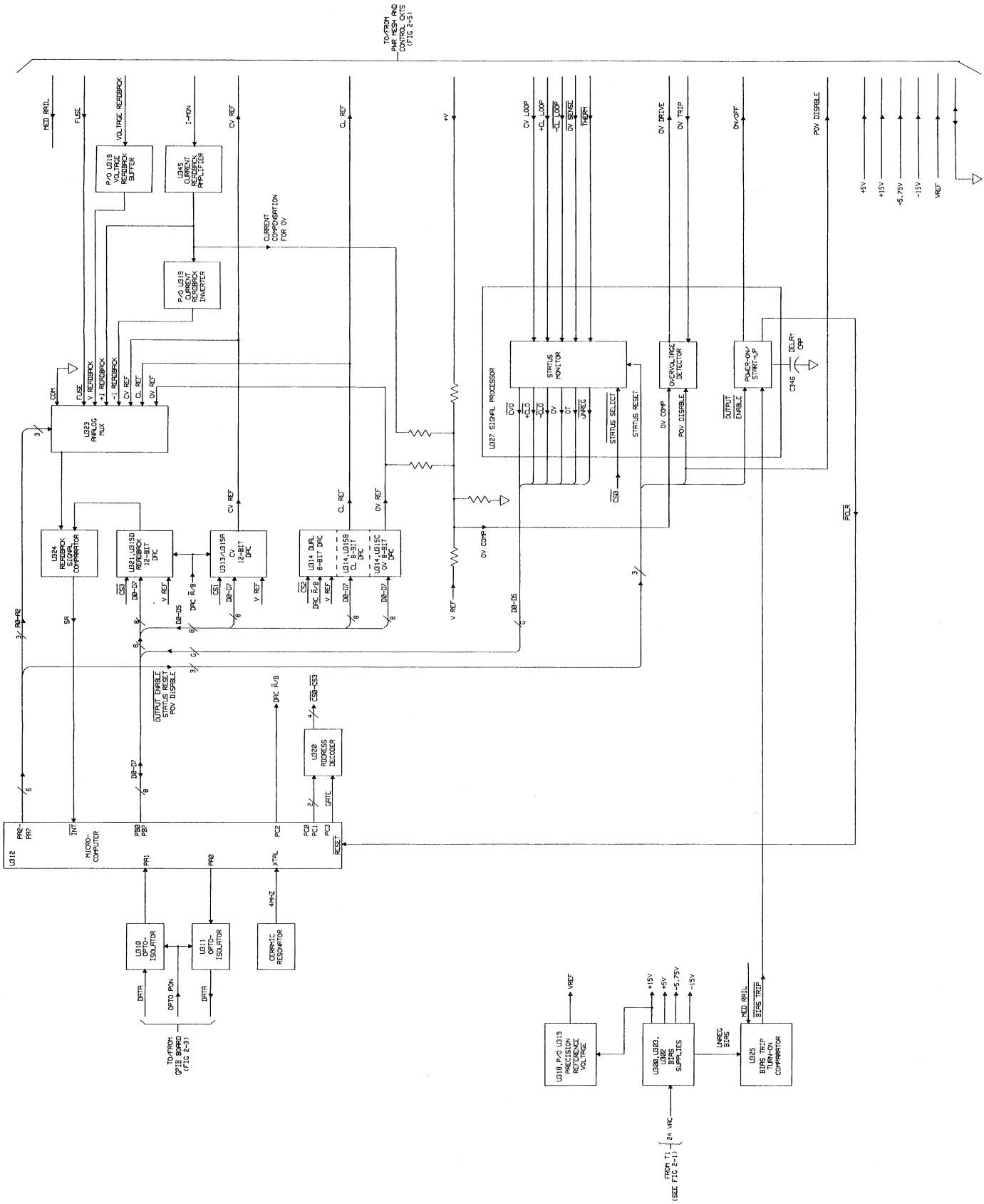


Figure 2-4. Output Board, Secondary Interface Circuits, Block Diagram

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is high, the ON/OFF signal is low and turns off the control circuit thus preventing power from reaching the output terminals.

If the line voltage drops below a minimum level, the comparator described above will shut-down the output (remove power from the output terminals) until normal line voltage is restored. This resets the microcomputer and sets the output to the turn-on state.

2-33 Bias Supplies and Precision Reference Voltage. The bias supplies (U300-U303) generate the voltages required to operate the circuits on the output board. The precision reference voltage circuit (U318, U319A/B) operates from the + 15 V bias and generates the VREF outputs (10 V ± 0.5%) which is used by the DAC's and the control circuit.

2-34 Power Mesh and Control Circuits (Figure 2-5)

The power mesh circuit in the upper half of Figure 2-5 converts the AC from the power transformer to regulated DC output power. The primary power control element is the power module hybrid. Note that the main difference between the 40W and 80W output boards is, the 40W output boards have one power module (U338), while the 80W output boards have two power modules (U338, U339) connected in parallel. The power mesh circuit generates a constant voltage or constant current output under control of the control circuits shown in the lower half of Figure 2-5. In addition to controlling the power mesh circuit, the control circuits send measurement and status data back to the GPIB controller and/or front panel via the interface circuits on the output board and the GPIB board.

2-35 Rectifier and Filter. These circuits consist of two full-wave bridge rectifier circuits with filter capacitors connected across the rectifier outputs. The proper ac voltage levels are applied to the rectifiers via secondary windings of chassis power transformer T1 (see Figure 2-1). The rectifiers provide raw dc to the power module at three different levels (high, medium, and low power rails). The return line for the rectifier circuits is fuse protected. If this fuse opens, the power supply will fail self test, all outputs will be disabled, and the error message "FUSE CH < n > " will be displayed (where n specifies the particular output board, 1-4).

2-36 Power-On Circuit and Current Sources. The power-on circuit (U341A and Q319) is used to turn on the current source transistors and the bleed circuit (see paragraph 2-40) which is connected across the output of the supply. The power-on circuit is activated when it receives the ON/OFF signal (2 V level) from the signal processor (U327).

The current sources (U336 on 40W boards, Q326-329 on 80W boards) are a series of transistors connected to the high rail. When activated by the power-on circuit, the current sources supply a few milliamps to the +BASE DRIVE of the power module and to the power module reference voltage circuit. The +BASE DRIVE, in conjunction with the -DRIVE signal (see base drive circuit description below), controls the conduction of the series pass elements in the power module.

2-37 Power Module Reference Voltage. When the current sources have been turned on, this circuit (P/O U340 and U337) provides a reference voltage (about 2V above +V) to the power module REF input. The REF input is used by an internal control circuit that allows switching between the low, medium, and high rails. The reference circuit includes a transistor (P/O U340) that turns on when the current source apply power, a programmable reference (U337) which provides the reference voltage, and bypass capacitors C366 and 0367.

2-38 Power Module. The power module hybrid U338 (80W output boards have two hybrids, U338 and U339, connected in parallel) receives three unregulated DC voltage levels on its high, medium, and low voltage input rails. The power module contains series regulator stages, an SCR overvoltage circuit, a down programmer, a built-in overtemperature thermistor, and a reverse output voltage protection diode.

Series Regulators - The series regulator stages consist of series pass transistors which regulate the voltage received from the selected power rail. The power module automatically selects the proper input rail depending upon the output voltage required, For example, if the low rail is supplying current and the output voltage exceeds the low rail minus about 2.5 V, the medium rail begins to raise the voltage on the BYPASS input and supply current. Finally, if the output voltage exceeds the medium rail minus about 2.5 V, the high rail will begin to supply current.

As stated previously, the conduction of the series pass transistors is controlled by the +BASE DRIVE and -DRIVE inputs. Normally there is about a diode drop between these two input pins. The current sources drive the series regulator into conduction via the +BASE DRIVE input. The -DRIVE input from the base drive circuit (see paragraph 2-42) controls the amount of +BASE DRIVE current that drives the series regulators in order to maintain a regulated output. Any +BASE DRIVE current from the current source that is not required by the series pass transistor to regulate the output is drawn away by the control circuit through the - DRIVE input via Q335. A level of current through Q335 that exceeds the +BASE DRIVE current can turn on the power module current sink transistors to sink output current up to the negative current limit value.

SCR Overvoltage Circuit - The power module has an internal SCR whose gate input is capacitively coupled to the OV GATE pin. The OV GATE signal can fire the SCR for a number of reasons which are descibed later under the "Overvoltage Protection Circuit" paragraph. In addition to shorting the output, the fired SCR will cause the $\overline{\text{OV SENSE}}$ signal to go low signaling the microcomputer to program the output to zero. The output will remain shorted and programmed to zero until the circuit is reset. The SCR circuit is reset when the POV DISABLE signal (OVRST command) is received by the OV reset circuit (Q320). The condition that caused the overvoltage must be removed in order for the circuit to remain reset. If the condition is not removed, the OV GATE signal will again fire the SCR and disable the output. Note that in addition to resetting the

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SCR, the OVRST command will program the output to the settings that existed before the OV occurred.

Down Programmer - Separate transistors in the power module are used to sink output current and are capable of rapidly downprogramming the output voltage to about 2 V. An external FET down programmer circuit (see paragraph 2-46), is connected across the output to continue down programming the output voltage below 2 V.

Overtemperature Protection - The power module also contains an overtemperature circuit that consists of a negative temperature coefficient thermistor that senses the power module's temperature. When the power module's temperature rises enough to reduce the $\overline{\text{THERM}}$ input resistance to about 8 K ohms, the thermistor drops below 2.5 V(approximately) notifying the signal processor that an overtemperature (OT) condition has occurred. The signal processor then relays this information to the microprocessor which will shutdown the particular output with the overtemperature condition. The output will be restored 30 seconds after a safe operating temperature is reached.

Reverse Output Voltage Protection Diode - The power module contains a diode with its cathode connected to the COLLECTOR output and its anode connected to the power module COMMON. This diode is essentially connected across the power supply's output terminals to protect the output from having reverse voltages applied.

2-39 Peak Current Limit. This circuit Q321, P/O U340, and P/O U341 (plus P/O U341 and Q325 on 80W output boards) quickly limits the amount of current through the series regulator elements in the power module. It is activated when the output current exceeds the full scale value + about 75% in either the sourcing or the sinking direction.

The series pass regulator in power module U338 is connected in series with an external resistor (R407). For 80W output boards, the series regulator in the additional power module U339 is connected in series with external resistor R416. (see Functional Schematic, Figure 6-3 for details). The peak current limit circuit for 80W boards includes addtional transistors P/O U341 and Q325 to monitor the current through R416. When the voltage across R407 (or R416 for 80 W boards) exceeds a diode drop in either direction, the peak current limit circuit is activated and limits the conduction of the series pass transistor element or current sink transistor. This circuit reacts much faster than the + or- current control circuits (see paragraph 2-44).

When the peak current limit circuit is activated in the current source direction, not only will the conduction of the series regulator be limited, but the current control circuit (U346) will be quickly activated through P/O U340 and R405 to take control of the current limiting action.

2-40 Bleed Circuit. This circuit (Q341, R456, etc.), connected from + V to - 5.75 V, provides a fixed current of about 15 mA (30mA in 80W boards) through the series pass elements in the power module so that they are never completely turned off. The bleed circuit is activated via the power-on circuit when the ON/OFF signal is high. The bleed circuit maintains stability with large output capacitors under light loading conditions and helps to keep the output impedance constant.

2-41 Sense Protect Circuit. This circuit (P/O U340 and P/O U341) monitors the voltage from +V to +S and from -S to –V. If either of these voltages exceeds 1.5 V, the sense protect circuit will generate the SENSE PROTECT signal which will fire the overvoltage protection circuits and shut down the output (see paragraph 2-47). This circuit prevents the output voltage from being regulated at a value higher than the maximum value for which it was designed.

Notice also that the series combination of R509 and R487 comprise the "positive sense protect resistor" and the series combination of R512 and R483 comprises the "negative sense protect resistor". In the case of open sense leads, these resistors allow the power supply to effectively switch to the local sensing mode.

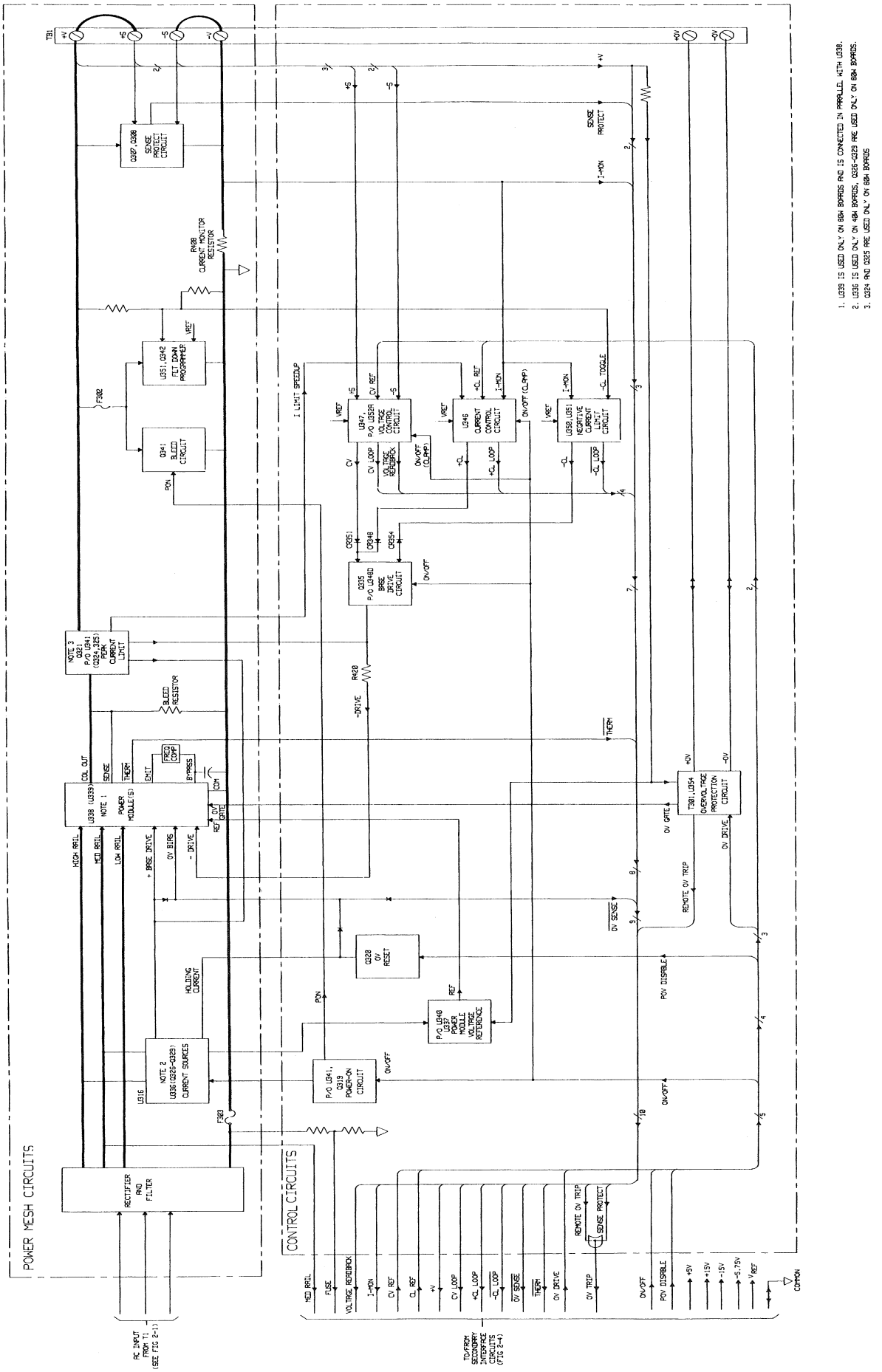
2-42 Base Drive Circuit. When activated (ON/$\overline{\text{OFF}}$ is at approximately 2 volts), this circuit (Q335 and U348) provides the - DRIVE input to the series regulator and current sink transistors in the power module. The - DRIVE input determines how much drive current (+BASE DRIVE) the power module will receive. The - DRIVE input is controlled by either the voltage control (CV), current control (+ CL), or negative current limit circuits (- CL).

The CV or + CL signal controls the base drive circuit via OR gate diodes CR351 or CR348 to generate the - DRIVE signal in order to control the conduction of the series regulators in the power module and provide a regulated output. If the output is less than the programmed value, the -DRIVE signal will allow more + BASE DRIVE current causing the series regulators to conduct more and raise the output. If the output exceeds the programmed value, the - DRIVE signal will divert current through Q335 and U348 of the base drive circuit and away from the + BASE DRIVE power module input causing the series regulators to conduct less thereby reducing the output. The voltage control (CV) circuit and the current control (+ CL) circuit is described in paragraphs 2-43 and 2-44, respectively.

When the output is operating in negative current limit, the - CL signal controls the base drive circuit via diode CR354 so that the - DRIVE signal controls the conduction of the current sink transistors in the power module. The negative current limit circuit which generates the - CL signal is described in paragraph 2-45.

24-3 Voltage Control Circuit. When the output is operating in the constant voltage mode, this circuit generates the CV control and CV LOOP signals. The CV control signal is applied through OR gate diode CR351 to control the base drive circuit in order to regulate the output voltage. The CV LOOP signal is sent back to the secondary interface circuit to indicate that the output is in the constant voltage mode of operation. The ON/OFF signal, received from the secondary

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1. U339 IS USED ONLY ON 80H BOARDS AND IS CONNECTED IN PARALLEL WITH U338.
2. U336 IS USED ONLY ON 40H BOARDS, Q226-Q229 ARE USED ONLY ON 80H BOARDS.
3. Q224 AND Q225 ARE USED ONLY ON 80H BOARDS

Figure 2-5. Output Board, Power Mesh and Control Circuits, Block Diagram

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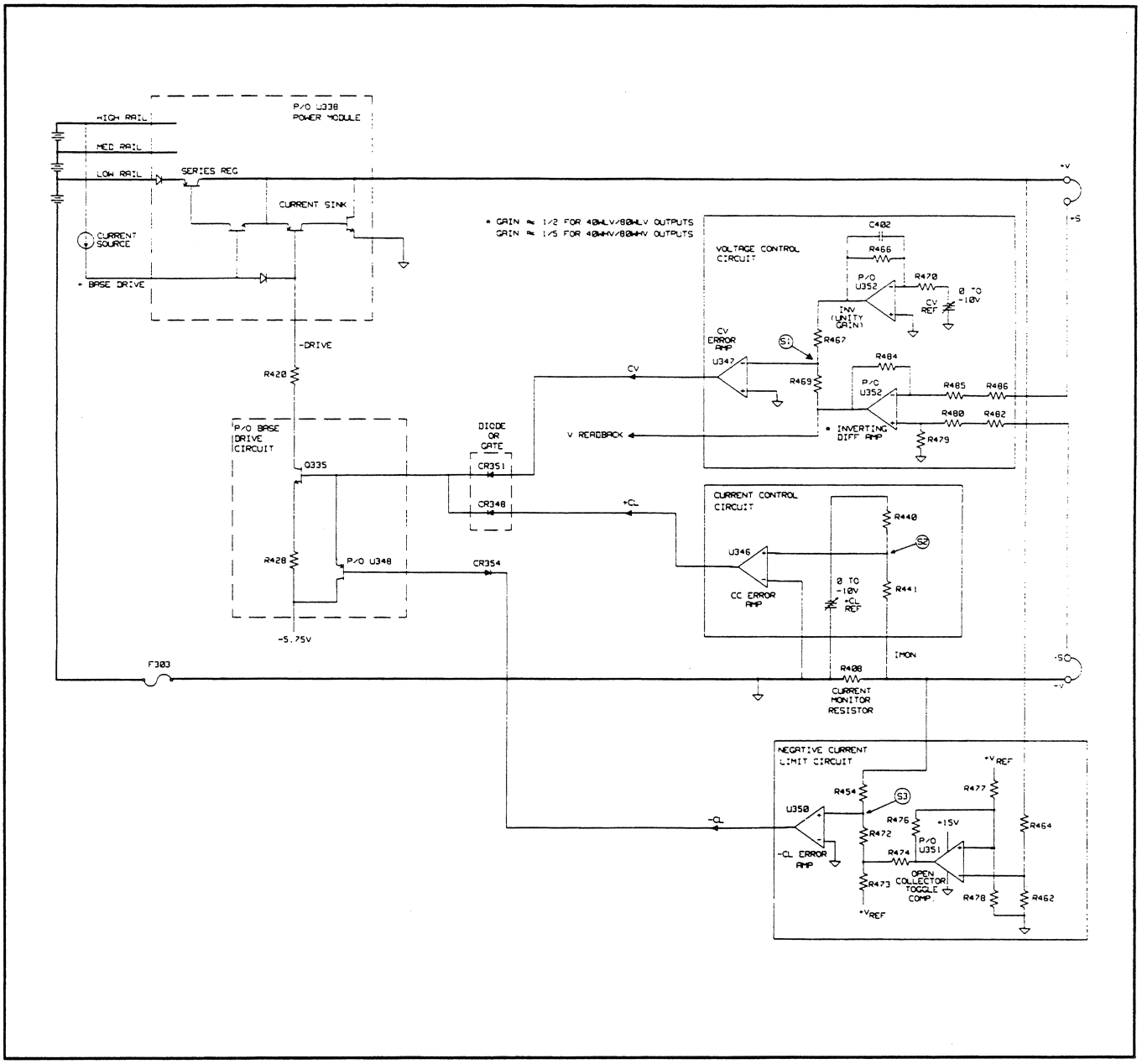


Figure 2-6. Voltage and Current Control Circuits, Simplified Schematic Diagram

interface circuit, must be on (approximately + 2 V) in order to activate the voltage control circuit.

The voltage control circuit compares the output voltage to the programmable reference voltage CV REF to produce the CV signal. As shown in the simplified schematic of Figure 2-6, the major components in the voltage control circuit are: unity gain inverter buffer U352B, output sense inverting differential amplifier U352A, and CV error amplifier U347. The reference voltage (CV REF, 0 to -10 V) is applied to U353 which produces a 0 to + 10 V signal feeding into the summing junction S1. The output voltage is monitored by U352A which produces a 0 to -10 V signal that represents the output voltage magnitude which is also fed into S1. The 0 to -10 V signal is also sent back (V READBACK) to the secondary interface to indicate the magnitude of the output voltage.

If the output voltage exceeds the programmed voltage, the summing junction S1 goes negative causing U347 to produce a positive going CV control signal. For this condition, the base drive circuits will conduct more and pull current away from the power modules + BASE DRIVE input via the - DRIVE input line. This will cause the power module's series regulators to conduct less and thus reduce the output voltage.

If the output voltage is less than the programmed voltage, S1 goes positive causing U347 to produce a negative going CV control signal. For this condition, the base drive circuit

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will conduct less allowing more current to flow into the + BASE DRIVE input. This will cause the power module's series regulators to conduct more and thus increase the output voltage.

2-44 Current Control Circuit. When the output is operating in the constant current mode, this circuit generates the + CL control and the + CL LOOP signals. The + CL control signal is applied through OR gate diode CR348 to control the base drive circuit in order to regulate the output current. The + CL LOOP signal is sent back to the secondary interface circuits to indicate that the output is in the constant current mode of operation. The ON/OFF signal, received from the secondary interface circuit, must be on (about + 2 V) in order to activate the current control circuit.

The current control circuit compares the output current to a programmable reference voltage (+ CL REF) that represents the programmed current value. This comparison produces the + CL control signal. In order to make this comparison, the circuit monitors the voltage (I-MON) across current monitoring resistor R408. This voltage drop represents the amount of output current. The I-MON and + CL REF signals are connected through scaling resistors to summing point S2 for application to U346 (CC Error Amplifier) as shown in Figure 2-6. Based on this summing action, U346 generates the + CL control signal which is applied to the base drive circuit via OR gate diode CR348 to control conduction of the series regulators in the power module in the same way as described above for the voltage control circuit. The I-MON signal is also amplified and sent back to the secondary interface to indicate the magnitude of the output current.

The current control circuit receives an input from the peak current limit circuit (in the current sourcing mode only) as shown in Figure 2-5. When the peak current limit circuit (see paragraph 2-39) is activated, it immediately limits the conduction of the series regulators in the power module and also notifies the current control circuit to take control of the current limiting action.

2-45 Negative Current Limit Circuit. This circuit provides a limit to the amount of current that the supply can sink. The circuit may be activated if a current source such as another power supply (or energy storage capacitor) is connected across the output terminals and its voltage is greater than the programmed output voltage.

When the output is in negative current limit, this circuit generates the - CL control and the - $\overline{\text{CL LOOP}}$ signals. The - CL control signal is applied through diode CR354 to the base drive circuit. The - $\overline{\text{CL LOOP}}$ signal is sent back to the secondary interface to indicate that the output is in the negative current limit mode.

As shown in the simplified schematic of Figure 2-6, the negative current limit circuit consist mainly of open collector toggle comparator (part of U351) and - CL error amplifier (U350).

The voltage drop (I-MON) across the current monitoring resistor R408 is applied to summing junction S3 along with a reference voltage. Based on this summing action, error amplifier U350 generates the - CL control signal which is applied through diode CR354 to control the base drive circuit.

Comparator U351 toggles the reference voltage between two different levels. This is required because the output board has two fixed ranges: a high voltage/low current range and a low voltage/high current range. Figure 2-7 illustrates the output range characteristics for the various output board types. As you can see in the figure, a 40W low voltage board can sink up to 2.2 A when its output voltage is above 10 V and up to 5.5 A when the output is between approximately 2 V and 10 V.

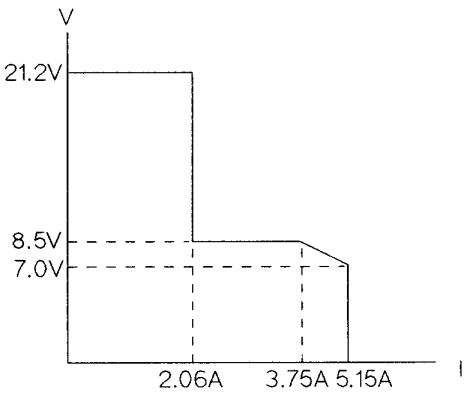
U351 constantly monitors the output voltage in order to provide the proper reference voltage to the summing junction of U350. If the output voltage is in the high range, the open collector output of U351 will be near ground; thereby dividing down the VREF voltage to summing junction S3 resulting in a lower sink current limit (- 2.2 A for a 40 W low voltage board). If the output voltage is in the low range, the collector output of U351 will be open, resulting in a higher sink current limit (about - 5.5 A for a 40 W low voltage board). R476 provides a small amount of positive feedback (hysteresis) to prevent "jitter" at the switch point.

2-46 FET Downprogrammer. When the output is sinking current and the output voltage drops below 2.0 V (approximately), the down programming characteristics (current sinking characteristic) are as shown in Figure 2-8 for each type of output board. The FET Downprogrammer circuit (Part of U351), connected across the output, senses when the output falls below 2.5 V (approximately) and connects a resistor across the output to aid downprogramming. Notice that in Figure 2-8 on the 40W low voltage graph, the 0.2 ohm slope relates to the saturated impedance of the current sink transistors, the 7.5 ohm slope is due to the resistor R457 in series with FET Q342, and the - 0.015 amps at VOUT equals zero volts represents the bleed current in Q341.

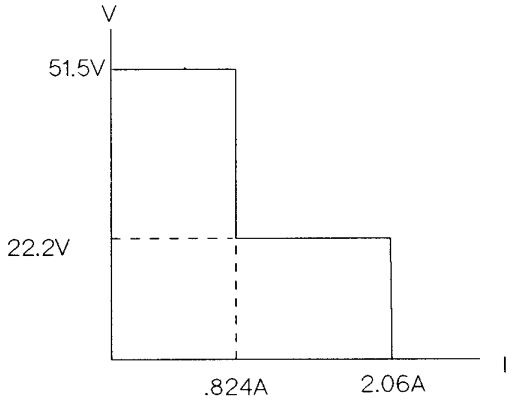
2-47 Overvoltage Protection Circuits. These circuits generate the OV GATE signal which fires the SCR in the power module and shuts down the output. Figure 2-9 is a simplified schematic of the overvoltage protection circuits which are comprised mainly of a fixed overvoltage sensing circuit (U354), signal processor U327, diodes CR356-CR360, and pulse transformer (T301) that couples the remote trip signals that are sent/received via the + OV and - OV terminals.

As shown in Figure 2-9, the main input to the overvoltage protection circuits is the OV DRIVE signal which is received from the overvoltage detector (P/O U327, see paragraph 2-32). The OV DRIVE signal goes high to activate the OV GATE signal which is sent via diode CR357 to fire the SCR in the power module. The conditions which activate OV DRIVE are described in the following paragraphs.

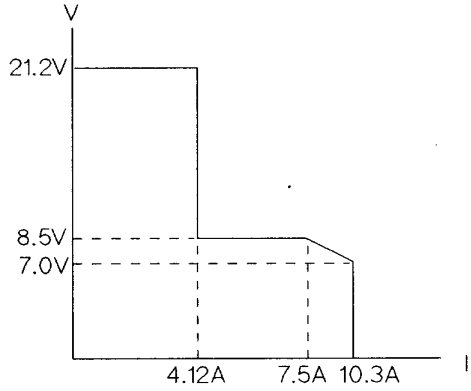
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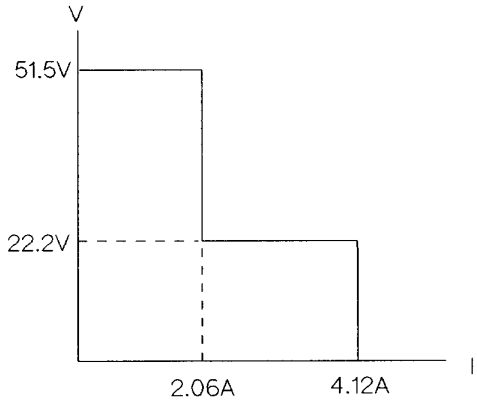
40W LOW VOLTAGE OUTPUT



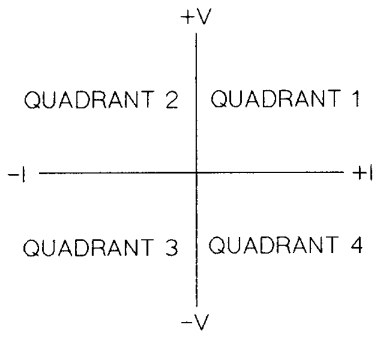
40W HIGH VOLTAGE OUTPUT



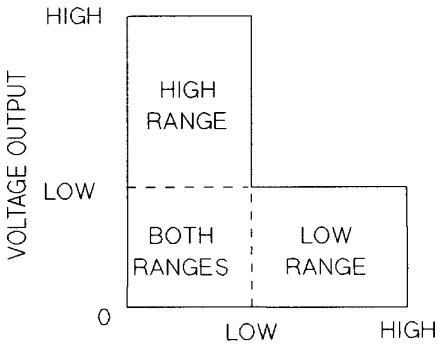
80W LOW VOLTAGE OUTPUT



80W HIGH VOLTAGE OUTPUT



QUADRANT 1 = CV OR +CC OPERATION
QUADRANT 2 = CURRENT SINK OPERATION (CV OR -CC)
QUADRANT 4 = REVERSE DIODE CHARACTERISTIC



+CURRENT OUTPUT
QUADRANT 1 RANGES

Figure 2-7. Typical Output Range Characteristics

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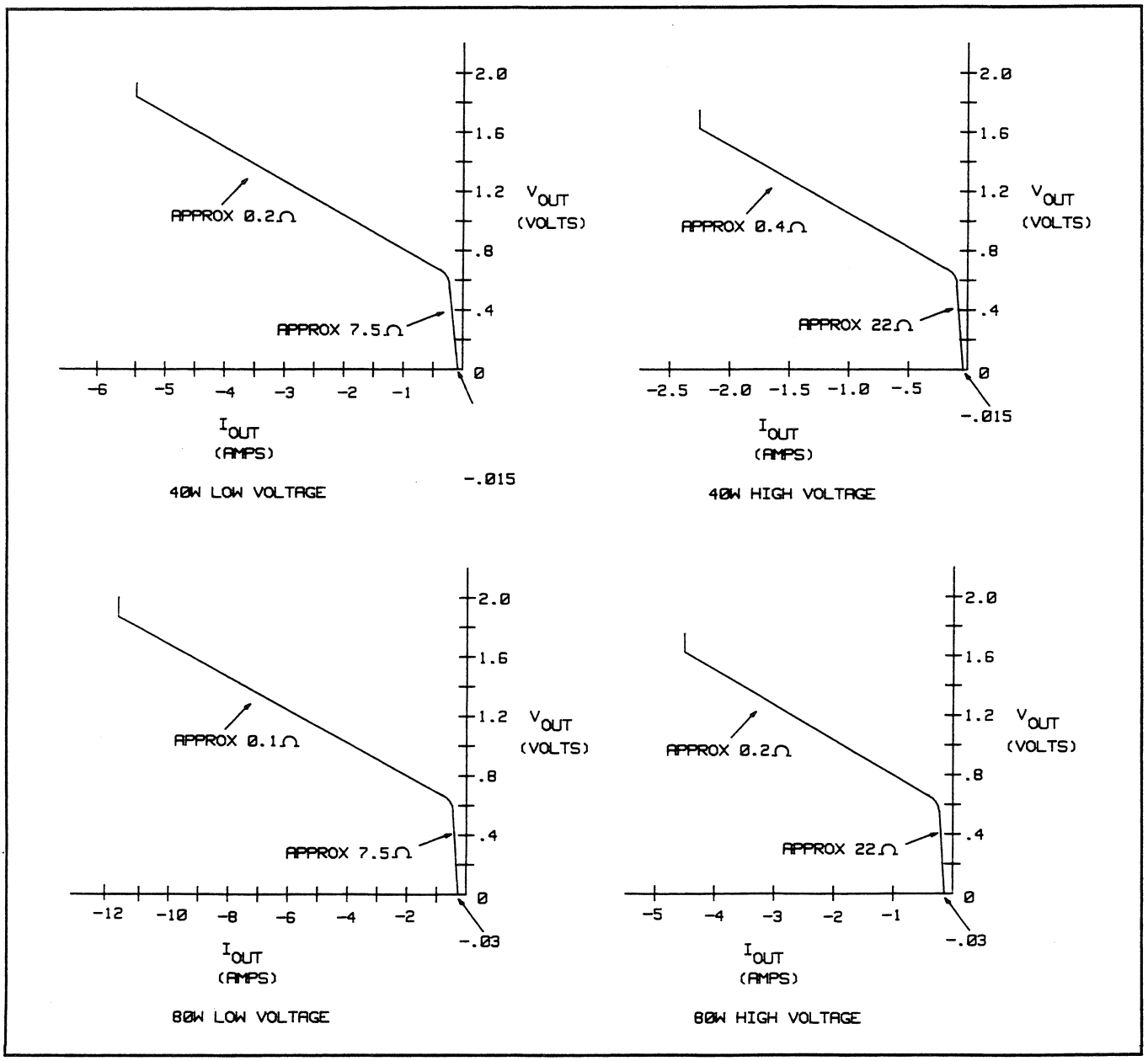


Figure 2-8. Typical Downprogramming Characteristic Below 2.0 V

If the output voltage from + V to - V exceeds the programmed overvoltage setting (derived from OV REF), the overvoltage comparator signal (OV COMP) will activate OV DRIVE and fire the SCR provided that the POV DISABLE signal is low. The CURRENT COMP signal is included in the comparison to compensate for the voltage drop across the current monitoring resistor and permit an accurate comparison. The POV DISABLE signal is high only during power on and for a brief time during an overvoltage reset.

Note that the OV DRIVE signal is also sent to the ± OV terminals via diode CR356 and transformer T301 to either notify a remote circuit that the overvoltage circuit was tripped or alternatively to fire other output boards (up to eight) by paralleling the external OV lines. The OV TRIP signal can activate the OV DRIVE and shut down the supply regardless of the state of the POV DISABLE signal. As shown in Figure 2-9, OV TRIP is the output of a wired OR signal can gate and can be activated by either the SENSE PROTECT signal (as described in paragraph 2 - 41) or by the REMOTE OV TRIP signal. The REMOTE OV TRIP signal can be generated by the fixed OV sensing circuit or by a remote signal connected to the output's + OV and - OV terminals.

Fixed Overvoltage Sensing Circuit - The fixed overvoltage sensing circuit (U354) continually monitors the voltage across the output terminals. Because it is biased by the voltage at the output terminals, it can be activated and provide protection even when the supply is not connected to the ac power line.

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The fixed overvoltage sensing circuit will activate when it senses a voltage that is approximately 120% of the maximum rated output voltage for the associated output. If the output voltage exceeds this threshold, the OV GATE signal is generated via diode CR358 and fires the SCR. Note that the fixed overvoltage sensing circuit will also activate the OV DRIVE signal via diode CR359 (REMOTE OV TRIP). The OV DRIVE signal then transmits the overvoltage condition to the ± OV terminals via diode CR356, and transformer T301 as previously described.

Remote Overvoltage Trip - Any output's OV can be triggered from its ± OV terminals by connection to a remote device (see Operating Manual) or another output's ± OV terminals. By connecting the OV terminals of up to 8 outputs together, an overvoltage shut down on any of the outputs will also trigger the OV and shutdown the remaining outputs.

As shown in Figure 2-9, the trip signal enters at the ± OV terminals and is coupled through pulse transformer T301, diode CR360, and the overvoltage detector circuit to generate OV GATE through CR357 and shut down the supply.

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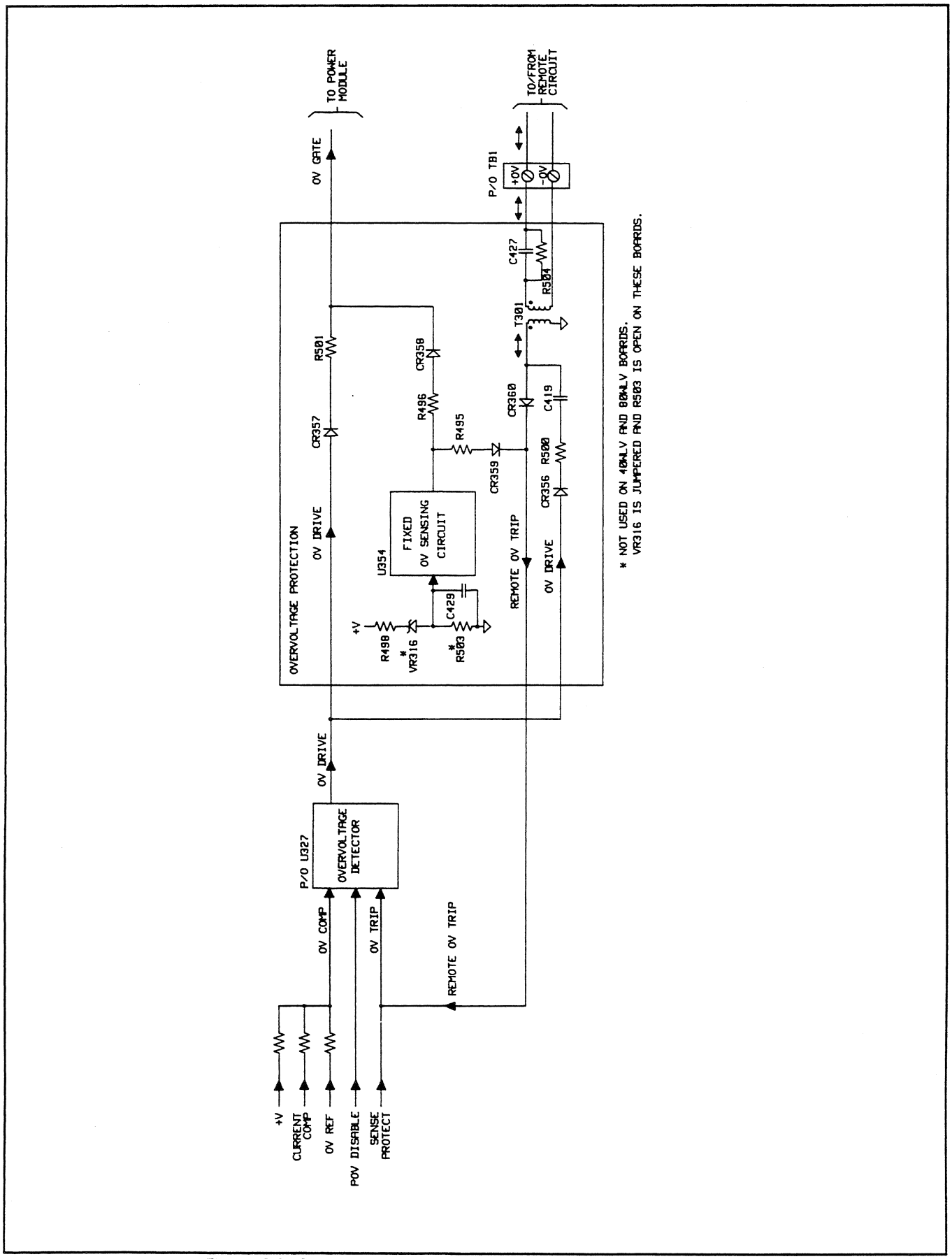


Figure 2-9. Overvoltage Protection Circuits, Simplified Schematic

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Section III
VERIFICATION

3-1 INTRODUCTION

This section contains test procedures that check the operation of the power supply. Four types of procedures are provided: Operation Verification Tests, Performance Tests, Extended Tests, and Temperature Coefficient Tests.

The Operation Verification Tests comprise a short procedure to verify that the supply is performing properly, without testing all specified parameters. The Performance Tests provide a more complete test of the supply by testing most of the specifications listed in Table 1-1 in the Operating Manual (Agilent Part No. 5957-6377).

The Extended and Temperature Coefficient tests are similar to the Performance tests except that they are conducted in a controlled environment and require a longer period of time to complete each test.

If failures are encountered or out of specification test results are observed, refer to the Troubleshooting Procedures in Section IV in this manual. The troubleshooting procedures will determine if repair and/or calibration is required. Calibration procedures are provided in Appendix A of the Operating Manual.

3-2 TEST EQUIPMENT REQUIRED

Table 3-1 lists the equipment required to perform the tests in this section. The tests are performed by sending commands to and receiving data from the supply under test via the GPIB. An Agilent 9825, 85, or series 200 computer is used as the GPIB controller. Tests that do not verify readback via the GPIB can also be performed manually from the supply's front panel and, consequently do not require use of a controller.

CAUTION

The tests should only be performed by qualified personnel. During the performance o f these tests, the output o f the supply being tested may reach voltage levels above safe levels.

3-3 OPERATION VERIFICATION TESTS

To assure that all outputs of your supply are performing properly, without testing all specified parameters, perform the test procedures outlined.

a. Perform the turn-on and checkout procedures given in Section III of the Operating Manual. These procedures include a power-on self test.
b. Perform the performance tests listed below on each output of your supply.

Voltage Programming and Readback Accuracy (paragraph 3-12)
CV Load Effect (paragraph 3-13)
CV Noise (paragraph 3-15)
Overvoltage Protection Tests (paragraph 3-20)
Current Programming and Readback Accuracy (paragraph 3-23)
CC Load Effect (paragraph 3-25)

3-4 PERFORMANCE TESTS

3-5 Introduction

The following paragraphs provide test procedures for verifying the supply's compliance with the specifications listed in Table 1-1 of the Operating manual. The procedures cover Agilent Models 6621A through 6624A and 6627A in the series of Multiple Output Power Supplies. The performance test procedures must be performed on each output. Figure 3-1 shows the outputs present and output ranges on each model.

The test procedures that follow give settings and results for each type of output that may be tested. There are four types of outputs: 40 Watt Low Voltage (40WLV), 40 Watt High Voltage (40WHV), 80 Watt Low Voltage (80WLV), and 80 Watt High Voltage (80WHV). Make sure that you use the test settings and results listed for the particular output being tested. It is recommended that the tests be performed in the sequence given, and that all data be recorded on the test record provided at the end of the test procedures (see paragraph 3-28).

3-6 Measurement Techniques

3-7 Setup for All Tests. Measure the dc output voltage directly at the + S and - S terminals of the output under test. Connect the output for local sensing and use adequate wire gauge for load leads as described in Section IV of the Operating Manual.

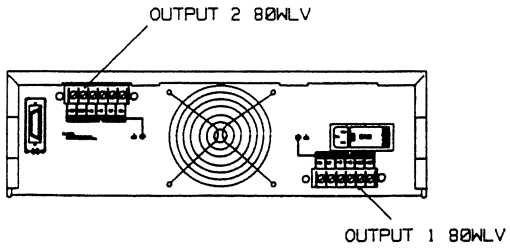
Many of the test procedures require the use of a variable load resistor capable of dissipating the required power (see Table 3-1). Using a variable load resistor requires that switches be used to connect, disconnect, and short the load resistor. An electronic load, if available, can be used in place of a variable load resistor and switches. The electronic load

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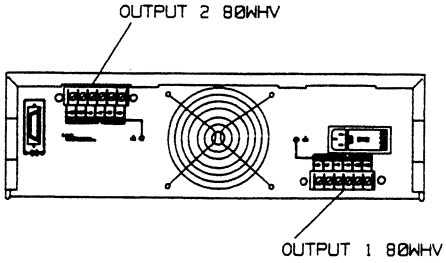
Table 3-1. Test Equipment Required for Verification

Type	Required Characteristics	Recommended Model
GPIB Controller	Full GPIB capabilities	Agilent 9825, 85 or series 200 computer
Oscilloscope	Dual Channel Sensitivity: 1 mV Bandwidth: 20 MHz Input: 50 ohms and 10 Meg	Agilent 1740A
RMS Voltmeter	True RMS: Bandwidth 10 MHz Sensitivity: 500 μV	Rohde and Schwarz Model URE or Agilent 3400A
Digital Voltmeter	Resolution: 100 nV Accuracy: 0.0035%, 6 digit	Agilent 3456A
Current Monitor Resistor	Value: 0.1 ohm, 10 amp Accuracy: 0.05% or better	Agilent 0811-3775 L&N 4221-B
Resistor (Figures 3-4 and 3-5)	2 K ohms, 2 W, $\pm$5%	Agilent 0764-0025
Diodes (2) (Figures 3-4 and 3-5)	100 V, 3 A Silicon diode	Agilent 1901-0719 or Agilent 1901-1087
Variable Voltage Transformer	Adjustable from $-$13% to $+$6% of input voltage range. 1 K VA minimum	
DC Power Supply (Figure 3-6)	60 V, 0.1 A 30 V, 15 A	Agilent 6274B Agilent 6274B
Electronic Load or Variable Load Resistors and Load Switch	Voltage Range: 50 V minimum Current Range: 10 A minimum Power Range: 100 W minimum Open and Short switches variable at 30 Hz rate. 0 to 1 ohm, 100 W minimum 0 to 5 ohms, 100 W minimum 0 to 100 ohms, 100 W minimum 10 A switchable at line freq.; consists of (see Figure 3-6): Relay Capacitor 0.47μF, 100 V Resistor 1.5 ohms, 3 W Diodes (2) 100 V, 1 A Resistor 10 K, 3 W Resistor, var., 25 K, 2 W	Transistor Dev. DLP 50-60-1000 Clare HGP 1002 Agilent 0160-5286 Agilent 0811-1220 Agilent 1901-0719 or 1901-1087 Agilent 0811-1816 Agilent 2100-3272
Impedance matching Resistor (Figure 3-3)	50 ohm resistor/50 ohm coax or 1:1 probe with RF tip	Agilent 0811-0592
Current Limiting Resistor (Figure 3-10)	1 ohm, 5 watts min.	Agilent 0811-1340

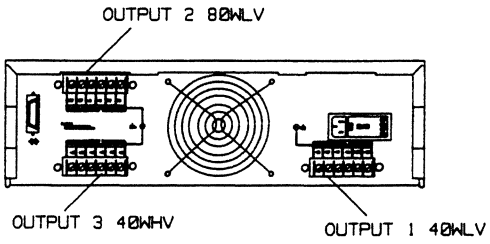
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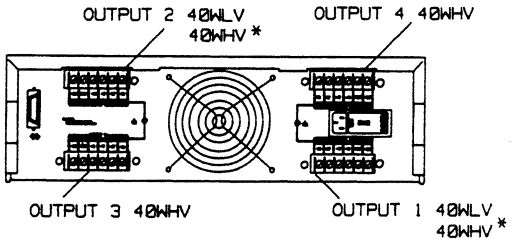
Agilent 6621A



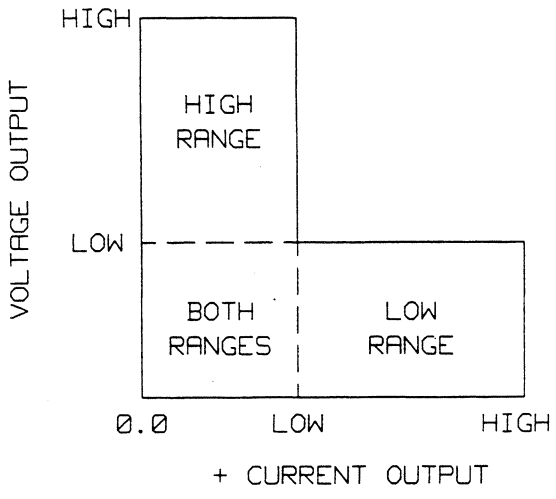
Agilent 6622A



Agilent 6623A



Agilent 6624A, Agilent 6627A*



Output	Low Range Rated Values	High Range Rated Values
80WLV	7 V @ 10 A	20 V @ 4 A
80WHV	20 V @ 4 A	50 V @ 2 A
40WLV	7 V @ 5 A	20 V @ 2 A
40WHV	20 V @ 2 A	50 V @ 0.8 A

Figure 3-1. Operating Ranges Available in Agilent Models 6621A-6624A and 6627A

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is considerably easier to use than load resistors. It eliminates the need for connecting resistors or rheostats in parallel to handle power, it is much more stable than a carbon-pile load, and it makes easy work of switching between load conditions as is required for the load regulation and load transient response tests. Substitution of the electronic load requires minor changes to the test procedures in this section.

3-8 Current-Monitoring Resistor. To eliminate output current measurement error caused by voltage drops in the leads and connections, connect the current monitoring resistor between the - V and the load as a four-terminal device. Figure 3-2 shows the connections. Connect the current-monitoring leads inside the load-lead connections directly at the monitoring points on the resistor element.

3-9 GPIB Controller. Most performance tests can be performed using only the front panel keypad; however, an GPIB controller is required to perform the voltage and current programming accuracy and readback accuracy tests. The test procedures are written assuming that you know how to program the supply remotely from an GPIB controller or locally using the control keys and indicators on the supply's front panel. Complete instructions on remote and local programming are given in the Operating Manual.

NOTE

In the test programs that follow, the brackets < > indicate a number to be sent. The < ch > specifies the output channel number from 1 through 4. The voltage and current values which are sent to the specified output channel are given in Tables 3-2 and 3-3.

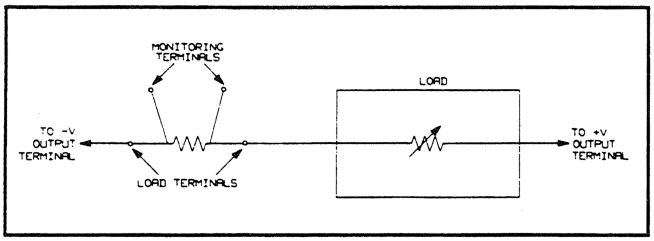


Figure 3-2. Current Monitoring Resistor Setup

3-10 Constant Voltage (CV) Tests

3-11 CV Setup. If more than one meter or a meter and an oscilloscope are used, connect each to the + S and - S terminals by a separate pair of leads to avoid mutual coupling effects. Connect only to + S and - S because the unit regulates the output voltage that appears between + S and - S, not between + V and - V. Use coaxial cable or shielded 2-wire cable to avoid noise pickup on the test leads.

3-12 Voltage Programming and Readback Accuracy. This test verifies that the voltage programming, GPIB readback, and front panel display functions are within specifications. An GPIB controller must be used for this test.

a. Turn off the supply and connect a digital voltmeter between the + S and - S terminals of the output to be tested.

b. Turn on the supply and select the desired output (OUTPUT SELECT key on the front panel).

c. Program the selected output channel to zero volts by sending the string:

VSET < ch >, 0

d. Record the output voltage readings on the digital voltmeter (DVM) and the front panel display. The readings should be within the limits specified below for the particular output type tested. Also, note that the display indicates the output current and the CV, RMT, and ADDR annunciators are on. Note that the output current reading is approximately zero because there is no load connected.

Output	Prog. Accuracy (DVM Reading)	Display Accuracy (Front Panel LCD)
40WLV/80WLV	0 V ± 19mV	DVM ± 25 mV
40WHV/80WHV	0 V ± 50mV	DVM ± 55 mV

e. Read back the output voltage from the selected channel the GPIB by entering and running the following program:

```
10 OUTPUT 705; "VOUT? < ch > "
20 ENTER 705;A
30 DISP A
40 END
```

f. Record the value displayed on the controller. This value should be within the DVM reading noted in step d and the limits specified below.

Output	Readback Accuracy (Controller Display)
40WLV/80WLV	DVM ± 20 mV
40WHV/80WHV	DVM ± 50 mV

g. Program the selected output's voltage to the High Range Full Scale value (20 V for 40WLV/80WLV or 50 V for 40WHV/80W'HV outputs) by sending the following string:

VSET < ch >, < 20 or 50 >

h. Record the output voltage readings on the DVM and the front panel display. The readings should be within the limits specified below for the particular output type tested.

Output	Prog. Accuracy (DVM Reading)	Display Accuracy (Front Panel LCD)
40WLV/80WLV	20 V ± 31 mV	DVM ± 35 mV
40WHV/80WHV	50 V ± 80 mV	DVM ± 80 mV

i. Run the program listed in step e - Record the value displayed by the controller. This value should be within the limits specified below.

Output	Readback Accuracy (Controller Display)
4OWLV/80WLV	DVM±30 mV
40WHV/80WHV	DVM±75 mV

j. Repeat steps a through i for each output present in your supply.

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Table 3-2. Low Range Voltage and Current Values

Output Board	Full Scale Voltage	Max. Prog. Voltage	Full Scale Current	Max. Prog. Current	Min. Prog. Current
40WLV	7 V	7.07 V	5 A	5.15 A	0.08 A
40WHV	20 V	20.2 V	2 A	2.06 A	0.05 A
80WLV	7 V	7.07 V	10 A	10.3 A	0.13 A
80WHV	20 V	20.2 V	4 A	4.12 A	0.07 A

* An output channel cannot be programmed to 0 amps. If the output channel receives a command to go to 0 amps (or any positive current below the minimum programmable value), it will set itself to the minimum programmable value.

3-13 CV Load Effect. This test measures the change in output voltage resulting from a change in output current from full to no load.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with the DVM connected between the +S and -S terminals, the Load switch closed, and the Short switch opened.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on front panel).
c. Program the current of the selected channel to the Low Range Maximum Programmable current value and the output voltage to the Low Range Full Scale voltage value (see Table 3-2) by sending the following strings:

ISET < ch >, < 5.15, 2.06, 10.3, or 4.12 >
VSET < ch >, < 7 or 20 >

d. Adjust the load for the Low Range Full Scale Current value (see Table 3-2) as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load down slightly.
e. Record the output voltage reading on the DVM connected to + S and - S.
f. Open the Load switch and again record the DVM voltage reading. The difference between the DVM readings in steps e and f is the load effect voltage and should not exceed 2 mV.
g. Repeat steps a through f for each output in your supply.

4 CV Source Effect. This test measures the change in output voltage that results from a change in ac line voltage from the minimum to maximum value within the line voltage specifications.

a. Turn off the supply and connect the ac power line through a variable voltage transformer.
b. Connect the output to be tested as shown in Figure 3-3 with the DVM connected between the + S and - S terminals, the Load switch closed, and the Short switch opened.
c. Adjust the transformer to 13% below the nominal line voltage.
d. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
e. Program the current of the selected output to the High Range Maximum Programmable Current value and the output voltage to the High Range Full Scale Voltage value (see Table 3-3) by sending the following strings:

ISET < ch >, < 2.06, 0.824, or 4.12 >
VSET < ch >, < 20 or 50 >

f. Adjust the load for the High Range Full Scale Current value (see Table 3-3) as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load down slightly.
g. Record the output voltage reading on the DVM.
h. Adjust the transformer to 6% above the nominal line voltage.
i. Record the output voltage reading on the DVM. The difference between the DVM readings in steps g and i is the source effect voltage and should not exceed 3 mV (40WLV and 80WLV outputs) or 6 mV (40WHV and 80WHV outputs).
j. Repeat steps b through i for each output in your supply. Be sure to turn off supply before performing step b.

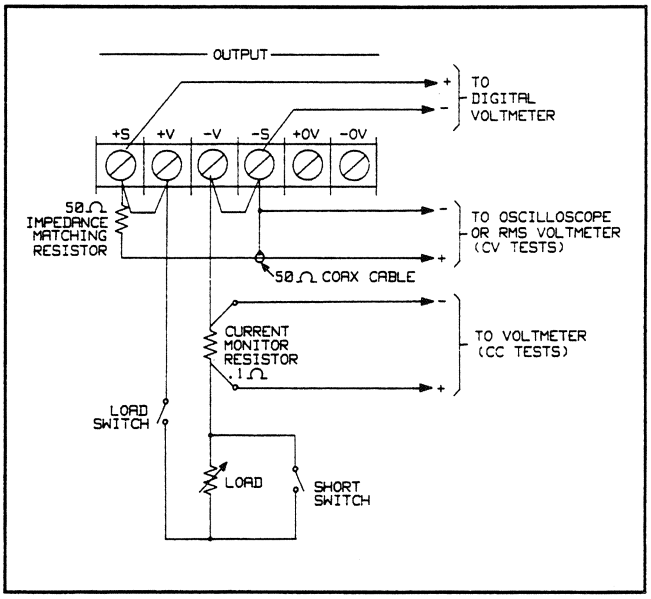


Figure 3-3. Basic Test Setup

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Table 3-3. High Range Voltage and Current Values

Output Board	Full Scale Voltage	Max. Prog. Voltage	Full Scale Current	Max. Prog. Current	Min. Prog. Current*
40WLV	20 V	20.2 V	2 A	2.06 A	0.08 A
40WHV	50 V	50.5 V	0.8 A	0.824 A	0.05 A
80WLV	20 V	20.2 V	4 A	4.12 A	0.13 A
80WHV	50 V	50.5 V	2 A	2.06 A	0.07 A

* An output channel cannot be programmed to 0 amps. If the output channel receives a command to go to 0 amps (or any positive current below the minimum programmable current), it will set itself to the mum programmable current.

3-15 CV Noise (PARD). Periodic and random deviations (PARD) in the output (ripple and noise) combine to produce a residual ac voltage superimposed on the dc output voltage. CV PARD is specified as the rms or peak-to-peak output voltage in a frequency range from 20 Hz to 20 MHz. This test measures the rms and peak-to-peak noise on the output.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 to an oscilloscope (ac coupled) between the +S and -S terminals, the Load switch closed, and the Short switch opened. Be sure to keep the leads from the 50 ohm impedance matching resistor and the 50 ohm coaxial cable shield that run to the + S and - S terminals as short as possible to avoid external noise pickup.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. Program the current to the Low Range Maximum Programmable Current Value and the output voltage to the Low Range Full Scale Voltage value (See Table 3-2) by sending the following strings:

ISET < ch >, < 5.15, 2.06, 10.3, or 4.12 >
VSET <ch>, <7 or 20>

d. Adjust the load for the Low Range Full Scale Current value (see Table 3-2) as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load down slightly.
e. Note that the waveform on the oscilloscope should not exceed 3 mV peak to peak.
f. Disconnect the oscilloscope and connect an rms voltmeter in its place. The rms voltage reading should not exceed 500 μV.
g. Repeat steps a through f for each output in your supply.

3-16 CV Down Programming Speed. This test measures the time required for the output voltage to fall to 37% of the High Range Full Scale Voltage (time constant). Also measured is the time an output takes to change from full scale to zero volts and settle within the specified voltage settling band (response time).

a. Turn off the supply and connect the output to be tested as shown in Figure 3-4.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. First, program the selected output to zero volts by sending the string:

VSET < ch >, 0

d. Using Channel A on the oscilloscope, set the volts/division switch to 5 V/div (40WLV/80WLV outputs) or to 10 V/div (40WHV/80WHV outputs) dc coupled and position the trace on the bottom horizontal line. Using Channel B on the oscilloscope, set the volts/division switch to 50 mV/div dc coupled and position the trace on the bottom horizontal line.
e. Program the output voltage in a loop which alternately programs the output voltage between 0 and the High Range Full Scale Voltage value by running the program listed below. Refer to Table 3-3 for the High Range Full Scale Voltage value for the particular output being tested.

```
10 OUT 705; "VSET < ch >,0"
20 WAIT 0.05
30 OUT 705; "VSET < ch >, < High
        Range F. S. Voltage >"
40 WAIT 0.05
50 GOTO 10
60 END
```

NOTE

The tested output's CV annunciator should remain on at all times while the test is in progress.

f. Observe Channel A on the oscilloscope and adjust for a stationary waveform by using Channel A as the trigger source set to trigger on a negative edge. Be sure to trigger as close as possible to the time when the output voltage just begins to fall.
g. On Channel A, observe the output voltage transition from the High Range Full Scale Voltage to the scope's bottom horizontal line. Look for a smooth exponential waveform with no "kinks" or aberrations. Perform a time contstant check by insuring that the output voltage falls to about 37% of the High Range Full Scale in less than 250 μsec. (40WLV/80WLV outputs) or 750 μsec. (40WHV/80WHV outputs). Refer to the Channel A waveform shown in Figure 3-5.

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h. Now observe Channel B on the oscilloscope while maintaining the trigger on Channel A as in step f. Note that the diode clamp, used in the test setup of Figure 3-4, prevents gross overload of Channel B (which is set at 50 mV/div) allowing examination of the "tail" of the exponential waveform. The output voltage should be within 20 mV of its final settling value on the bottom horizontal line in less than 2 msec for 40WLV/80WLV outputs and within 50 mV in less than 6 msec for 40 WHV/80 WHV outputs. Refer to the Channel B waveform shown in Figure 3-5.

i. Repeat steps a through h for each output in your supply.

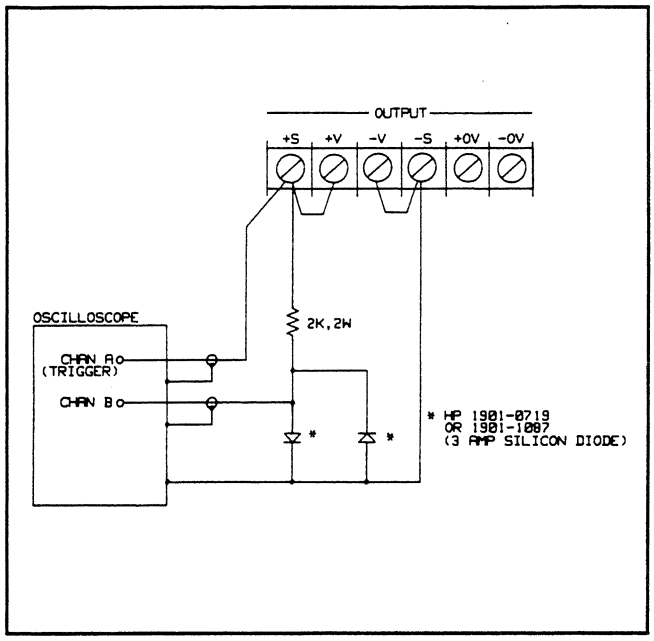


Figure 3-4. Down Programming Speed Test Setup

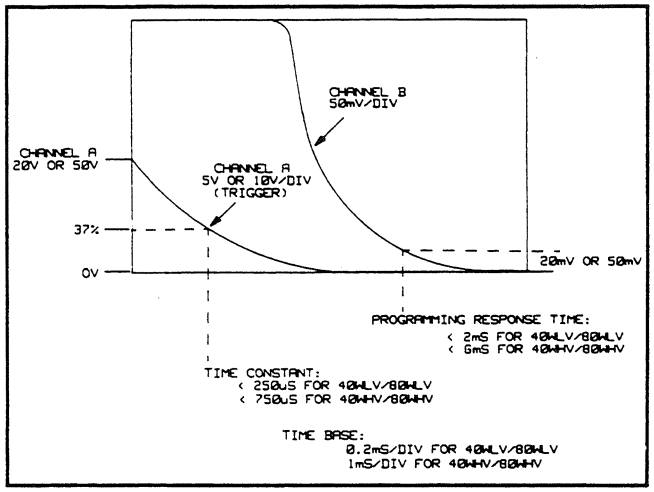


Figure 3-5. CV Down Programming Speed Test Waveforms

3-17 CV Up Programming Speed. This test measures the time required for the output voltage to rise to 63% of the High Range Full Scale Voltage (time constant). Also measured is the time the output takes to change from .4 volts to full scale and settle within the specified settling band (response time).

a. Turn off the supply and connect the output to be tested as shown in Figure 3-6.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. First, program the selected output's voltage to its High Range Full Scale value (see Table 3-3) by sending the following string:

VSET < ch >, < 20 or 50 >

d. Set the vertical sensitivity switch of Channel A on the oscilloscope to 5 V/div (40WLV/80WLV outputs) or to 10 V/div (40WHV/80WHV outputs). With the oscilloscope's input switch in the GND position, adjust the trace to the bottom horizontal line. Then set the input switch to the dc coupled position. Set the vertical sensitivity switch of channel B on the oscilloscope to 50 mV/div and the input switch to the GND position.
e. Adjust the Channel B trace to the top horizontal line of the oscilloscope and move the input switch to the DC position.
f. Adjust the bucking supply until the Channel B trace is as close as possible (within 1 division) to the top horizontal line and then use the scope vertical adjust to fine adjust the trace to the top horizontal line.

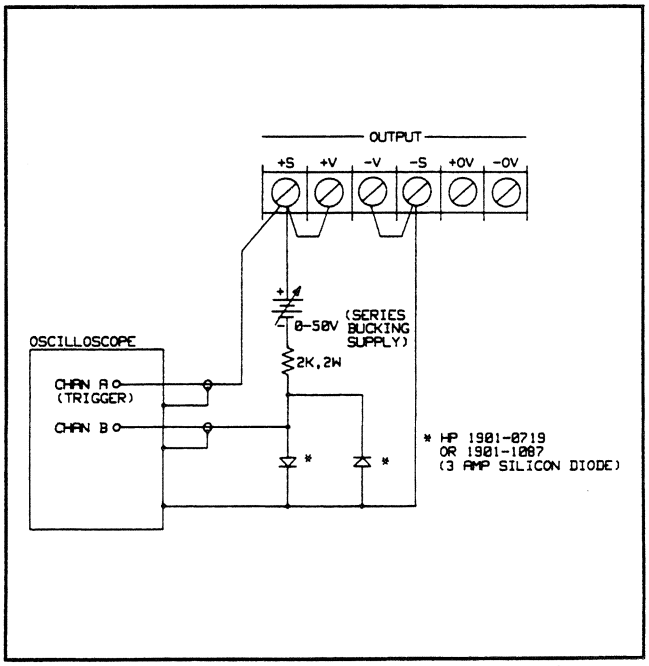


Figure 3-6. CV Up Programming Speed Test Setup

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g. Program the output voltage in a loop which alternately programs the output voltage between 0.4 V and the High Range Full Scale Voltage value (20 .V for 40WLV/80WLV outputs or 50 V for 40WHV/80WHV outputs) by running the following program:

```
10 OUTPUT 705;"VSET < ch >, < 20 or 50 >"
20 WAIT 0.05
30 OUTPUT 705;"VSET <ch>, .4"
40 WAIT 0.05
50 GOTO 10
60 END
```

NOTE

The tested output's CV annunciator should remain on at all times while the test is in progress.

h. Observe Channel A on the oscilloscope and adjust for a stationary waveform by using Channel A as the trigger source set to trigger on a positive edge. Be sure to trigger as close as possible to the time when the output voltage just begins to rise.

i. On Channel A, observe the output voltage transition from the scope's bottom horizontal line to the High Range Full Scale Voltage. Look for a smooth exponential waveform with no "kinks" or aberrations. Perform a time constant check by insuring that the output voltage rises to about 63% of the High Range Full Scale Voltage in less than 250 μsec. (40WLV/80WLV outputs) or 750 μs. (40WHV/80WHV outputs). Refer to the Channel A waveform shown in Figure 3-7.

j. Now observe Channel B on the oscilloscope while maintaining the trigger on Channel A as in step h. Note the series supply bucks out the Full Scale Output Voltage and that the waveform is clamped at approximately -0.6 V and rises to the top horizontal line when the output voltage is at full scale. The diodes (see Figure 3-6) prevent gross overload of Channel B (which is set at 50 mV division) allowing examination of the "tail" of the exponential waveform. The output voltage should be within 20 mV of its final settling value on the top horizontal line is less than 2 msec. for 40WLV /80WLV outputs and within 50 mV in less than 6 msec. for 40WHV/80WHV outputs.

k. Repeat steps a through j for each output in your supply.

3-18 Transient Recovery Time. This test measures the time for the output voltage to recover to within the specified value following a change from a low current value to the Low Range Full Scale Current value.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-8.

b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).

c. Program the selected output's voltage to the Low Range Full Scale Voltage value and the current to the Low Range Maximum Programmable Current value (see Table 3-2).

d. With R2 disconnected, adjust R1 for 300 mA (for 40WLV/80WLV outputs) or 150 mA (for 40WHV/ 80WHV outputs) as indicated on the front panel display.

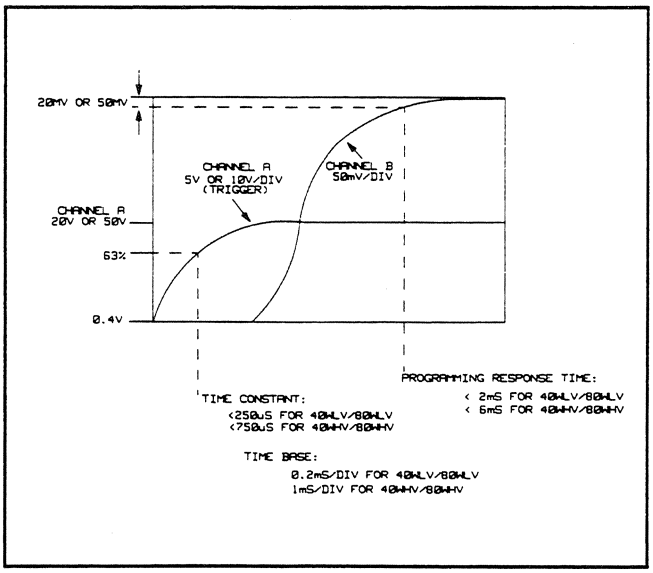


Figure 3-7. CV Up Programming Speed Test Waveforms

e. Connect R2 and adjust to read the Low Range Full Scale current value on the front panel display. Note that the CV annunciator should be on. If it is not on, readjust R2 until it is on.

f. Set the oscilloscope to 50 mv/div, ac coupled, 10 us/div, internal trigger, normal, and - slope.

g. Turn on the load switch to perform the transient response test. Alternatively, remove R1 and modulate an electronic load between 300 mA (40WLV/80WLV outputs) or 150 mA (40WHV/80WHV outputs) and the Low Range Full Scale Current value. Note that if an electronic load is used, the load's current rise time must be less than 25 μsec to perform an adequate test. If a load with longer rise time is used, the transient response recovery time may appear to be out of specification.

h. Adjust the oscilloscope trigger level for a stationary waveform as shown in Figure 3-9 and check that the loading transient is within 75 mV of its final value in less than 75 , μs.

i. Change the oscilloscope settings to + slope and repeat steps g and h for the unloading transient (see Figure 3-9).

j. Repeat steps a through i for each output in your supply.

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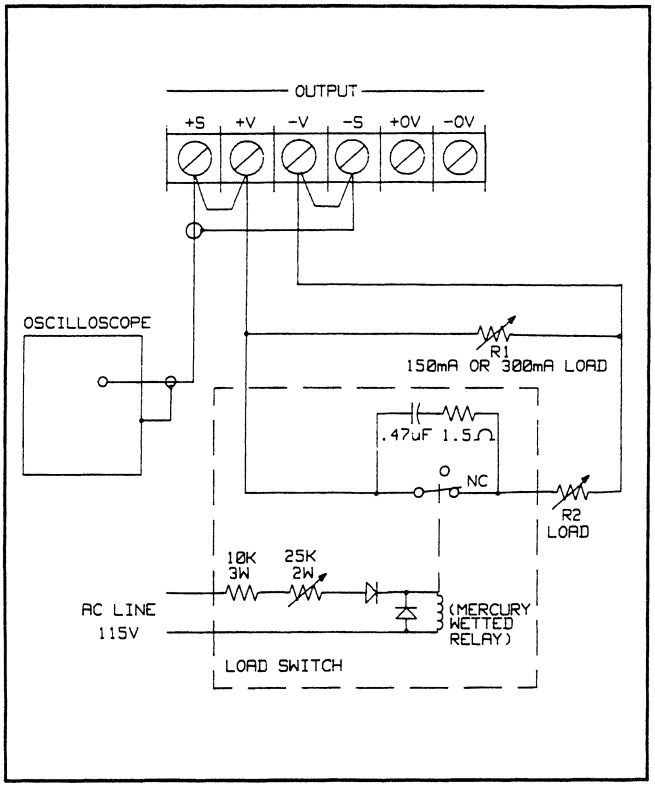


Figure 3-8. Transient Recovery Time Test Setup

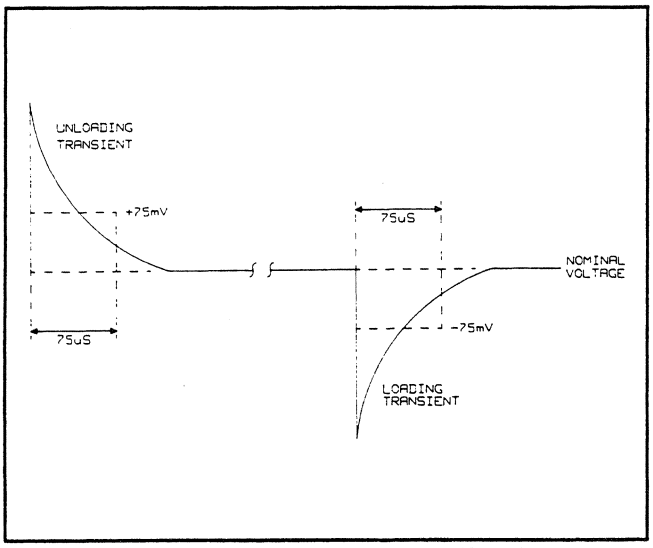


Figure 3-9. Transient Response Waveform

3-19 Turn On/Off Overshoot. This test measures the amplitude of any transients in the output during turn on or turn off of the supply.

a. Turn off the supply and connect an oscilloscope across the + V and - V terminals of the output to be tested.
b. Set the oscilloscope to 50 mV/div, dc coupled, 1 sec/div, and + slope.
c. Turn on the supply while observing the oscilloscope. The maximum transient amplitude should not exceed ± 100 mV. Repeat test by observing the scope after turning off the supply.
d. Repeat the test (steps a through c) for each output in your supply.

3-20 Overvoltage Protection. The following tests check the operation and accuracy of the fixed OV, programmable OV, and the external OV protection circuits.

Fixed OV Test. This test verifies that the fixed OV circuit will be activated when the output is about 20% above the High Range Full Scale Voltage value.

a. Turn off the supply and connect an external power supply to the output to be tested as shown in Figure 3-10.
b. Do not turn on the supply. This test is performed with the ac power turned off.

WARNING

To avoid possible damage to the output under test, the external supply should be current limited to less than 1 amp.

c. Set the external power supply to 20 V (for 40WLV/80WLV outputs) or to 50 V (for 40WHV/80WHV outputs).
d. Slowly increase the voltage of the external supply until the overvoltage circuit in the supply under test trips. This is indicated by a sudden drop in the voltage of the external supply. The fixed OV circuit should trip between 22.7 V and 25.7 V (for 4OWLV/80WLV outputs) or between 56.8 V and 63.5 V (for 40WHV/80WHV outputs).
e. Repeat steps a through d for each output in your supply.

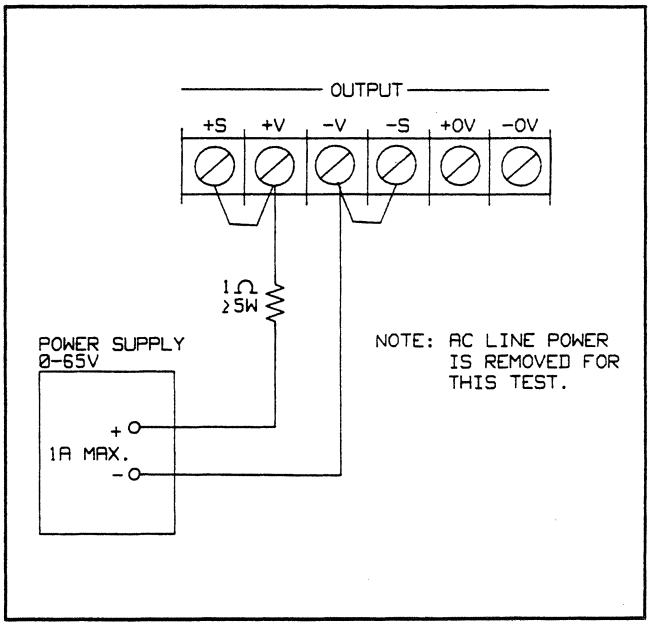


Figure 3-10. Fixed OV Protection Test Setup

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Programmable OV Accuracy Test. This test checks the overvoltage (OV) programming accuracy. Taking the OV programming accuracy and the voltage programming accuracy into account, the upper and lower limits of the OV firing range for each output type are as follows:

Output	Lower VSET for no OV	Nominal OV Setting	Upper VSET to fire OV
40WLV/80WLV	18.74 V	19.0 V	19.26 V
40WHV/80WHV	48.38 V	49.0 V	49.62 V

a. Turn off the supply and disconnect all loads and test equipment.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. Program the OV to 1 V below the High Range Full Scale Voltage value: 19 V (40WLV/80WLV outputs) or 49 V (40WHV/80WHV outputs). Send the following string:

OVSET < ch >, < 19 or 49 >

d. Program the output voltage to the Lower VSET Limit specified above by sending the following string:

VSET < ch >, < 18.74 or 48.38 >

e. Note that the overvoltage should not trip and the front panel should display the programmed output voltage and no current.
f. Program the output voltage to the Upper VSET limit specified above by sending the following string:

VSET < ch >, < 19.26 or 49.62 >

g. Note that the overvoltage has tripped as indicated by the display showing "OVERVOLTAGE".
h. Reset the output by setting the OV to the maximum value (23 V for 40WLV/80WLV or 55V for 40WHV/80WHV) and resetting the OV circuit as shown below:

OVSET < ch >, < 23 or 55 >
OVRST < ch >

i. Check that the front panel again displays the programmed output voltage and no current.
j. Repeat steps b through i for each output in your supply.

External OV Test. This test checks the operation of the external OV circuit.

a. Turn off the supply and connect the OV terminals of all outputs in parallel noting proper polarity. Figure 3-11 shows two outputs connected in parallel.
b. Turn on the supply and select the desired (OUTPUT SELECT key on the front panel).
c. Program the output voltage to 5 V and the OV to 4 V.

VSET < ch >, 5
OVSET < ch >, 4

d. Note the display should indicate "OVERVOLTAGE" for all outputs.
e. Reset all outputs by turning the supply off and on again.
f. Repeat the above tests until all supply outputs have been checked.

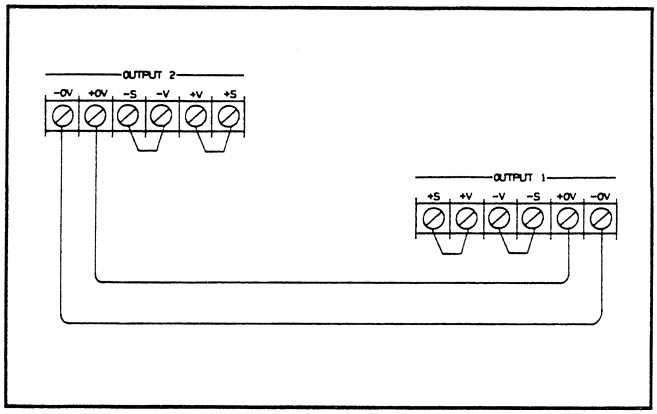


Figure 3-11. OV External Trip Test Connections

3-21 Constant Current (CC) Tests

3-22 CC Setup. Follow the general setup instructions of paragraphs 3-5 through 3-9 and the specific instructions given in the following paragraphs.

3-23 Current Programming and Readback Accuracy. This test verifies that the current programming, GPIB readback, and front panel display functions are within specifications. An GPIB controller must be used for this test. The accuracy of the current monitoring resistor must be 0.05% or better.

a. Turn off the supply and connect a 0.1 ohm current monitoring resistor across the output and a DVM across the resistor (see paragraph 3-8).
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. Program the output voltage to 5 V and the current to the Minimum Programmable Current value by sending the following strings:

VSET <ch>,5
ISET < ch >,0

NOTE

An output channel cannot be programmed to 0 amps. If the output channel receives a command to go to 0 amps (or any positive current below the minimum programmable current), it will set itself to the minimum value (see Tables 3-2 and 3-3).

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d. Multiply the voltage drop across the current monitoring resistor by 10 to convert to amps and record this value (Io). Note also the current reading on the front panel display. The readings should be within the limits specified below for the particular output type being tested.

Output	Prog. Accuracy (DVM Reading X10)	Display Accuracy (Front Panel LCD)
40WLV	80 mA ± 50 mA	Io ± 15 mA
80WLV	130 mA ± 100 mA	lo ± 25 mA
40WHV	50 mA ± 20 mA	Io ± 4.5 mA
80WHV	70 mA ± 40 mA	Io ± 8.5 mA

e. Read back the output current from the selected channel over the GPIB to the controller by running the following program:

```
10 OUTPUT 705; "IOUT? < ch > "
20 ENTER 705; A
30 DISP A
40 END
```

f. Record the value displayed on the controller. This value should be within the limits specified below using the Io reading noted in step d.

Output	Readback Accuracy (Controller Display)
40WLV	Io ± 10 mA
80WLV	Io ± 20 mA
40WHV	Io ± 4 mA
80WHV	Io ± 8 mA

g. Program the selected outputs voltage to 5 V and the current to the Low Range Full Scale Current value (see Table 3-2) by sending the strings:

```
VSET < ch >, 5
ISET < ch >, <5, 2, 10, or 4 >
```

h. Multiply the voltage drop across the current monitoring resistor by 10 to convert to amps. Record this value (Io). Note also the current reading on the front panel display. The readings should be within the limits specified below for the particular output type being tested.

Output	Prog. Accuracy (Io = DVM Reading X 10)	Display Accuracy (Front Panel LCD)
40WLV	5 A ± 58 mA	lo ± 20 mA
80WLV	10 A± 116 mA	lo ± 35 mA
40WHV	2 A ± 23 mA	Io ± 6.5 mA
80WHV	4 A± 46 mA	lo ± 12.5 mA

i. Run the program listed in step e. Record the value displayed by the controller. This value should be within the limits specified below using the Io reading noted in step h.

Output	Readback Accuracy (Controller Display)
40WLV	lo ± 15 mA
80WLV	Io ± 30 mA
40WHV	lo ± 6mA
80WHV	Io ± 12 mA

j. Repeat steps a through i for each output in your supply.

3-24 Negative Constant Current (- CC) Operation. This test verifies the readback and display accuracies when the output is in negative current limit operation. It also checks that the negative current limit has two different values depending upon the output voltage.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-12.

b. Set the external power supply to 5V and its current limit to 1.5 times (approximately) the Low Range Full Scale current value (see Table 3-2) of the output under test. For example, if the Low Range Full Scale current value is 2 A, set the external supply's current limit to about 3 A.

c. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).

d. Program the selected output channel to 0V by sending the string:

```
VSET < ch >, 0
```

e. Multiply the voltage drop across the current monitoring resistor by 10 to obtain the current sink value (Is) in amps and record the value. Record also the current reading on the display. The readings should be within the limits specified below for the particular output type being tested. Note that the CC annunciator must be on.

Output	Neg. Current Limit Low Range Output V (Is= DVM Reading X 10)	Display Accuracy (Front Panel LCD)
40WLV	5.35 to 5.85 A	Is ± 42 mA
80WLV	10.7 to 11.7 A	Is ± 78 mA
40WHV	2.15 to 2.35 A	Is ± 13.5 mA
80WHV	4.3 to 4.7 A	Is ± 30 mA

f. Read back the sink current from the selected channel over the GPIB by entering and running the program listed in step e of paragraph 3-23.

g. Record the value displayed on the controller. This value should be within the reading (Is) noted in step e and the limits specified below.

Output	Readback Accuracy (Controller Display)
40WLV	Is ± 37 mA
80WLV	Is ± 73 mA
40WHV	Is ± 13 rnA
80WHV	Is ± 29.5 mA

h. Raise the voltage of the external supply up to approximately 12 V (40WLV or 80WLV outputs) or to 26 V (40WHV or 80WHV outputs) as indicated on your supply's front panel and note that the sink current (Is) changes from the previous value to a value within the range indicated below.

Output	Neg. Current Limit High Range Output V (DVM Reading X 10)
40WLV	2.25 to 2.55 A
80WLV	4.5 to 5.1 A
40WHV	0.9 to 1.02 A
80WHV	2.1 to 2.5 A

i. Repeat this test (steps a through h) for each output in your supply.

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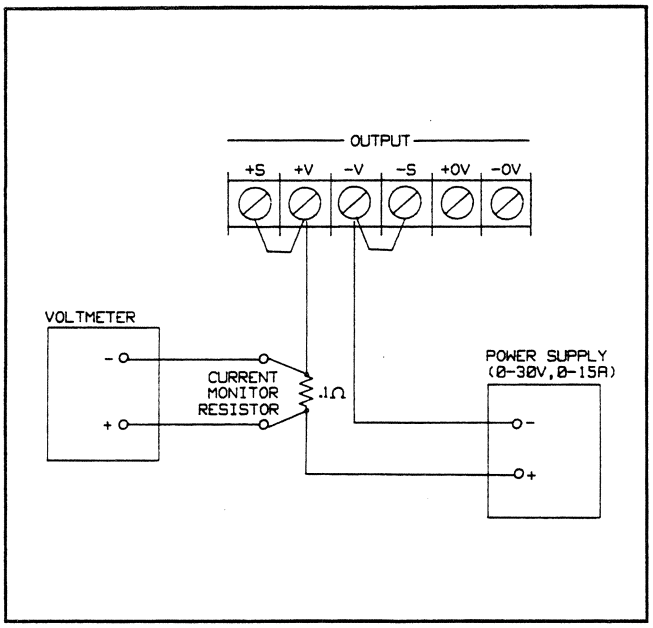


Figure 3-12. Negative Current Limit (–CC) Readback Accuracy

3-25 CC Load Effect. This test measures the change in output current for a change in the load from High Range Full Scale Voltage to short circuit.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with the DVM connected across the current monitoring resistor, the load switch closed, and the short switch opened.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. Program the current of the selected output to the High Range Full Scale Current value and the output voltage to the High Range Maximum Programmable Voltage value (see Table 3-3) by sending the following strings:

ISET < ch >, < 2, .8, or 4 >
VSET < ch >, < 20.2 or 50.5 >

d. Adjust the load for High Range Full Scale Voltage as indicated on the front panel display. Check that the CC annunciator is on. If it is not, adjust the load so the output voltage drops slightly.
e. Record the output current reading (DVM reading X 10).
f. Close the short switch and record the output current reading. The difference in the current readings in steps e and f is the load effect and should not exceed the values listed below for the particular output being tested.

Output	CC Load Effect
40WLV	1 mA
80WLV	2 mA
40WHV	0.5 mA
80WHV	1 mA

g. Repeat this test (steps a through f) for each output in your supply.

3-26 CC Source Effect. This test measures the change in output current that results when the ac line voltage changes from the minimum to the maximum value within the specifications.

a. Turn off the supply and connect the ac power line through a variable voltage transformer.
b. Connect the output to be tested as shown in Figure 3-3 with the DVM connected across the current monitoring resistor, the load switch closed, and the short switch opened.
c. Adjust the transformer to 13% below the nominal line voltage.
d. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
e. Program the current of the selected output to the High Range Full Scale Current value and the output voltage to the High Range Maximum Programmable Voltage value (see Table 3-3) by sending the following strings:

ISET < ch >, < 2, .8, or 4 >
VSET < ch >, <20.2 or 50.5 >

f. Adjust the load for High Range Full Scale Voltage as indicated on the front panel display. Check that the CC annunciator is on. If it is not, adjust the load so that the output voltage drops slightly.
g. Record the output current reading (DVM reading X 10)
h. Adjust the transformer to 6% above the nominal line voltage.
i. Record the output current reading again. The difference in the current readings in steps g and i is the CC source effect and should not exceed the values listed below for the particular output being tested.

Output	CC Source Effect
40WLV	2.2 mA
80WLV	4.4 mA
40WHV	1.4 mA
80WHV	3.2 mA

j. Repeat this test (steps a through i) for each output in your supply.

3-27 CC RMS Noise. This test measures the rms noise in the output when operating in the constant current mode.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with an rms voltmeter connected across the output, the load switch closed, and the short switch opened.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT switch on front panel).

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c. Program the current of the selected output to 1.9 amps and the output voltage to 20.2 volts by sending the following strings:

ISET < ch >, 1.9
VSET <ch>, 20.2

NOTE

This test must be performed with a resistive load only. The use of an electronic load will invariably inject extra ripple and may cause the CC RMS noise to be out of specification.

d. Adjust the load resistor to about 10 ohms so that the output voltage is close to 19 volts. Check that the CC annunciator is on.
e. Note that the reading on the rms voltmeter should be less than 10 mV (equivalent to 1mA RMS).
f. Repeat this test (steps a through e) for each output in your supply.

3-28 Performance Test Record

All of the performance test specifications for the power supply listed are in Tables 3-4 and/or 3-5. Table 3-4 covers the 40WLV and 80WLV outputs; Table 3-5 covers the 40WHV and 80WHV outputs.

3-29 EXTENDED TESTS

These tests are similar to the Performance Tests except they have a much longer duration and are conducted with controlled temperature conditions.

3-30 Output Drift

The tests are divided into two parts: short term and long term drift. For all drift tests, place the supply to be tested in a temperature chamber or in a temperature controlled environment such as a standards room.

3-31 Short Term Voltage Drift Test. This test measures the change in output voltage within the first 30 minutes of a change in the line voltage or the load.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with the load switch closed and the short switch opened. Connect the supply to the ac power line through a variable voltage transformer and adjust it for the nominal value.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on front panel).
c. Program the current of the selected output to the Low Range Maximum Programmable Current value and the output voltage to the Low Range Full Scale value (see Table 3-2).
d. Adjust the load for slightly less than Low Range Full Scale Current as read on the display. Check that the CV annunciator is on.
e. Adjust the transformer to 13% below the nominal line voltage.
f. Wait 30 minutes for the output to stabilize under these initial conditions and then record the output voltage value.
g. Adjust the transformer to 6% above the nominal line voltage.
h. Wait 30 minutes and record the output voltage value again. The difference in the readings taken in steps f and h should be less than 5.0 mV for 40WLV/80WLV outputs and 10.4 mV for 40WHV/80WHV outputs.
i. Open the load switch and immediately record the output voltage reading.
j. Wait 30 minutes and record the output voltage reading. The difference in the readings taken in steps i and j should be less than 5.0 mV for 40WLV/80WLV outputs and 10.4 mV for 40WHV/ 80WHV outputs.
k. Repeat steps a through j for each output in your supply.

3-32 Short Term Current Drift Test. This test measures the change in output current within the first 30 minutes of a change in the line voltage or the load. Place the supply to be tested in a temperature chamber or in a temperature controlled environment such as a standards room.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with the DVM connected across the current monitoring resistor, the load switch closed, and the short switch opened. Connect the supply to the ac power line through a variable voltage transformer and adjust it for the nominal value.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on front panel).
c. Program the current of the selected output to the Low Range Full Scale Current value and the output voltage to the Low Range Maximum Programmable Voltage value (See Table 3-2).
d. Adjust the load until the output enters the CC mode with the displayed output voltage slightly less than the Low Range Full Scale Voltage value. The CC annuciator must be on.
e. Adjust the transformer to 13% below the nominal line voltage.
f. Wait 30 minutes for the output to stabilize under these conditions and record the output current (DVM reading X 10).
g. Adjust the transformer to 6% above the nominal line voltage.
h. Wait 30 minutes and record the output current. The difference in the readings taken in steps f and h should be less than the values given below for the particular output type being tested.

Output	Drift
40WLV	9.5 mA
80WLV	19 mA
40WHV	6.2 mA
80WHV	12.4 mA

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i. Close the short switch and immediately record the output current.
j. Wait 30 minutes and again record the output current. The difference in the readings taken in steps i and j should be less than the values given in step h for the particular output type being tested.
k. Repeat steps a through j for each output in the supply.

3-33 Long Term Voltage Drift Test. This test measures the output voltage drift over an 8 hour period. Place the supply to be tested in a temperature chamber or in a temperature controlled environment such as a standards room.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with the DVM connected across the + S and - S terminals, the load switch closed, and the short switch opened.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. Program the current of the selected output to the Low Range Maximum Programmable Current value and the output voltage to the Low Range Full Scale value (see Table 3-2).
d. Adjust the load for slightly less than Low Range Full Scale Current as read on the display. Check that the CV annunciator is on.
e. Wait 30 minutes and record the output voltage reading on the DVM.
f. Observe and record the output voltage reading periodically over an 8 hour period. The difference between any two readings should not exceed 1.84 mV for 40WLV/80WLV outputs or 3.4 mV for 40WHV/80WHV outputs.
g. Repeat steps a through f for each output in your supply.

3-34 Long Term Current Drift. This test measures the output current drift over an 8 hour period. Place the supply to be tested in a temperature chamber or in a temperature controlled environment such as a standards room.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with the DVM connected across the current monitoring resistor, the load switch closed, and the short switch opened.
b. Turn on the supply and select the output to be tested (OUTPUT Select key on the front panel).
c. Program the current of the selected output to the Low Range Full Scale Current value and the output voltage to the Low Range Maximum Programmable Voltage value (see Table 3-2).
d. Adjust the load until the output enters the CC mode with the displayed output voltage slightly less than the Low Range Full Scale Voltage value as read on the front panel display. Check that the CC annunciator is on.
e. Wait 30 minutes and record the output current (DVM reading X 10).
f. Observe and record the output current reading periodically over an 8 hour period. The difference between any two readings should be less than the value listed below for the particular output type tested.

Output	Drift
40WLV	3.6 mA
80WLV	7.2 mA
40WHV	2.64 mA
80WHV	5.28 mA

g. Repeat steps a through f for each output in your supply.

3-35 TEMPERATURE COEFFICIENT (TC) TESTS

These tests check certain temperature coefficient specifications with the supply placed in a temperature controlled oven that provides an even temperature distribution. The temperature is varied over the supply's operating range and changes in output voltage and current are measured. The supply is left in the oven for 30 minutes to ensure stability. Note that the test equipment,. e.g. current monitor resistor, DVM, load, etc., is located outside of the oven.

3-36 Output Voltage and Readback Voltage TC

a. Turn off the supply and connect the output to be tested as shown in Figure 3-3 with the DVM connected across the + S and -S terminals, the load switch closed, and the short switch opened.
b. Turn on the supply and select the output to be tested (OUTPUT SELECT key on the front panel).
c. Program the current of the selected output to the High Range Maximum Programmable Current value and the output voltage to the High Range Full Scale Voltage value (see Table 3-3).
d. Adjust the load for slightly less than High Range Full Scale Current as read on the display. Check that the CV annunciator is on.
e. Set the temperature chamber to 30 degrees C and allow 30 minutes for the output to stabilize.
f. Record the output voltage on the DVM.
g. Readback the output voltage over the GPIB and record the value.
h. Increase the temperature to 40 degrees C and allow 30 minutes for the output to stabilize.
i. Repeat steps f and g. Note the difference between the values read before and after the temperature change. The difference between the output voltage DVM readings should be less than 16 mV for 40WLV/80WLV outputs or less than 40 mV for 40WHV/80W`HV outputs. The difference the readback voltage should be less than 21 mV for 40WLV/80WLV outputs or less than 50 mV for 40WHV/80WHV outputs.

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j. Repeat steps a through i for each output in your supply.

3-37 Output Current and Readback Current TC

a. Repeat steps a through d of paragraph 3-33.
b. Set the temperature chamber to 30 degrees C and allow 30 minutes for the output to stabilize.
c. Record the output current (DVM reading X 10).
d. Readback the output current over the GPIB and record the value.
e. Increase the temperature to 40 degrees C and wait 30 minutes for the output to stabilize.
f. Repeat steps c and d. Note the difference between the values read before and after the temperature change. The differences should not be more than those listed below for the particular output being tested.

Output	Current TC Spec.	Current Readback TC Spec.
40WLV	10 mA	6.25 mA
80WLV	20 mA	12.5 mA
40WHV	4.2 mA	2.4 mA
80WHV	8.4 mA	4.9 mA

g. Repeat steps a through f for each output in your supply.

3-38 Negative Current Limit (-CC) Readback TC

a. Repeat steps a through d of paragraph 3-24.
b. Set the temperature chamber to 30 degrees C and allow 30 minutes for the output to stabilize.
c. Record the negative current limit value (DVM reading x 10).
d. Readback the current over the GPIB and record this value.
e. Increase the temperature to 40 degrees C and wait 30 minutes for the output to stabilize.
f. Repeat steps c and d. Note the difference between the values read before and after the temperature change. The differences should not be more than those listed below for the particular output being tested.

Output	Negative Current Limit Readback TC Spec
40WLV	11.3 mA
80WLV	22.6 mA
40WHV	4.4 mA
80WHV	8.6 mA

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Table 3-4. Performance Test Record for 40WLV and 80WLV Outputs

Model _____	**40WLV** _____ **80WLV** _____	**Pre Cal**_____**Post Cal**_____
Serial No._____	**Temperature** _____	**Test Performed By**_____
Output No._____	**Humidity** _____	**Date** _____

Para.	Test	Specification		Actual
		40WLV	80WLV	
3-12	CV PROGRAMMING @ 0 Volts			
	Output Accuracy (DVM Reading)	0 V ± 19 mV	0 V ± 19 mV	_____
	Display Accuracy	DVM ± 25 mV	DVM ± 25 mV	_____
	Readback Accuracy	DVM ± 20 mV	DVM ± 20 mV	_____
	CV PROGRAMMING @ FULL SCALE			
	Output Accuracy (DVM Reading)	20 V ± 31 mV	20 V ± 31 mV	_____
	Display Accuracy	DVM ± 35 mV	DVM ± 35 mV	_____
	Readback Accuracy	DVM ± 30 mV	DVM ± 30 mV	_____
3-13	CV LOAD EFFECT	± 2 mV	± 2 mV	_____
3-14	CV SOURCE EFFECT	± 3 mV	±3 mV	_____
3-15	CV NOISE (PARD)			
	Peak to Peak	3 mV	3 mV	_____
	Rms	500 μV	500 μV	_____
3-16	CV DOWN PROG. SPEED			
	Time Constant to 37% (7.4 V)	250 μS	250 μS	_____
	To +20 mV	2 mS	2 mS	_____
3-17	CV UP PROGRAMMING SPEED			
	Time Constant to 63% (12.6 V)	250 μS	250 μS	_____
	To Full Scale −20 mV	2 mS	2 mS	_____
3-18	TRANSIENT RECOVERY @ 75 μS	75 mV	75 mV	_____
3-19	TURN ON/OFF OVERSHOOT	0 V ± 100 mV	0 V ±100 mV	_____
3-20	OVERVOLTAGE PROTECTION			
	Fixed OV	22.7 to 25.7 V	22.7 to 25.7 V	_____
	Programmable @19 V	18.74 to 19.26 V	18.74 to 19.26 V	_____
	External OV	Check if OK	Check if OK	
3-23	CC PROGRAMMING @ 0 Amps			
	Output Accuracy (Io)	80 mA ± 50 mA	130 mA ± 100 mA	_____
	Display Accuracy	Io ± 15 mA	Io ± 25 mA	_____
	Readback Accuracy	Io ± 10 mA	Io ± 20 mA	_____
	CC PROGRAMMING @ FULL SCALE			
	Output Accuracy (Io)	5A ± 58 mA	10A ±116 mA	_____
	Display Accuracy	Io ± 20 mA	Io ± 35 mA	_____
	Readback Accuracy	Io ± 15 mA	Io ± 30 mA	_____
3-24	−CC			
	Low Range Limit (Is)	5.35 to 5.85A	10.7 to 11.7A	_____
	Display Accuracy	Is ± 42 mA	Is ± 78 mA	_____
	Readback Accuracy	Is ± 37 mA	Is ± 73 mA	_____
	High Range Limit	2.25 to 2.55A	4.5 to 5.1A	_____
3-25	CC LOAD EFFECT	± 1 mA	± 2 mA	_____
3-26	CC SOURCE EFFECT	± 2.2 mA	± 4.4 mA	_____
3-27	CC NOISE (RMS)	1 mA	1 mA	_____

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Table 3-5. Performance Test Record for 40WHV and 80WHV Outputs

Model _____ **40WHV** _____ **80WHV** _____ **Pre Cal**_____**Post Cal**_____

Serial No._____ **Temperature** _____ **Test Performed By**_____

Output No._____ **Humidity** _____ **Date** _____

Para.	Test	Specification		Actual
		40WHV	80WHV	
3-12	CV PROGRAMMING @ 0 Volts			
	Output Accuracy (DVM Reading)	0 V ± 25 mV	0 V ± 25 mV	_____
	Display Accuracy	DVM ± 55 mV	DVM ± 55 mV	_____
	Readback Accuracy	DVM ± 50 mV	DVM ± 50 mV	_____
	CV PROGRAMMING @ FULL SCALE			
	Output Accuracy (DVM Reading)	50 V ± 50 mV	50 V ± 50 mV	_____
	Display Accuracy	DVM ± 80 mV	DVM ± 80 mV	_____
	Readback Accuracy	DVM ± 75 mV	DVM ± 75 mV	_____
3-13	CV LOAD EFFECT	± 2 mV	± 2 mV	_____
3-14	CV SOURCE EFFECT	± 6 mV	±6 mV	_____
3-15	CV NOISE (PARD)			
	Peak to Peak	3 mV	3 mV	_____
	Rms	500 μV	500 μV	_____
3-16	CV DOWN PROG. SPEED			
	Time Constant to 37% (18.5 V)	750 μS	750 μS	_____
	To +50 mV	6 mS	6 mS	_____
3-17	CV UP PROGRAMMING SPEED			
	Time Constant to 63% (12.6 V)	750 μS	750 μS	_____
	To Full Scale −50 mV	6 mS	6 mS	_____
3-18	TRANSIENT RECOVERY @ 75 μS	75 mV	75 mV	_____
3-19	TURN ON/OFF OVERSHOOT	0 V ± 100 mV	0 V ±100 mV	_____
3-20	OVERVOLTAGE PROTECTION			
	Fixed OV	56.8 to 63.5 V	56.8 to 63.5 V	_____
	Programmable @49 V	48.38 to 49.62 V	18.74 to 19.26 V	_____
	External OV	Check if OK	Check if OK	
3-23	CC PROGRAMMING @ 0 Amps			
	Output Accuracy (Io)	50 mA ± 20 mA	70 mA ± 40 mA	_____
	Display Accuracy	Io ± 4.5 mA	Io ± 8.5 mA	_____
	Readback Accuracy	Io ± 4 mA	Io ± 8 mA	_____
	CC PROGRAMMING @ FULL SCALE			
	Output Accuracy (Io)	2 A ± 23 mA	4 A ±46 mA	_____
	Display Accuracy	Io ± 6.5 mA	Io ± 12.5 mA	_____
	Readback Accuracy	Io ± 6 mA	Io ± 12 mA	_____
3-24	−CC			
	Low Range Limit (Is)	2.15 to 2.35 A	4.3 to 4.7 A	_____
	Display Accuracy	Is ± 13.5 mA	Is ± 30 mA	_____
	Readback Accuracy	Is ± 13 mA	Is ± 29.5 mA	_____
	High Range Limit	0.9 to 1.02 A	2.1 to 2.5 A	_____
3-25	CC LOAD EFFECT	± 0.5 mA	± 1 mA	_____
3-26	CC SOURCE EFFECT	± 1.4 mA	± 3.2 mA	_____
3-27	CC NOISE (RMS)	1 mA	1 mA	_____

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Section IV
TROUBLESHOOTING

WARNING

Most of the maintenance procedures given in this section are performed with power applied and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock).

4-1 INTRODUCTION

This section provides troubleshooting and repair information for the power supply. The troubleshooting technique is to first isolate the problem to an assembly and then follow the troubleshooting procedure provided for the faulty assembly. The assembly (GPIB board or output board) troubleshooting procedures will isolate the problem to the defective component or circuit on the board.

Before attempting to troubleshoot the supply, ensure that the fault is with the supply itself and not with an associated circuit, load, or power line. The verification tests described in Section III enable this to be determined without having to remove the covers from the supply.

The most important aspect of troubleshooting is the formulation of a logical approach to locating the source of trouble. A good understanding of the principles of operation is particularly helpful and it is recommended that Section II of this manual as well as the Operating Manual (Agilent Part No. 9557-6377) be reviewed before attempting to troubleshoot the unit.

If a component is found to be defective, replace it and re-conduct the performance tests given in Section III of this manual. When the GPIB board or the EEPROM (U221) IC on the GPIB board is replaced, each output present in the supply must first be recalibrated as described in Appendix A of the operating Manual. If an Output board is replaced, the associated output channel must be recalibrated. If a component in the output circuits or readback circuits on an output board is replaced, the output must be calibrated before you can reconduct the performance tests.

Section V in this manual lists all of the replaceable parts for the power supply.

4-2 ELECTROSTATIC PROTECTION

CAUTION

This instrument uses components which can be damaged by static charge. Most semiconductors can suffer serious performance degradation as a result of static charge, even though complete failure may not occur. The following precautions should be observed when handling static-sensitive devices.

a. Always turn power off before removing or installing printed circuit boards or components.
b. Always store or transport static-sensitive devices (all semiconductors and thin-film devices) in conductive material. Attach warning labels to the container or bag enclosing the device.
c. Handle static-sensitive devices only at static-free work stations. These work stations should include special conductive work surfaces (such as Agilent Part No. 9300-0797) grounded through a one-megohm resistor. Note that metal table tops and highly conductive carbon-impregnated plastic surfaces are too conductive; they can shunt charges too quickly. The work surfaces should have distributed resistance between 10^6 and 10^{12} ohms per square.
d. Ground all conductive equipment or devices that may come in contact with static-sensitive devices or assemblies.
e. Where direct grounding of objects in the work area is impractical, a static neutralizer should be used (ionized-air blower directed at work). Note that this method is considerably less effective than direct grounding and provides less protection for static-sensitive devices.
f. While working with equipment on which no point exceeds 500 volts, use a conductive wrist strap in contact with skin. The wrist strap should be connected to ground through a one-megohm resistor. A wrist strap with insulated cord and built-in resistor is recommended, such as 3M Co. No. 1066 Agilent Part No. 9300-0969 (small wrist size) and 9300-0970 (large).

WARNING

Do not wear a conductive wrist strap when working with potentials in excess of 500 volts; the one-megohm resistor will provide insufficient current limiting for personal safety.

g. All grounding (device being repaired, test equipment, soldering iron, work surface, wrist strap, etc.) should be done to the same point.
h. Do not wear synthetic (e.g. nylon) clothing. Keep clothing of any kind from coming within 12 inches of static-sensitive devices.
i. Low-impedance test equipment (signal generators, logic pulsers, etc.) should be connected to static-sensitive inputs only while the components are powered.

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j. Use a mildly activated rosin core solder (such as Alpha Metal Reliacor No. 1, Agilent Part No. 8090-0098) for repair. The flux residue of this type of solder can be left on the printed-circuit board. Generally, it is safer not to clean the printed-circuit board after repair. Do not use Freon or other types of spray cleaners. If necessary, the printed-circuit board can be brushed using a natural-bristle brush only. Do not use nylon-bristle or other synthetic-bristle brushes. Do not use high-velocity air blowers (unless ionized).

k. Keep the work area free of non-conductive objects such as Styrofoam-type cups, polystyrenefoam, poly-ethylene bags, and plastic wrappers. Non-conductive devices that are necessary in the area can be kept from building up a static charge by spraying them with an anti-static chemical (Agilent Part No. 8500-3397).

i. Do not allow long hair to come in contact with static-sensitive assemblies.

4-3 REMOVAL AND REPLACEMENT

The major assemblies within the power supply are illustrated in Figure 4-1. The major differences between the models are the quantity and type of output boards they contain. the 80 Watt Output boards are about twice the size of the 40 Watt Output boards. Figure 4-1 shows the board configuration for each model. Component location diagrams and functional schematics for the individual assemblies are given in Section VI. Replaceable electrical and mechanical parts for all models are listed in Section V. The following paragraphs provide instructions for removing certain assemblies and components for which the procedure may not be obvious upon inspection. Replacement procedures are essentially the same as the corresponding removal procedure except that they are performed in the reverse order.

WARNING

To avoid the possibility of personal injury, remove the power supply from operation before removing the covers. Turn off ac power and disconnect the line cord, GPIB cable, loads, and remote sense leads before attempting any repair or replacement.

CAUTION

Most of the attaching hardware is metric. Use of other types of fasteners will damage threaded inserts. When removing or installing screws, use a No. 1 or a No. 2 Pozidriv screwdriver.

4-4 Top Cover Removal

The top cover must be removed to gain access to the assemblies inside the supply. To remove the cover, proceed as follows:

a. Remove the four screws which hold the carrying straps.

b. Spread the bottom rear of the cover slightly and pull back to disengage it from the front panel.

c. Remove the top cover. Note that you can use the top cover assembly as a support when you open the top chassis in the next procedure.

4-5 Gaining Access to Assemblies in the Supply

As shown in Figure 4-1, each power supply model contains an GPIB board and at least two output boards. The output boards are mounted on an upper chassis assembly and in the lower section of the main chassis. The upper chassis assembly is hinged and its output boards are mounted with the components facing down. The output board(s) in the main chassis are mounted with the components facing up. To gain access to the output boards, the GPIB board, power transformer, and other components inside the supply, proceed as follows:

a. Remove four screws located on top of the chassis near the front.

b. Remove three screws from top left side and two screws from rear which hold the upper chassis to the main chassis.

c. Open the hinged upper chassis by lifting it from the left side. This will give you access to the components on the output board(s) mounted in the hinged upper chassis as well as those mounted in the lower main chassis. Be sure to avoid any cable snag when opening the hinged chassis.

d. Place the removed top cover assembly under the opened upper chassis for support.

4-6 GPIB Board Removal

Looking at the unit from the front, the GPIB board is located on the right side with its components facing to the left. Most of the components are accessible for test purposes without removing the board from the unit. However, for easy access it is best to remove the board from the unit. To remove the GPIB board, proceed as follows:

a. Disconnect all cables. Note the routing of cables if they have to be removed since their position may affect the supply's ripple performance.

b. Remove two hex standoffs from rear which secure the GPIB connector to the chassis. Retain the lock or flat washers for reassembly.

c. Remove one ground screw from the top front of the GPIB board. Retain lock or flat washers for reassembly.

d. Slide board forward approximately 1/4 inch to disengage the keyed standoffs.

e. Lift board out of chassis.

4-7 40 Watt output hoard Removal

Model 6623A has two 40 Watt Output boards located in the main chassis and Models 6624A and 6627A have four 40 Watt Output boards; two boards are mounted in the upper chassis assembly and two are mounted in the main chassis. To remove a 40 Watt Output boards, proceed as follows:

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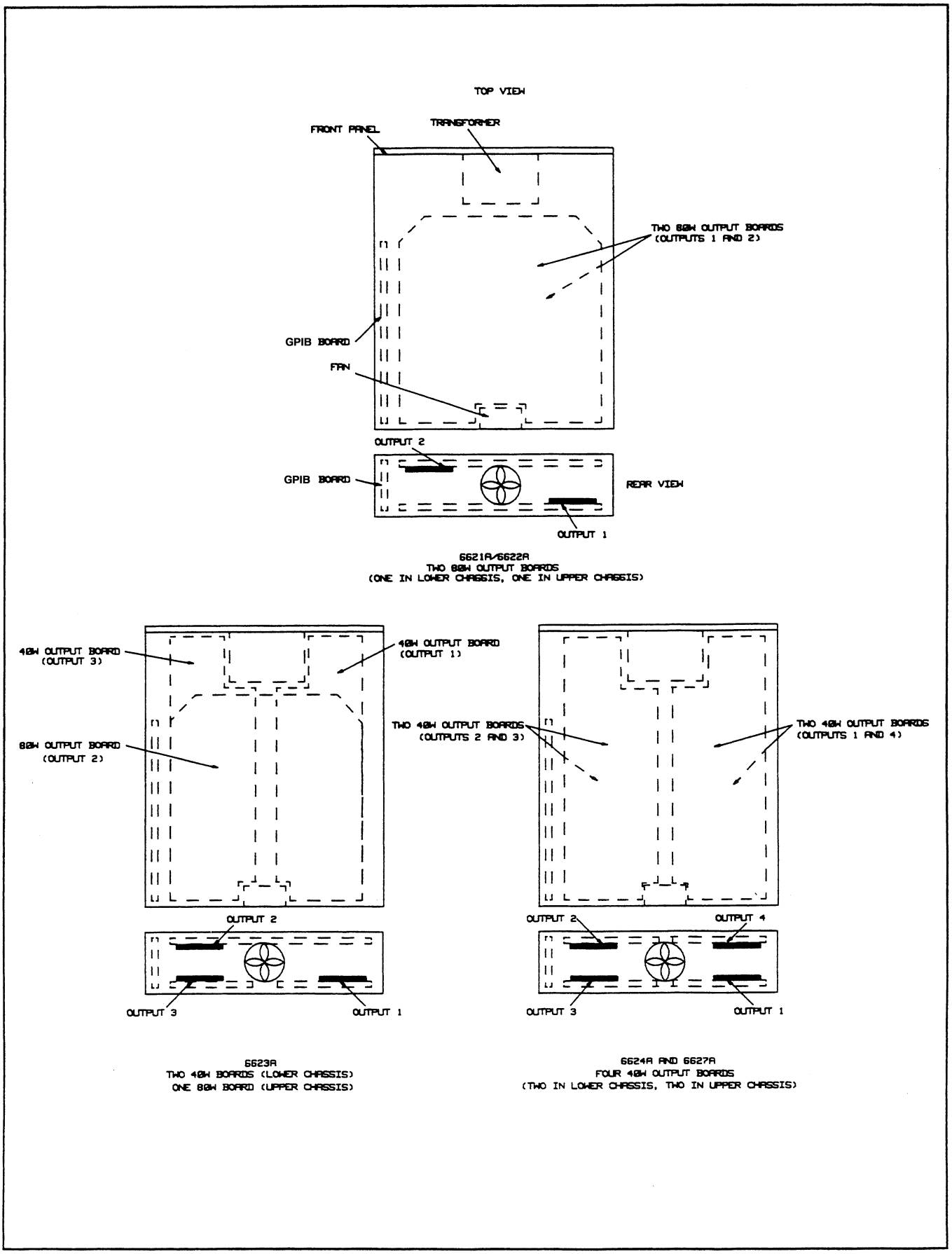


Figure 4-1. Agilent 6621A-6624A and 6627A Multiple Output Power Supplies, Assembly Locations

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NOTE

Before you can remove output 3, located in the main chassis, you must remove the GPIB board.

a. Disconnect all cables. Note the routing of cables if they must be removed since cable position may affect the output's ripple performance.
b. Remove one ground screw located at rear of board near terminal block. Retain the lock or flat washers for reassembly.
c. Remove one ground screw located at extreme front of board. Retain the lock or flat washers for reassembly.
d. Remove two screws which hold the heat sink assembly to the chassis. These must be removed completely.
e. Slide the board slightly forward to disengage the keyed standoffs.
f. Lift board out of chassis.

4-8 80 Watt Output boards

Models 6621A and 6622A each have two 80 Watt Output boards; one mounted in the upper chassis and one in the lower chassis. Model 6623A has one 80 Watt Output board which is mounted in the upper chassis assembly. To remove an 80 Watt Output Board, proceed as follows:

NOTE

Before you can remove the output board located in the main chassis (output 1), you must remove the GPIB board.

a. Disconnect all cables. Note the routing of cables if they must be removed since cable position may affect the supply's ripple performance.
b. Remove two screws on rear of board.
c. Remove two screws located near the front of the board. Retain the lock or flat washers for reassembly.
d. Remove four screws which hold the heat sink assembly to the chassis. These screws must be removed completely.

NOTE

If an insulator is present beneath the heat sink assembly, be sure to align all four holes in the insulator with the heat sink holes when replacing the four screws.

e. Slide the board forward slightly to disengage the keyed standoffs.
f. Lift the board out of the chassis.

4-9 Replacing the Power Module U338 (U339)

Use the following procedure when it has been determined that the power module (U338 on 40 W boards; U338 and U339 on 80 W boards) is defective and must be replaced:

40 Watt Output Boards

a. Remove the output board as described in paragraph 4-7.
b. Carefully unsolder all 14 power module pins.
c. Remove the power module and heat sink from the board.
d. Remove four power module screws and retain all hardware.
e. Wipe the heat sink surface to remove the old layer of heat sink compound. Apply a thin layer of new compound to the back surface of the replacement power module.
f. Reassemble using the reverse of the above procedure.

CAUTION

Before soldering the new power module/heat sink assembly to the board, be sure that the heat sink lies flat and securely against the board. Use the long heat sink screws and M4 nuts to temporarily hold the assembly to the board while soldering.

80 Watt Output Boards

a. Remove the output board as described in paragraph 4-8.
b. Use the same procedure outlined above but note that for 80 Watt boards, U338 and U339 are a matched pair. Therefore, both power modules must be replaced if either module fails.
c. Note that if an insulator is present under the heat sink assembly, be sure to align it properly as outlined in paragraph 4-8.

4-10 Front Panel Removal

The front panel contains the keypad assembly, LCD display assembly, and the line switch. You must remove the front panel in order to gain access to these components. The LCD display and line switch are replaceable components. On some units you may have to replace the front panel if the keypad is defective. To remove the front panel assembly, proceed as follows:

a. Disconnect the keypad and display ribbon cables from P202 and P203 on the GPIB board. Ensure that these cables are not pinched between the front panel and the chassis when reassembling.
b. Remove the grounding screw nut located behind the front panel (upper right corner or below display). This nut is accessible through cut outs in the chassis.

CAUTION

Do not overtighten the grounding screw nut when replacing the front panel.

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c. Remove the rack ears or vinyl trim from the sides of the front panel.
d. Remove the two screws on each side of front panel.
e. Slide the panel forward.

4-11 Chassis Mounted Components

The power transformer is fastened to a mounting bracket by mounting screws, flat washers, and shoulder washers. Before removing the attaching hardware, disconnect the power cable leads at the transformer.

CAUTION

To avoid breaking the transformer tabs (lugs), do not bend the transformer tabs. When disconnecting a lead, pull the lead connector straight back from the tab. When reconnecting a lead, push the connector straight forward onto the transformer tab. Do not flex the leads or tabs when making connections or disconnections.

When replacing the transformer, refer to the label on the transformer to ensure you reconnect the leads correctly. You can also refer to Figure 6-1 which shows all AC connections schematically for each of the models.

The fan and fan guard are secured to the chassis by mounting screws, flat washers, and nuts. Remove this hardware, disconnect the ac connector on the fan assembly, and lift the fan from the unit.

WARNING

Be sure to remove the AC line cord from the unit before attempting to work on the AC line module.

To remove the AC line module, first disconnect all of the wires from it (including the RFI capacitor). Then use a screwdriver inside the unit to press the mounting clip on one side of the line module and push (from inside the unit) that side of the module slightly away from the chassis. Finally, use the screwdriver again to press on the mounting clip on the other side of the module and push that side out. The module can be replaced simply by sliding it straight back into the mounting hole until the mounting clips spring into position securing the module. The wires can be replaced according to the AC connections shown in Figure 6-1.

4-12 TEST EQUIPMENT REQUIRED

Table 4-1 lists the test equipment required to troubleshoot the power supply. Recommended models are listed.

4-13 FUSE REPLACEMENT

Table 4-2 gives the rating of the fuses in the supplies. The clip mounted ac line fuse is located in the line module on the rear of the supply. The line module also contains a voltage selection card which must be set to the associated ac input (100, 120,220, or 240 VAC). Section II in the Operating Manual (Agilent 5957-6332) explains how to change the line voltage setting.

The GPIB board has one fuse F201 as shown in Figure 4-2. The 40WLV Output board and 40WHV Output board fuse locations are shown in Figures 4-3 and 4-4, respectively. The 80WLV Output board and 80WHV Output board fuse locations are shown in Figure 4-5. The fuses are shown schematically in Figures 6-1 through 6-3 in the rear of this manual.

Table 4-1. Test Equipment Required for Troubleshooting

Type	Purpose	Recommended Model
GPIB Controller	Communicate with the supply via the GPIB	Agilent 9825, 85, or Series 200 Controller
Signature Analyzer	Test most of the circuits on the GPIB board	Agilent 5005A
Digital Voltmeter	Check various voltage levels.	Agilent 3456A
5 V, 12 A Power Supply	Check current sink operation and negative current limit.	Agilent 6274B
Logic Probe	Check bus lines on output board.	Agilent 545A
Oscilloscope	Check clock signal, waveforms, and signal levels on GPIB and output boards.	Agilent 1740A
Frequency Counter	Check operation of the RAM and ROM on the GPIB board.	Part of Agilent 5005A or use an Agilent 5384A
Load Resistor	100 ohms, 100 W	

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Table 4-2. Fuses

Location/Ref. Desig.	Description	Rating	Agilent Part No.
AC Line Module, Figure 6-1			
F1	Main fuse(ac line). Clip mounted in line module on rear of unit.	For 100/120 V 8 A, 250 V (Normal Blow) or For 220/240 V 4 A, 250 V (Normal Blow)	2110-0342 2110-0055
HP-IB Board, Figure 6-2			
F201	Bias supply fuse (Soldered to board)	4 A, 125 V	2110-0712
40WLV Output Board, Fig. 6-3 Sheet 2			
F300,F301, F305,F306	Secondary ac input fuses	10 A, 125 V	2110-0713
F302	Output bleed circuit and downprogrammer circuit fuse	0.5 A, 125 V	2110-0716
F303	Output return fuse	7 A, 125 V	2110-0685
F304,F307	Secondary ac input fuses	7A, 125V	2110-0685
F308, F309	Bias AC Input Fuses	2 A, slo-blo	2110-0303
40WHV Output Board, Fig. 6-3 sheet 2			
F300,F301 F305,F306	Secondary ac input fuses	7 A, 125 V	2110-0685
F302	Output bleed circuit and downprogrammer circuit fuse	0.25 A, 125 V	2110-0763
F303	Output return fuse	7 A, 125 V	2110-0685
F304	Secondary ac input fuse	10 A, 125 V	2110-0713
F307	Not used		
F308, F309	Bias AC Input Fuses	2 A, slo-blo	2100-0303
80WLV Output Board, Fig. 6-3 Sheet 3			
F300, F301	Not used		
F302	Bleed circuit and downprogrammer circuit fuse	0.5 A, 125 V	2110-0716
F303	Output return fuse	20 A,250 V	2110-0767
F304	Secondary ac input fuse	8 SA slo-blo	2110-0383
F305, F306	Secondary ac input fuses	20 A, 250 V	2110-0767
F307	Not used		
F308, F309	Bias AC Input Fuses	2 A slo-blo	2110-0303

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Table 4-2. Fuses (continued)

Location/Ref. Desig.	Description	Rating	Agilent Part No.
80WHV Output Board, Fig. 6-3 Sheet 3			
F300, F301	Not used		
F302	Bleed circuit and downprogrammer circuit fuse	0.25 A, 125 V	2110-0763
F303	Output return fuse	8 A, 250 V	2110-0383
F304	Secondary ac input fuses	8 A, slo-blo	2110-0383
F305, F306	Secondary ac input fuses	8 A, 250 V	2110-0383
F308, F309	Bias AC Input Fuses	2 A slo-blo	2110-0303

NOTE:

The GPIB troubleshooting procedures in this section apply only to earlier through-hole board assemblies. Surface-mount GPIB assemblies are not repairable to the component level. If defective, the entire GPIB assembly must be replaced.

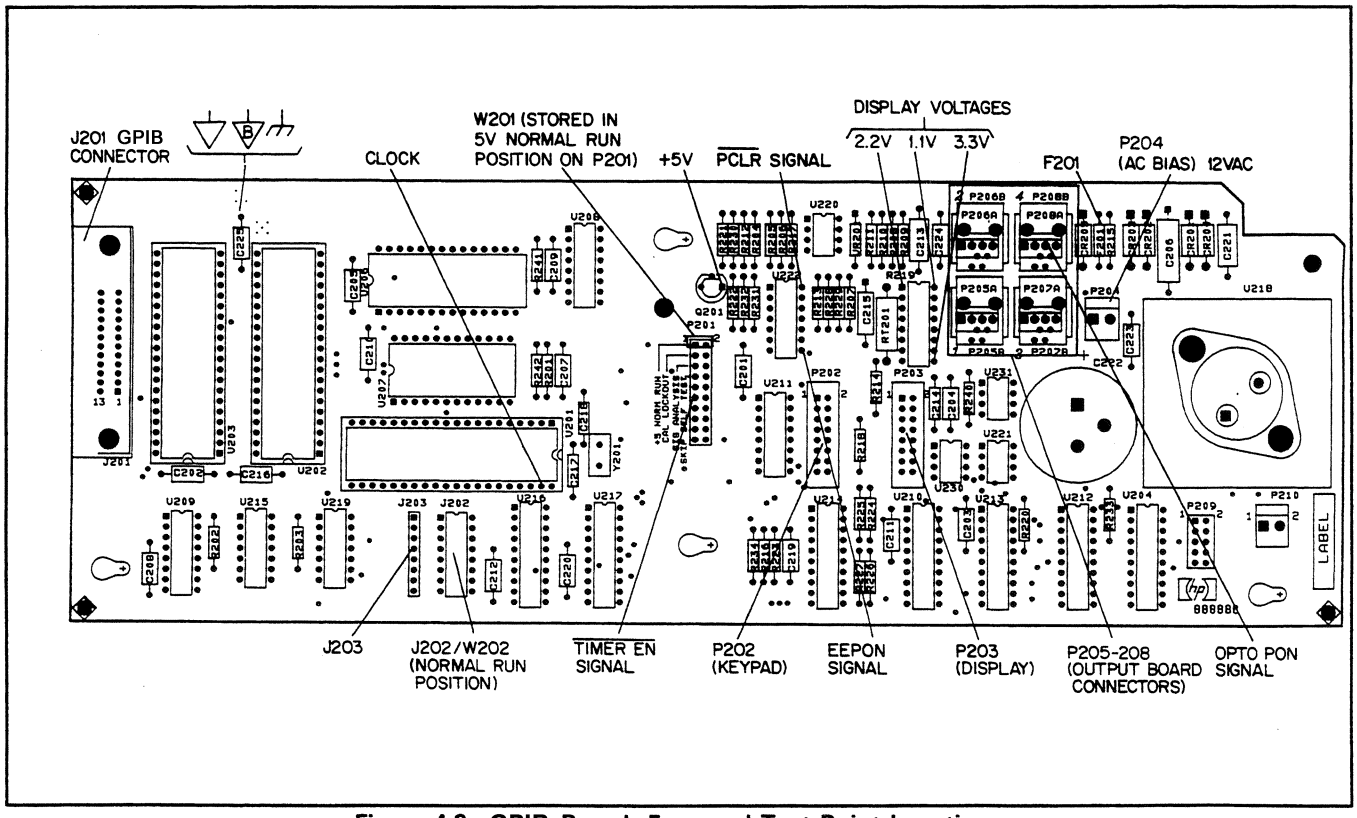


Figure 4-2. GPIB Board, Fuse and Test Point Locations

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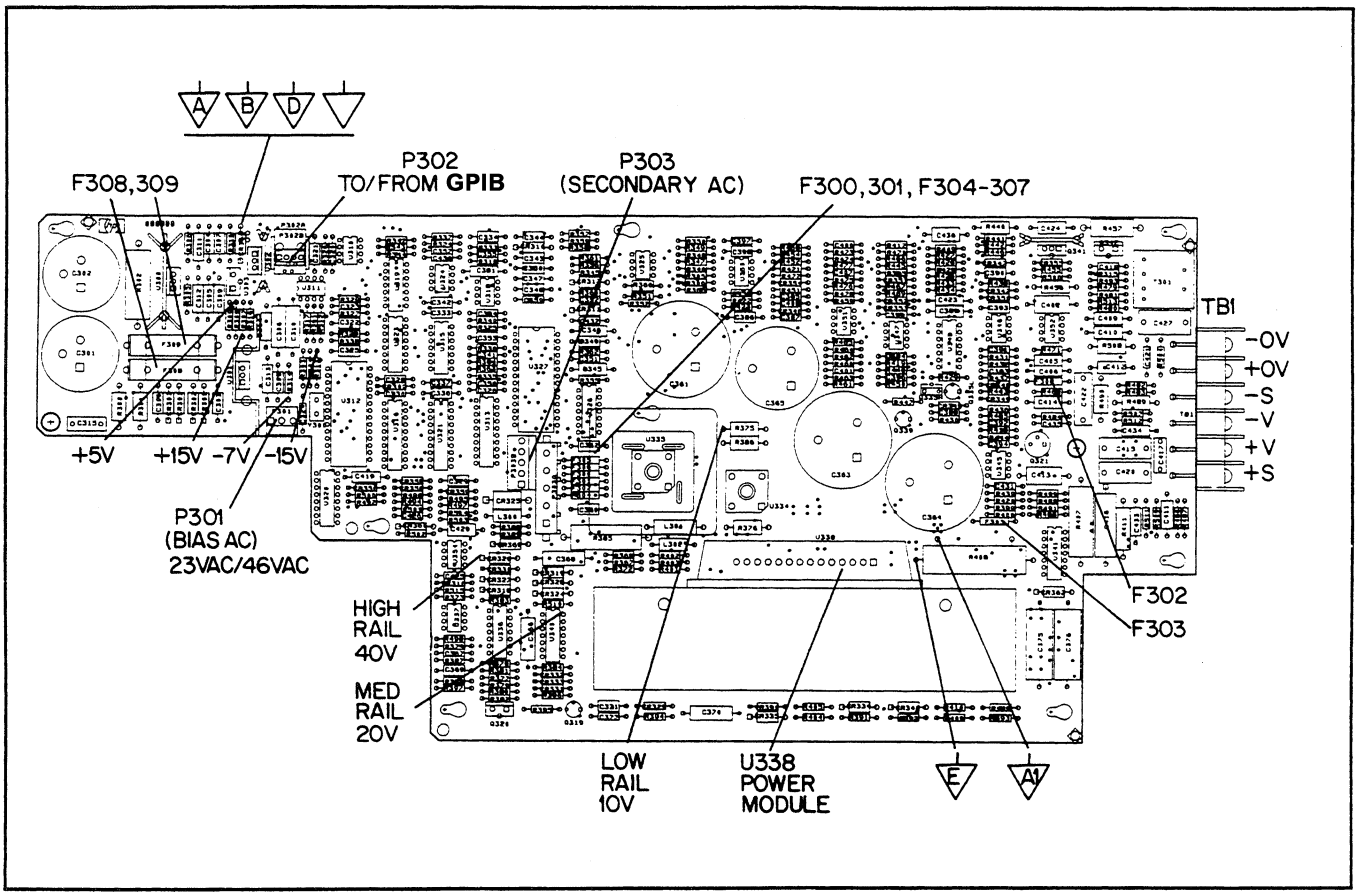


Figure 4-3. 40W Right Hand Output Board, Fuse and Test Point Locations

4-14 INITIAL TROUBLESHOOTING AND BOARD ISOLATION PROCEDURES

Initial troubleshooting procedures for the power supply are given in the flow chart of Figure 4-6. The procedures first ensure that an ac input failure is not causing the problem and that the supply passes the power on self test. The normal power on self test indications are described in Section III of the Operating Manual.

If the supply passes self test, the procedures check to see if each output channel can be programmed from the front panel and from the GPIB controller and if calibration is required. If the supply passes all of these tests, you are referenced to a table at the end of this section that lists various troubles and remedies not covered by the flow chart.

If the supply does not pass self test as indicated by a blank display, the flow chart isolates the problem to either an ac input problem, a defective GPIB board, or a defective display.

If the supply does not pass self test as indicated by a power on self test or ERR message, the flow chart isolates the problem to the GPIB board, one of the output boards, or to cabling.

4-15 Power-On Self Test

The power-on self test sequence performs tests on the GPIB board as well as on each output board in the supply. Table 4-3 lists the tests, the boards tested, and the error message that appears on the display if a particular test fails. Note that two of the output board tests (the RAM and ROM tests) are performed even when jumper W201 is installed in the SKIP SELF TEST position of connector P201 on the GPIB board (see paragraph 4-16). The other eight tests are skipped (not performed) if W201 is installed in the SKIP SELF TEST position.

If any board fails power-on self test, the OUTPUT ENABLE line (U312-22) is held high which keeps the ON/OFF line (U327-25) low. For this condition, the supply will not respond over the GPIB and none of the output boards will operate.

When W201 is installed in the SKIP SELF TEST position in service connector P201 on the GPIB board, a circuit problem that could have been detected with the self test will no longer cause the GPIB board to prevent the outputs from operating.

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Table 4-3. Tests Performed at Power-On

Test	Board Tested	Failed Test Error Message	With W201 in SKIP SELF TEST Position
RAM Test	GPIB	blank display	test skipped
ROM Test	GPIB	blank display	test skipped
8291	GPIB	8291 FAILED	test skipped
Timer	GPIB	TIMER FAILED	test skipped
CVDAC	Output	CV DAC CH <ch>	test skipped
CLDAC	Output	CL DAC CH <ch>	test skipped
OVDAC	Output	OV DAC CH <ch>	test skipped
Fuse	Output	FUSE CH <ch>	test skipped
RAM	Output	HDW ERR CH <ch>	test performed
ROM	Output	HDW ERR CH <ch>	test performed

Note that error number 22, SKIP SLF TST, is initially generated when W201 is in the SKIP SELF TEST position. This error is cleared when read. However, if an output board fails the output board RAM or ROM tests which are performed regardless of the W201 position, error number 11, 12, 13, or 14 (HDW ERR CH < ch >) is generated and will be regenerated after the error is read since the problem still exists.

Table 4-4 lists all of the self-test error messages that can appear on the front panel display when power is first turned on. Each message is explained and a troubleshooting procedure is recommended. This table is to be used in conjunction with Figure 4-6 and other troubleshooting flow charts provided in this section.

4-16 Connector P201 Jumper Positions

The GPIB board contains a connector (P201), see Figure 4-2, with jumper positions that are used for normal operation of the power supply or troubleshooting. The following discussion describes the function of each of four jumper positions.

+5 V NORM RUN: This jumper position is used as the normal running position. The two pins on P201 that W201 connects in this position are both tied to the GPIB board + 5 V bias supply. The jumper is simply stored in this position when not used in one of the other positions.

CAL. LOCKOUT: This position is an alternate to the NORM RUN position and is used to ensure against accidental calibration of the power supply. With W201 in this position, error number 18 (CAL LOCKED) is generated if an attempt is made to turn on the calibration mode (see Appendix A, in the Operating Manual).

SIG. ANALYSIS: This position is used to perform signature analysis on the GPIB board for troubleshooting the GPIB board (see para. 4-23).

SKIP SELF TEST: This position causes the power supply to skip the power-on self tests described in paragraph 4-15. This position allows the GPIB board to attempt to power on all output boards in the supply even if one or more output would not have passed self test.

CAUTION

Exercise care when using SKIP SELF TEST on a unit with output boards that are known to fail self test since the output may operate beyond its rated parameters. The output voltage may even reach full scale voltage without being programmed.

4-17 ERROR Codes and Messages

Table 4-5 lists all of the error codes and messages that can occur when operating the supply. Each code and the corresponding message (if applicable) are explained and a remedy or troubleshooting procedure is recommended. This table is used in conjunction with Figure 4-6 and other troubleshooting flow charts provided in this section.

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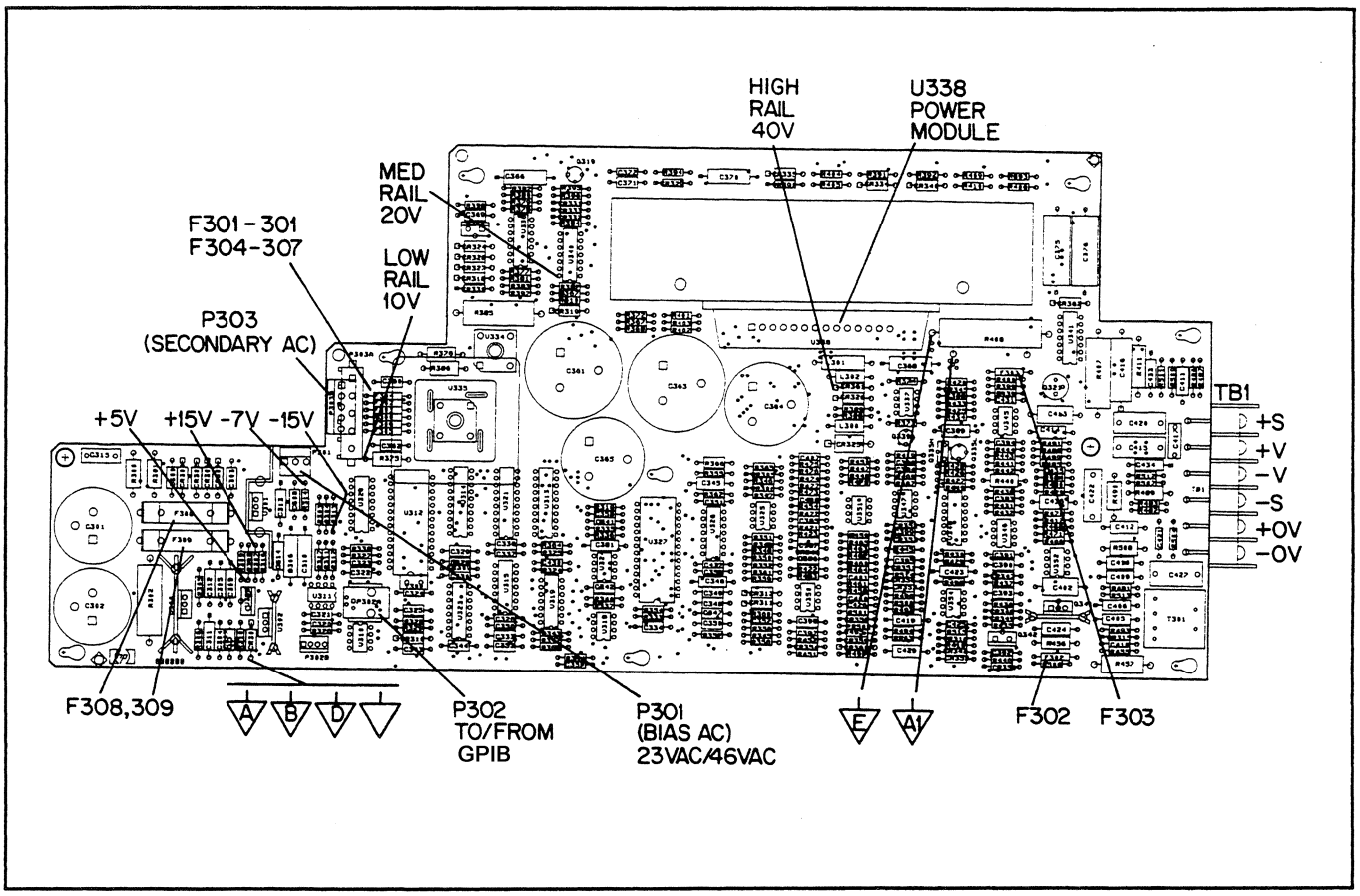


Figure 4-4. 40W Left Hand Output Board, Fuse and Test Point Locations

Table 4-4. Power-On Self Test Error Messages

Front Panel Display Message	Explanation/Troubleshooting Procedure
TIMER FAILED	The timer on the GPIB board failed. Microprocessor (U201) or real time clock (U209) could be defective. Perform GPIB board troubleshooting procedures (see paragraph 4-18).
8291 FAILED	The GPIB talker/listener U202 on the GPIB is probably defective. Perform S.A. test No. 5 (Table 4-10).
CV DAC CH <ch> *	The voltage DAC (U313/P/O U315) on the specified output board probably failed. Perform the output board troubleshooting procedures (see paragraph 4-25).
CC DAC CH <ch> *	The current DAC (U314/P/O U315) on the specified output board probably. Perform the output board troubleshooting procedures (see paragraph 4-25).
OV DAC CH <ch> *	The overvoltage (OV) DAC (U314/P/O U315) on the specified output board probably failed. Perform the output board troubleshooting procedures (see paragraph 4-25).
FUSE CH <ch>	The output return fuse (F303) on the specified output board is opened. If error occurs again after fuse has been replaced, the power module on the output board may be defective. Perform the output board troubleshooting procedures (see paragraph 4-25).
HDW ERR CH <ch>	The specified output board failed, the GPIB board is defective, or the cabling between the output board and GPIB board is defective. Follow the board isolation procedures outlined in Figure 4-6.

* If all three messages appear, the readback circuit is probably defective.

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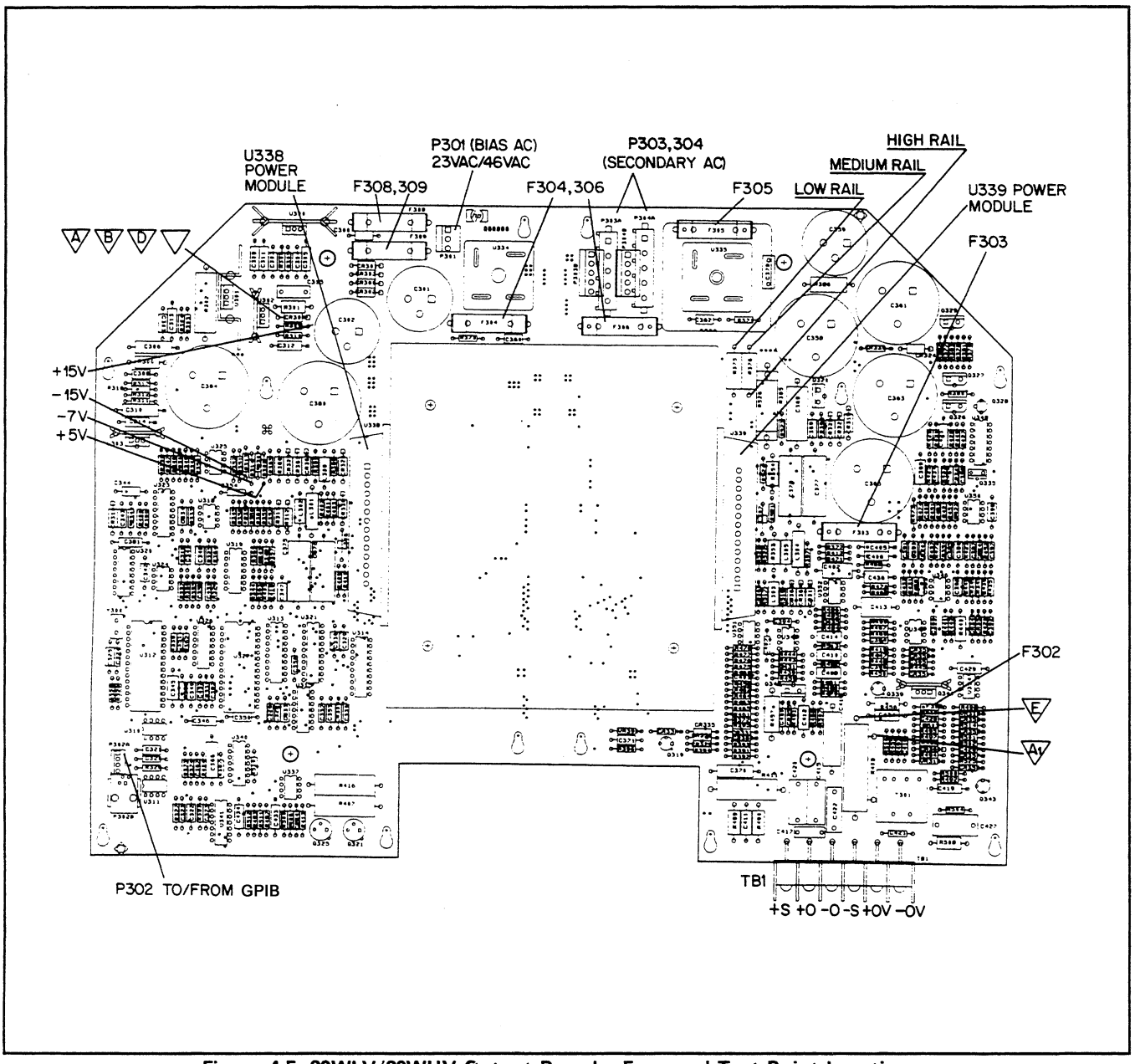


Figure 4-5. 80WLV/80WHV Output Boards, Fuse and Test Point Locations

Table 4-5. ERROR Codes and Messages

Message (ERR key)	Error Code (ERR? query)	Explanation and Remedy
Programming Errors		
NO ERROR	0	Indicates there are no errors.
INVALID CHAR	1	You sent a character that the supply did not recognize.
INVALID NUM	2	The format of your number string is incorrect. Check syntax (see Section V in the Operating Manual).
INVALID STR	3 or 28	You sent a command that the supply did not understand. Check command summary (see Appendix C in the Operating Manual).

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Table 4-5. ERROR Codes and Messages (continued)

Message (ERR key)	Error Code (ERR? query)	Explanation and Remedy
SYNTAX ERROR	4	You sent a command with improper syntax. Check the syntax of your command (see Section V in the Operating Manual).
NUMBER RANGE	5	An out of range number was sent. Send a new number within the acceptable range. If the error occurs again, the output may require calibration (See Appendix A in the Operating Manual).
NO QUERY	6	The computer addressed the supply to talk, but it did not first request data. Send query first, then address supply to talk.
DISP LENGTH	7	Quoted string in the DSP command exceeds the display length of 12 characters.
BUFFER FULL	8	May occur if too many characters are sent. Error code 4 or 5 is more likely to occur for the condition.
Hardware Errors		
EEPROM ERROR	9	The EEPROM (U221) on the GPIB board is not responding correctly to programming commands. Try recalibrating (see Appendix A in Operating Manual). If calibration doesn't work, troubleshoot the GPIB board (see paragraph 4-18).
HARDWARE ERR	10	An error has occurred on an output. The problem may be on the GPIB or the output board. This error only occurs if the SKIP SELF TEST jumper is installed and the channel with the hardware error is selected to be displayed.
HDW ERR CH 1	11	Error codes 11 through 14 refer to a specific output where an error has occurred. If all output channels have this error, the problem is probably on the GPIB board. If only a particular output channel has the error, follow the board isolation procedures in Figure 4-6 to isolate the problem to the defective output board, the GPIB board, or the cable between the specified output board and the GPIB board.
HDW ERR CH 2	12	Same as error code 11
HDW ERR CH 3	13	Same as error code 11
HDW ERR CH 4	14	Same as error code 11
NO MODEL NUM	15	The supply's model number cannot be found. The GPIB board may be defective (see paragraph 4-18) or the supply's model number may require reprogramming using the MODEL command (see paragraph 4-21).
UNCALIBRATED	17	Supply requires recalibration. An unexplained EEPROM error has occurred. Recalibrate as described in Appendix A of the Operating Manual. If recalibration doesn't fix the problem, troubleshoot the GPIB board (see paragraph 4-18).
SKIP SLF TST	22	Jumper W201 on the GPIB board is in the SKIP SELF TEST position of connector P201 (see Figure 4-2). Install W201 in the NORM RUN position and carry out self test if desired.
Errors that can occur while attempting calibration		
CAL ERROR	16	An error has occurred during calibration. This may result if out of range numbers are sent. If recalibration (see Appendix A in Operating Manual), doesn't fix the problem, there may be a hardware problem (see GPIB troubleshooting paragraph 4-18).

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Table 4-5. ERROR Codes and Messages (continued)

Message (ERR key)	Error Code (ERR? query)	Explanation and Remedy
CAL LOCK	18	Calibration was attempted with jumper W201 installed in the CAL LOCKOUT position of connector P201 on the HP-IB board (see Figure 4-2). Install W201 in the NORM RUN position and recalibrate if desired.
Error codes that can be sent back over the HP-IB in response to TEST?		
	0	No errors were detected.
TEST? initiates a self test of the supply. There are no messages on the front panel in response to the TEST? query. Only the applicable error code is sent back.	20	The timer on the HP-IB board failed. Microprocessor (U201) or real time clock (U208) could be defective. Perform the HP-IB troubleshooting procedures (see paragraph 4-18).
	21	The RAM (U207) on the HP-IB board failed self-test (see paragraph 4-18).
	27	The ROM (U206) on the HP-IB board failed self test(see paragraph 4-18).

4-18 GPIB BOARD AND FRONT PANEL TROUBLESHOOTING PROCEDURES

NOTE:

The GPIB troubleshooting procedures in this section apply only to earlier through-hole board assemblies. Surface-mount GPIB assemblies are not repairable to the component level. If defective, the entire GPIB assembly must be replaced.

Troubleshooting procedures for the GPIB board and Front Panel are given in the flow chart of Figure 4-7. The procedures first ensure that the bias voltages for the GPIB board circuits and the Front Panel display are correct. The microprocessor clock, the RAM, and ROM circuits are then checked. After these preliminary checks are made, signature analysis tests are performed as described in paragraph 4-22 to determine which component is defective.

4-19 Test Setup

The following test setup allows access to the components on the GPIB board:

a. Disconnect the line cord.
b. Remove the GPIB board as described in paragraphs 4-3 through 4-6.
c. Place an insulating material on the chassis and lay the GPIB board on top of the material.
d. Reconnect all cables in their proper locations.
e. Connect the line cord.

CAUTION

The GPIB board is connected to the chassis ground with one PC board screw and through the GPIB connector. When checking the GPIB board with an oscilloscope, be sure that the scope's ground is connected only to a ground point on the GPIB board itself. Connecting the scope ground to any other point on the GPIB board may result in damage to the supply.

4-20 Post Repair Calibration

If the GPIB board is replaced or it is repaired by replacing the EEPROM chip (U211), each output in the supply must be recalibrated as described in Appendix A of the Operating Manual. Since the EEPROM provides non-volatile storage of the supply's Model number and GPIB address, you must reassign these values before the calibration procedures can be performed on the new (or repaired) GPIB board. The GPIB address is set manually using the front panel ADDR key as described in Section III of the Operating Manual. The supply's Model number is set as described in the next paragraph.

4-21 Setting the Model Number

At turn-on, the supply's model number and letter suffix (e.g. Agilent 6624A) are read out of the EEPROM along with other constants which are required to program the supply correctly. The model number constant specifies how many and what type of outputs (e.g. 40 W or 80 W, etc.) your supply contains and thus establishes the programming limits for a particular supply.

The MODEL command is used to set the model number and letter suffix of the supply. This was done before your supply left the factory. However, when you replace a defective GPIB board or repair an GPIB board by changing its EEPROM chip (U211), this setting may be lost and you must set the model number using the MODEL command.

To assign a model number to your supply, the following short program can be used with BASIC installed in an GPIB controller. Note that in this programming example, it is assumed that the GPIB Interface address is 7 and the supply's GPIB address is 05 and your supply is a Agilent Model 6624A.

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NOTE

The MODEL command removes all calibration constants and substitutes default values. Consequently, after the MODEL command is sent, you must recalibrate each output.

```
10 OUTPUT 705; "CMODE 1"
20 OUTPUT 705; "MODEL 6624A"
30 OUTPUT 705; "CMODE 0"
40 OUTPUY 705; "CLR"
50 END
```

After sending the above program, wait at least 3 seconds for the supply to complete initialization. Next, cycle the ac power to initiate a power-on self test and initialize the supply; then perform the calibration procedures outlined in Appendix A of the Operating Manual.

4-22 Signature Analysis Testing

The easiest and most efficient method of troubleshooting microprocessor-based instruments is signature analysis which is similar to signal tracing with an oscilloscope in linear circuits. Part of the microcomputer memory is dedicated to signature analysis and a known bit stream is generated to stimulate as many nodes as possible within the circuit. However, because it is virtually impossible to analyze a bit stream with an oscilloscope, a signature analyzer is used to compress the bit stream into a four-character signature. By comparing signatures of the IC under test to the correct signatures for each node, faults can usually be isolated to one or two components.

Signature Analysis (S.A.) Tests 1 through 8 (Tables 4-6 through 4-13, respectively) test most of the circuits on the GPIB board as well as the keypad and display circuit boards on the front panel. The tests should be performed in sequence (i. e. Test No. 1, No. 2, etc.). Note that the signatures taken for the ROM (S.A. Test No. 2, Table 4-7) apply only to firmware revision A_02 (date 2629), see paragraph 4-24.

The general test setup for S.A. tests is given in paragraph 4-23. The following general notes apply to signature analysis of the GPIB board.

1. Be certain to use the correct test setup.
2. Note the signatures for Vcc (+ 5 V) and ground on the IC being examined. If an incorrect signature is the same as that of Vcc or ground, that point is probably shorted to Vcc or ground.
3. If two pins have identical signatures, they are probably shorted together. If two signatures are similar, it is only a concidence.
4. If a signature is incorrect at an input pin, but is correct at its source (output of the previous IC), check for printed circuit and soldering problems.
5. An incorrect signature at an output could be caused by a faulty component producing that output. It can also be caused by an input short circuit in another component on the board.

4-23 Test Setup for S.A

Figure 4-8 shows the general test setup for the signature analysis tests given in Tables 4-6 through 4-13. Note that jumper pack W202 can be installed in either of two positions as shown in Figure 4-8. The following is a general description of the test setup. Specific signature analyzer and jumper connections for each test are given in the applicable table.

a. Gain access to the GPIB board components as described in paragraph 4-19. Be sure that the power supply is turned off before continuing with the following steps.
b. Connect jumper W201 in the SIG. ANALYSIS position (across pins 5 and 6) of connector P201 as shown in Figure 4-8.
c. Short pins 1 and 4 together on connectors P205 through P208 as shown in Figure 4-8.
d. Check that jumper pack W202 is in the proper position specified by the particular S.A. test. Figure 4-8 shows two operating positions: normal run position and NOP (no operation) position. W202 is a 16-pin jumper pack. To select the normal run position, W202 is plugged into 16-pin socket J202. To select the NOP position, W202 is connected between 8-pin socket J203 and pins 1-8 of 16-pin socket J202 (see Figure 4-8).
e. Set the signature analyzer START, STOP, CLOCK, GND, and edge settings as described in the applicable S.A. Test table.
f. Turn the power supply on and use the signature analyzer probe to take signatures at the applicable IC test points (see Table 4-6 through 4-13).
g. Upon completion of the S.A. tests, remove short circuit connections from pins 1 and 4 on P205-P208 And return jumpers W201 and W202 to their normal run positions.

4-24 Firmware Revisions

The ROM chip (U206) on the GPIB board is identified with a label that specifies the revision of your supply's firmware. Alternatively, if the GPIB board is operating properly, the ROM? command can be used to query the revision date. As stated in paragraph 4-22, the revision date for firmware revision A_02 is 2629; where 26 specifies 1986 and 29 is the week number. The previous firmware revision was 1.01 (2605). To query the revision date of the firmware (ROM) in your supply, run the short program listed below.

```
10 OUTPUT 705;"ROM?"
20 ENTER 705;A
30 DISP A
40 END
```

The computer should display the revision date; e.g. "2629"

Note that the signatures in Table 4-7 (GPIB Board S.A. Test No. 2) for the ROM are for revision A_02 and will be different for different revisions. The signatures for the previous revision (1.01) are given in Appendix A in the back of this manual.

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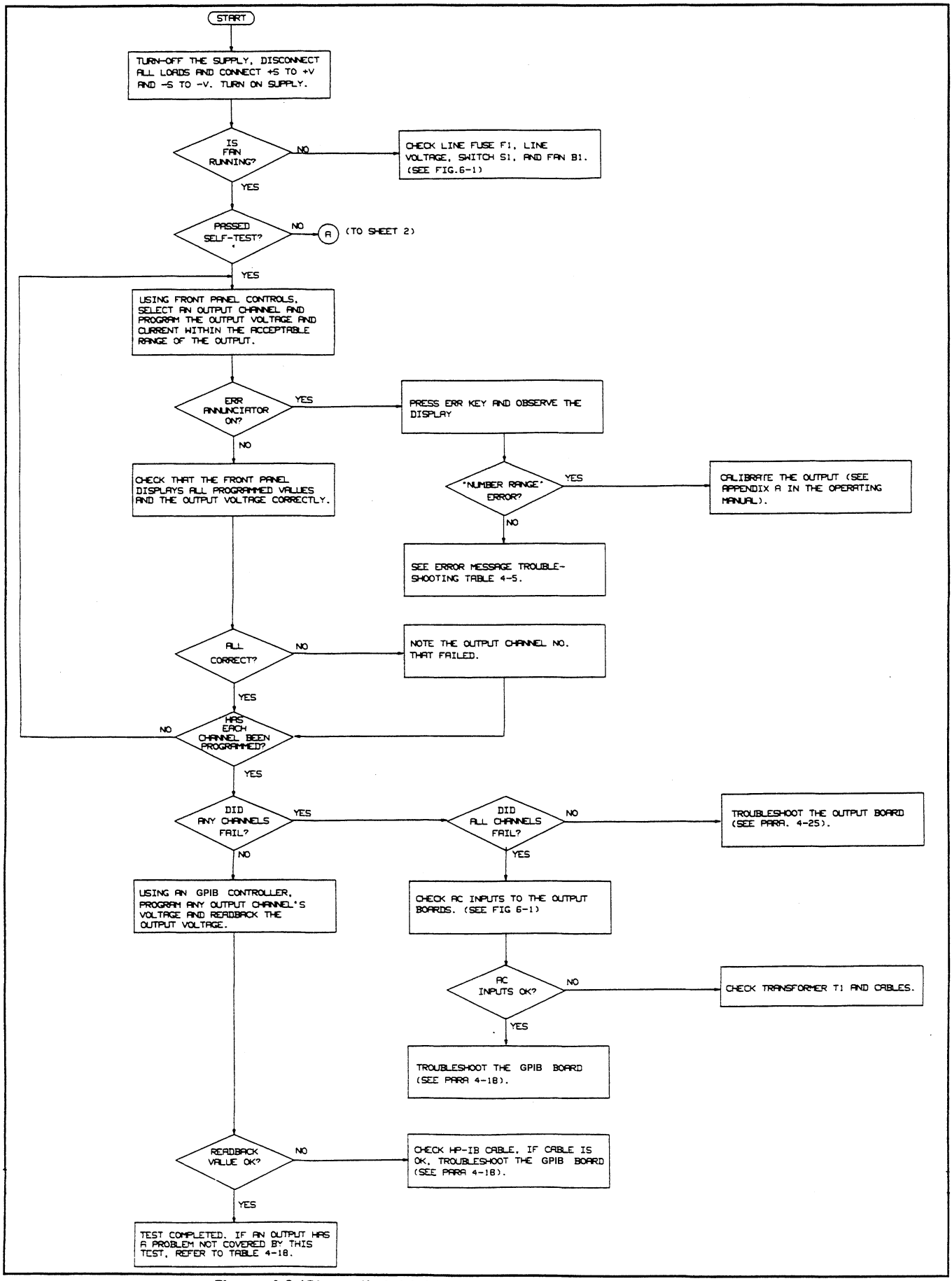


Figure 4-6 (Sheet 1). Initial Troubleshooting and Board Isolation

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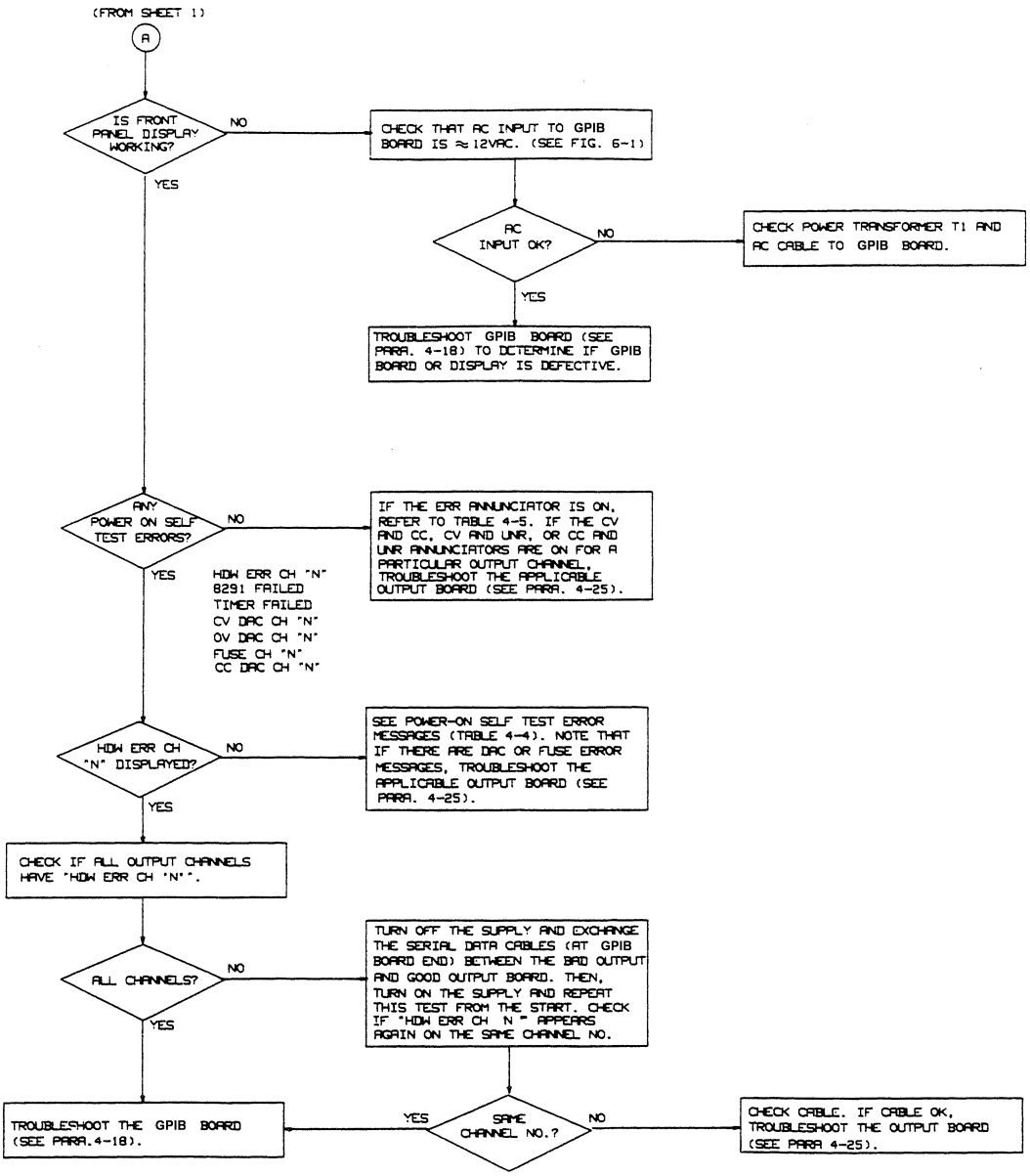


Figure 4-6 (Sheet 2). Initial Troubleshooting and Board Isolation

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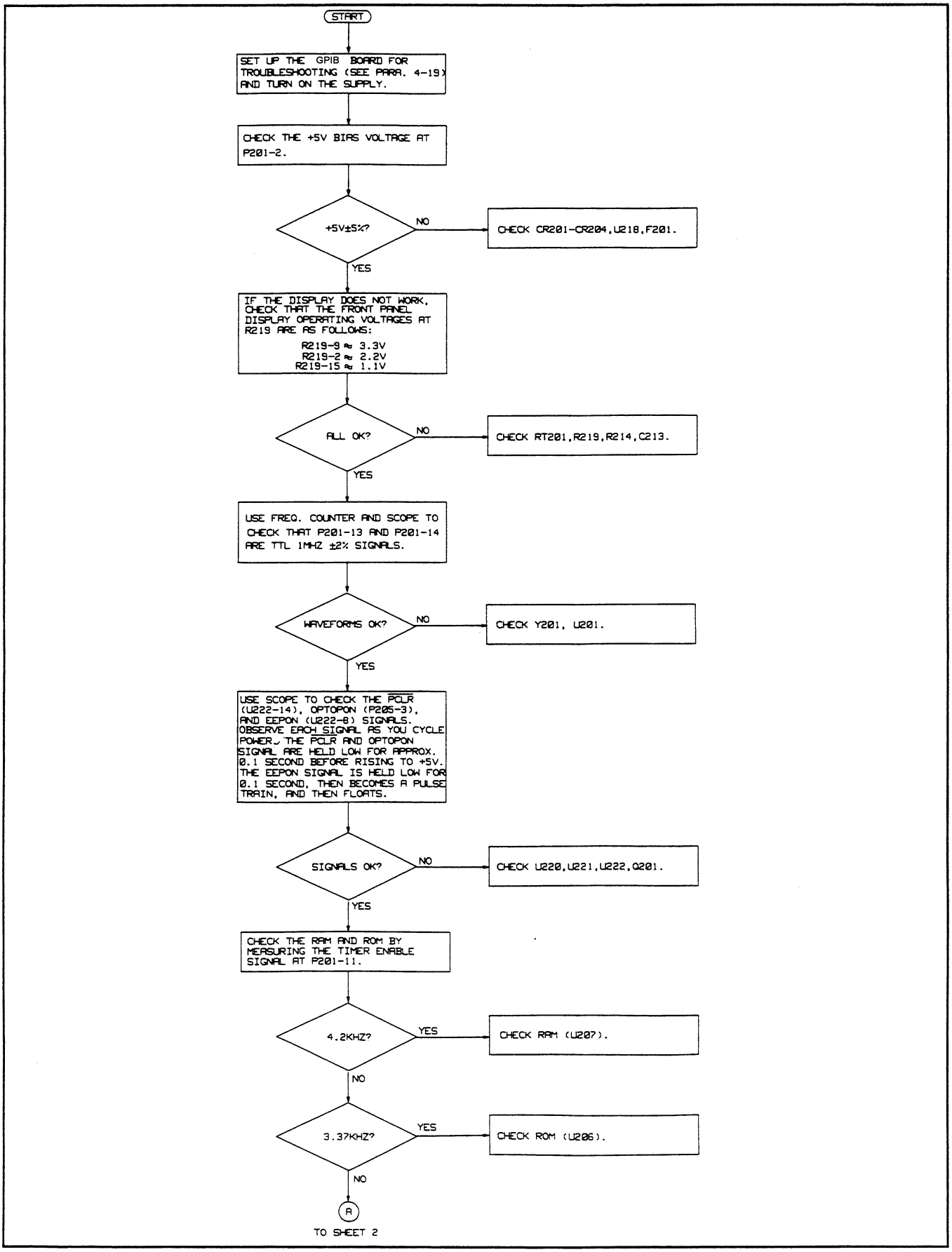


Figure 4-7 (Sheet 1). GPIB Board and Front Panel Troubleshooting

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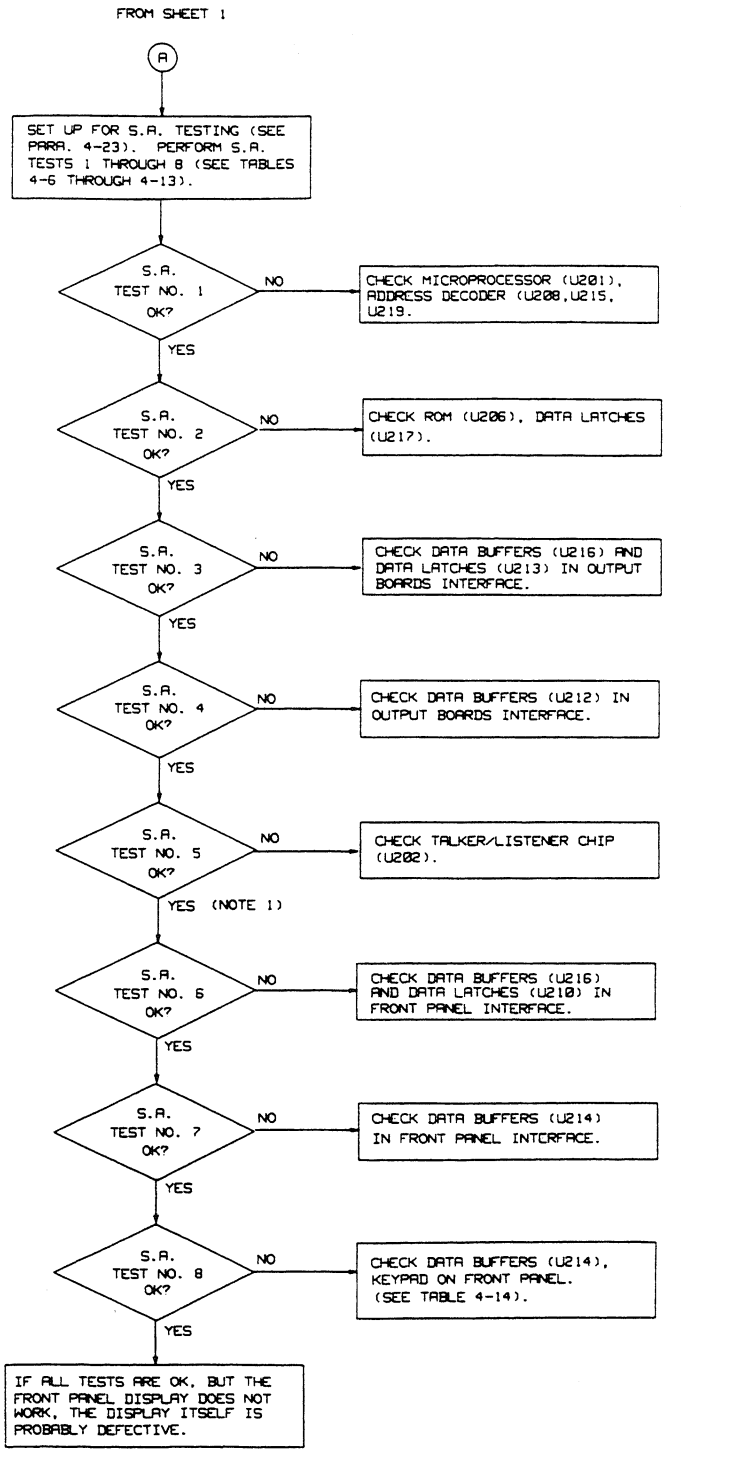


Figure 4-7 (Sheet 2). GPIB Board and Front Panel Troubleshooting and Board Isolation

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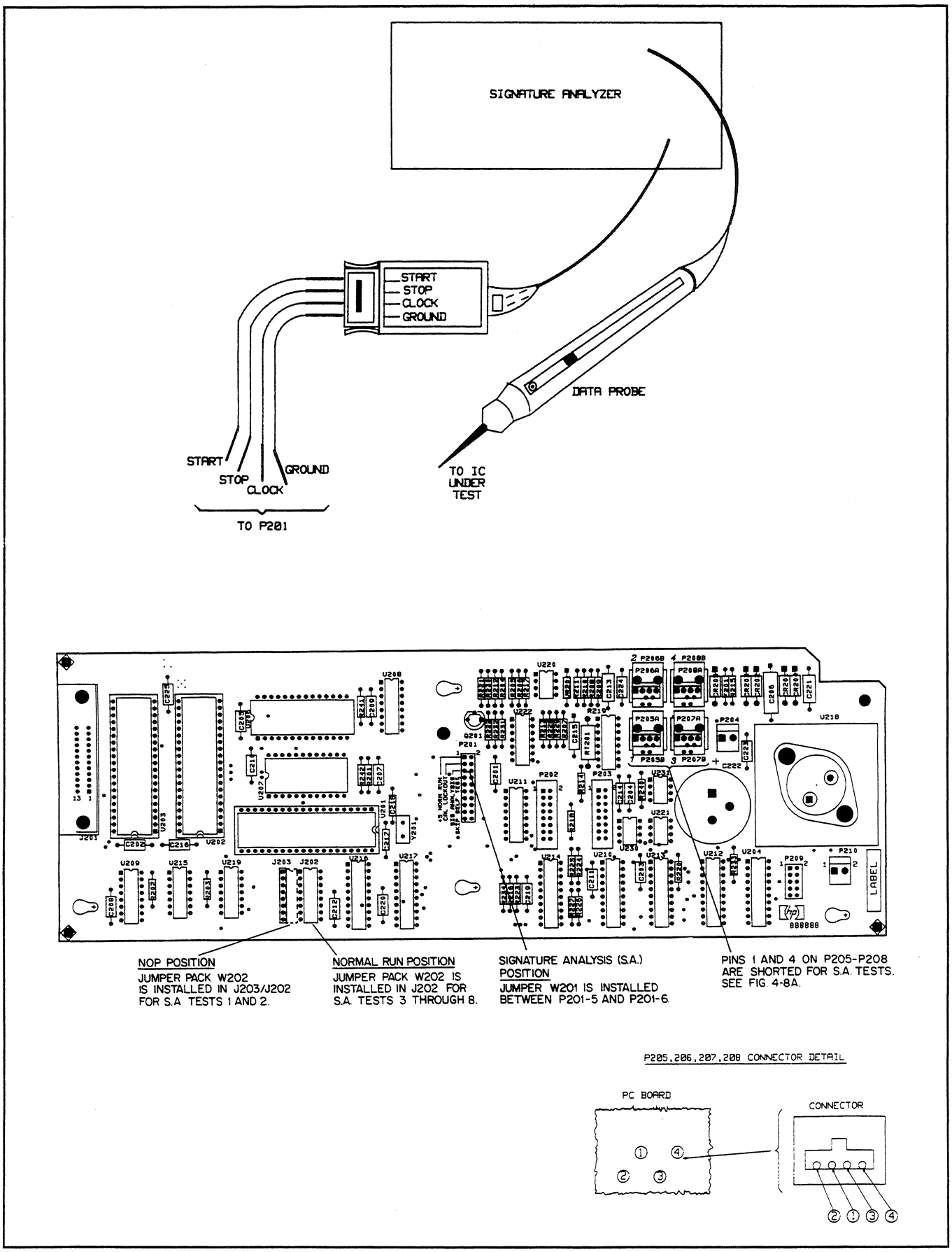


Figure 4-8. Signature Analysis Test Setup

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Table 4-6. GPIB Board S.A. Test No. 1

Description: This test checks Microprocessor (U201) address lines A0-A15 and Address Decoder (U208/215) chip select lines (CS1-CS8).

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the NOP position and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		9
STOP		10
CLOCK		13
GND		4

Measurements: Use the data probe to take signatures for each circuit at the output pins listed below.

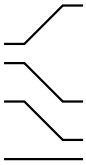
Circuit	Output	Signature
+5V	P201-1	0003
Microprocessor Address Bus Lines	U201-8	UUUU
	U201-9	FFFF
	U201-10	8484
	U201-11	P763
	U201-12	1U5P
	U201-13	0356
	U201-14	U759
	U201-15	6F9A
	U201-16	7791
	U201-17	6321
	U201-18	37C5
	U201-19	6U28
	U201-20	4FCA
	U201-21	4868
	U201-22	9UP1
Address Decoder U208/U215 Chip Select Lines	U208-15	4P08
	U208-14	12U1
	U208-13	PC03
	U208-12	F2A4
	U208-11	6H4C
	U208-10	0994
	U215-11	0001

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Table 4-7. GPIB Board S.A. Test No. 2

Description: This test checks the ROM (U206) and the data bus to the output of the Data Latches (U217) in the system microcomputer.

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the NOP and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		**9**
STOP		**10**
CLOCK		**14**
GND		**4**

Measurements: Use the data probe to take signatures for each circuit at the output pins listed below. These signatures apply to the firmware revsions listed. Refer to Appendix A for previous versions.

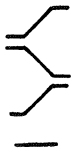
Date code -->		2629	2839
Revision #-->		A.00.02	A.00.03
Circuit	**Output**	**Signatures**	
+5	P201-1	0001	0001
ROM U206 Data Bus Lines	U206-11	AH2C	UF2F
	U206-12	13CC	9650
	U206-13	PUCC	4134
	U206-15	C2A3	164A
	U206-16	HU49	3449
	U206-17	PF79	A11F
	U206-18	3856	H930
	U206-19	AHU7	A791
System Microcomputer Data Latches U217	U217-2	H694	UP17
	U217-5	09HF	4C29
	U217-6	77HF	A09C
	U217-9	H950	8C24
	U217-12	6UA5	9A25
	U217-15	U63H	508U
	U217-16	1F2A	6F99
	U217-19	H6UA	53F9

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Table 4-8. GPIB Board S.A. Test No. 3

Description: This test checks the data path from the Microprocessor through the Data Buffers U216 and to the output of Data Latches (U213) in the Output Boards Interface Circuit.

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the normal operating position and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		11
STOP		12
CLOCK		16
GND		4

Measurements: Use the data probe to take signatures for each circuit at the input and output pins listed below.

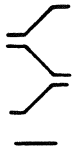
Circuit	Input	Signature	Output	Signature
+5V			P201-1	3U9F
SYSTEM DATA BUFFERS U216 (Data Bus Lines)	U216-2	1561		
	U216-4	OFHU		
	U216-6	03F6		
	U216-8	0020		
	U216-11	3U9H		
	U216-13	0008		
	U216-15	0004		
	U216-17	0002		
OUTPUT BOARDS INTERFACE DATA LATCHES U213	U213-3	1561	U213-2	0AC0
	U213-4	0FHU	U213-5	066U
	U213-7	03F6	U213-6	01P3
	U213-8	0020	U213-9	0010
	U213-13	3U9H	U213-12	3U9F
	U213-14	0008	U213-15	0004
	U213-17	0004	U213-16	0002
	U213-18	0002	U213-19	0001

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Table 4-9. GPIB Board S.A. Test No. 4

Description: This test checks Data Buffers U212 (p/o the Output Boards Interface Circuit) which send data back to the System Microcomputer from the Output Boards.

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the normal operating position and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		11
STOP		12
CLOCK		17
GND		4

Measurements: Use the data probe to take signatures for each circuit at the input and output pins listed below.

Circuit	Input	Signature	Output	Signature
+5V			P201-1	3U9F
	U212-2	1561	U212-3	3U9F
	U212-4	0FHU	U212-5	0000
OUTPUT BOARD	U212-6	03F6	U212-7	0000
INTERFACE	U212-8	0020	U212-9	0000
DATA BUFFERS	U212-11	0000	U212-12	0020
U212	U212-13	0000	U212-14	03F6
	U212-15	0000	U212-16	0FHU
	U212-17	3U9F	U212-18	1561

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Table 4-10. GPIB Board S.A. Test No. 5

Description: This test checks the GPIB Talker/Listener chip (U202) bidirectional data bus lines.

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the normal operating position and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		**11**
STOP		**12**
CLOCK		**15**
GND		**4**

Measurements: Use the data probe to take signatures for each circuit at the input/output pins listed below.

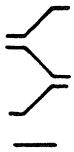
Circuit	Input/Output	Signature
+5	P201-1	7U39
GPIB Talker/Listener U202 (Bidirectional Bus)	U202-12	60U7
	U202-13	183H
	U202-14	060U
	U202-15	0183
	U202-16	0060
	U202-17	0018
	U202-18	0000
	U202-19	0006

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Table 4-11. GPIB Board S.A. Test No. 6

Description: This test checks the data path from the Microprocessor through Data Buffers U216 to the output of Data Latches U210 in the Front Panel Interface circuit.

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the normal operating position and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		11
STOP		12
CLOCK		19
GND		4

Measurements: Use the data probe to take signatures for each circuit at the input and output pins listed below.

Circuit	Input	Signature	Output	Signature
+5V			P201-1	3U9F
SYSTEM MICROCOMPUTER DATA BUFFERS U216	U216-2	1561		
	U216-4	0FHU		
	U216-6	03F6		
	U216-8	0020		
	U216-11	0010		
	U216-13	0008		
	U216-15	0004		
	U216-17	0002		
FRONT PANEL INTERFACE DATA LATCHES U210	U210-3	1561	U210-2	0AC0
	U210-4	0FHU	U210-5	066U
	U210-7	03F6	U210-6	01P3
	U210-8	0020	U210-9	0010
	U210-13	0010	U210-12	0008
	U210-14	0008	U210-15	0004
	U210-17	0004	U210-16	0002
	U210-18	0002	U210-19	0001

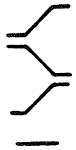
Note: The output of U210 to keyboard is not tested during S.A.

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Table 4-12. GPIB Board S.A. Test No. 7

Description: This test checks Data Buffers U214 which send data back to the System Microcomputer from the Front Panel. The test is made with no front panel keys depressed .

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the normal operating position and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		11
STOP		12
CLOCK		18
GND		4

Measurements: Use the data probe to take signature for each circuit at the input and output pins listed below. Do not press any front panel keys.

Circuit	Input	Signature	Output	Signature
+5V			P201-1	3U9F
	U214-2	3U9F	U214-18	3U9F
	U214-4	3U9F	U214-16	3U9F
FRONT PANEL	U214-6	3U9F	U214-14	3U9F
INTERFACE	U214-8	0000	U214-12	0000
DATA BUFFERS	U214-11	3U9F	U214-9	3U9F
U214	U214-13	3U9F	U214-7	3U9F
	U214-15	3U9F	U214-5	3U9F
	U214-17	3U9F	U214-3	3U9F

Note: The output of U210 to keyboard is not tested during S.A. Errors in input signatures to U214 may be caused by U210.

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Table 4-13. GPIB Board S.A. Test No. 8

Description: This test checks the operation of each key on the front panel.

Test Setup: Use the test setup described in paragraph 4-23. Connect jumper pack W202 in the normal operating position and set up the signature analyzer as shown below.

Signature Analyzer Input	Edge Setting	P201 PIN Connection
START		11
STOP		12
CLOCK		18
GND		4

Measurements: Use the data probe to take signatures for each key at the input and output pins listed below. The appropriate key must be pressed and held while the signatures are measured at the specified pins. The +5V signature for this test is 3U9F. The signal path for each pressed key is given in Table 4-14. Figure 6-2 shows the keypad schematically.

	SIGNATURES							
KEY	U214 OUTPUT PINS				U214 INPUT PINS			
	3	5	7	9	11	13	15	17
LCL	3C96	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	3C96
ADDR	3U1H	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	3U1H
ERR	3U9F	3C96	3U9F	3U9F	3U9F	3U9F	3C96	3U9F
STO	3U9F	3U9F	3C96	3U9F	3U9F	3C96	3U9F	3U9F
RCL	3U9F	3U9F	3UIH	3U9F	3U9F	3UIH	3U9F	3U9F
DLY	3788	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	3788
METER	3U9F	3U9F	3U9F	3UIH	3UIH	3U9F	3U9F	3U9F
UN MASK	3U9F	3UIH	3U9F	3U9F	3U9F	3U9F	3UIH	3U9F
FAULT	3U9F	3U9F	3788	3U9F	3U9F	3788	3U9F	3U9F
OV RST	2UC5	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	2UC5
OV SET	3U9F	3U9F	3U9F	3788	3788	3U9F	3U9F	3U9F
OCP	3U9F	3788	3U9F	3U9F	3U9F	3U9F	3788	3U9F
OC RST	3U9F	3U9F	2UC5	3U9F	3U9F	2UC5	3U9F	3U9F
OUTPUT SELECT ►	3U9F	3U9F	3U9F	3H99	3H99	3U9F	3U9F	3U9F
◄ OUTPUT SELECT	3U9F	3U9F	3U9F	2UC5	2UC5	3U9F	3U9F	3U9F
VSET	3H99	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	3H99

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Table 4-13. GPIB Board S.A. Test No. 8 (cont.)

KEY	SIGNATURES							
	U214 OUTPUT PINS				U214 INPUT PINS			
	3	5	7	9	11	13	15	17
ISET	3U9F	2UC5	3U9F	3U9F	3U9F	3U9F	2UC5	3U9F
OUTPUT ON/OFF	3U9F	3U9F	3H99	3U9F	3U9F	3H99	3U9F	3U9F
0	3U9F	3U9F	3P9P	3U9F	3U9F	3P9P	3U9F	3U9F
1	3U9F	3H99	3U9F	3U9F	3U9F	3U9F	3H99	3U9F
2	3U9F	3P9P	3U9F	3U9F	3U9F	3U9F	3P9P	3U9F
3	3U9F	1UU1	3U9F	3U9F	3U9F	3U9F	1UU1	3U9F
4	3P9P	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	3P9P
5	1UU1	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	1UU1
6	3UHF	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	3UHF
7	3U9F	3U9F	3U9F	3P9P	3P9P	3U9F	3U9F	3U9F
8	3U9F	3U9F	3U9F	1UU1	1UU1	3U9F	3U9F	3U9F
9	3U9F	3U9F	3U9F	3UHF	3UHF	3U9F	3U9F	3U9F
•	3U9F	3U9F	3UHF	3U9F	3U9F	3UHF	3U9F	3U9F
←	3U9F	3U9F	1UU1	3U9F	3U9F	1UU1	3U9F	3U9F
ENTER	3U9F	3UHF	3U9F	3U9F	3U9F	3U9F	3UHF	3U9F

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Table 4-14. Keypad Signal Paths (See Figure 6-2)

Pressed Key	Scan Lines from Decoder U211 pin	Keyboard connector pins	Readback Lines to Data Buffer U214 pin
9	4	2 and 14	11
8	9	8 and 14	11
7	6	6 and 14	11
OUTPUT SELECT ►	7	9 and 14	11
◄ OUTPUT SELECT	10	10 and 14	11
OVSET	11	11 and 14	11
METER	5	12 and 14	11
6	4	2 and 7	17
5	9	8 and 7	17
4	6	6 and 7	17
VSET	7	9 and 7	17
OVRST	10	10 and 7	177
DLY	11	11 and 7	17
ADDR	5	12 and 7	17
LCL	12	13 and 7	17
ENTER	4	2 and 5	15
3	9	8 and 5	15
2	6	6 and 5	15
1	7	9 and 5	15
ISET	10	10 and 5	15
OCP	11	11 and 5	15
UNMASK	5	12 and 5	15
ERR	12	13 and 5	15
•	4	2 and 3	13
←	9	8 and 3	13
0	6	6 and 3	13
OUTPUT ON/OFF	7	9 and 3	13
OCRST	10	10 and 3	13
FAULT	11	11 and 3	13
RCL	5	12 and 3	13
STO	12	13 and 3	13

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4-25 OUTPUT BOARD TROUBLESHOOTING PROCEDURES

Overall troubleshooting procedures for an output board are given in Figure 4-9. This flow chart is used when a fault has already been isolated to a particular output board using the board isolation procedures (see paragraph 4-14). The procedures of Figure 4-9 will isolate the problem to a component(s) on the defective output board or will refer you to other troubleshooting charts (Figure 4-11 to 4-16) to continue troubleshooting. Figures 4-10 and 4-11 illustrate waveforms on the output card to aid you in troubleshooting. Figure 4-12 provides troubleshooting procedures when a problem has been isolated to one to the DAC/amplifier circuits on the defective output board. Figures 4-13 through 4-16 provide troubleshooting procedures for various trouble symptoms which may be encountered.

In addition to the troubleshooting flow charts described above, subsequent paragraphs in this section contain special troubleshooting information for some of the complex circuits on an output board. Troubleshooting information is included for Analog Multiplexer U323, Signal Processor U327, Power Module (U338/U339), and Microcomputer U312.

4-26 Test Setup

The following test setup allows you to access the components on the output board and perform the troubleshooting procedures.

a. Disconnect the line cord.
b. Gain access to the output board as described in paragraphs 4-3 through 4-5.
c. Make sure that jumper W201 (P201) and W202 jumper pack on the GPIB board are installed in their normal run positions (See Figure 4-2).
d. Check that + S is connected to + V and -S is connected to - V on the output terminal block.
e. Connect the line cord.

4-27 Post Repair Calibration

if the output board is replaced, the associated output channel must be recalibrated as described in Appendix A of the Operating Manual. If certain components in the output circuits (DAC'S, voltage control circuit, or current control circuit) or the readback circuits (e.g. readback buffers, DAC, amplifiers, signal comparator) on the output board are replaced, the associated output channel must be recalibrated as described in Appendix A of the Operating Manual.

4-28 Self Exercise Routine on an Output Board

The output board can be put into a mode that exercises the microcomputer (U312) and all of the DAC's for ease of troubleshooting. In order to enter this mode, U312 pin 27 must be tied to common before the supply is turned on. Immediately following turn-on, the RAM and ROM self tests on U312 are performed provided that the PCLR signal from the signal processor (U327) goes High. Then, the self exercise routine begins. This routine runs independently of the GPIB board which is ignored by an output board operating in this mode. During the routine, the display indicates "HDW ERR CH < ch > " as if that output board were defective. The self exercise routine is used in the troubleshooting procedures provided on sheets 5 and 6 of Figure 4-9.

WARNING

The output voltage and current limit are repetitively programmed to full scale values during the self exercise routine. Be sure that no load of any kind is connected to the output terminals when operating in this mode. Also, note that the POV DISABLE line (U312 pin 23) is High which disables the programmable OV the fixed overvoltage circuit can still operate).

In the self exercise routine, microcomputer U312 repetitively programs each of the DAC's: U313 (12-bit DAC), U314 (both 8-bit DAC's in this dual DAC), and U321(12-bit DAC). Each DAC is programmed from zero to full output (approximately -10 V). This is accomplished by starting with the LSB and turning on each successive bit leaving the previous bits on until all bits including the MSB are on. The DAC output is programmed back to zero in the same manner also starting with the LSB.

Table 4-15 lists the signals that should be present on pins 1 through 28 of U312 during the self exercise routine. Figures 4-10 and 4-11 illustrate waveforms that should be observed at various points on the output board during the self exercise routine. Figure 4-10 illustrates the waveforms for the low voltage (40WLV and 80WLV) output boards; Figure 4-11 illustrates the waveforms for the high voltage (40WHV and 80WHV) output boards. The waveforms shown on these figures are referenced in the troubleshooting procedures of Figure 4-9.

Figures 4-10A and 4-11A show what the output of the CV DAC (U315 pin 1) and Readback DAC (U315 pin 14) should look like (12 steps total in waveform). Figures 4-10H and 4-11H show what the output of the CC DAC (U315 pin 7) and the OV DAC (U315 pin 8) should look like (8 steps total).

The analog multiplexer (U323) is also partially exercised. It is repeatedly programmed to switch its output (pin 8) from input 1 (Common, pin 4) to input 3 (V READBACK, pin 6) resulting in the waveforms shown in Figures 4-10G and 4-11G. Note that if there is a problem preventing the output voltage from programming up and down properly, or if the differential amplifier providing the VOLTAGE READBACK signal is defective, this waveform will not be correct. Figures 4-10C and 4-11C show the output voltage waveform. assuming that the control loop and power mesh are working properly.

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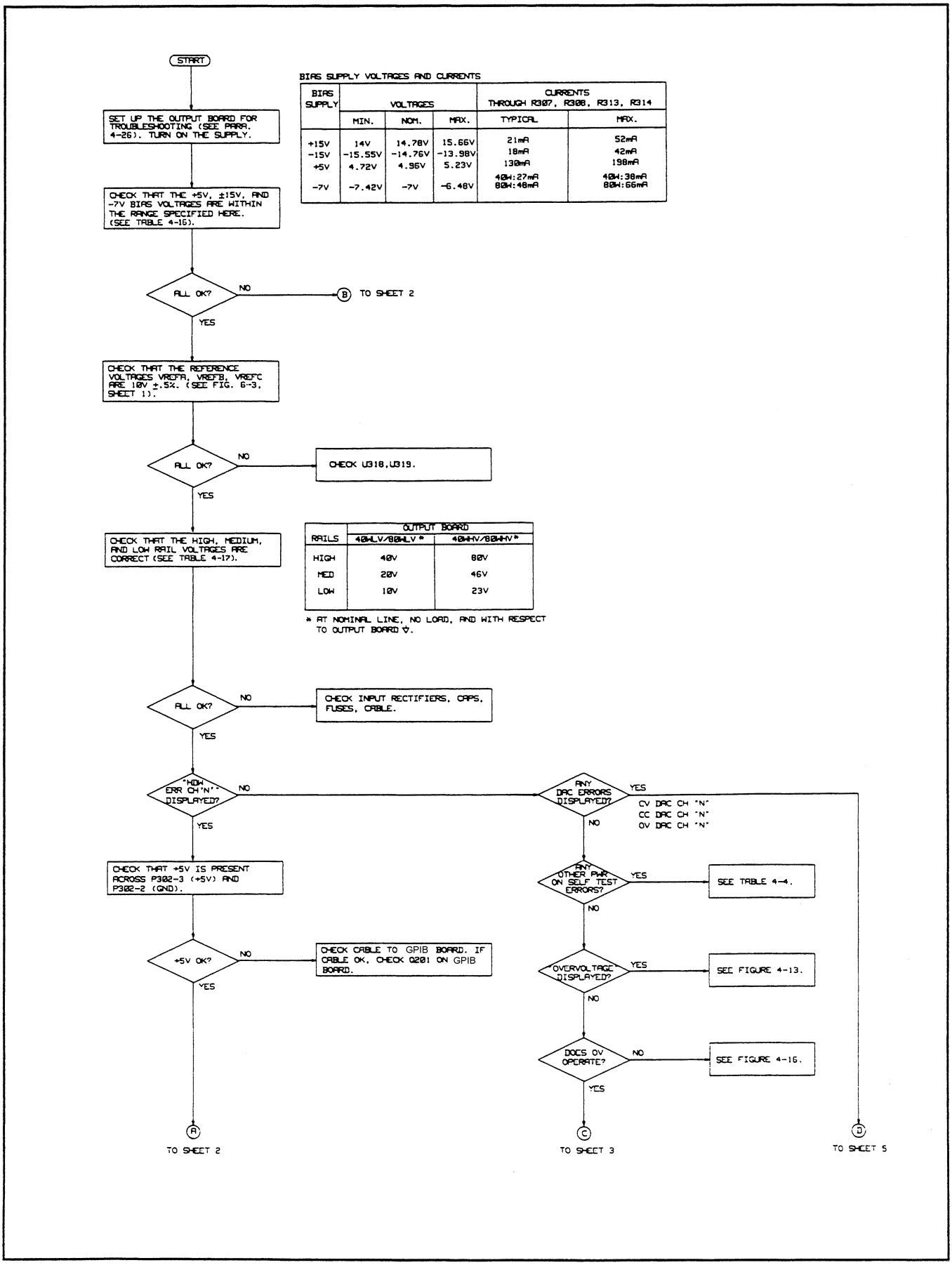


Figure 4-9 (Sheet 1). Output Board Troubleshooting

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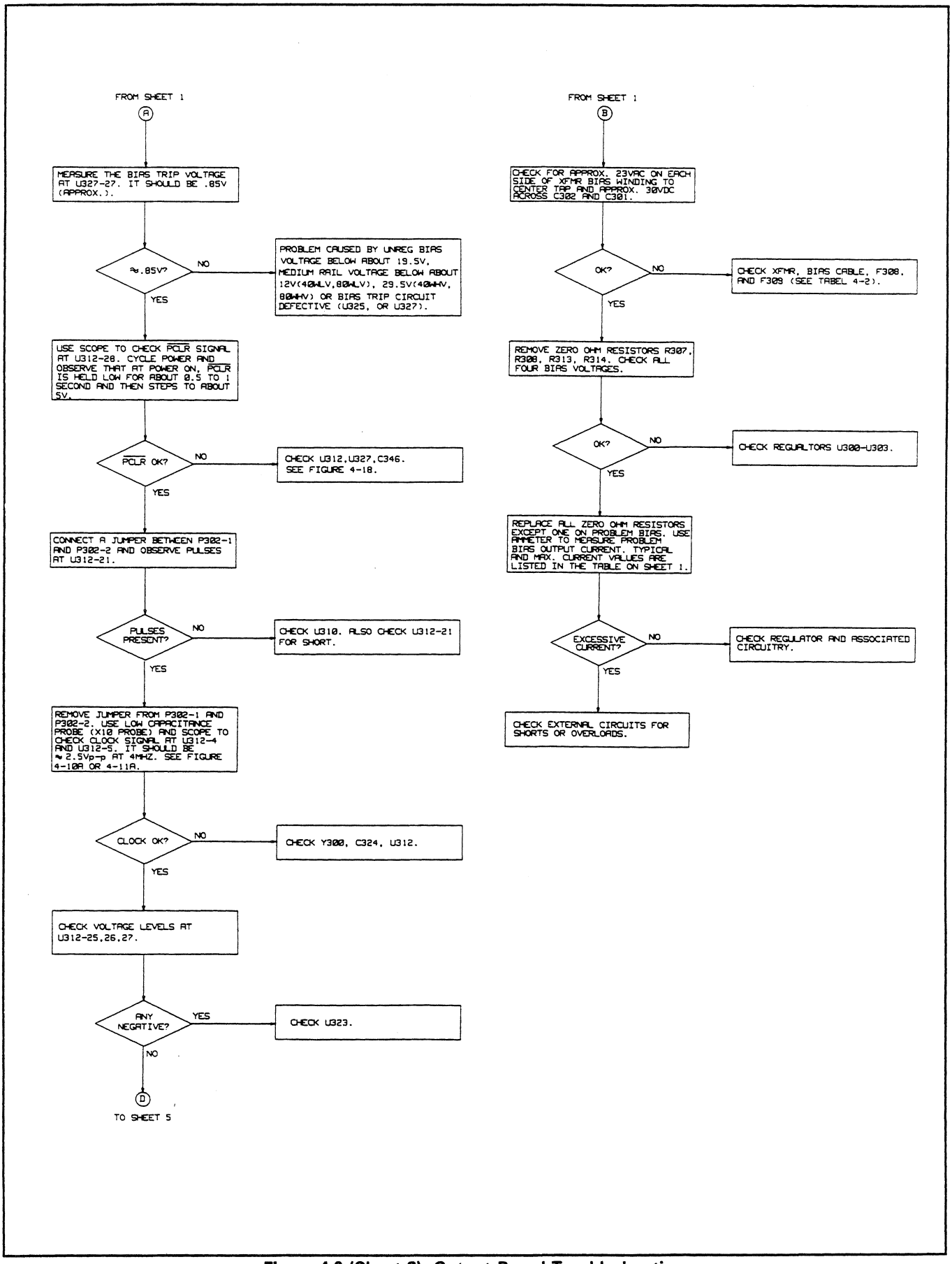


Figure 4-9 (Sheet 2). Output Board Troubleshooting

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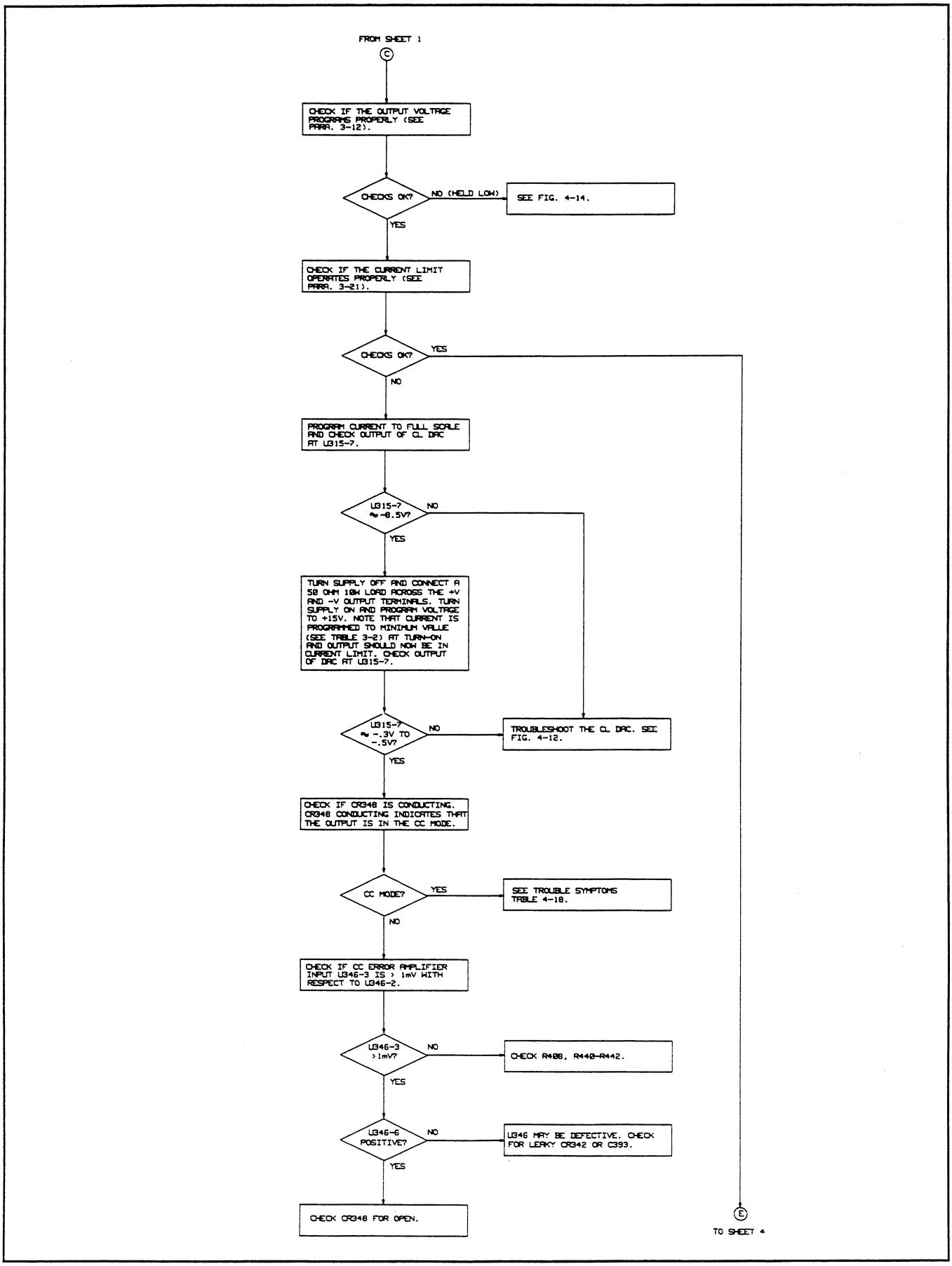


Figure 4-9 (Sheet 3). Output Board Troubleshooting

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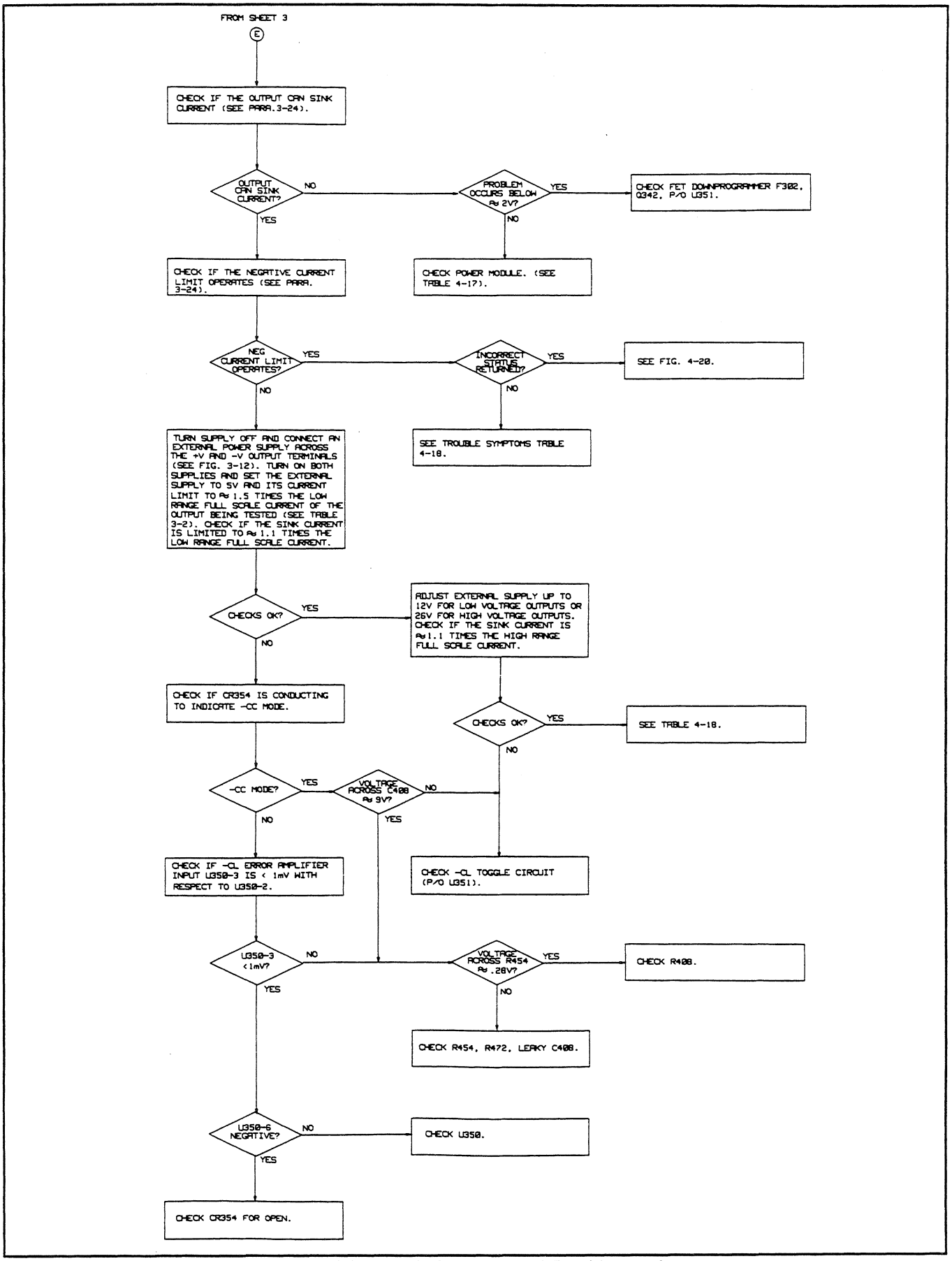


Figure 4-9 (Sheet 4). Output Board Troubleshooting

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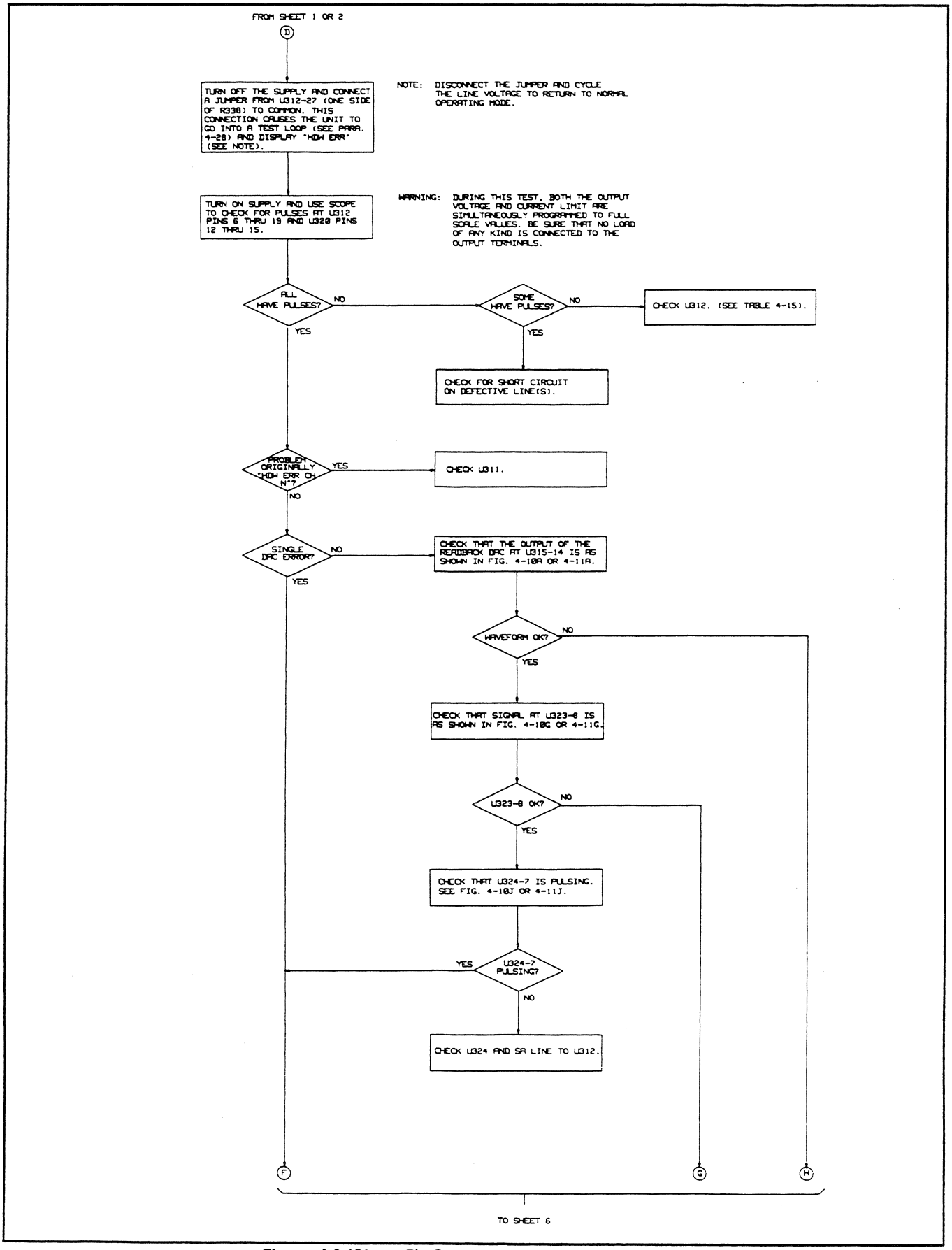


Figure 4-9 (Sheet 5). Output Board Troubleshooting

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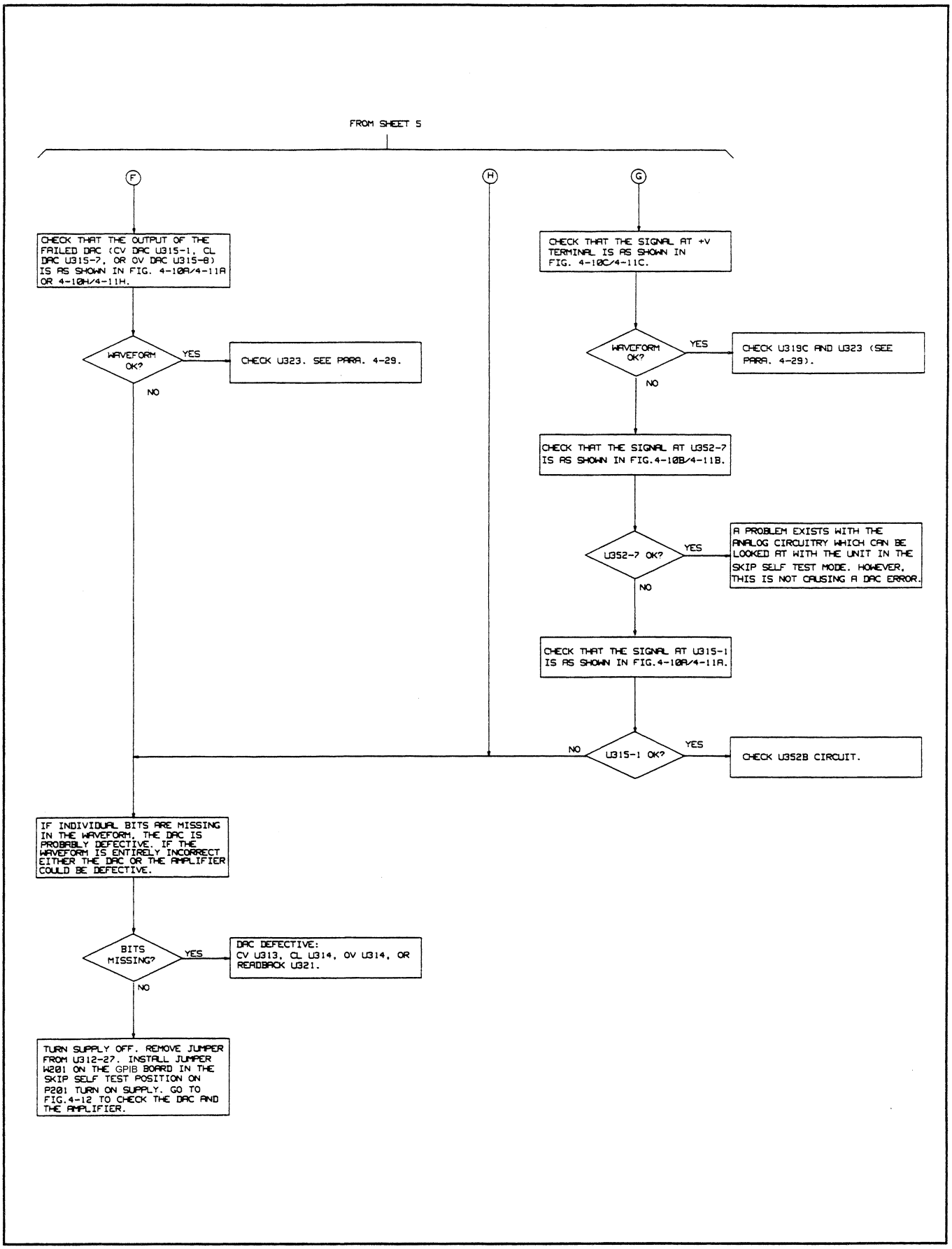
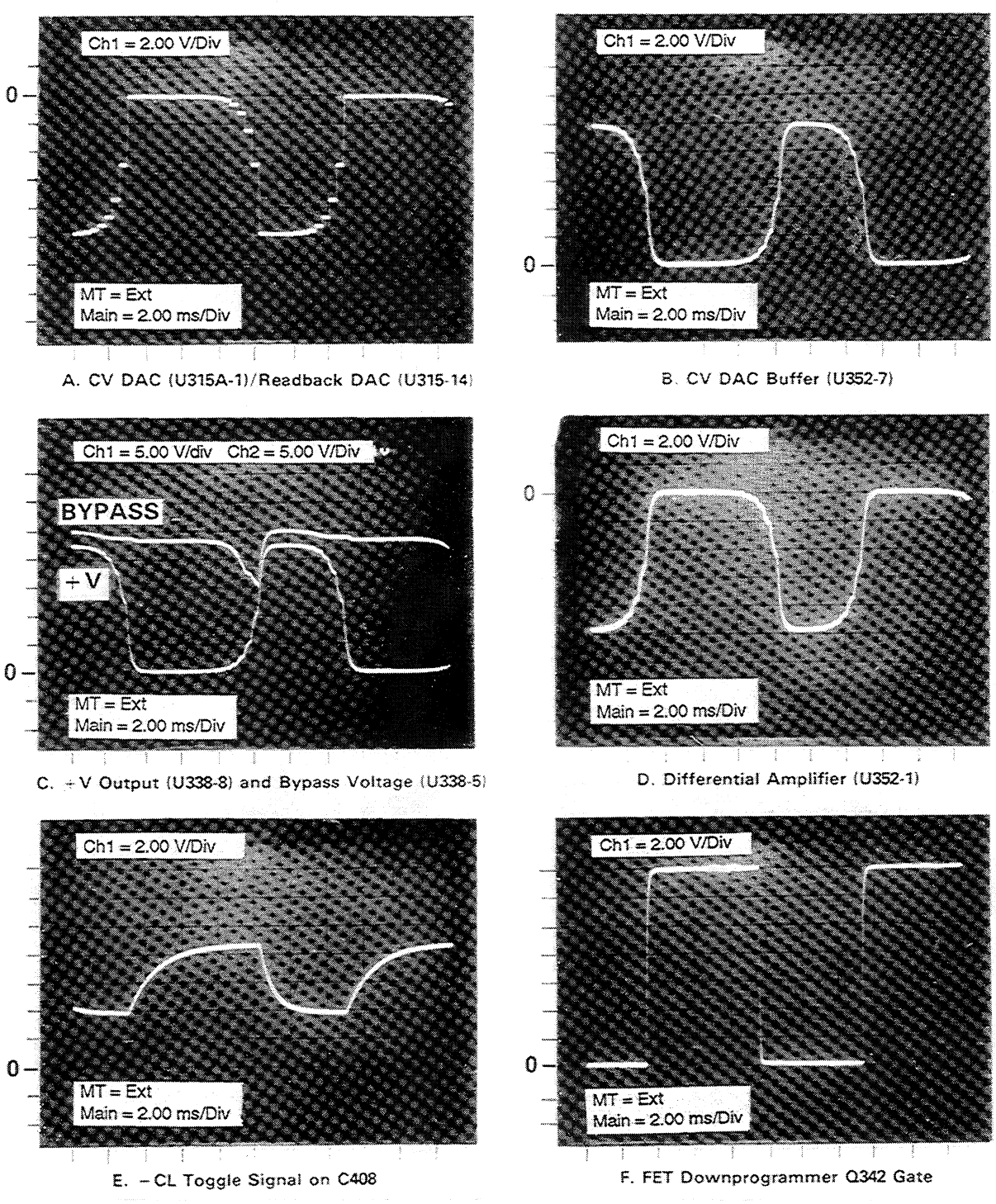


Figure 4-9 (Sheet 6). Output Board Troubleshooting

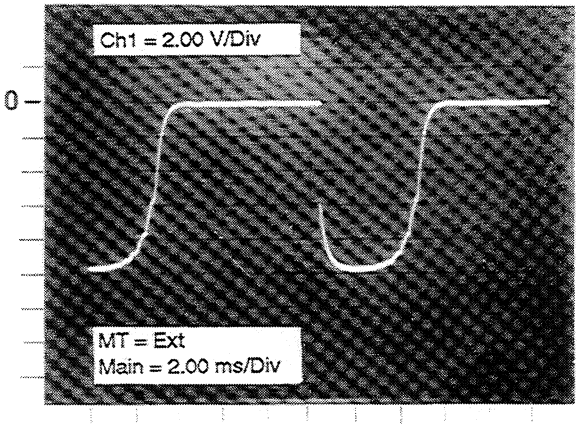
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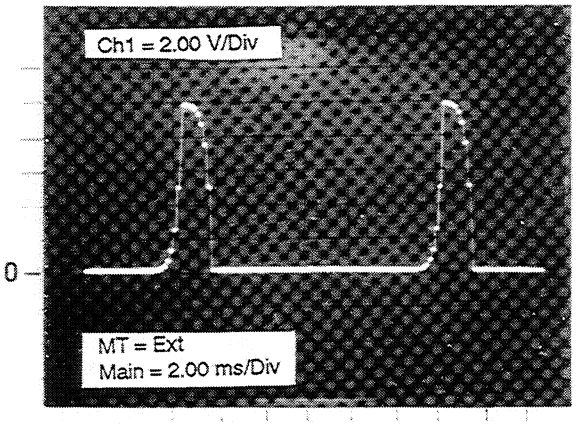
NOTE: The waveforms are all referenced to ⏚ common. The Readback Signal Comparator output (U324-7) was used as the trigger source (negative edge).

Figure 4-10 (Sheet 1). Low Voltage Output Board Waveforms During Self Exercise Routine

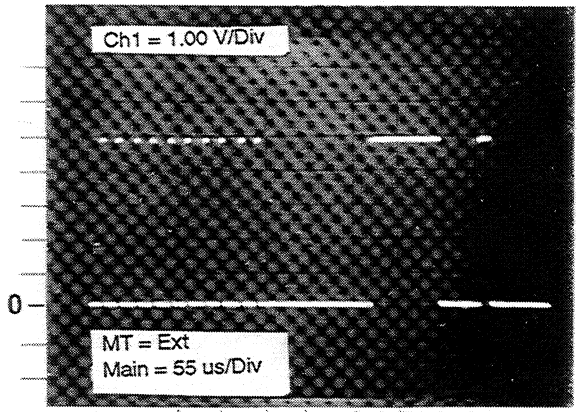
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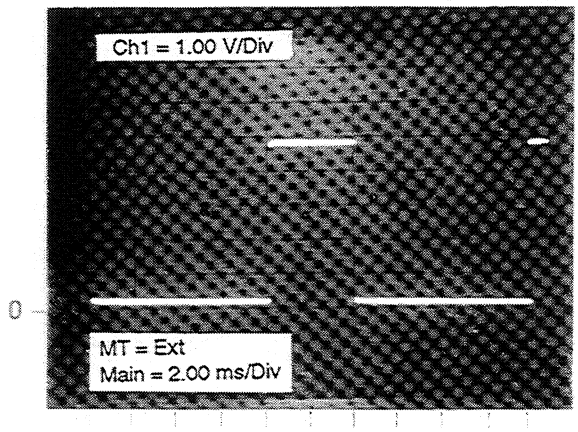
G. Analog Multiplexer Output (U323-8)



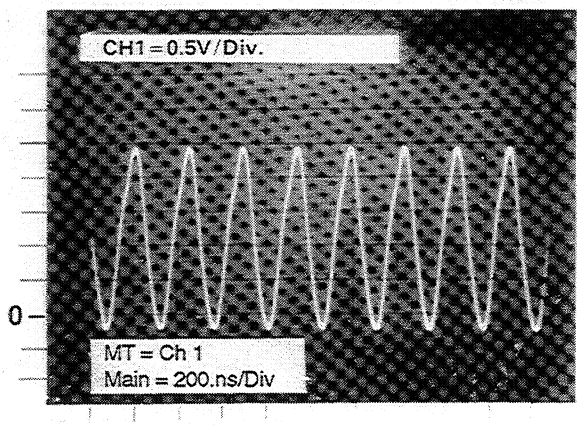
H. CL DAC (U315B-7)/OV DAC (U315-8)



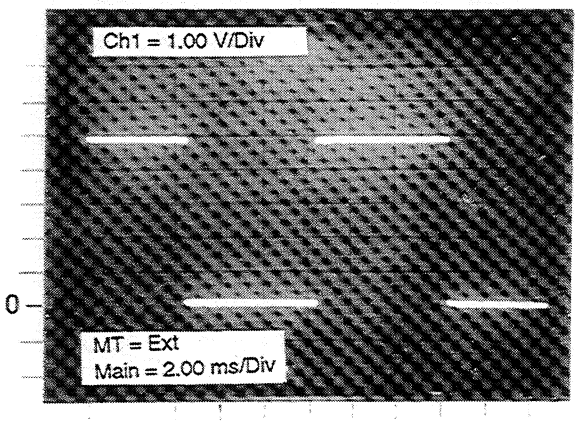
I. Typical Data Line (U312 pins 12-19; pin 17 shown)



J. Readback Signal Comparator Output (U324-7)



K. 4 MHz Resonator (U312-5)

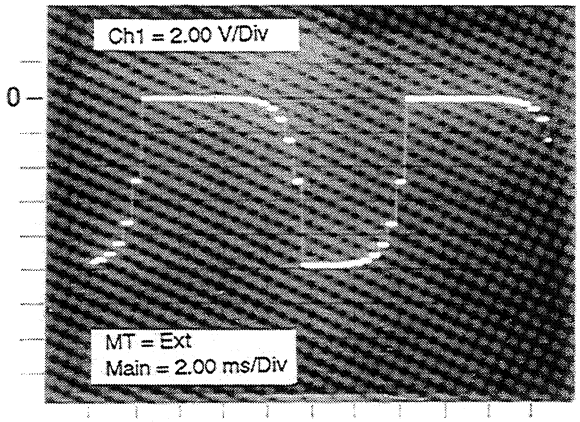


L. Analog Multiplexer Address Line (U323-16)

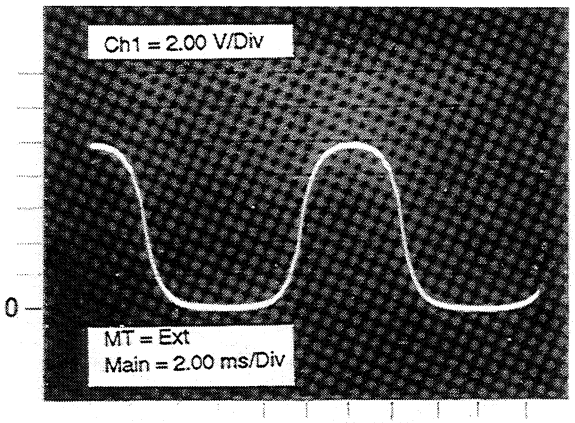
NOTE: The waveforms are all referenced to ⏚ common. The Readback Signal Comparator output (U324-7) was used as the trigger source (negative edge).

Figure 4-10 (Sheet 2). Low Voltage Output Board Waveforms During Self Exercise Routine

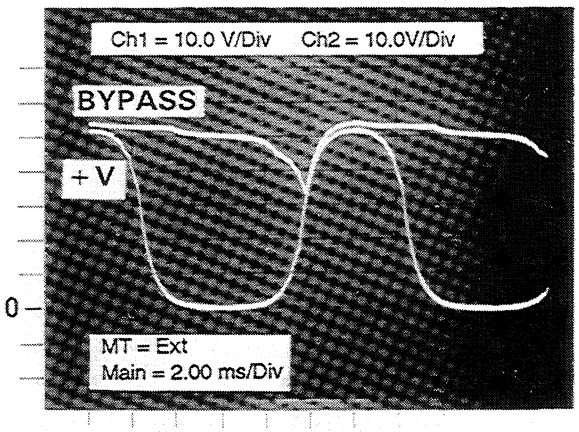
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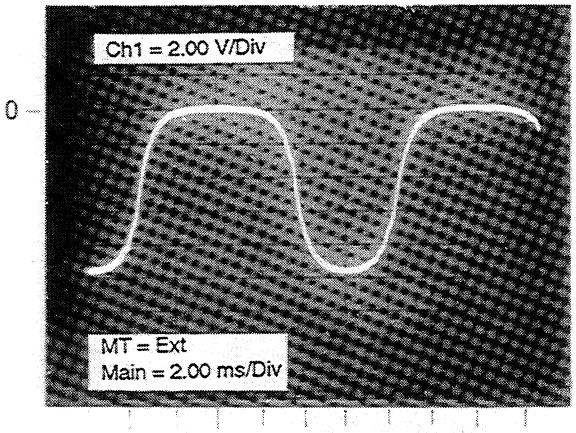
A. CV DAC (U315-1)/Readback DAC (U315-14)



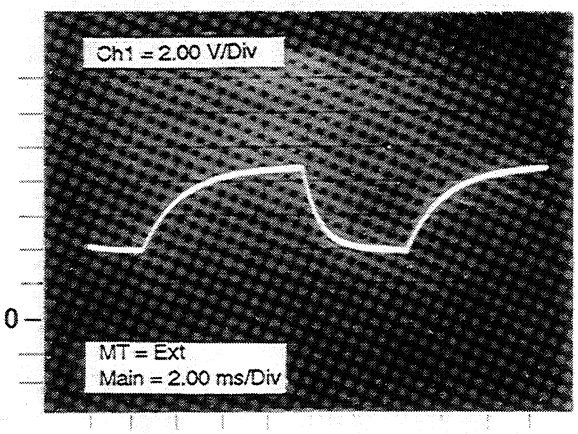
B. CV DAC Buffer (U352-7)



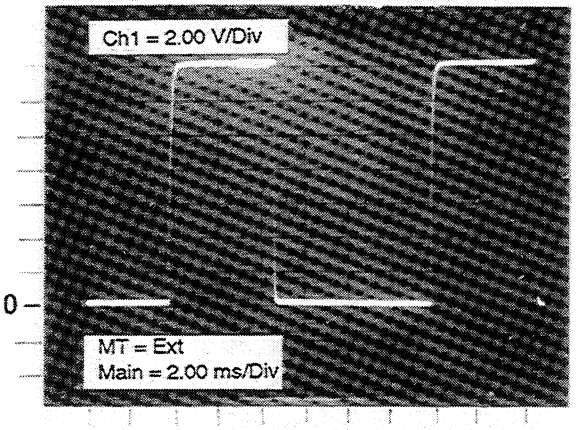
C. +V Output (U338-8) and Bypass Voltage (U338 5



D. Differential Amplifier (U352-1)



E. −CL Toggle Signal on C408

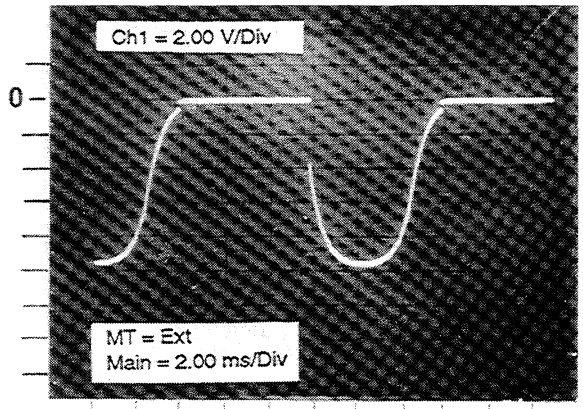


F. FET Downprogrammer Q342 Gate

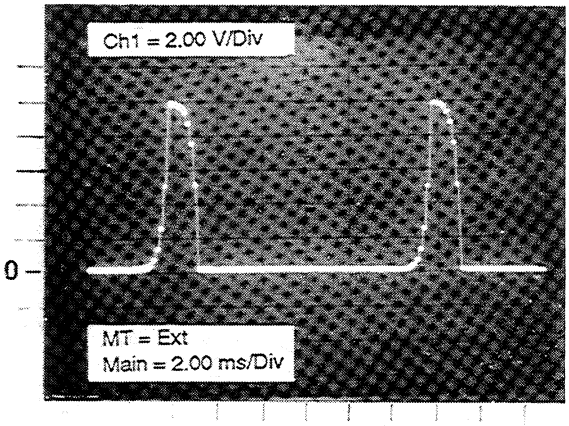
NOTE: The waveforms are all referenced to ⏚ (AI) common. The Readback Signal Comparator output (U324-7) was used as the trigger source (negative edge).

Figure 4-11 (Sheet 1). High Voltage Output Board Waveforms During Self Exercise Routine

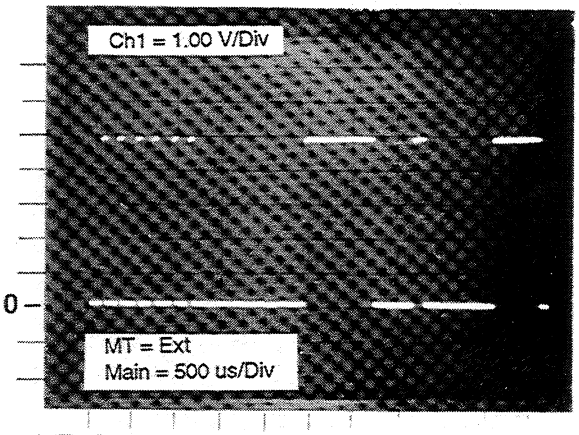
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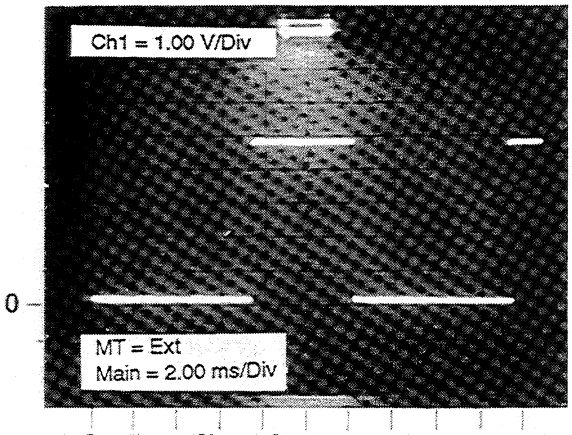
G. Analog Multiplexer Output (U323-8)



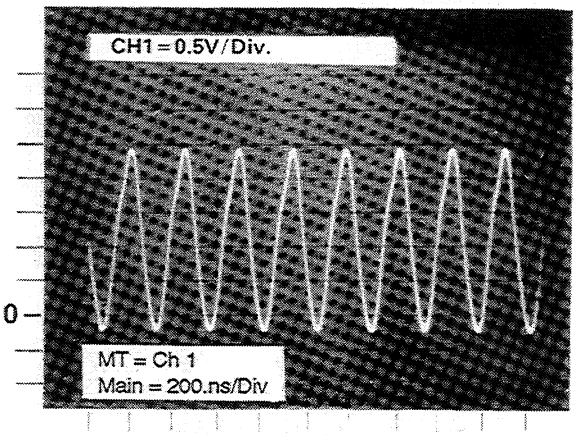
H. CL DAC (U315-7)/OV DAC (U315-8)



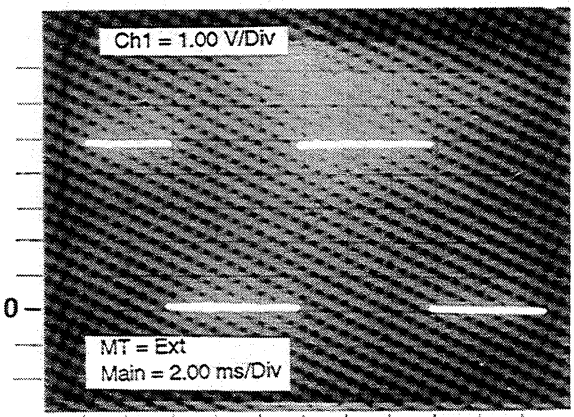
I. Typical Data Line (U312 pins 12-19, pin 17 shown)



J. Readback Signal Comparator Output (U324-7)



K. 4 MHz Resonator (U312-5)

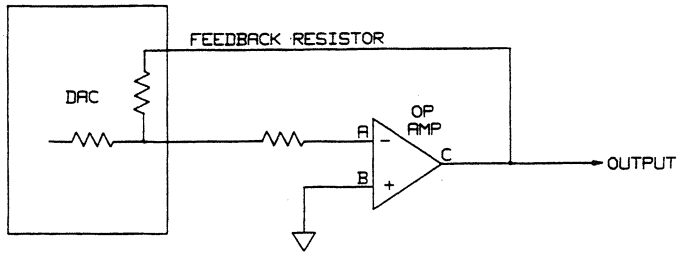


L. Analog Multiplexer Address Line (U323-16)

NOTE: The waveforms are all referenced to ⏚ common. The Readback Signal Comparator output (U324-7) was used as the trigger source (negative edge).

Figure 4-11 (Sheet 2). High Voltage Output Board Waveforms During Self Exercise Routine

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NOTE: DRASTICALLY INCORRECT FRONT PANEL READINGS (E.G. -50V, -25A) OR DAC OUTPUTS PROGRAMMING IN A SEVERELY NON-LINEAR FASHION MAY INDICATE THAT THE OUTPUT'S CALIBRATION CONSTANTS ARE GROSSLY INCORRECT. THE DEFAULT CALIBRATION CONSTANTS CAN BE RESTORED TO ALL OUTPUTS AT ONCE BY USING THE MODEL COMMAND (SEE PARA. 4-21). NOTE THAT USING THIS COMMAND CAUSES ALL OUTPUTS TO BE UNCALIBRATED.

	DAC	OP AMP
CV	U313	U315A
CL	U314	U315B
OV	U314	U315C
READBACK	U321	U315D

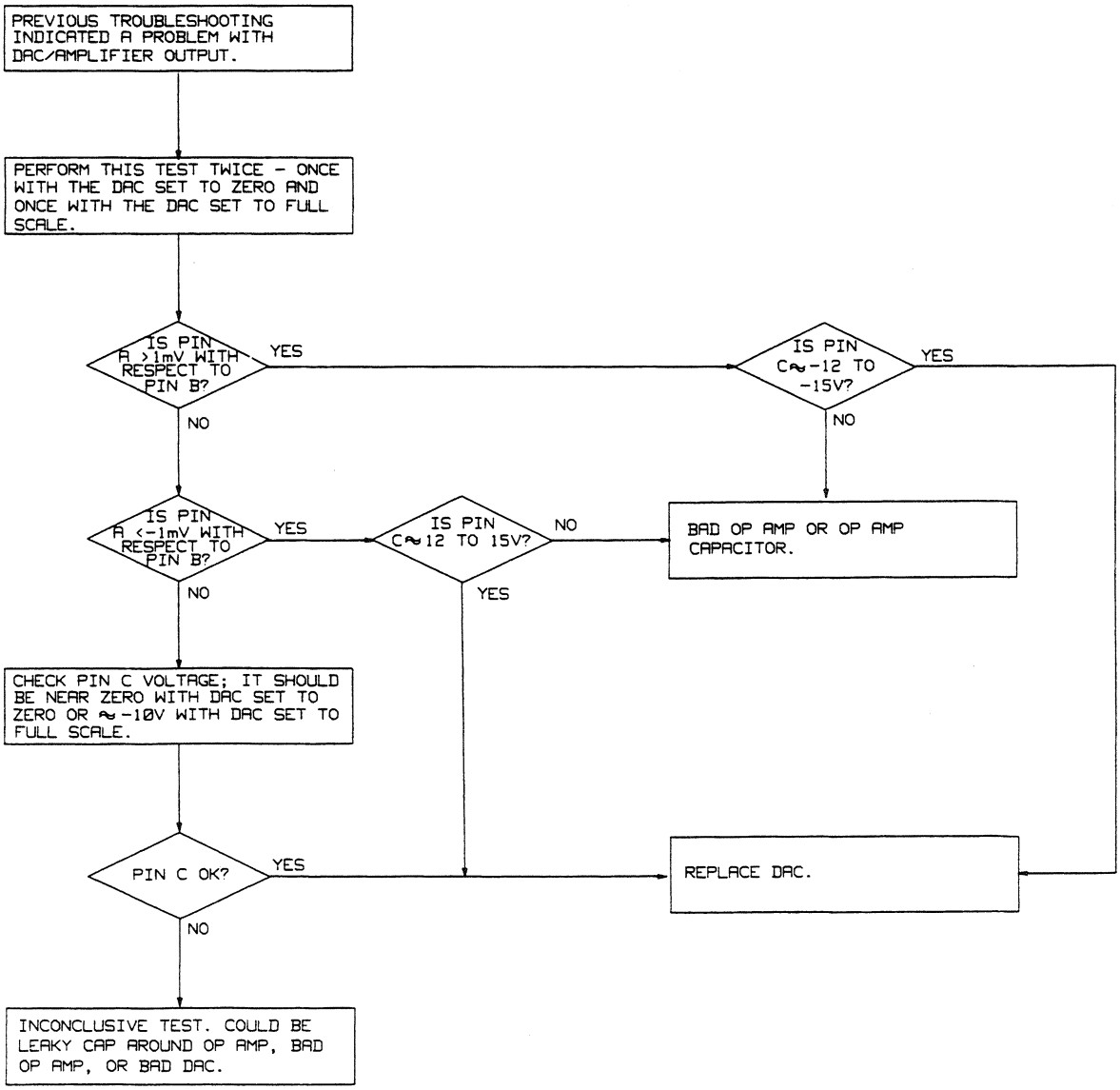


Figure 4-12. DAC/Amplifier Circuit Troubleshooting

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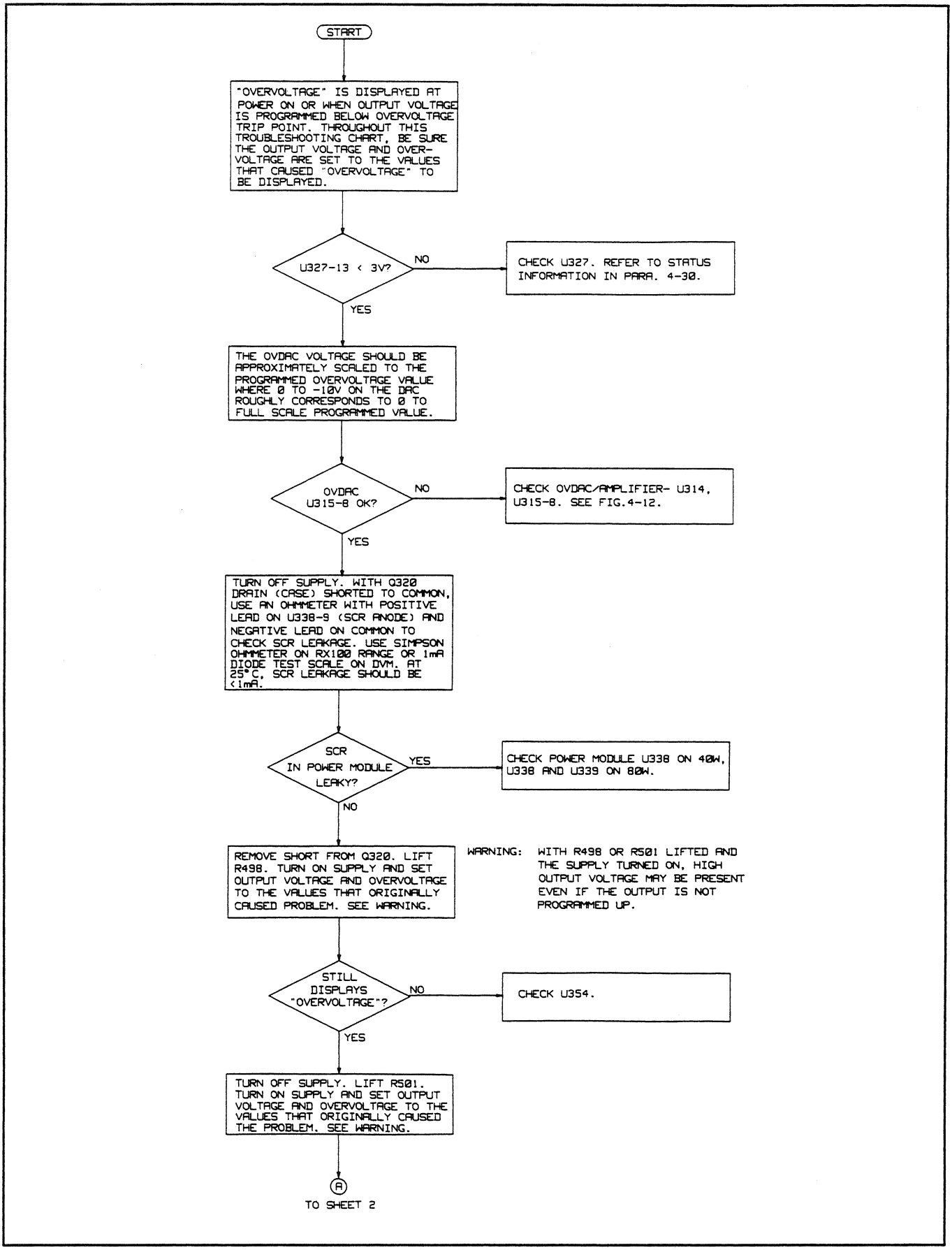


Figure 4-13 (Sheet 1). Overvoltage, Troubleshooting Flow Chart

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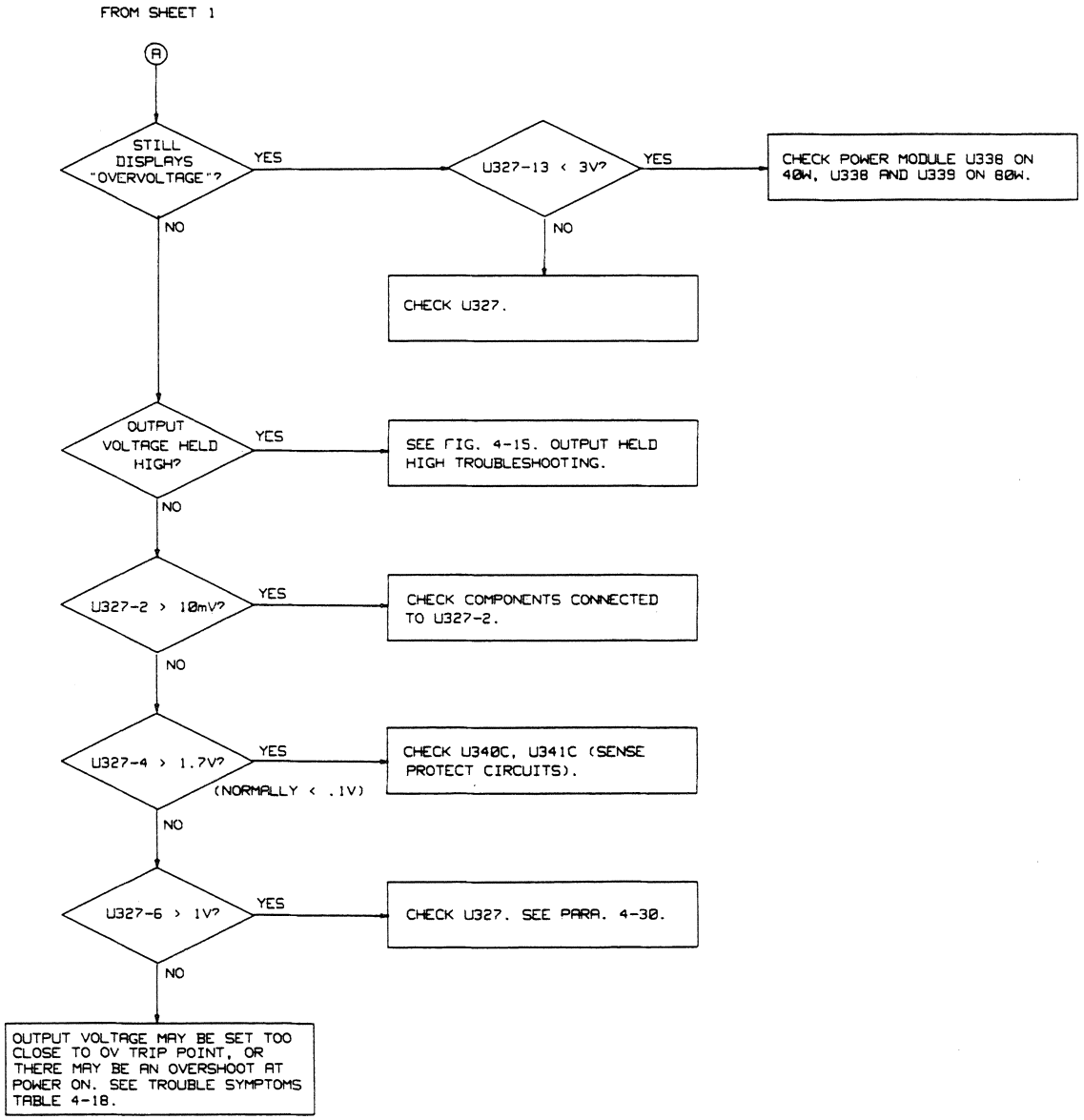


Figure 4-13 (Sheet 2). Overvoltage, Troubleshooting Flow Chart

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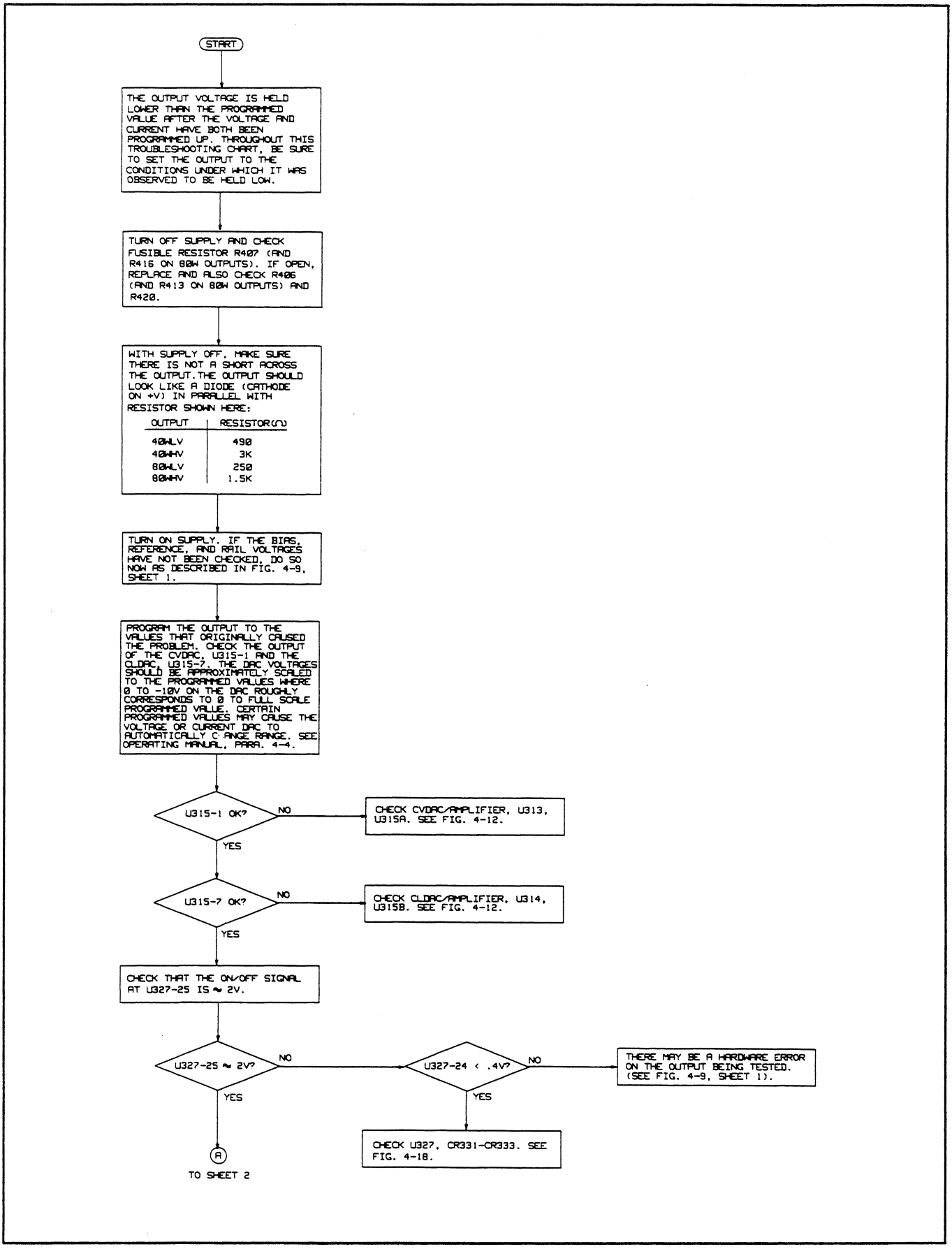


Figure 4-14 (Sheet 1). Output Held Low, Troubleshooting Flow Chart

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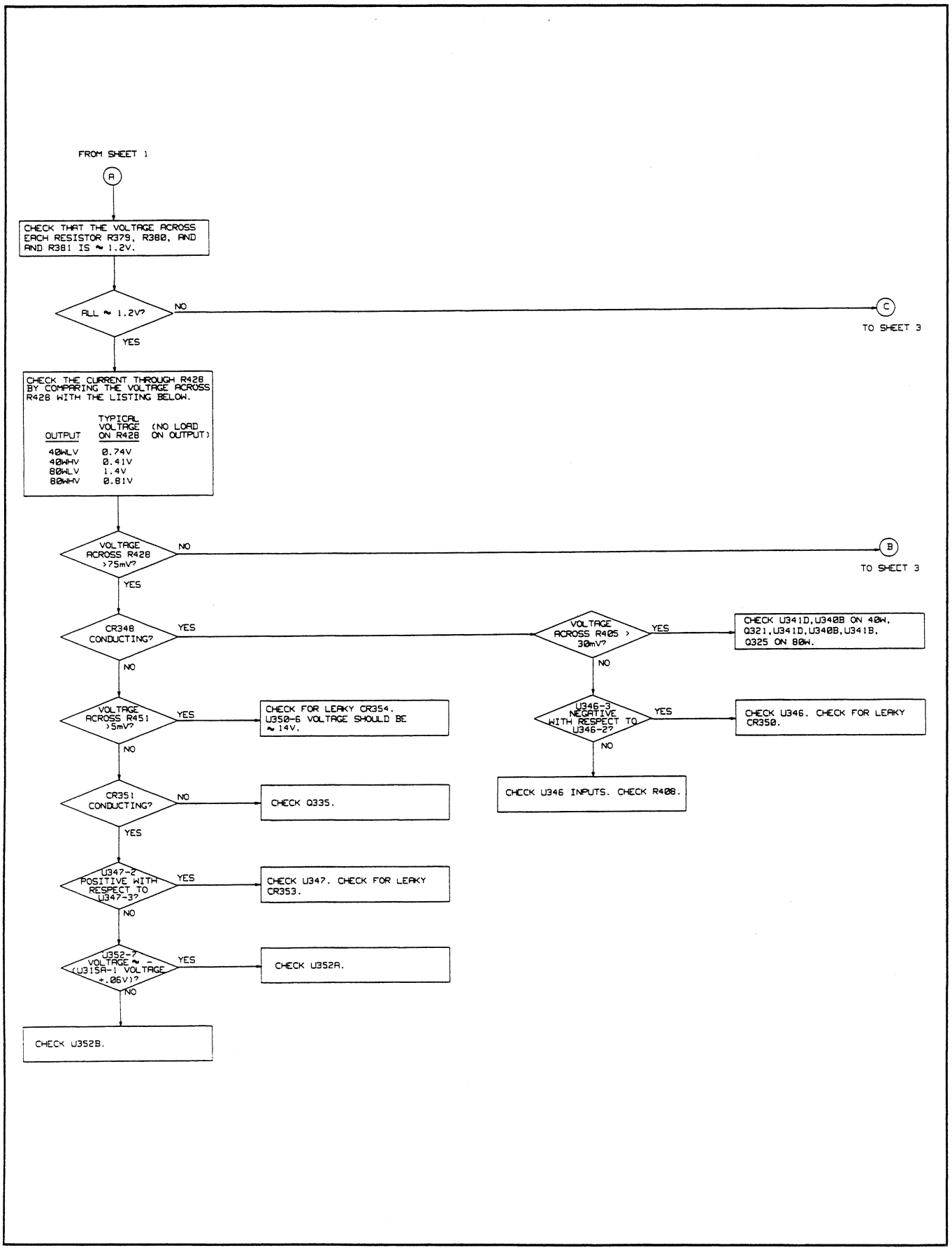


Figure 4-14 (Sheet 2). Output Held Low, Troubleshooting Flow Chart

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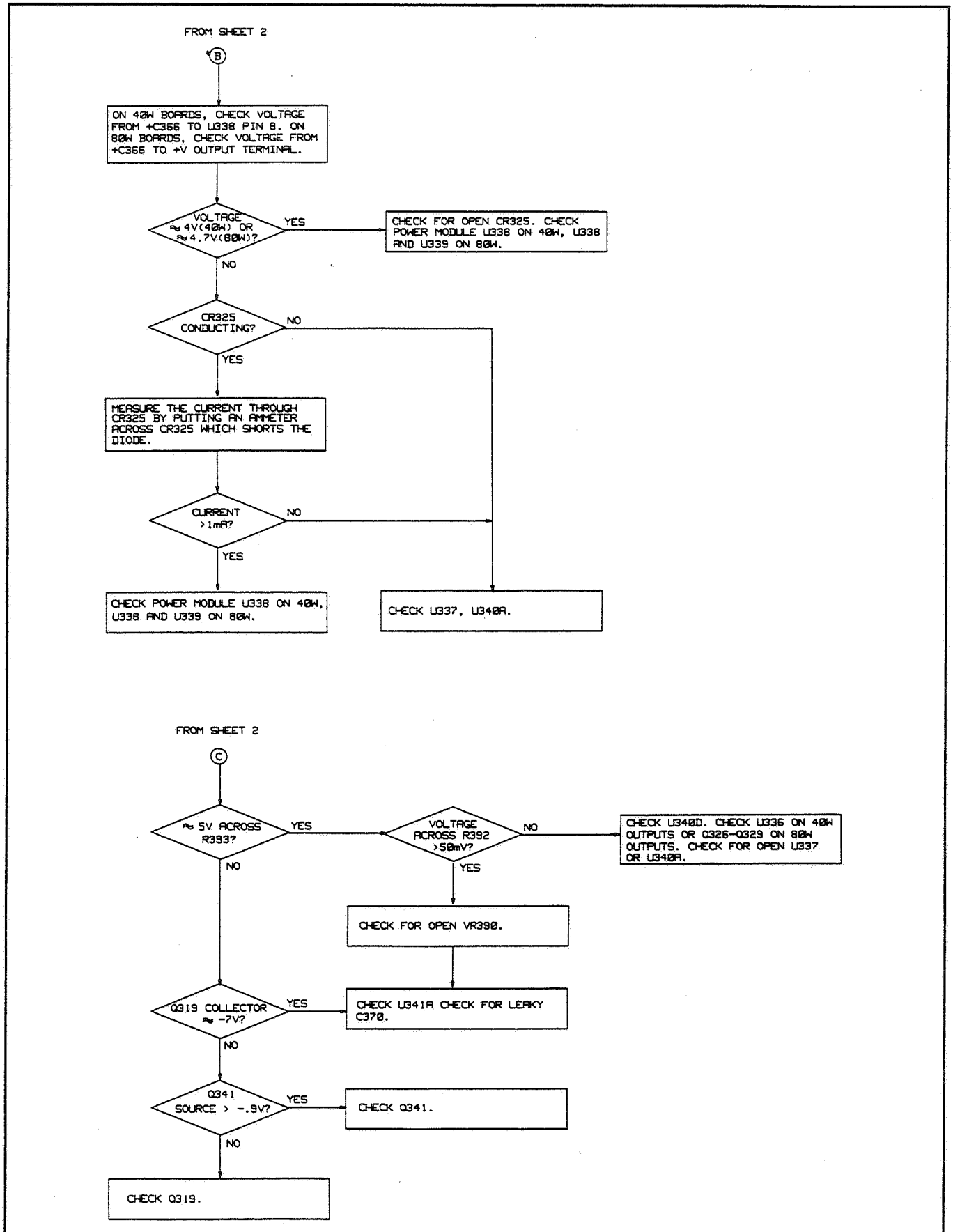


Figure 4-14 (Sheet 3). Output Held Low, Troubleshooting Flow Chart

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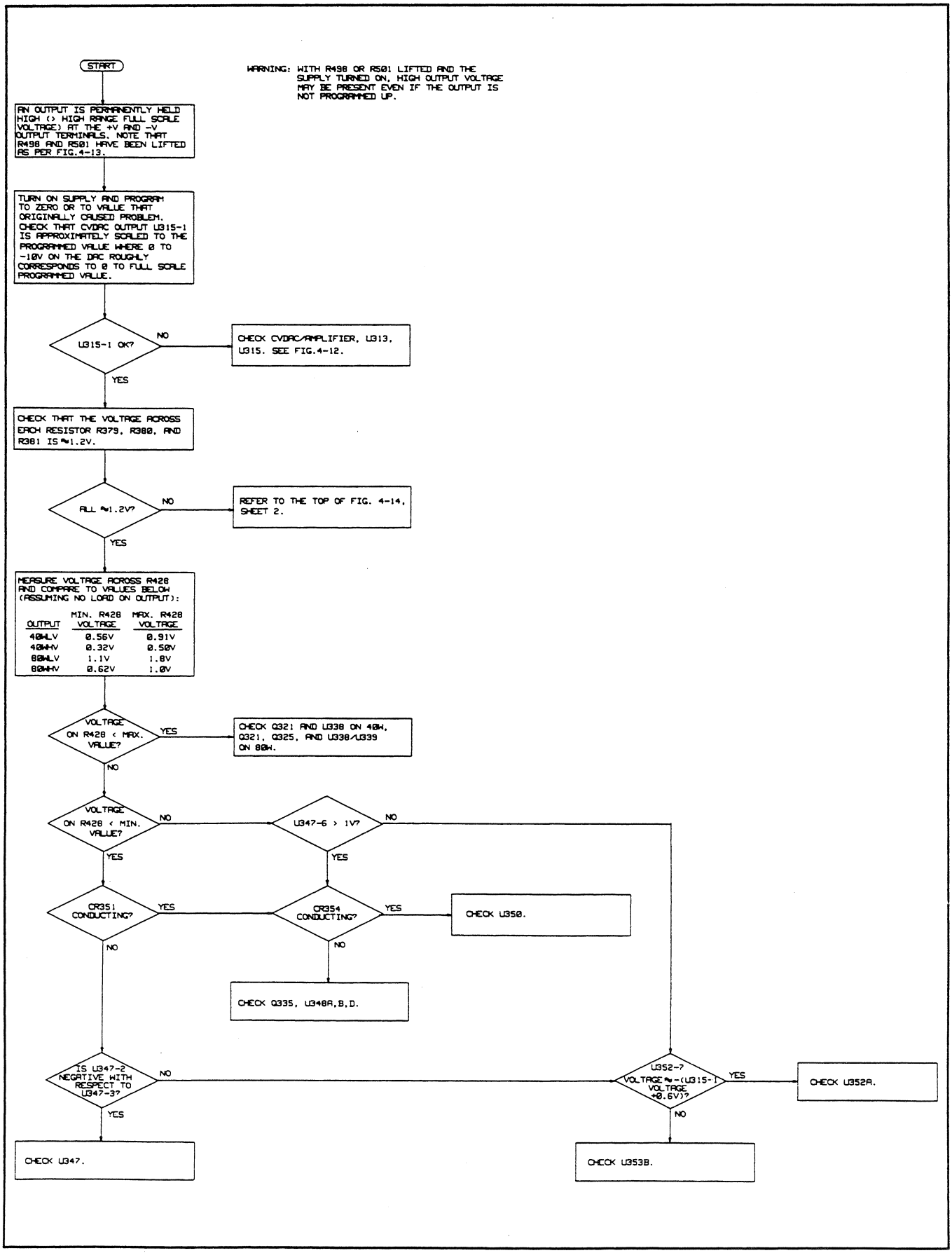


Figure 4-15. Output Held High Troubleshooting

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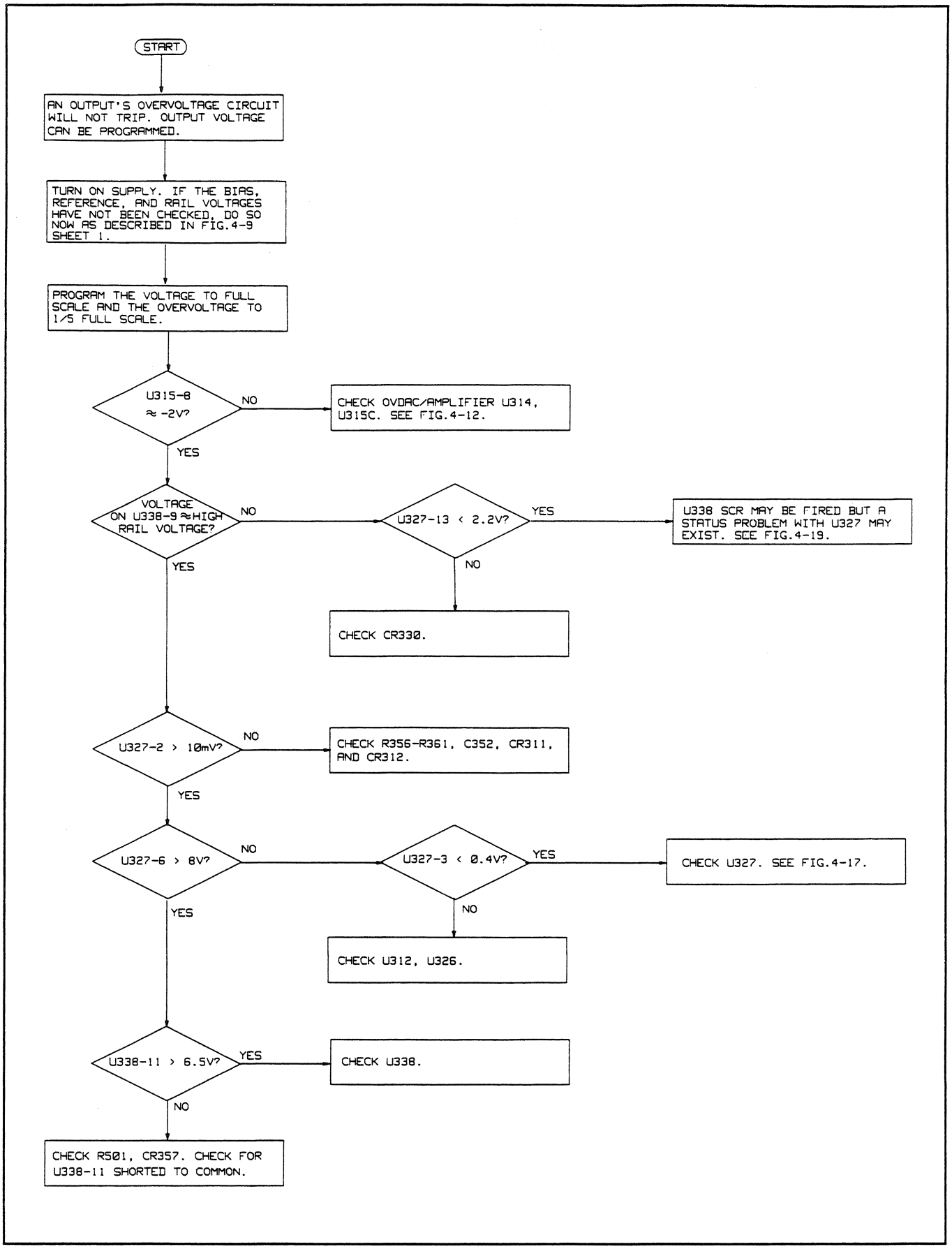


Figure 4-16. OV Will Not Trip, Troubleshooting Flow Chart

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Table 4-15. Microcomputer U312 Pin Measurements During the Self Exercise Routine

U312 Pin No.	Reading* Pin No.
1	Low (common)
2	Pulses
3	High (VCC)
4	4 MHz sine wave (2 V P-P)
5	4 MHZ sine wave (2 V P-P)
6	High (VCC)
7	High (VCC)
8	Pulses
9	Pulses
10	Pulses
11	Pulses
12	Pulses
13	Pulses
14	Pulses
15	Pulses
16	Pulses
17	Pulses
18	Pulses
19	Pulses
20	Pulses
21	Low
22	Low
23	High
24	Pulses
25	Low
26	Pulses
27	Low (Shorted to com)
28	Low to High

* Referenced to ⏚ (Common)

4-29 Troubleshooting Analog Multiplexer U323 and Readback Using VMUX? Command

Analog multiplexer U323 directs one of eight inputs to the readback signal comparator U324 (see paragraph 2-31). The instruction set for the power supply includes the VMUX? command which measures the voltage at these inputs. This command can be used to troubleshoot the analog multiplexer and the readback circuitry on the output board. The supply may have to be put into the SKIP SELF-TEST mode in order to program the output (see paragraph 4-126). The syntax for the VMUX? command is as follows:

VMUX? < ch >, < input no. >

A complete description of the syntax structure is shown as C4 in Figure 5-2 (sheet 1) in the Operating Manual. The response to the VMUX? command is SZD.DDD (see Table 5-2 in the Operating Manual for an explanation of these abbreviations). The resolution of the returned voltage reading is approximately 2 mV.

The analog multiplexer circuit is shown on the functional schematic of Figure 6-3, Sheet 1 and on the block diagram of Figure 2-4. The eight input signals to the analog multiplexer U323 are shown in table below.

The VMUX? command reads back approximately -1.01 times the voltage that appears on the selected input. Its readback range is limited to approximately - 0.1 to + 10 corresponding to +0.1 V to -10 V on the input pins. However, any positive voltage from approximately + 0.1 V to + 10 V on the input pins will readback about - 0.1 V.

After the VMUX? command is processed, the selected input will remain connected to the multiplexer output (U323, pin 8) as long as no other A/D conversions (voltage measurements) take place due to readback either over the GPIB or internally to the front panel. The A/D conversions on a particular output channel can be stopped by using the front panel OUTPUT SELECT key to monitor a different output channel (or, alternatively, simply pressing the front panel VSET, ISET, etc. keys will stop the internal A/D conversions).

For example, if it is desired to measure the multiplexer output voltage with an external voltmeter when the CV REF signal (Input No. 6) on output channel 2 is selected, stop the A/D conversions by pressing the VSET button on the front panel. Next, use the following program to select input 6 on channel 2 and to display the value read back to the computer.

```
10 OUTPUT 705; "VMUX? 2,6"
20 ENTER 705;A
30 DISP A
40 END
```

After the program is run, a voltmeter can be used to confirm that the multiplexer output (U323, pin 8) and input 6 (U323, pin 11) measure the same voltage and that the VMUX? result is valid.

Input No.	U323 Pin No.	Signal Name	Signal Magnitude Approx.
1	4	Common	±2 mV
2	5	Fuse	0 to −10mV(good), −.75V to −9 V (blown)
3	6	V READBACK(Output Voltage)	0 to −10 V
4	7	−CURRENT READBACK (Output I Sink)	0 to −10 V
5	12	CURRENT READBACK (Output I Source)	0 to −10 V
6	11	CV REF (Programmed Voltage)	0 to −10 V
7	10	CL REF (Programmed Current)	0 to −10 V
8	9	OV REF (Programmed OVERVOLTAGE)	0 to −10 V

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The next program uses a FOR/NEXT loop to read the 8 analog multiplexer inputs one at a time. The readings and associated input nos. are printed by the computer (see Input and Response columns in the table below).

```
10 FOR X=1 TO 8
20 OUT 705;"VMUX? 2";X
30 ENTER 705;V
40 PRINT X,V
50 NEXT X
60 END
```

The table below shows the 8 measured input voltage values as well as the VMUX? response for a typical calibrated 40WLV output (no load connected) whose voltage and current have been programmed to their High Range Full Scalue values (20V and 2A) and the OV (overvoltage) to 23 V.

Input No.	VMUX? Response	U323 Pin No.	U323 Input Volt.
1	0	4	0
2	0	5	0
3	9.021	6	−8.931
4	0	7	0
5	0	12	0
6	9.077	11	−8.985
7	3.551	10	−3.515
8	9.883	9	−9.783

If all of the inputs read back by the VMUX? command are incorrect, the analog multiplexer U323 and/or the readback circuitry (U321-U324) is probably defective. If only one input is incorrect, the circuitry associated with that one input is probably defective (see Figure 6-3).

4-30 Understanding and Troubleshooting the Signal Processor U327

This custom IC processes both analog and digital signals to interface the microcomputer (U312) with the power mesh and control circuits. The signal processor circuits can be functionally divided into three areas: overvoltage and driver, power-on/start-up, and status monitor circuits. A general description of this IC is provided in paragraph 2-32. The following information will help you troubleshoot the three signal processor functions.

Proper operation of the IC can be verified by measuring the pin voltages and using Table 4-16 which lists the voltage levels and defines the low and high states. This information is used in conjunction with the pin descriptions (paragraph 4-31) and simplified schematics to troubleshoot the signal processor's overvoltage (Figure 4-17), power-on/start-up (Figure 4-18), and status monitor circuits (Figure 4-19). Additional troubleshooting information for the status monitor circuit is given in paragraph 4-32 and Figure 4-20.

4-31 Signal Processor (U327) Pin Function Descriptions. The signal processor's circuits are shown on the functional schematic of Figure 6-3, sheet 1, and on the block diagram of Figure 2-4. The 28 signal processor pins are described as follows:

+ 5 V (pin 1): The + 5 V bias voltage can range from 4.72 V to 5.23 V.

OV COMP (pin 2): The OV COMP (overvoltage comparator) input signal, when High, causes OV DRIVE (pin 6) to be High (> 8 V) if POV DISABLE (pin 3) is Low.

POV DISABLE (pin 3): The POV DISABLE (programmed overvoltage disable) input signal, when High, prevents OV COMP (pin 2) from causing OV DRIVE (pin 6) to be High. It does not prevent OV TRIP (pin 4) from causing OV Drive to be High.

OV TRIP (pin 4): This input signal, when High, causes OV DRIVE (pin 6) to be High (> 11 V) independent of POV DISABLE (pin 3).

Common (pin 5): Along with pin 22, this is a common return for the bias supplies.

OV DRIVE (pin 6): This output signal is a function of inputs: OV COMP, POV DISABLE, and OV TRIP. When OV DRIVE goes High, it fires the SCR in the power module. The OV DRIVE pin voltage will be > 8 V when tripped from OV COMP and > 11 V when tripped from OV TRIP (see Figure 4-17).

STATUS RESET (pin 7): This input pin, when High, causes four internal flip-flops to be reset. The four flip-flops are used to catch and hold the occurrence of four status conditions: CV, + CC, - CC, and UNR.

+ 15 V (pin 8): The + 15 V bias voltage can range from 14 V to 15.66 V.

$\overline{\text{UNREG}}$ (pin 9): The $\overline{\text{UNREG}}$ (unregulated) output signal (open collector) takes on the state of the internal UNR flip-flop when $\overline{\text{STATUS SELECT}}$ (pin 11) is Low. The unregulated mode is indicated when $\overline{\text{UNREG}}$ is Low. Figure 4-19 shows the conditions that cause $\overline{\text{UNREG}}$ to go Low. $\overline{\text{UNREG}}$ is open-circuited when $\overline{\text{STATUS SELECT}}$ is High.

$\overline{\text{- CLO}}$ (pin 10): The $\overline{\text{-CLO}}$ (-current limit output) output signal (open collector) takes on the state of the internal -CC flip-flop when $\overline{\text{STATUS SELECT}}$ (pin 11) is Low. The –CC mode is indicated when $\overline{\text{-CLO}}$ is Low. Figure 4-19 shows the conditons that cause $\overline{\text{-CLO}}$ to be Low. $\overline{\text{-CLO}}$ is open-circuited when $\overline{\text{STATUS SELECT}}$ is High.

$\overline{\text{STATUS SELECT}}$ (pin 11): This input signal, when Low, causes the four status conditions held in the flip-flops as well as the overvoltage and overtemperature signals to be transferred to the six output pins on the data bus (CVO, $\overline{\text{+CLO}}$, $\overline{\text{-CLO}}$, $\overline{\text{UNREG}}$, OV, and OT). When $\overline{\text{STATUS SELECT}}$ is High, the six output pins are open-circuited.

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Table 4-16. Signal Processor (U327) Signal Levels

U327 PIN NO.	SIGNAL		LOW AND HIGH LEVELS		MIN. & MAX. DC PIN VOLTAGES ON A PROPERLY OPERATING BOARD	
	NAME	TYPE	LOW	HIGH	MIN.	MAX.
1	+5 V	Bias	—	—	4.72 V	5.23 V
2	OV COMP	Input	<0±10 mV	>0 ±10 mV	−0.7 V***	10 mV
3	POV DISABLE	Input	<0.4 V	>2.4 V	0 V	5.23 V
4	OV TRIP	Input	<1.3 V±0.2 V (↓)	>1.95 V±0.25 V(↑)	0V	5 V pulse
5	Common	Bias Return	—	—	0 V	0 V
6	OV DRIVE	Output	<1 V	>8 V or >11 V**	0 V	14 V
7	STATUS RESET	Input	<0.4 V	>2.4 V	0 V	5.23 V
8	+15 V	Bias	—	—	14 V	15.66 V
9	$\overline{\text{UNREG}}$	Status Output	<0.4 V	>2.4 V	0 V	5.23 V
10	$\overline{-\text{CLO}}$	Status Output	<0.4 V	>2.4 V	0 V	5.23 V
11	$\overline{\text{STATUS SELECT}}$	Input	<0.4 V	>2.4 V	0 V	5.23 V
12	OV	Status Output	<0.4 V	>2.4 V	0 V	5.23 V
13	$\overline{\text{OV SENSE}}$	Status Input	<2.6 V±0.4 V	>2.6 V±0.4 V	1 V	5.23 V
14	$\overline{\text{THERM}}$	Status Input	<2.5 V±0.15 V(↓)	>2.8 V±0.3 V(↑)	2.35 V	5.1 V
15	OT	Status Output	<0.4 V	>2.4 V	0 V	5.23 V
16	$\overline{-\text{CL LOOP}}$	Status Input	<0.8 V±0.3 V(↓)	>0.85 V±0.25 V(↑)	−6.5 V	15.66 V
17	−7.00 V	Bias	—	—	−7.42 V	−6.48 V
18	$\overline{+\text{CLO}}$	Status Output	<0.4 V	>2.4 V	0 V	5.23 V
19	$\overline{\text{CVO}}$	Status Output	<0.4 V	>2.4 V	0 V	5.23 V
20	+CL LOOP	Status Input	< −4.4 V±0.25 V(↓)*	> −4.2 V±0.25 V(↑)*	−6.08 V	2.5 V
21	CV LOOP	Status Input	LOW: < −4.4 V±0.25 V(↓)* MEDIUM: > −4.2 V±0.25 V(↑)* or <0.85V±0.25 V(↓) HIGH: >0.95 V±0.25 V(↑)		−7.5 V	2.5 V
22	Common	Bias Return	—	—	0 V	0 V
23	DELAY CAP	Time Delay	<6.7 V±1.3 V	>6.7 V±1.3 V	0 V	10 V
24	$\overline{\text{OUTPUT ENABLE}}$	Input	<0.4 V	>2.4 V	0 V	5.23 V
25	ON/OFF	Output	< −6.7 V*	>1.7 V	−7.42 V	2.5 V
26	$\overline{\text{PCLR}}$	Output	<0.8 V	>2.4 V	0 V	5.23 V
27	$\overline{\text{BIAS TRIP}}$	Input	<0.3 V	>0.85 V±0.2 V	0 V	1.05 V
28	−15 V	Bias	—	—	−15.55 V	−13.98 V

NOTES:

1. Signal levels are referenced to common.
2. * Indicates that the stated voltage threshold depends upon the value of the - 7 V (nominal) supply. For example, if the value of the - 7 V supply is actually - 7.1 V (0.1 V lower than - 7 V), then the LOW value given for pin 25 would read < - 6.8 V (which is 0.1 V lower than - 6.7 V).
3. ** See OV DRIVE (pin 6) description in paragraph 4-30.
4. *** Minus one diode drop.
5. (↑) Indicates that hysteresis is involved in the trip voltage level and a transition from a lower voltage up to the indicated level must have occurred (e.g., $\overline{\text{THERM}}$, pin 14, is HIGH only when the voltage increases to a level >2.8 V ±0.3 V).
6. (↓) Indicates that hysteresis is involved in the trip voltage level and a transition from a higher voltage down to the indicated level must have occurred (e.g., $\overline{\text{THERM}}$, pin 14, is LOW only when the voltage decreases to a level <2.5 V ± 0.15 V).

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OV (pin 12): This open collector output pin goes High when STATUS SELECT (pin 11) is Low and the OV SENSE (pin 13) is Low. The Low state of pin 13 indicates an overvoltage condition. OV is open-circuited when STATUS SELECT is High.

OV SENSE (pin 13): When an overvoltage occurs (pin 9 on the power module goes Low), this input pin goes Low which causes OV (pin 12) to go High when STATUS SELECT (pin 11) is Low.

THERM (pin 14): This input signal, when Low (indicating an overtemperature condition), causes OT (pin 15) to go High when STATUS SELECT (pin 11) is Low.

OT (pin 15): This open collector output signal goes High when both the STATUS SELECT (pin 11) and THERM (pin 14) inputs are Low indicating an OT (overtemperature) condition. OT is open-circuited when STATUS SELECT is High.

- CL LOOP (pin 16): This input signal, when Low, indicates that the supply's output is in negative current limit. Figure 4-19 shows how this signal is decoded causing -CLO (pin 10) to go Low.

-7.00 V (pin 17): The - 7.00 V bias voltage can range from - 7.42 V to - 6.48 V.

+ CLO (pin 18): This open-collector output signal takes on the state of the internal +CC flip-flop when STATUS SELECT (pin 11) is Low. Figure 4-19 shows the conditions that cause + CLO to be Low. The + CC mode is indicated when + CLO is Low. +CLO is open-circuited when STATUS SELECT is High.

CVO (pin 19): This open collector output signal takes on the state of the internal CV flip-flop when STATUS SELECT is Low. Figure 4-19 shows the conditions that cause CVO to go Low. The CV mode is indicated when CVO is Low. CVO is open-circuited when STATUS SELECT is High.

+ CL LOOP (pin 20): This input signal, when High, indicates that the supply's output is in the positive current limit. Figure 4-19 shows how this signal is decoded causing + CLO (pin 18) to go Low.

CV LOOP (pin 21): When the supply's output is in the CV mode, the voltage level of this input signal should fall within the "medium" level (see Table 4-16). A High level at pin 21 indicates that the output is unregulated. Figure 4-19 shows how the CV LOOP signal is decoded causing CVO (pin 19) to go Low.

Common (pin 22): Along with pin 5, this is a common return for the bias supplies.

DELAY CAP (pin 23): When BIAS TRIP (pin 27) is High, this signal causes a slow charge of an external delay capacitor toward the DELAY CAP High level which, when reached, causes PCLR (pin 26) to go High. When BIAS TRIP is Low, this signal causes a quick discharge of the external delay capacitor (see Figure 4-18).

OUTPUT ENABLE (pin 24): After PCLR (pin 26) goes High and the power supply passes its self test, the microcomputer U312 causes this pin to go Low. With PCLR High and OUTPUT ENABLE Low, ON/OFF (pin 25) goes High enabling the output. With OUT ENABLE High, ON/OFF is Low and the output will not supply power.

ON/OFF (pin 25): This output pin goes High when PCLR (pin 26) is High and OUTPUT ENABLE (pin 24) is Low (see Figure 4-18). When High, the ON/OFF line enables the control circuits and current sources of the output board which allows power to reach the output terminals.

PCLR (pin 26): This output goes High when DELAY CAP (pin 23) goes High (see Figure 4-18). When PCLR is High and OUTPUT ENABLE (pin 24) is Low, ON/OFF (pin 25) goes High.

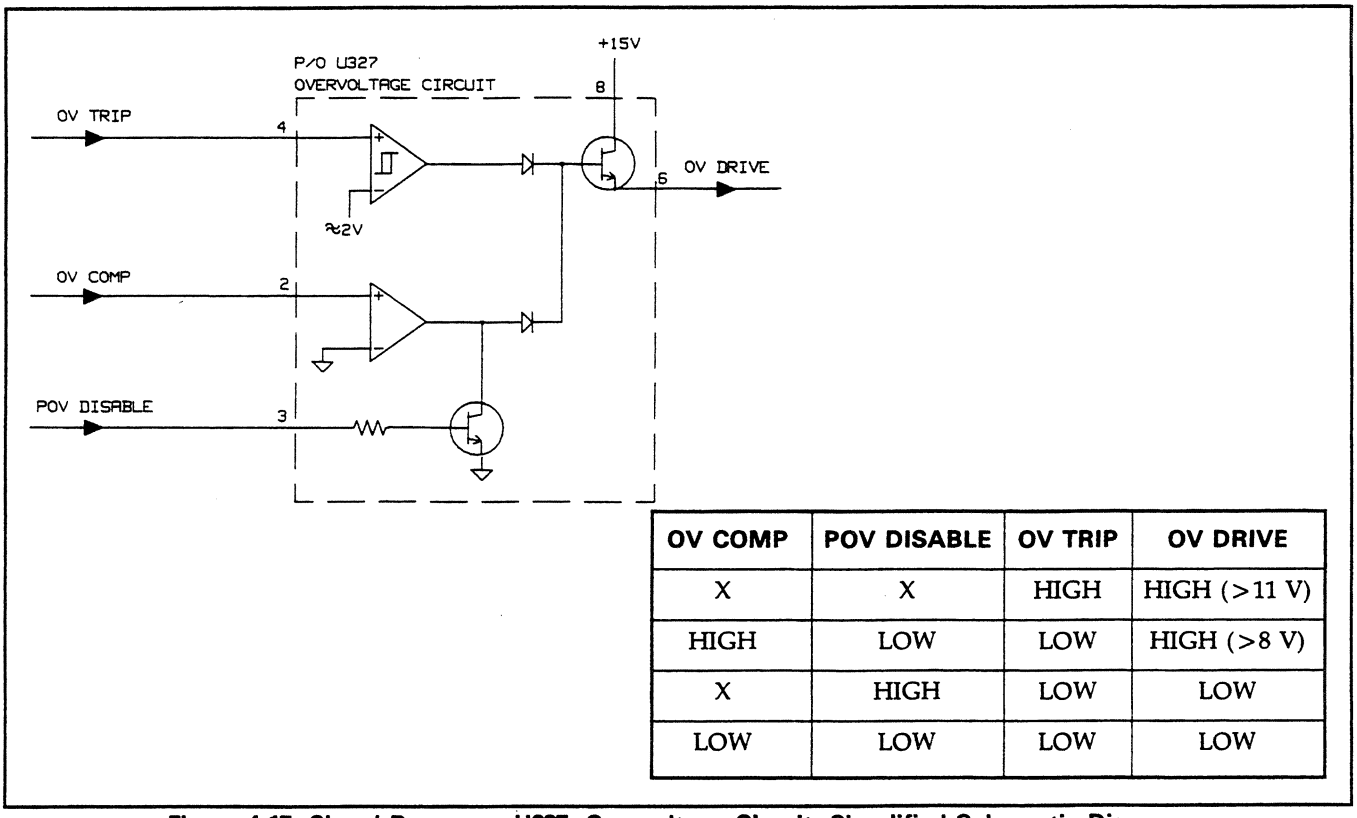
BIAS TRIP (pin 27): See DELAY CAP (pin 23) description. Note that BIAS TRIP goes High when both the unregulated bias supply voltage and the medium rail voltage are high enough.

15 V (pin 28): The -15 V bias voltage can range from 15.55 V to -13.98 V.

4-32 Troubleshooting Status Problems. An output will report its operating status (CV, + CC, - CC, OV, OT, and UNR) when queried to do so (see paragraph 5-25 in the Operating Manual). The front panel also indicates the present status of the output. When an output appears to operate properly but incorrect or multiple status is reported, the problem may be caused by the status monitor circuit section of U327, microcomputer U312, or a short on the data lines between these two IC's. Note, however, that certain load transients can cause a temporary multiple status condition to exist and this is not to be considered a problem.

A status decoding table, which indicates the logic relationship between the five status input lines and the six status output lines, is included in Figure 4-19. To troubleshoot status problem, set up an oscilloscope as

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OV COMP	POV DISABLE	OV TRIP	OV DRIVE
X	X	HIGH	HIGH (>11 V)
HIGH	LOW	LOW	HIGH (>8 V)
X	HIGH	LOW	LOW
LOW	LOW	LOW	LOW

Figure 4-17. Signal Processor U327, Overvoltage Circuit, Simplified Schematic Diagram

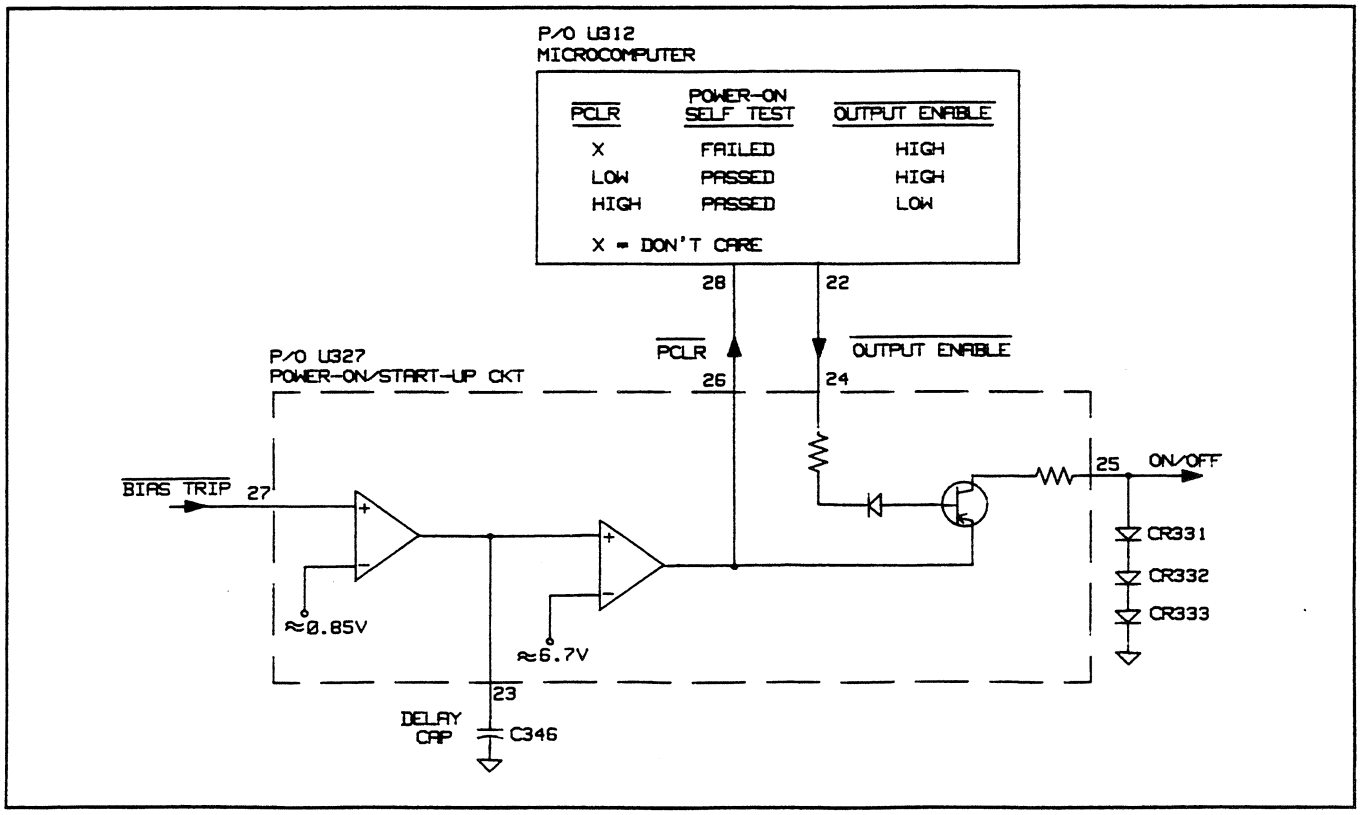


Figure 4-18. Signal Processor U327, Power-On/Start-Up Circuit, Simplified Schematic Diagram

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described below and refer to Figure 4-19 and the troubleshooting procedures of Figure 4-20.

a. Connect oscilloscope Channel A at 2 volts/div to $\overline{\text{STATUS SELECT}}$ (U327, pin 11).
b. Trigger on Channel A, negative slope. Set time base to 10μS/div.
c. The $\overline{\text{STATUS SELECT}}$ line should go low for about 30μS. During this interval, each of the six TTL compatible status output lines from U327 can be checked against the information given in the table on Figure 4-19 by connecting Channel B of the oscilloscope to the IC pin in question.
d. The five status input lines to U327 can also be checked with the scope. The input lines should be relatively clean dc waveforms (unless there are load transients occurring). The input lines are not TTL signals. Check Table 4-16 for the voltage values that correspond to a particular input line being High or Low.
e. Follow the procedures outline in Figure 4-20.

4-33 Power Module Signals

Table 4-17 gives the function and typical signal levels at each pin for a properly operating power module(s): U338 on 40W output boards, U338 and U339 on 80W output boards. As indicated in the table, the voltage levels were measured with the output voltage set to the maximum programmable value, with no load connected to the output, and at nominal line voltage.

4-34 Miscellaneous Trouble Symptoms and Remedies

Table 4-18 lists various trouble symptoms along with suggested remedies. Most of the trouble symptoms are concerned with an output not meeting a particular specification. Verification tests for all specifications are given in Section III of this manual.

Table 4-17. Typical Power Module U338 Voltage Levels

U338 Pin No. (Note 3)	Function	Output Board				Voltage Referenced to
		40WLV	40WHV	80WLV	80WHV	
1	Reference	3.5 V	3.5 V	4.1 V	4.1 V	+V
2	Emitter	2.7 V	2.7 V	3.4 V	3.4 V	+V
3	High Rail	39 V	78 V	39 V	78 V	Common
4	Medium Rail	21 V	46 V	21 V	46 V	Common
5	Bypass	2.7 V	2.7 V	3.4 V	3.4 V	+V
6	Low Rail	10.5 V	23 V	10.5 V	23 V	Common
7	Thermistor (Note 4)	4.5 V	4.5 V	4.5 V	4.5 V	Common
8	Collector Output	20 V	50 V	20 V	50 V	Common
9	O V Bias	≈ −0.6 V	≈ −0.6 V	≈ −0.6 V	≈ −0.6 V	pin 3
10	Output Sense	20V	50V	20V	50V	Common
11	OV Gate	0V	0V	0V	0V	Common
12	Common	0V	0V	0V	0V	Common
13	+ Drive	.6 V	.6 V	.6 V	.6 V	+V
14	- Drive	≈ −0.7 V	≈ −0.7 V	≈ −0.7 V	≈ −0.7 V	pin 13

Notes:

1. Conditions:
   a. Output voltage set to maximum. programmable value (20 V or 50 V).
   b. No load on output
   c. Nominal line voltage
2. Voltages are referenced to + V or Common or another power module pin as indicated in the table.
3. Power Module U339 is connected in parallel with U338 on 80WLV and 80WHV boards and has the same voltage levels and connections as U338 (see Figure 6-3 sheet 3) except that the OV GATE input (pin 11) to U339 is tied to common. U338 and U339 are matched pairs and should be replaced as such. Agilent Part No. 5080-2111 contains a matched pair of U338/U339 power modules.
4. The Thermistor output (pin 1) level of 4.5 V was measured at a temperature of 25°C. Voltage decreases with a rise in temperature. OVERTEMP occurs at approximately 2.5 V.

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Table 4-18. Miscellaneous Trouble Symptoms

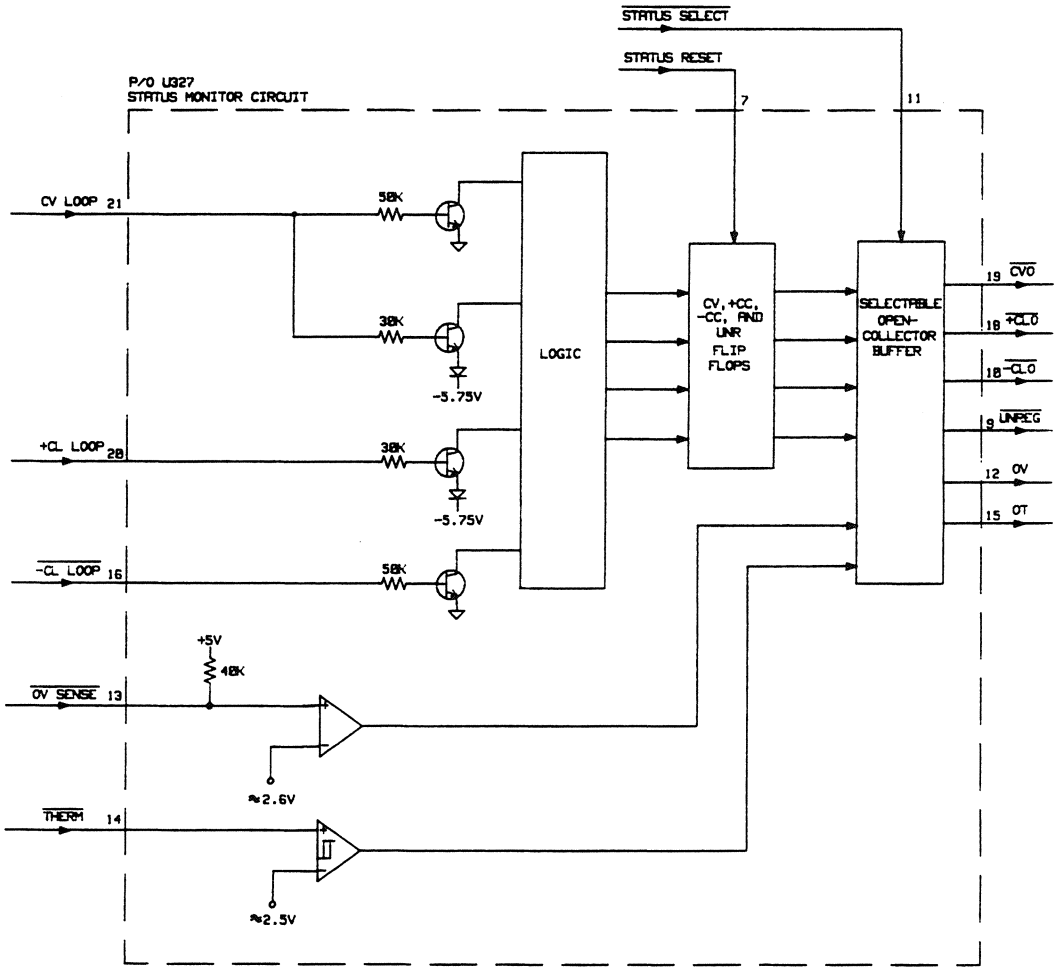
Trouble Symptom	Remedy
Spikes on output	See paragraph 3-15 for proper noise measurement technique. Check dress of GPIB board cabling. Check GPIB board and output board for loose ground screws. Check for sense lead pick up (see paragraph 4-12 in the Operating Manual).
Ripple on output	Check for ripple on bias voltages or VREF voltages. Check for about 2.5 V to 3.5 V on power module pins 5 to 8 when output voltage is programmed to full scale.
Poor transient response or oscillations on the output	Check stable operating area with capacitive and inductive loads as given in Figures 1-4 through 1-6 of the Operating Manual. Check output capacitors C416 and C417. Check compensation components (tied to R420) for appropriate loop (CV, CC, or −CC). Check power module compensation components between U338 (U339) pins 2 and 5, and capacitor(s) between pin(s) 5 and common. Check for an open FET Q339. Check if board is in the self exercise mode (see paragraph 4-28).
CV load effect	Check that the sense leads are connected properly. Regulation can be affected by load lead drop when remote sensing. See paragraph 4-11 in the Operating Manual. Check U352 and C404, U347 and C399. Check for oscillations on the output (see remedy for the trouble symptom above).
CC load effect	Check for over 30 mV on R405 to confirm a leaky transistor P/O U340B. Check for leaky C390, C391, C393.
Line regulation	Check regulation of bias supply 3-pin regulators as a function of line voltage. Check the stability of the 10 V reference voltages.
Readback Error	Check if the output has been properly calibrated. Check U319, U345, U323. See paragraph 4-28. If current readback as well as current accuracy are incorrect by approximately the same percentage, check sense resistor R408.
Overshoot or overvoltage at turn on (output may apparently work properly after turn on)	Check for proper operation of FET Q339 and transistor P/O U348A. Check for slow turn on of Q319 as controlled by C371. Check for leaky current sources U336, U340D on 40 W boards, Q326-Q329 and U340D on 80 W boards by shorting U327-23 (delay cap) to common to turn off Q319 and P/O U341A. The voltage on each of R379-R381 should be less than 2 millivolts.
OV fires when output is loaded or during loading or unloading transients	Check that the OV setting is accurate (properly calibrated). Check that the OV setting is not too close to the sum of the sense lead voltage plus the load lead drop. Note that the overvoltage circuit senses the output voltage at the +V and −V output terminals, not at the sense leads. Check for open C433, C434 in the sense protect circuit. Check for open C429, C359, C352. Check for excessive load lead voltage drop (see paragraph 4-5 in the Operating Manual). See "Poor Transient Response" symptom in this table.
OV will not reset	Check output with an oscilloscope. The overvoltage circuit may be resetting and then tripping again. Check FET Q320. Check U312 pin 23 waveform when attempting reset. This line should go high for about 1.5 mS. If it does not, check U312. Check Check U327.
Output voltage programming speed out of specification	Programming speed will be affected by external output capacitors (see paragraph 4-13 in the Operating Manual). If problem occurs with no external output capacitor, check the voltage programming time constant capacitor C402 in the P/O U352B CV DAC buffer circuit. Check CR347 in the CC loop. When not in the CC mode, check that U346-6 is approximately −14 volts, so that the CC loop will not interfere with up programming. Check C393.

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Table 4-18. Miscellaneous Trouble Symptoms (continued)

Trouble Symptom	Remedy
Output resets to zero volts apparently at random or at low line	Check operation of the medium rail turn on comparator and bias trip low line comparator (U325). If there is an intermittent power transformer connection to the medium rail or a blown medium rail fuse, a ''voltage doubler'' action will take place which will make the medium rail ''sag'' at heavy load but will appear normal at light and no load. In this case, the medium rail ripple frequency will equal the line frequency instead of being twice the line frequency as is normal. Check medium rail fuses F300, F301, F305, F306 on 40 W boards and F305, F306, on 80 W boards.
''OVERTEMP'' displayed	Check for proper fan operation. Check that the power module(s) are screwed down tightly to the heatsink. Check voltage on U327-14 against Table 4-16 (see paragraph 4-30). Check R355. If the over temperature condition occurs rapidly after application of output load, power module(s) U338 (U339) may be defective.
Fuse F303 in the output return line blows after being replaced	Check for shorted capacitor(s) from power module(s) pin 5 to common. Check for open CR327. Check power module(s) U338 (U339).

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STATUS DECODING

STATUS INPUTS						RESULTING OUTPUT	FRONT PANEL INDICATION
STATUS SELECT	CV LOOP	+CL LOOP	−CL LOOP	OV SENSE	THERM		
LOW	MEDIUM	X	HIGH	X	X	CVO LOW (CV MODE)	CV ANNUNCIATOR
LOW	LOW	HIGH	HIGH	X	X	+CLO LOW (+CC MODE)	CC ANNUNCIATOR
LOW	LOW OR MED	X	LOW	X	X	−CLO LOW (−CC MODE)	CC ANNUNCIATOR
LOW	HIGH	X	X	X	X	UNREG LOW (UNR MODE)	UNR ANNUNCIATOR
LOW	LOW	LOW	HIGH	X	X	UNREG LOW (UNR MODE)	UNR ANNUNCIATOR
LOW	X	X	X	LOW	X	OV HIGH (OVERVOLTAGE)	"OVERVOLTAGE" MESSAGE
LOW	X	X	X	X	LOW	OT HIGH (OVERTEMPERATURE)	"OVERTEMP" MESSAGE
HIGH	X	X	X	X	X	ALL 6 OUTPUTS OPEN-CIRCUIT	NO CHANGE

X = DON'T CARE
HIGH, LOW, MEDIUM LEVELS ARE GIVEN IN TABLE 4-16

Figure 4-19. Signal Processor U327, Status Monitor Circuit, Simplified Schematic Diagram

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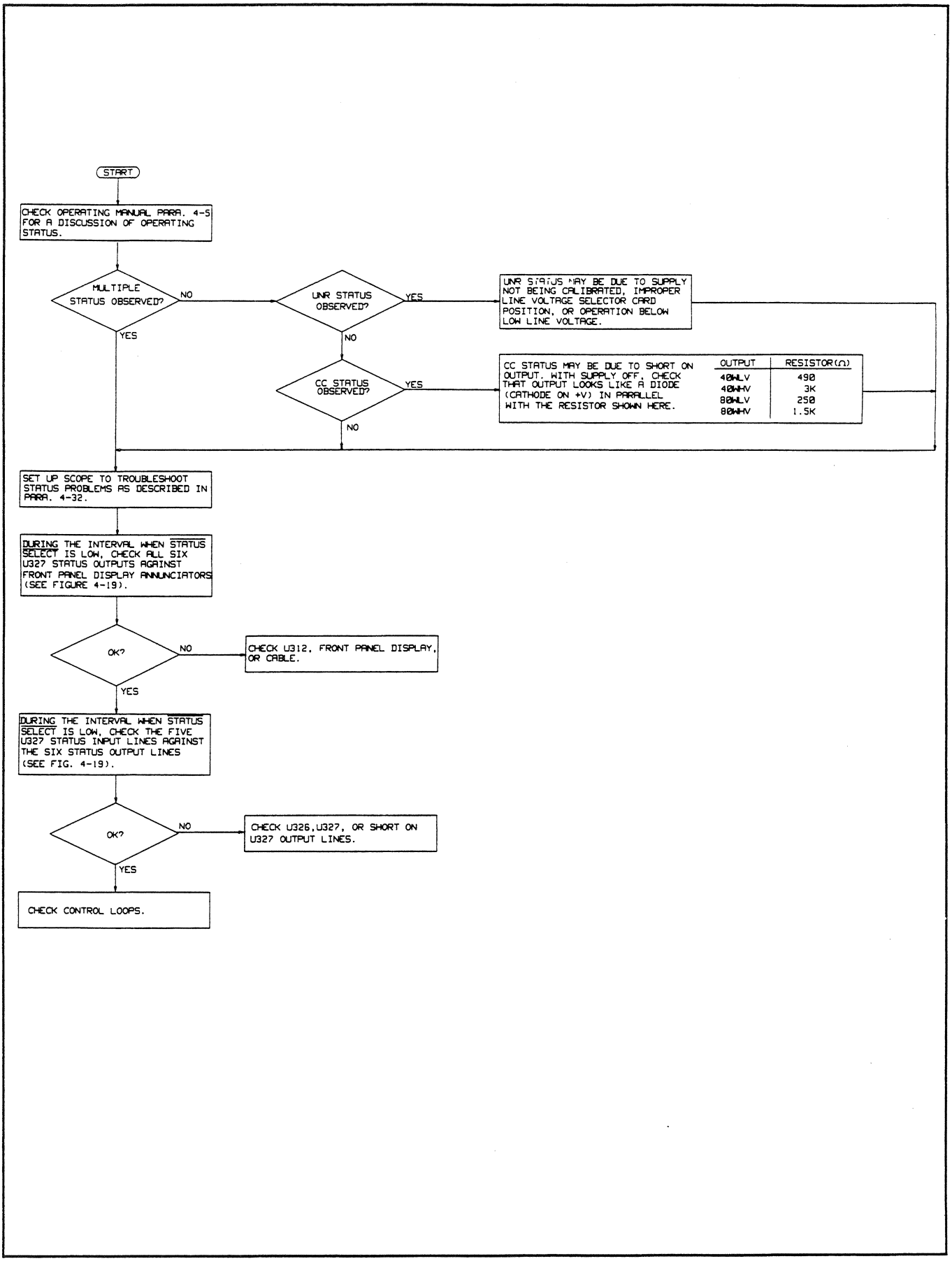


Figure 4-20. Status Problems Troubleshooting

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Section V
REPLACEABLE PARTS

5-1 INTRODUCTION

This section contains information on ordering replacement parts. Tables 5-5 through 5-7 list all of the electrical and mechanical components for the power supply. Each entry in these tables includes the following information:

a. Reference designator (Refer to Table 5-2).
b. Agilent Technologies part number.
c. Description of Part (Refer to Table 5-3 for abbreviations).
d. Manufacturer's federal supply code number (refer to Table 5-4 for manufacturer's name and address).
e. Manufacturer's Part Number.

Table 5-5 lists the circuit board assemblies, cables, and electrical components within the chassis of the power supply.

Table 5-6 lists all of the electrical and mechanical components on the GPIB board. This board is identical in models 6621A-6624A and 6627A.

Table 5-7 lists all of the electrical and mechanical parts on the 40 Watt Low Voltage (40WLV), 40 Watt High Voltage (40WHV), 80 Watt Low Voltage (80WLV), and 80 Watt High Voltage (80WHV) output board types. The abbreviations (40WLV, 40WHV, etc.) are used in table 5-7 to show the differences between the four output board types. The output board configuration for each model is given in Table 5-1 below.

Table 5-1. Output Board Configuration

Output / Model	1	2	3	4
6621A	80WLV	80WLV	-	-
6622A	80WHV	80WHV	-	-
6623A	40WLV	80WLV	40WHV	-
6624A	40WLV	40WLV	40WHV	40WHV
6627A	40WHV	40WHV	40WHV	40WHV

5-2 HOW TO ORDER PART

You can order parts from your local Agilent Technologies 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:

a. The Agilent Technologies part number.
b. A description of the part.
c. The quantity desired.
d. The model number (Agilent 6621A, 6622A, 6623A, 6624A, or 6627A) in which the part is used.

If you wish to order a part directly from the manufacturer, locate the manufacturer's Federal Supply Code and corresponding address in Table 5-4.

Table 5-2. Reference Designators

B	—	Blower (fan)
C	—	Capacitor
CR	—	Diode
F	—	Fuse
J	—	Jack
L	—	Inductor
P	—	Plug
Q	—	Transistor
R	—	Resistor
RT	—	Thermal Resistor
T	—	Transformer
S	—	Switch
TB	—	Terminal Block
U	—	Integrated Circuit
VR	—	Voltage Regulator (Zener Diode)
W	—	Wire
Y	—	Oscillator

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Table 5-3 Description of Abbreviations

ANLG	Analog
ASSY	Assembly
AWG	American Wire Gauge
BAR-BLK	Barrier Block
BNDPOST	Binding Post
BOT	Bottom
BRDG	Bridge
CER	Ceramic
CHAS	Chassis
COMP	Carbon Film Composition
CONN	Connector
CORR	Corrugated
CTN	Container
CUSHD	Cushioned
DAC	Digital-to-Analog Converter
DBLCHAM	Double Chamber
DIO	Diode
EEPROM	Electrically Erasable Programmable Read Only Memory
ELECT	Electrolytic
EPROM	Erasable Programmable Read Only Memory
FET	Field Effect Transistor
FF	Flip Flop
FW	Full Wave
FXD	Fixed
GND	Ground
GP	General Purpose
HDR	Header
HS	Heatsink
IC	Integrated Circuit
IMP	Impedance
INDTR	Inductor
INSUL	Insulator
ISO	Isolator
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LKWR	Lockwasher
LS	Low Speed
MACH	Machine
METPA	Metalized Paper
METPOL	Metalized Polycarbonate
MOD	Module
MOS	Metal Oxide Semi-Conductor
MPU	Microprocessor Unit
MTG	Mounting
MUXR	Mutliplexer
NMOS	Negative Channel Metal Oxide Semiconductor
OSC	Oscillator
PCB	Printed Circuit Board
PLSTC	Plastic
PNL	Panel
PROGMD	Programmed
RAM	Random Access Memory
RECT	Rectifier
REGIS	Register
RES	Resistor
RGLTR	REGULATOR
ROM	Read Only Memory
SCR	Screw

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Table 5-3 Description of Abbreviations

SHLD	Shoulder
STDF	Standoff
TAN	Tantalum
TBAX	Tube, Axial
VAR	Variable
VLTG REG	Voltage Regulator
WASH	Washer
WW	Wire Wound
XFMR	Transformer
XSTR	Transistor
ZNR	Zener

Table 5-4. Federal Manufacturer Codes

Code	Manufacturer	
01121	Allen Bradley Company	Milwaukee, Wi
16299	Corning Glass Works	Raleigh, NC
07263	Fairchild Semiconductor Corp.	Hicksville, NY
28480	Hewlett-Packard Company	Palo Alto, Ca
80795	ITT	New York, NY
81483	International Rectifier	Los Angeles, Ca
19701	Mepco/Electro Corp.	Mineral Wells, Tx
04713	Motorola Semiconductor products	Phoenix, Az
27014	National Semiconductor Corp.	Santa Clara, Ca
17896	Siliconxs	Santa Clara, Ca
56289	Sprague Electric Company	North Adams, Mass
01281	TRW Inc.	Philadelphia, Pa
01295	Texas Instruments Inc. (Semi Div)	Dallas, Tx

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Table 5-5. Agilent 6621A-6624A Multiple Output Power Supplies, Parts List

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
GPIB Board	06624-60029	GPIB Board Assembly (See Table 5-6)		
		Output Board 1 (See Table 5-7)		
6621	06621-60023	80W Low Voltage (80WLV) Bd	28480	
6622	06622-60021	80W High Voltage (80WHV) Bd	28480	
6623,24	06624-60028	40W Low Voltage (40WLV) Bd	28480	
6627	06627-60023	40W High Voltage (40WHV) Bd	28480	
		Output Board 2 (See Table 5-7)		
6621,23	06621-60023	80W Low Voltage (80WLV) Bd	28480	
6622	06622-60021	80W High Voltage (80WHV) Bd	28480	
6624	06624-60028	40W Low Voltage (40WLV) Bd	28480	
6627	06627-60023	40W High Voltage (40WHV) Bd	28480	
		Output Board 3 (See Table 5-7)		
6621,22	NOT USED			
6623,24,27	06627-60022	40W High Voltage (40WHV) Bd	28480	
		Output Board 4 (See Table 5-7)		
6621,22,23	NOT USED			
6624,27	06627-60022	40W High Voltage (40WHV) Bd	28480	
		Front Panel		
	5040-1660	FRONT FRAME		
6621	06621-00004	FRONT PANEL-LTR	28480	
6622	06622-00004	FRONT PANEL-LTR	28480	
6623	06623-00004	FRONT PANEL-LTR	28480	
6624	06624-00007	FRONT PANEL-LTR	28480	
6627	06627-00002	FRONT PANEL-LTR	28480	
	5063-2304	LCD DISPLAY (for through-hole GPIB assemblies)	28480	
	5063-3472	LCD DISPLAY (for surface-mount GPIB assemblies)		
		Chassis Electrical		
B1	3160-0097	COOLING FAN-TBAX		
	3160-0092	GUARD (COOLING FAN)		
	9135-0419	LINE MODULE	28480	
C0	5060-3218	.22uF CAP ASSY REF LINE MOD	28480	
	0160-4259	.22uF CAP REF 5060-3218 (C0)	28480	
F1	2110-0342	110V/120V LINE FUSE 8A 250V	28480	
	2110-0055	220V/240V LINE FUSE 4A 250V	28480	
S1	3101-2862	ON/OFF SWITCH	28480	
T1				
6621	9100-4645	BIAS / POWER TRANSFORMER	28480	
6622	9100-4490	BIAS / POWER TRANSFORMER	28480	
6623	9100-4646	BIAS / POWER TRANSFORMER	28480	
6624	9100-4561	BIAS / POWER TRANSFORMER	28480	
6627	9100-4592	BIAS / POWER TRANSFORMER	28480	

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Table 5-5. Agilent 6621A-6624A Multiple Output Power Supplies, Parts List(continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
		Chassis Cabling		
W1	8120-1348	LINE CORD ASSY	28480	
W2	5060-3272	XFMR TO AC SWITCH	28480	
W3	5060-3110	FAN WIRE ASSY	28480	
W4	5060-3264	XFMR ASSY (PRIMARY)	28480	
W5	5060-3271	XFMR - GPIB BIAS	28480	
W6			28480	
6621,22	8120-5174	GPIB - OUTPUT BD.	28480	
6623,24,27	8120-5177	GPIB - OUTPUT BD.	28480	
W7				
6621,22,23	TPPNR-18433	GPIB - OUTPUT BD.	28480	
6624,27	TPPNR-18431	GPIB - OUTPUT BD.	28480	
W8				
6621,22	NOT USED			
6623,24,27	8120-5175	GPIB - OUTPUT BD.	28480	
W9				
6621,22,23	NOT USED			
6624,27	8120-5176	GPIB - OUTPUT BD.	28480	
W10				
6621,23,24	5060-3267	XFMR (POWER 7V/5A)	28480	
6622,27	5060-3268	XFMR (POWER 20V/2A)	28480	
W11				
6621	5060-3267	XFMR (POWER 7V/5A)	28480	
6622	5060-3268	XFMR (POWER 20V/2A)	28480	
6623,24,27	5060-3269	XFMR BIAS	28480	
W12				
6621,6622	5060-3269	XFMR BIAS	28480	
6623	5060-3273	XFMR (POWER 7V/5A)	28480	
6624	5060-3265	XFMR (POWER 7V/5A & BIAS)	28480	
6627	06627-80006	XFMR (POWER 20V/2A & BIAS)	28480	
W13				
6621	5060-3273	XFMR (POWER 7V/5A)	28480	
6622	5060-3274	XFMR (POWER 20V/2A)	28480	
6623	5060-3270	XFMR (POWER 7V/5A & BIAS)	28480	
6624,27	5060-3268	XFMR (POWER 20V/2A)	28480	
W14				
6621	5060-3270	XFMR (POWER 7V/5A & BIAS)	28480	
6622	5060-3275	XFMR (POWER 20V/2A & BIAS)	28480	
6623	5060-3268	XFMR (POWER 20V/2A)	28480	
6624,27	5060-3269	XFMR BIAS	28480	
W15				
6621,22	NOT USED			
6623	5060-3269	XFMR BIAS	28480	
6624,27	5060-3266	XFMR (POWER 20V/2A & BIAS)	28480	
W16	06624-80011	FRONT PANEL HARNESS	28480	
		Chassis Mechanical		
	5040-1653	WASHER-HLDR REF XFMR		
	0361-1218	RIVET REF CHAS		
	0380-0644	STDF-STUD MTG REF GPIB		
	0380-1860	STDF REF CHAS & CHAS TOP		
	0515-0885	SCR-MACH M4X0.7 REF BAR-BLK		
		REF XFMR GROUND		
	0515-0886	SCR-MACH M3X0.5 REF BOARD GROUND		
		REF GPIB		

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Table 5-5. Agilent 6621A-6624A Multiple Output Power Supplies, Parts List(continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
		Chassis Mechanical		
	0515-0890	SCR-MACH M3X0.5 REF CHAS TOP		
	0515-0923	SCR-MACH M4X0.7 REF XFMR		
	0515-0906	SCR-MACH M4X0.7 REF H.SINK		
	0515-0910	SCR-MACH M4X0.7 REF MOD-HS		
	0515-0920	SCR-MACH M3X0.5 REF FAN-CHAS		
	0515-0923	SCR-MACH M4X0.7 REF XFMR-CHAS MT		
	0515-0981	SCR-MACH M4X0.7 REF U335		
	0515-1132	SCR-MACH M5X0.8 REF HANDLE MTG		
	0535-0031	NUT-HEX W/LKWR REF FAN TO CHASS GNDSTD		
	0535-0082	NUT-HEX REF FTPNL GNDSTD		
	0590-1381	THREADED INSERT REF CHAS TOP		
	0590-1088	THREADED INSERT REF CHAS TOP		
6621	06621-80003	LABEL, REAR PANEL		
6622	06621-80003	LABEL, REAR PANEL		
6623	06623-80003	LABEL, REAR PANEL		
6624	06624-80009	LABEL, REAR PANEL		
6627	06624-80009	LABEL, REAR PANEL		
	06624-80010	LABEL - COMP PRINTABLE		
	06624-00013	COVER, OUTER		
6621	06621-60006	CHASSIS ASSEMBLY		
6622	06622-60006	CHASSIS ASSEMBLY		
6623	06623-60006	CHASSIS ASSEMBLY		
6624	06624-60008	CHASSIS ASSEMBLY		
6627	06627-60008	CHASSIS ASSEMBLY		
	06624-00009	CHASSIS-MAIN		
	06624-00010	CHASSIS-TOP ASSEMBLY		
	1510-0044	BINDING POST REF REAR PANEL GND		
	2190-0034	WASHER-LK HCCL REF GPIB STDF		
	2190-0584	WASHER-LK HLCL REF FRONT FRAME		
	2190-0586	WASHER-LK HLCL REF HS TO PCB		
		REF OUTPUT BD		
	2190-0587	WASHER-LK REF XFMR		
	2190-0646	WASHER-LK REF GND STUD,XFMR GND		
	3050-0891	WASHER-FL MTLC REF FT FR		
	3050-0893	WASHER-FL MTLC REF XFMR		
	3050-0894	WASHER-FLT REF FLT XFMR		
	3110-0177	HINGE ASSEMBLY		
	5001-0539	SIDE TRIM 5 1/4		
	5040-5448	WINDOW LCD REF FRONT PANEL		
	5040-1653	WASHER-SHLD REF CHASS-MAIN-ASSY		
	5041-8801	FEET REF CHASS-ASSY		
	5041-8819	CAP, STRAP REF HANDLE		
	5041-8820	CAP, STRAP REF HANDLE		
	5062-3704	STRAP, HANDLE		
	5080-2117	INSULATOR,NOMEX REF XFMR		
	1400-0611	CABLE CLAMP REF FRONT PANEL		
	06624-20007	BARRIER BLOCK, COVER	28480	
	0360-2310	BARRIER BLOCK, JUMPER	28480	
		Chassis Miscellaneous		
	5080-2120	FOAM PACKING		
	5957-6377	MANUAL-OPERATION		
	9211-5869	CTN-CORR (PACKING CARTON)		
	9222-0456	BAG-CUSHD (PACKING BAG)		

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Table 5-6A. GPIB Through-hole Board Parts List

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C201-205	0160-4835	FXD CER 0.1uf 10% 50VDC	28480	
C206	0180-0374	FXD ELECT 10uf 10% 20VDC TAN	56289	150D106X9020B2
C207-212	0160-4835	FXD CER 0-luf 10% 50VDC	28480	
C213	0160-4834	FXD CER 0.047uf 10% 100VDC	28480	
C214	0160-4808	FXD CER 470pf 5% 100VDC	28480	
C215	0l80-0405	FXD ELECT 1.8uf 10% 20VDC	56289	150D185X9020A2
C216	0160-4835	FXD CER 0.1uf 10% 50VDC	28480	
C217,218	0l60-4807	FXD CER 33pF 100V 5%	28480	
C219,220	0160-4835	FXD CER 0.1uf 10% 50VDC	28480	
C221	0160-4834	FXD CER 0.047uf 10% 100VDC	28480	
C222	0180-3798	FXD ELECT 4700uF 10% 25VDC	28480	
C223-225	0160-4835	FXD CER 0.1uf 100 50VDC	28480	
CR201-205	1901-0731	DIO-PWR RECT 400V 1A	80795	1N4004G
F201	2110-0712	FUSE 4A 125V	28480	
J201	1252-0268	CONNECTOR FEMALE 24-CONT.	28480	
J202	1200-0607	IC-SOCKET 16-CONT. REF W202	28480	
J203	1200-0940	SOCKET STRIP 8-CONT.	28480	
P201	1251-5240	CONN-POST-TYPE-HDR 20 CONT.	28480	
P202,203	1251-8105	CONK-POST-TYPE-HDR 16 CONT.	28480	
P204	1252-0761	CONN-POST-TYPE-HDR 2 CONT.	28480	
P205-208	1252-2493	CONN-POST-TYPE-HDR 4 CONT.	28480	
P209	1252-1152	CONN	28480	
Q201	1853-0099	TRANSISTOR PNP SI	28480	
R201-203	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-TO-5111F
R204	0698-0083	FXD FILM 1.96K 1% 1/8W	24546	CT4-1/8-TO-1961
R205	0757-0427	FXD FILM 1.5K 1% 1/8W	24546	CT4-1/8-TO-1501F
R206	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-TO-5111F
R207	0757-0459	FXD FILM 56.2K 1% 1/8W	24546	CT4-i/8-TO-5622
R208	0757-0442	FXD FILM 10K 1% 1/8W	24546	CT4-1/8-TO-1002F
R209	0757-0449	FXD FILM 20K 1% 1/8W	24546	CT4-1/8-TO-2002
R210	0698-4536	FXD FILM 340K 1% 1/8W	28480	
R211	0757-0442	FXD FILM 10K 1% 1/8W	24546	CT4-1/8-TO-1002F
R212	0698-4440	FXD FILM 3.4K 1% 1/8W	24546	CT4-1/8-TO-3401
R213	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-TO-5111F
R214	0698-3359	FXD FILM 12.7K 1% 1/8W	24546	CT4-1/8-TO-1272
R215,216	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-TO-5111F
R217	0757-0411	FXD FILM 332 1% 1/8W	24546	CT4-1/8-TO-332R
R218	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-TO-5111F
R219	1810-0560	RES-NETWORK 16-DIP 5.6Kx8	28480	
R220-222	0757-0442	FXD FILM 10K 1°% 1/8W	24546	CT4-1/8-TO-1002F
R223-230	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-TO-5111F
R231-232	0757-0280	FXD FILM 1K 1% 1/8W	24546	CT4-1/8-TO-1001F
R233	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-TO-5111F
R234	0698-4440	FXD FILM 3.4K 1% 1/8W	24546	CT4-1/8-TO-3401F
R235-241	NOT USED			
R242	8159-0005	FXD FILM ZERO OHMS	28480	
RT201	0837-0412	THERMISTOR ROD 2K	28480	
U201	1820-2490	IC MPU CLK FREQ=l MHZ	04713	MC6809P
U202	1820-2549	IC 8291A TALKER/LISTENER	28480	
U203	1LH4-0001	IC GPIB TRANSCEIVER	28480	
U204	1820-1730	IC OCTAL D-TYPE LATCH	28480	
U205	NOT USED			
U206	5080-2093	IC PRGMD-EPROM (STANDARD)	28480	
U207	1818-1845	IC NMOS (16K) STATIC RAM	34335	AM9128-10PC
U208	1820-1216	IC DCDR TTL LS 3-TO-8 LINE	01295	SN74LS138N
U209	1820-0935	IC COUNTER CMOS BINARY	04713	MCl4020BCP
U210	1820-3848	IC FF CMOS D-TYPE	04713	MM74HCT374N
U211	1820-1427	IC DCDR TTL LS 2 TO 4 LINE	01295	SN74LS156N

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Table 5-6A. GPIB Through-hole Board Parts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
U212	1820-2024	IC LINE DRIVER TTL LS OCTAL	01295	SN74LS244N
U213	1820-1997	IC FF TTL LS D-TYPE	01295	SN74LS374PC
U214	1820-2024	IC LINE DRIVER TTL LS OCTAL	01295	SN74LS244N
U215	1820-1208	IC GATE TTL LS OR QUAD	01295	SN74LS32N
U216	1820-2024	IC LINE DRIVER TTL LS OCTAL	01295	SN74LS244N
U217	1820-1997	IC FF TTL LS D-TYPE	01295	SN74LS374PC
U218	1820-0430	IC V REG. 4.8V/5.2V RANGE	27014	LM309K
U219	1820-1199	IC INVERTER TTL LS HEX	01295	SN74LS04N
U220	1826-0412	IC COMPARATOR PRCN DUAL	27014	LM393N
U221	1818-3921	IC EEPROM, 1K	28480	
U222	1858-0032	XSTR-ARRAY 14-PIN PLSTC DIP	27014	LM3146
U223-229	NOT USED			
VR201	1902-1377	DIO-ZNR 6.19V 2% PD= .4W MAX	28480	
W201	1258-0189	JUMPER REF W201	28480	
W202	1251-4782	JUMPER REF J202	28480	
Y201	0410-1627	CERAMIC RESONATOR	28480	
		Mechanical Parts GPIB Board		
	1205-0366	HEAT SINK REF (U218)		
	5080-2101	ROM-LABEL REF U206		
	0515-0886	SCR-MACH M3X0.5 REF U218		
	0535-0004	NUT-HEX DBLCHAM REF J201		
	2190-0584	WASHER-LK HLCL REF U218(2)		
	2190-0584	WASHER-LK HLCL REF J201(2)		
	0380-1679	STDF-HEX HEAD REF U218		
	0570-0639	STUD-STD-PRS-IN REF GPIB BD		

Table 5-6B. GPIB Board Parts List (surface-mount assembly)

Design.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
		Electrical Parts		
	5063-4837	GPIB Board - tested assembly (5063-3471 - untested)		
U218	1853-0567	Transistor - PNP		
		Note: All other electrical parts are surface-mounted and are not field repairable.		
		Mechanical Parts		
	1205-0886	Heatsink U218		
	0340-0884	Insulator U218		
	0515-1105	Screw, M3x0.5, U218 (2)		
	2190-0584	Lockwasher, U218 (2)		
	0380-1679	Standoff, HEX, U218 (2)		
	0535-0031	Nut hex w/lockwasher J101 (2)		

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Table 5-7 Output BoardParts List

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C300	0160-4833	FXD CER 0.022uF 10% 100V	28480	
C301	0180-4141			
C302	0180-4141			
C303-304	0l60-4835	FXD CER 0.1uF 10% 50V	28480	
C305	0180-0291	FXD ELECT 1uF 10% 35VDC TAN	56289	150D105X9035A2
C306	0180-0100	FXD ELECT 4.7uF 10% TAN 35V	56289	150D475X9035B2
C307-308	0160-4835	FXD CER 0.1uF 10% 50V	28480	
C309	0180-0291	FXD ELECT 1uF 10% 35VDC TAN	56289	150D105X9035A2
C310	0180-0100	FXD ELECT 4.7uF 10% TAN 35V	56289	150D475X9035B2
C311-313	0180-0291	FXD ELECT 1uF 10% 35VDC TAN	56289	150D105X9035A2
C314	0180-0291	FXD ELECT 1uF 10% 35VDC TAN	56289	150D105X9035A2
C315	0160-4281	FXD METPA 2200pF 20% 250VDC	28480	
C316-319	NOT USED			
C320	0160-4800	FXD,CER 120PF 5% 100VDC	28480	
C321,322	0160-4835	FXD CER 0.1uF 10% 50v	28480	
C323	0160-4800	FXD CER 120pF 5% 100VDC	28480	
C324	0160-4787	FXD CER 22pF 5% 100V	28480	
C325	0160-4835	FXD CER 0.1uF 10% 50V	28480	
C326	0160-4812	FXD CER 220pF 5% 100VDC	28480	
C327	NOT USED			
C328	0160-4801	FXD CER 100pF 5% 100VDC	28480	
C329	0160-4835	FXD CER.0.1uF 10% 50V	28480	
C330	0160-4801	FXD CER 100pF 5% 100VDC	28480	
C331,332	NOT USED			
C333,334	0160-4835	FXD CER 0.1uF 10%, 50V	28480	
C335	NOT USED			
C336	0160-4835	FXD CER 0.1uF 10% 50V	28480	
C337	0160-4814	FXD CER 150pF 5% 100V	28480	
C338-340	NOT USED			
C341	0160-4830	FXD CER 2200pF 10% 100VDC	28480	
C342	0160-4834	FXD CER 0.047uF 10% 100VDC	28480	
C343,344	0160-4835	FXD CER 0.1uF 10% 50V	28480	
C345	0160-4834	FXD CER 0.047uF 10% 100VDC	28480	
C346	0180-2264	FXD ELECT 3.3uF 15V 5% TAN	56289	150D335X5015A2
C347-350	0160-4835	FXD CER 0.1uF 10% 50V	28480	
C351	0160-4810	FXD CER 330pF 5% 100VDC	28480	
C352	0160-4554	FXD CER .01uF 20% 50V	28480	
C353	0l60-4835	FXD CER 0.1uF 10% 50V	28480	
C354	0160-4822	FXD CER 1000pF 5% 100VDC	28480	
C355	0160-4831	FXD CER 4700pF 10% 100VDC	28480	
C356	0160-4812	FXD CER 220pF 5% 100VDC	28480	
C357	0160-4791	FXD CER 10pF 5% 100V	28480	
C358				
40WLV,40WHV	NOT USED			
80WLV	0180-4038	FXD ELECT 27000uF 16V	28480	
80WHV	NOT USED			
C359				
40WLV,40WHV	0160-4831	FXD CER 4700pF 10% 100VDC	28480	
80WLV	0180-3798	FXD ELECT 4700uF 10% 25VDC	28480	
80WHV	NOT USED			

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C360				
40WLV,40WHV	0160-4833	FXD CER 0.022uF 10% 100V	28480	
80WLV	0160-4835	FXD CER 0.1uF 10% 50V	28480	
80WHV	0160-4834	FXD CER 0.047uF 10% 100VDC	28480	
C361				
40WLV	0180-4037			
40WHV,80WHV	0180-4038			
80WLV	0180-4036			
C362				
40WLV,40WHV	0160-4833	FXD CER 0.022uF 10% 100V	28480	
80WLV	0160-4835	FXD CER 0.1uF 10% 50V	28480	
80WHV	0160-4834	FXD CER 0.047uF 10% 100VDC	28480	
C363				
40WLV	0180-4137			
40WHV,80WHV	0180-4139			
80WLV	0180-4037			
C364				
40WHV	0180-4137			
40WLV, 80WLV	0180-4038			
80WHV	0180-4036			
C365				
40WLV	0180-4137			
80WLV	0180-4037			
40WHV,80WHV	NOT USED			
C366	0180-0374	FXD ELECT 10uF 10% 20VDC TAN	56289	150Dl06X9020B2
C367	0160-4832	FXD CER 0.01uF 10% 100VDC	28480	
C368				
40WLV,40WHV	0180-0393	FXD ELECT 39uF 10V 10% TAN	56289	150D396X9010B2
80WLV,80WHV	0180-1838	FXD ELECT 75uF 16V 10% ALUM	56289	30D756G016CC2
C369	0160-4833	FXD CER 0.022uF 10% 100V	28480	
C370	0180-0393	FXD ELECT 39uF 10V 10% TAN	56289	150D396X9010B2
C371	0160-4835	FXD CER 0.1uF 10% 50V	28480	
C372	0160-4830	FXD CER 2200pF 10% 100VDC	28480	
C373				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0160-4814	FXD CER 150pF 5% 100V	28480	
C374	NOT USED			
C375				
40WLV,40WHV, 80WHV	0180-3804	FXD ELECT 47uF 35V	28480	
80WLV	NOT USED			
C376				
40WLV	NOT USED			
40WHV,80WLV, 80WHV	0180-3804	FXD ELECT 47uF 35V	28480	
C377				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0180-3804	FXD ELECT 47uF 35V	28480	
C378				
40WLV,40WHV, 80WLV	NOT USED			
80WHV	0180-3804	FXD ELECT 47uF 35V	28480	
C379				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0160-4281	FXD METPA 2200pF 20% 250VDC	28480	

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C380				
40WLV,40WHV	NOT USED			
80WLV	0180-4037			
80WHV	0180-4139			
C381	0180-0230	FXD ELECT 1uF 50V 10% TAN	56289	150D105X0050A2
C382				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0160-4831	FXD CER 4700uF 10% 100VDC	28480	
C383,384	0160-4791	FXD CER 10pF 5% 100V	28480	
C385	0160-4812	FXD CER 220pF 5% 100VDC	28480	
C386	0160-4820	FXD CER 1800pF 5% 100VDC	28480	
C387	0160-4832	FXD CER 0.01uF 10% 100VDC	28480	
C388				
40WLV,80WLV	0160-4813	FXD CER 180pF 5% 100VDC	28480	
40WHV,80WHV	0160-4801	FXD CER 100pF 5% 100VDC	28480	
C389	0160-5098	FXD CER 0.22uF 10% 50VDC	24546	CAC05XTR224J050
C390	0160-4820	FXD CER 1800pF 5% 100VDC	28480	
C391	0160-4812	FXD CER 220pF 5% 100VDC	28480	
C392	0160-5166	FXD CER 0.015uF 20% 100VDC	28480	
C393				
40WLV,80WLV	0160-5410	FXD CER 3300pF 5% 50VDC	28480	
40WHV,80WHV	0160-4832	FXD CER 0.01uF 10%	28480	
C394	0160-4807	FXD CER 33pF 5% 100V	28480	
C395	0160-5166	FXD CER 0.015uF 20% 100VDC	28480	
C396	0160-4832	FXD CER 0.01uF 10% 100VDC	28480	
C397	0160-5166	FXD CER 0.015uF 20% 100VDC	28480	
C398				
40WLV,80WLV	0160-4822	FXD CER 1.000pF 5% 100VDC	28480	
40WHV,80WHV	0160-5409	FXD CER 3000pF 5% 50VDC	28480	
C399	0160-4805	FXD CER 47pF 5% 100V	28480	
C400	0160-4830	FXD CER 2200pF 10% 100VDC	28480	
C401	0160-4801	FXD CER 100pF 5% 100VDC	28480	
C402				
40WLV,80WLV	0160-7320	FXD CER 0.01uF 2.5%	28480	
40WHV,80WHV	0160-7319			
C403,404	NOT USED			
C405,406	0180-0291	FXD ELECT 1uF 10% 35VDC TAN	56289	150D105X9035A2
C407	0160-4801	FXD CER 100pF 5% 100VDC	28480	
C408	0160-5422	FXD CER 0. 047 uF 20% 50VDC	28480	
C409,410				
40WLV,80WLV	0160-4904	FXD CER 6800pF 5% 50VDC	28480	
40WHV,80WHV	0160-5410	FXD CER 3300pF 5% 50VDC	28480	
C411,412	0160-5098	FXD CER 0.22uF 100 50VDC	24546	CAC05X7R22
C413				
40WLV,80WLV	0160-6827			
40WHV,80WHV	0160-7320	FXD CER 0.01uF 2.5%	28480	
C414				
40WLV,80WLV	0160-4904	FXD CER 6800pF 5% 50VDC	28480	
40WHV,80WHV	0160-5410	FXD CER 3300pF 5% 50VDC	28480	
C415	0160-4048	FXD METPA 0.022uF 20% 250VDC	28480	
C416				
40WLV,80WLV	0180-3805	FXD ELECT 10uF 50V	28480	
40WHV,80WHV	0180-3803	FXD ELECT 6.8uF 75V	28480	
C417				
40WLV,80WLV	0160-6564	FXD ELECT 1.8uF 50V	28480	
40WHV,80WHV	0160-6565	FXD ELECT 1uF 100V	28480	
C418	0160-4832	FXD CER 0.01uF 10% 100VDC	28480	

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C419	0180-0291	FXD ELECT 1uF 10% 35VDC TAN	56289	150D105X9035A2
C420	0160-4048	FXD METPA 0.022uF 20% 250VDC	28480	
C421	0160-4832	FXD CER 0.01uF 10% 100VDC	28480	
C422	0160-3969	FXD METPA 0.015uF 20% 250VDC	28480	
C423	0180-0291	FXD ELECT 1uF 10%, 35VDC TAN	56289	150D105X9035A2
C424				
40WLV,80WLV	0160-4833	FXD CER 0.022uF 10% 100V	28480	
40WHV,80WHV	0160-4834	FXD CER 0.047uF 10% 100VDC	28480	
C426	0160-4832	FXD CER 0.01uF 10% 100VDC	28480	
C427	0160-4966	METPLSTC CER 1uF 10% 100VDC	28480	
C428	NOT USED			
C429	0160-5098	FXD CER .22uF 10% 50VDC	24546	CAC05X7R224J050A
C430	0160-4795	FXD CER 4.7pF 5%, 100V	28480	
C431	0160-4812	FXD CER 220pF 5% 100VDC	28480	
C432	0160-4822	FXD CER 1000pF 5% 100VDC	28480	
C433,434	0180-2623	F XD ELECT 12uF 10% 6V ALUM	28480	
C435				
40WLV,80WLV	0160-4789	FXD CER 15pF 5% 100V	28480	
40WHV,80WHV	0160-4807	FXD CER 33PF 5% 100V	28480	
C436				
40WLV,80WLV	0160-6998			
40WHV,80WHV	0160-6999			
C439,440	0160-4830	FXD CER 2200pF 10% 100VDC	28480	
C600	0160-4835	FXD CER 0.1uF 10% 50V	28480	
CR300-304	1901-0731	DIO-PWR RECT 400V 1A	80795	1N4004G
CR305-308	NOT USED		13141	1N4150
CR309	1901-0050	DIO-SW	80795	1N4004G
CR310	1901-0731	DIO-PWR RECT 400V 1A	28480	
CR311,312	1901-0028	DIO-PWR RECT		
CR313-317	NOT USED			1N4150
CR318	1901-0050	DIO-PWR	13141	1N4004G
CR319	1901-0731	DIO-PWR RECT 400V 1A	80795	
CR320-323	NOT USED			
CR324	1901-0028	DIO-PWR RECT	28480	
CR325				
40WLV,40WHV	1901-0719	DIO-PWR RECT	04713	MR854
80WLV,80WHV	1901-0731	DIO-PWR RECT	80795	1N4004G
CR326	1901-0028	DIO-PWR RECT	28480	
CR327	1901-0731	DIO-PWR RECT 400V lA	80795	1N4004G
CR328	1901-0028	DIO-PWR RECT	28480	
CR329	1901-0050	DIO-SW	13141	1N4150
CR330	1901-0033			
CR33-,333	1901-0050	DIO-SW	13141	1N4150
CR334,335				
40WLV,40WHV	1901-0028	DIO-PWR RECT	28480	
80WLV	1901-0050	DIO-SW	13141	1N4150
80WHV	NOT USED			
CR336				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1901-0731	DIO PWR RECT	80795	1N4004G
CR337-338	NOT USED			
CR339				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1901-0033	DIO-SW	13141	1N645
CR340				
40WLV,40WHV	1901-0731	DIO-PWR RECT 400V 1A	80795	1N4004G
80WLV,80WHV	1901-0033	DIO-SW	13141	1N645
CR341	NOT USED			

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
CR342	1901-0033	DIO-SW	13141	1N645
CR343,344	NOT USED			
CR345-349	1901-0050	DIO-SW	13141	1N4150
CR350	1901-0033	DIO-SW	13141	1N645
CR351	1901-0050	DIO-SW	13141	1N4150
CR352,353	1901-0033	DIO-SW	13141	1N645
CR354-359	1901-0050	DIO-SW	13141	1N4150
CR360	1901-1080	DIO-SCHOTTKY	04713	1N5817
CR361,362	1901-0731	DIO-PWR RECT 400v 1A	80795	1N4004G
CR363,364				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1901-0731	DIO-PWR RECT 400v 1A	80795	1N4004G
CR365				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1901-1065	DIO-PWR RECT	28480	
CR366				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1901-0050	DIO-SW	13141	1N4150
F300				
40WLV	2110-0713	FUSE 10A 125V	28480	
40WHV	2110-0916	FUSE 7A 125V	28480	
80WLV,80WHV	NOT USED			
F301				
40WLV	2110-0713	FUSE 10A 125V	28480	
40WHV	2110-0685	FUSE 7A 125V	28480	
80WLV,80WHV	NOT USED			
F302				
40WLV,80WLV	2110-0716	FUSE 0.5A	28480	
40WHV,80WHV	2110-0763	FUSE 0.25A	28480	
F303				
40WLV,40WHV	2110-0685	FUSE 7A 125V	28480	
80WLV	2110-0767	FUSE 20A 250V	28480	
80WHV	2110-0383	FUSE 8A 250V	28480	
F304				
40WLV	2110-0916	FUSE 7A 125V	28480	
40WHV	2110-0916	FUSE 7A 125V	28480	
80WLV,80WHV	2110-0383	FUSE 8A SLO-BLO	28480	
F305,306				
40WLV	2110-0713	FUSE 10A 125V	28480	
40WHV	2110-0916	FUSE 7A 125V	28480	
80WLV	2110-0767	FUSE 20A 250V	28480	
80WHV	2110-0383	FUSE 8A 250V	28480	
F307				
40WLV,40WHV	NOT USED			
80WLV,80WHV	NOT USED			
F308,309	2110-0303	FUSE 2A 250V	28480	
L300	9140-0129	INDTR FXD 220uH 5%	28480	
L301	NOT USED			
L302				
40WLV,80WLV	9140-0238	INDTR-FXD 82uH 5%	28480	
40WHV,80WHV	9100-1640	INDTR-FXD 160uH 5%	28480	
L303				
40WLV,40WHV	NOT USED			
80WLV,80WHV	9140-0129	INDTR FXD 220uH 5%	28480	
L304	NOT USED			
L305				
40WLV,40WHV	NOT USED			
80WLV	9100-0238	INDTR-FXD 82uH 5%	28480	
80WHV	9100-1640	INDTR-FXD 160uH 5%	28480	

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
L306,307				
40WLV, 40WHV	NOT USED			
80WLV,80WHV	9170-0894	FERRITE BEAD	28480	
P301	1251-4246	CONN-POST-TP-HDR	28480	
P302	1252-2493	CONN-POST-TYPE-HDR 4 CONT.	28480	
P303				
40WLV,80WLV	1251-6832	CONN-POST-TP	28480	
40WHV,80WHV	1252-1670	CONN-POST-TP	28480	
P304				
40WLV,40WHV	NOT USED			
80WLV	1251-6832	CONN-POST-TP	28480	
80WHV	1252-1670	CONN-POST-TP	28480	
Q300-318	NOT USED			
Q319	1854-0477	XSTR NPN 2N2222A	80795	2N2222A
Q320	1855-0665	XSTR FET N CHAN LOG LEV	28480	
Q321	1853-0320	XSTR PNP 2N4032	07263	2N4032
Q322-24	NOT USED			
Q325				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1853-0320	XSTR PNP 2N4032	28480	
Q326,327				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1853-0423	XSTR PNP SI	28480	
Q328				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1853-0036	XSTR PNP SI	28480	
Q329				
40WLV,40WHV	NOT USED			
80WLV,80WHV	1853-0423	XSTR PNP SI	28480	
Q330-334	NOT USED			
Q335				
40WLV	1854-0404	XSTR NPN SI	28480	
40WHV,80WLV, 80WHV	1854-0585	XSTR NPN SI	04713	MJE182
Q336-340	NOT USED			
Q341				
40WHV,80WHV, 80WLV	5060-3211	XSTR FET ASSEMBLY	28480	IRF512
40WLV	1855-0665	XSTR FET	28480	EB4725
Q342	1855-0549	XSTR FET (BEAD: 9170-0894)	81483	
Q343	1854-0477			
R300,301	0686-4725	FXD FILM 4.7K 5% 1/2W	01121	
R302	0811-0610	FXD FILM 56 5% 5W	28480	
R303	0698-8911	FXD FILM 1.3K .1%	28480	
R304	0757-0403	FXD FILM 121 1% 1/8W	28480	
R305	0698-8672	FXD FILM 243.4K .1%	28480	
R306	0698-3700	FXD FILM 715 1% 1/8W	24546	CT4-1/8-T0-715RF
R307,308	8159-0005	FXD FILM ZERO OHMS	28480	
R309	0698-8672	FXD FILM 243.4 .1%	28480	
R310	0698-0085	FXD FILM 2.61K 1% 1/8w	28480	
R311	0698-4123	FXD FILM 499 1% 1/8w	28480	
R312	0757-0402	FXD FILM 110 1% 1/8W	28480	
R313,314	8159-0005	FXD FILM ZERO OHMS	28480	
R315	NOT USED			
R316,317	0699-0208	FXD FILM 1 5% 1/4W CF	28480	
R318	0757-0284	FXD FILM 150 1% 1/8W	28480	
R319-323	NOT USED			

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R324,325	0757-0452	FXD FILM 27.4K 1% 1/8W	24546	CT4-1/8-T0-2742F
R326,327	0757-0424	FXD FILM 1.1K 1% 1/8W	28480	
R328	NOT USED			
R329	8159-0005	FXD FILM ZERO OHMS	28480	
R330-332	NOT USED			
R333	0757-0410	F XD FILM 301 1% 1/8W	24546	CT4-1/8-T0-301RF
R334	NOT USED			
R335	0698-3215	FXD FILM 499K 1% 1/8W	28480	
R336	0698-3279	FXD FILM 4.99K 1% 1/8W	28480	
R337,338	0757 -0438	FXD FILM 5.11K 1% 1/8W	28480	
R339	NOT USED			
R340	0698-3279	FXD FILM 4.99K 1% 1/8W	28480	
R341	NOT USED			
R342	0699-0118	FXD FILM 20K .1% .1W	28480	
R343	0698-8494	FXD FILM 23.3K .1%	28480	
R344	0757-0442	FXD FILM 10K 1% 1/8W	28480	CT4-1/8-T0-1002F
R345				
40WLV	8159-0005	FM FILM ZERO OHMS	28480	
80WLV	0698-3265	FXD FILM 118K 1% 1/8W	28480	
40WHV,80WHV	0699-0070	FXD FILM 3.16M 1% 1/8W	28480	
R346	0698-5579	FXD FILM 5K .5% 1/8W	28480	
R347	0698-3329	FXD FILM 10K .5%	28480	
R348	0698-6533	FXD FILM 12.5K .1%	28480	
R349	0698-7929	FXD FILM 9.09K .1'%	28480	
R350	0757-0283	FXD FILM 2K 1% 1/8W	28480	
R351	0698-4493	FXD FILM 34K 1% 1/8w	24546	CT4-1/8-T0-3402F
R352	0757-0439	FXD FILM 6.81K 1% 1/8W	28480	
R353,354				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0686-2405	FXD FILM 24 1/2W	28480	
R355				
40WLV,40WHV	0698-3328	FXD FILM 8.25K .5%	28480	
80WLV,80WHV	0698-3493	FXD FILM 4.12K 1% 1/8W	28480	
R356	0698-8913	FXD FILM 1.5M 1% 1/8W	28480	
R357				
40WLV,80WLV	0699-0056	FXD FILM 15K .1% .1W	28480	
40WHV,80WHV	0699-0489	FXD FILM 16.15K .1%	28480	
R358				
40WLV	0699-0088	FXD FILM 1.21M 1% 1/8W	28480	
80WLV	0698-3215	FXD FILM 499K	28480	
40WHV,80WHV	0698-4539	FXD FILM 402K 1% 1/8W	28480	
R359				
40WLV,80WLV	0699-0934	FXD FILM 35.65K .1% .1W	28480	
40WHV,80WHV	0699-1211	FXD FILM 95K .1%	28480	
R360				
40WLV,80WLV	0757-0451	FXD FILM 24.3K 1% 1/8W	28480	
40WHV,80WHV	0757-0446	FXD FILM 15K 1% 1/8W	24546	
R361	8159-0005	FXD FILM ZERO OHMS	28480	
R362	0757-0283	FXD FILM 2K 1'% 1/8W	28480	
R363,364	0757-0416	FXD FILM 511 1% 1/8W	28480	
R365				
40WLV,80WLV	0698-3329	FXD FILM 10K .5%	28480	
40WHV,80WHV	0699-1212	FXD FILM 19K .1%	28480	
R366				
40WLV,80WLV	0757-0458	FXD FILM 51.1K 1% 1/8W	28480	
40WHV,80WHV	0699-1722	FXD FILM 9.75K .1% 1/8W	28480	

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R367				
40WLV	8159-0005	FXD FILM ZERO OHMS	28480	
40WHV,80WLV,				
80WHV	NOT USED			
R368				
40WLV,80WLV,	NOT USED			
80WHV	8159-0005	FXD FILM ZERO OHMS	28480	
40WHV	NOT USED			
R369				
R370				
40WLV,40WHV	NOT USED			
80WHV	0683-6805	FXD FILM 68 5% 1/4W	28480	
80WLV	8159-0005	FXD FILM ZERO OHMS	28480	
R371				
40WLV,40WHV	NOT USED			
80WHV	0683-6805	FXD FILM 68 5% 1/4w	28480	
80WLV	8159-0005	FXD FILM ZERO OHMS	28480	
R372	0683-0335	FXD FILM 3.3 5% 1/4w	01121	CB33G5
R373				
40WLV,40WHV	0698-4470	FXD FILM 6.98K 1% 1/8W	16299	CT4-1/8-T0-6981F
80WLV	0698-3359	FXD FILM 12.7K 1% 1/8W	28480	
80WHV	0698-3156	FXD FILM 14.7K 1% 1/8W	28480	
R374	0757-0452	FXD FILM 27.4K 1% 1/8W	28480	
R375				
40WLV	0686-5615	FXD FILM 560 5% 1/2W	01121	EB5615
80WLV	0698-3629	FXD FILM 270 5% 2W	01121	EB2715
40WHV	0686-2225	FXD FILM 2.2K 5% 1/2W	01121	EB2225
80WHV	0764-0016	FXD FILM 1K 5% 2W	01121	EB1025
R376				
40WLV	0686-2225	FXD FILM 2.2K 5% 1/2W	01121	EB2225
40WHV	0686-4725	FXD FILM 4.7 5% 1/2W	01121	EB4725
80WLV	0698-3638	FXD FILM 1.1K 5% 2W	01121	EB2225
80WHV	0764-0019	FXD FILM 3.9K 5% 1/2W	01121	EB8225
R377				
40WLV,40WHV	0698-4446	FXD FILM 267 1% 1/8W	28480	
80WLV,80WHV	0758-0404	FXD FILM 130 1% 1/8W	28480	
R378	0757-0438	FXD FILM 5.11K 1% 1/8W	24546	CT4-1/8-T0-5111F
R379	0698-5347	FXD FILM 495.5 .1%	28480	
R380				
40WLV	0698-4416	FXD FILM 169 1% 1/8W	16299	CT4-1/8-T0-169RF
40WHV	0698-3510	FXD FILM 453 1% 1/8w	28480	
80WLV	0698-4397	FXD FILM 84.5	28480	
80WHV	0757-0282	FXD FILM 221	16299	CT4-1/8-T0-221RF
R381				
40WLV	0698-3486	FXD FILM 232 1% 1/8W	16299	CT4-1/8-T0-232RF
40WHV	0698-3510	FXD FILM 453 1% 1/8W	16299	CT4-1/8-T0-453RF
80WLV	0698-4406	FXD FILM 115	28480	
80WHV	0757-0282	FXD FILM 221	16299	CT4-1/8-T0-211RF
R382	0757-0465	FXD FILM 100K	16299	CT4-1/8-T0-1003F
R383				
40WLV,40WHV	0757-0280	FXD FILM 1K 1% 1/8W	16299	CT4-1/8-T0-1001F
80WLV,80WHV	0757-0419	FXD FILM 681 1% 1/8W	28480	
R384				
40WLV,40WHV	0757-0280	FXD FILM 1K 1% 1/8W	16299	CT4-1/8-T0-1001F
80WLV,80WHV	NOT USED			

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R385				
40WLV	0811-0098	FXD FILM 135 5% 5W PW	28480	
40WHV	0811-1217	FXD FILM 150 5% 5W PW	28480	
80WLV	0811-0941	FXD FILM 75 5% 5W PW	28480	
80WHV	NOT USED			
R386				
40WLV	0686-2225	FXD FILM 2.2K 5% 1/2W	01121	EB2225
40WHV	0686-8225	FXD FILM 8.2K 5% 1/2W	01121	EB8225
80WLV	0698-3638	FXD FILM 1.1K 5% 2W	01121	EB2225
80WHV	0764-0019	FXD FILM 3.9K	28480	
R387	0698-4123	FXD FILM 499 1% 1/8W	28480	
R388	0683-4715	FXD FILM 470 5% 1/4W	01121	CB4715
R389				
40WLV,40WHV	0698-5088	FXD FILM 12K 1% 1/8W	16299	CT4-1/8-T0-1202
80WLV,80WHV	0757-0444	FXD FILM 12.1K 1% 1/8W	16299	CT4-1/8-T0-1212F
R390				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0757-0404	FXD FILM 130 1% 1/8W	28480	
R391	0757-0442	FXD FILM 10K 1% 1/8W	16299	CT4-1/8-T0-1002F
R392	0757-0282	FXD FILM 221 1% 1/8W	16299	CT4-1/8-T0-221RF
R393	0698-4435	FXD FILM 2.49K 1% 1/8W	28480	
R394	0757-0473	FXD FILM 221K 1% 1/8W	16299	CT4-1/8-T0-2213F
R395	0757-0431	FXD FILM 2.43K 1% 1/8W	28480	
R396	0757-0200	FXD FILM 5.62K 1% 1/8W	16299	CT4-1/8-T0-5612F
R397	0757-0481	FXD FILM 475K 1% 1/8W	80031	5033R-1/8T04753F
R398				
40WLV,40WHV	0757-0280	FXD FILM 1K l% 1/8W	16299	CT4-1/8-T0-1001F
80WLV,80WHV	0757-0419	FXD FILM 681 1% 1/8W	28480	
R399	0757-0464	FXD FILM 90.9K 1°% 1/8W	16299	CT4-1/8-T0-9092F
R400	0757-0442	FXD FILM 10K 1% 1/8W	28480	CT4-1/8-T0-1002F
R401				
40WLV,80WLV	0757-0397	FXD FILM 68.1 1% 1/8W	16299	CT4-1/8-T0-68R1F
40WHV,80WHV	0698-4099	FXD FILM 139 1% 1/8W	16299	CT4-1/8-T0-8331F
R402	8159-0005	FXD FILM ZERO OHMS		
R403	NOT USED			
R404	0757-0429	FXD FILM 1.82K 1% 1/8W	16299	CT4-1/8-T0-1821F
R405	0698-5089	FXD FILM 33K 1% 1/8W	16299	CT4-1/8-T0-3302F
R406				
40WLV,40WHV, 80WLV	0683-4715	FXD FILM 470 5% 1/4W	01121	CB4715
80WHV	0683-2025	FXD FILM 2K 5°% 1/4W	28480	
R407				
40WLV,80WLV	0811-3751	FXD RES .07 5% 2W	28480	
40WHV,80WHV	0811-3752	FXD RES .18 5% 2W	28480	
R408				
40WLV	0811-3796	FXD RES .050 7W 2%	28480	
40WHV	0811-3795	FXD RES .125 7W 2%	28480	
80WLV	0811-3764	FXD RES .025 7W 2%	28480	
80WHV	0811-3765	FXD RES .062 7W 2%	28480	
R409				
40WLV	2110-0712	FUSE, SUBMIN. 4A	28480	
80WLV	8159-0005	FXD FILM ZERO OHMS	28480	
40WHV	0757-0442	FXD FILM 10K 1% 1/8W	16299	CT4-1/8-T0-1002F
80WHV	0683-1035	FXD FILM 10K 5% 1/4W	01121	CB1035

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R410				
40WLV	NOT USED			
40WHV	0757-0442	FXD FILM 10K 1% 1/8W	28480	
80WLV	2110-0712	FUSE, SUBMIN. 4A	28480	
80WHV	0683-1035	FXD FILM 10K 1% 1/8W	28480	
R411				
40WLV	0811-1801	FXD FILM 490 5% 3W	28480	
40WHV	0812-0010	FXD FILM 3K 5% 3W PW	28480	
80WLV	0811-1856	FXD FILM 250 5% 5W	28480	
80WHV	0811-1805	FXD FILM 1.5K 5% 3W	28480	
R412				
40WLV,80WLV	0699-1972	FXD FILM 1.74M 1% 1/8W	28480	
40WHV,80WHV	0698-4536	FXD FILM 340K 1% 1/8W	28480	
R413				
40WLV,40WHV	NOT USED			
80WLV	0683-4715	FXD FILM 470 5% 1/4W	01121	CB4715
80WHV	0683-2025	FXD FILM 2K 5% 1/4W	28480	
R414,R415	NOT USED			
R416				
40WLV,40WHV	NOT USED			
80WLV	0811-3751	FXD FILM .07 5% 2W	28480	
80WHV	0811-3752	FXD FILM .18 5% 2W	28480	
R417	NOT USED			
R418	0757-0469	FXD FILM 150K 1% 1/8W	16299	CT4-1/8-T0-1530F
R419	0698-4435	FXD FILM 2.49K 1% 1/8W	28480	
R420	0683-3305	FXD FILM 33 5% 1/4W	01121	CB3305
R421	0698-3449	FXD FILM 28.7K 1% 1/2W	16299	CT4-1/8-T0-2872F
R422	0698-8827	FXD FILM 1M 1% 1/8W	28480	
R423	0757-0401	FXD FILM 100 1% 1/8W	16299	CT4-1/8-T0-101F
R424	NOT USED			
R425	0757-0413	FXD FILM 392 1% 1/8W	16299	CT4-1/8-T0-392RF
R426				
40WLV,40WHV, 80WHV	0757-0427	FXD FILM 1.5K 1% 1/8W	16299	CT4F/8-T0F501F
80WLV	0757-0422	FXD FILM 909 1% 1/8W	28480	
R427				
40WLV,80WHV	0698-4123	FXD FILM 499 1% 1/8W	28480	
40WHV	0698-3444	FXD FILM 316 1% 1/8W	28480	
80WLV	0698-4457	FXD FILM 576 1% 1/8W	16299	CT4-1/8-T0-576RF
R428	0757-0405	FXD FILM 162 1% 1/8W	16299	CT4-1/8-T0-162RF
R429,430	0757-0439	FXD FILM 6.81K 1% 1/8W	28480	
R431	0698-8827	FXD FILM 1M 1% 1/8W	28480	
R432	0698-3449	FXD FILM 28.7K 1% 1/8W	16299	CT4-1/8-T0-2872F
R433				
40WLV	0757-0290	FXD FILM 6.19K 1% 1/8W	28480	
40WHV	0757-0439	FXD FILM 6.81K 1% 1/8W	28480	
80WLV	0698-0083	FXD FILM 1.96K 1% 1/8W	16299	
80WHV	0698-3279	FXD FILM 4.99K 1% 1/8W	28480	
R434	0757-0442	FXD FILM 10K 1% 1/8W	16299	CT4-1/8-T0-1002F
R435	0757-0283	FXD FILM 2K 1% 1/8W	16299	CT4-1/8-T0-2001F
R436	0683-4735	FXD FILM 47K 5% 1/4W	01121	CB4735
R437	0698-4480	FXD FILM 15.8K 1% 1/8W	16299	CT4-1/8-T0-1582F
R438	0698-3156	FXD FILM 14.7 1% 1/8W	16299	CT4-1/8-T0-1472F
R439	0757-0280	FXD FILM 1K 1% 1/8W	16299	CTF-1/8-T0-1001F
R440	0699-0811	FXD FILM 33K .1%	28480	
R441	0698-6414	FXD FILM 1K 1% 1/8W	28480	
R442	0698-8913	FXD FILM 1.5M 1% 1/8W	28480	

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R443	0698-6414	FXD FILM 1K .1% 1/8W	28480	
R444	0699-0934	FXD FILM 35.65K .1% .1W	28480	
R445	0757-0280	FXD FILM 1K 1% 1/8W	16299	CT4-1/8-T0-1001F
R446	0698-4480	FXD FILM 15.8K 1% 1/8W	16299	CT4-1/8-T0-1002
R447	0757-0440	FXD FILM 7.5K 1% 1/8W	16299	CT4-1/8-T0-7501F
R448				
40WLV,80WLV	0757-0462	FXD FILM 75K 1% 1/8W	16299	CT4-1/8-T0-7502F
40WHV,80WHV	0757-0469	FXD FILM 150K 1% 1/8W	16299	CT4-1/8-T0-1503F
R449				
40WLV	0757-0282	FXD FILM 221 1% 1/8W	16299	CT4-1/8-T0-221RF
40WHV	0698-3447	FXD FILM 422 1% 1/8W	16299	CT4-1/8-T0-422RF
80WLV	0757-4406	FXD FILM 115 1% 1/8W	16299	CT4-1/8-T0-562RF
80WHV	0698-3486	FXD FILM 232 1% 1/8W	28480	
R450	0698-8827	FXD FILM 1M 1% 1/8W	28480	
R451	0757-0280	FXD FILM 1K 1% 1/8W	16299	CT4-1/8-T0-1001F
R452	0757-0283	FXD FILM 2K 1% 1/8W	16299	CT4-1/8-T0-2001F
R453	0698-4480	FXD FILM 15.8K 1'% 1/8W	16299	CT4-1
R454	0699-0953	FXD FILM 15.4K .1%	28480	
R455	0698-8827	FXD FILM 1M 1% 1/8W	28480	
R456				
40WLV,40WHV	0698-0087	FXD FILM 316 1% 1/4W	16299	CT4-1/8-T0-316RF
80WLV,80WHV	0686-1515	FXD COMP 150 5% 1/2W	28480	
R457				
40WLV,80WLV	0811-2553	FXD FILM 7.5 5% 2W	01281	BWH2-7R5-J
40WHV,80WHV	0698-3609	FXD FILM 22 5% 2W	16299	FP42-2-T00-22R0J
R458	0757-0442	FXD FILM 10K 1% 1/8W	16299	CT4-1/8-T0-1002F
R459	0757-0446	FXD FILM 15K 1% 1/8W	16299	CT4-1/8-T0-1502F
R460	0698-8913	FXD FILM 1.5M 1% 1/8W	28480	
R461	0683-4735	FXD FILM 47K 5% 1/4W	01121	CB4735
R462	0757-0288	FXD FILM 9.09K 1% 1/8W	80031	5033-1/8T0-9091F
R463	0698-3279	FXD FILM 4.99K 1% 1/8W	16299	CT4-1/8T0-4991-F
R464	0757-0455	FXD FILM 36.5K 1% 1/4W	28480	
R465	0757-0464	FXD FILM 90.9K 1% 1/8W	16299	CT4-1/8-T0-9092F
R466,467	0699-0118	FXD FILM 20K .1% .1W	28480	
R468	0757-0442	FXD FILM 10K 1% 1/8W	16299	CT4-1/8-T0-1002F
R469,470	0699-0118	FXD FILM 20K .1% .1W	28480	
R471	0699-0070	FXD FILM 3.16M 1% 1/8W	28480	
R472	0699-0388	FXD FILM 500K .1% 1/8W	28480	
R473	0757-0124	FXD FILM 39.2K 1% 1/8W	28480	
R474				
40WLV,40WHV, 80WLV	0698-7842	FXD FILM 26.1K 1% 1/8W	80031	5033Rl/89T2612B
80WHV	0757-0123	FXD FILM 34.8K 1%	28480	
R475	0683-8235	FXD FILM 82K 5% 1/4W	01121	CB8235
R476	0699-0088	FXD FILM 1.2M 1% 1/8W	28480	
R477				
40WLV,80WLV	0698-5090	FXD FILM 43K 1% 1/8W	16299	CT4-1/8-T0-4302F
40WHV,80WHV	0698-3159	FXD FILM 26.1K 1% 1/8W	16299	CT4-1/8-T0-2612F
R478				
40WLV,80WLV	0698-4477	FXD FILM 10.5K 1% 1/8W	16299	CT4-1/8-T0-1052F
40WHV,80WHV	0757-0451	FXD FILM 24.3K 1% 1/8W	16299	CT4-1
R479	0699-0118	FXD FILM 20K .1% .1W	28480	
R480				
40WLV,80WLV	0698-8093	FXD FILM 40K .1% .1W	01281	MAR5-1/10-T16-40
40WHV,80WHV	0699-1211	FXD FILM 95K .1% .1W	28480	
R481				
40WLV,80WLV	0698-3449	FXD FILM 28.7K 1% 1/8W	16299	CT4-1/8-T0-2872F
40WHV,80WHV	0757-0460	FXD FILM 61.9K 1% 1/8W	16299	CT4-1/8-T0-6192F

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R482				
40WLV,80WLV	0699-0107	FXD FILM 4.75K .1%	28480	
40WHV,80WHV	0698-6360	FXD FILM 10K .1%	28480	
R483				
40WLV,80WLV	0683-7515	FXD FILM 750 5% 1/4W	01121	CB7515
40WHV,80WHV	0683-2225	FXD FILM 2.2K 5% 1/4W	80031	CR25 1-4-5P-2K
R484	0699-0118	FXD FILM 20K .1% .1W	28480	
R485				
40WLV,80WLV	0698-8093	FXD FILM 40K .1% .1W	01281	MAR5-.1T16-4002B
40WHV,80WHV	0699-1211	FXD FILM 95K .1% .1W	28480	
R486				
40WLV,80WLV	0699-0107	FXD FILM 4.75K .1%	28480	
40WHV,80WHV	0698-6360	FXD FILM 10K .1'%	28480	
R487				
40WLV,80WLV	0683-7515	FXD FILM 750 5% 1/4W	01121	CB7515
40WHV,80WHV	0683-2225	FXD FILM 2.2K 5% 1/4W	80031	CR25 1-4-5P2K2
R488				
40WLV,80WLV	0698-3449	FXD FILM 28.7K 1% 1/8W	16299	CT4-1/8-T0-2872F
40WHV,80WHV	0757-0460	FXD FILM 61.9K 1% 1/8W	16299	CT4-1/8-T0-6192F
R489,490	0686-1065	FXD FILM 10M 5% 1/2W	01121	EB1065
R491	0683-0475	FXD FILM 4.7 5% 1/4W	80031	CR25 1-4-5P4E7
R492	0686-2225	FXD FILM 2.2K 5% 1/4W	01121	EB2225
R493	0757-0430	FXD FILM 2.21K 1% 1/8W	16299	CT4-1/8-T0-2211F
R494	0698-3430	FXD FILM 21.5 1% 1/8W	28480	
R495	0757-0447	FXD FILM 16.2K 1% 1/8W	16299	CT4-1/8-T0-1622F
R496	0757-0401	FXD FILM 100 1% 1/8W	16299	CT4-1/8-T0-101F
R497	0683-3915	FXD FILM 390 5% 1/4W	80031	CR25 1-4-5P-390E
R498	0757-0401	FXD FILM 100 1% 1/4W	28480	
R499				
40WLV,80WLV	0757-0446	FXD FILM 15K 1% 1/8W	16299	CT4-1/8-T0-1502F
40WHV,80WHV	0698-4493	FXD FILM 34K 1% 1/8W	16299	CT4-1/8-T0-3402F
R500				
40WLV,40WHV	0757-0404	FXD FILM 130 1% 1/8W	16299	CT4-1/B-T0-131-F
80WLV,80WHV	0757-0399	FXD FILM 82.5 1% 1/8W	16299	CT4-1/8-T0-82R5
R501				
40WLV,40WHV	0757-0404	FXD FILM 130 1% 1/8W	16299	CT4-1/8-T0-131-F
80WLV,80WHV	0757-0397	FXD FILM 68.1 1% 1/8W	28480	
R502	0757-0283	FXD FILM 2K 1% 1/8W	28480	
R503				
40WLV,80WLV	NOT USED			
40WHV,80WHV	0757-0199	FXD FILM 21.5K 1% 1/8W	16299	CT4-1/8-T0-901F
R504	0683-1035	FXD FILM 10K 5% 1/4W	28480	
R505	NOT USED			
R506	0757-0280	FXD FILM 1K 1% 1/8W	16299	CT4-1/8-T0-1001F
R507	0683-0475	FXD FILM 4.7 5% 1/4W	80031	CR25 1-4-5P4E7
R508	0686-1065	FXD FILM 10M 5% 1/2W	01121	EB1065
R509				
40WLV,80WLV	0698-5663	FXD FILM 330 1% 1/8W	28480	
40WHV,80WHV	0757-0280	FXD FILM 1K 1% 1/8W	16299	CT4-1/8-T0-1001F
R510				
40WLV,80WLV	0757-0441	FXD FILM 8.25K 1% 1/8W	16299	CT4-1/8-T0-8251F
40WHV,80WHV	0757-0199	FXD FILM 21.5K 1% 1/8W	16299	CT4-1/8-T0-901F
R511				
40WLV,80WLV	0683-2725	FXD FILM 2.7K 5% 1/4W	80031	CR25 1-4-5P2K7
40WHV,80WHV	0698-4480	FXD FILM 15.8K 1% 1/8W	16299	CT4-1/8-T0-1582F
R512				
40WLV,80WLV	0698-5663	FXD FILM 330 1% 1/8W	28480	
40WHV,80WHV	0757-0280	FXD FILM 1K 1% 1/8W	16299	CT4-1/8-T0-1001F

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R513				
40WLV,80WLV	0757-0446	FXD FILM 15K 1% 1/8W	16299	CT4-1/8-T0-101F
40WHV,80WHV	0698-4493	FXD FILM 34K 1% 1/8W	16299	CT4-1/8-T0-3402F
R514	0698-6631	FXD FILM 2.5K		
R515				
40WLV,80WLV	8159-0005	FXD FILM ZERO OHMS	28480	
40WHV,80WHV	NOT USED			
R516	NOT USED			
R517				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0683-4715	FXD FILM 470 5% 1/4W	01121	CB4715
R518				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0757-0444	FXD FILM 12.1K 1% 1/8W	16299	CT4-1/8-T0-1212F
R519	NOT USED			
R520				
40WLV	0698-6983	FXD FILM 20.4K		
40WHV	0698-7842	FXD FILM 21.6K		
80WLV,80WHV	NOT USED			
R521				
40WLV,40WHV	NOT USED			
80WLV,80WHV	8159-0005	FXD FILM ZERO OHMS		
R522				
40WLV, 40WHV	NOT USED			
80WLV	0757-0397	FXD FILM 68.1 1% 1/8W	16299	CT4-1/8-T0-68R1F
80WHV	0698-4099	FXD FILM 139 1% 1/8W	16299	CT4-1/8-T0-8331F
R523				
40WLV,40WHV, 80WLV	NOT USED			
80WHV	0683-1035	FXD FILM 10K 5% 1/4W	01121	CB1035
R524				
40WLV,40WHV 80WHV	NOT USED			
80WLV	2110-0712	FUSE, SUBMIN. 4A		
R525				
40WLV,40WHV	NOT USED			
80WLV,80WHV	0757-0280	FXD FILM 1K 1% 1/8W		
R526				
40WLV,40WHV, 80WLV	NOT USED			
80WHV	0811-0941	FXD FILM 75 5% 10W	28480	
R528				
40WLV,40WHV	NOT USED			
80WLV	0698-6983	FXD FILM 20.4K		
80WHV	0698-7842	FXD FILM 21.6K		
T301	06624-80091	XFMR-PULSE	28480	
TB1	0360-2195	BARRIER BLOCK	28480	
U300	5060-3212	ASSY - H.S. & 1826-0393	28480	
U301	5060-3260	ASSY REG		
U302	5060-2942	ASSY - H.S. & 1826-0393	28480	
U303	1826-0527	IC-VTL-REG	28480	
U304-309	NOT USED			
U310-311	1990-0996	IC-OPTO-ISO LED GATE	28480	
U312	1820-4714	MICROCOMPUTER	28480	
U313	1826-1488	IC-DAC	28480	
U314	1826-1231	IC-D/A 8-1/2-BIT	28480	

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
U315	1826-1553	IC-OPAMP LO-BIAS-H-IMP	28480	
U316,317	NOT USED			
U318	1826-1369	IC-VLT-REG	28480	
U319	1826-0315	IC-OPAMP GP QUAD 14-DIP	27014	
U320	1820-1216	IC-SN74LS138N	28480	
U321	1826-1488	IC-DAC	28480	
U322	NOT USED			
U323	1826-1021	IC-ANLG MUXR	28480	
U324	1826-1475	IC-VOLTAGE COMPARATOR	28480	
U325	1826-0412	IC COMPARATOR PRCN DUAL	27014	LM393N
U326	1810-0639	NETWORK-RES DIP-14 20K X 13	28480	
U327	1826-1842	IC-SEMI CUSTOM	28480	
U328-U333	NOT USED			
U334				
40WLV,40WHV	1906-0349	DIO-FW BRDG 600V 35A	28480	
80WLV,80WHV	1906-0348			
U335				
40WLV,80WLV, 80WHV	1906-0348		04713	MPQ7091
40WHV	1906-0349	DIO-FW BRDG 600V 35A		
U336				
40WLV,40WHV	1858-0088	IC-XSTR-ARRAY 14-DIP		
80WLV,80WHV	NOT USED			
U337	1826-1843			
U338*	5060-3567	IC-PWR HYBRID	28480	
U339*				
40WLV,40WHV	NOT USED			
80WLV,80WHV	5060-3567	IC-PWR HYBRID MATCHED W/U338	28480	
U340	1858-0127			
U341	1858-0107			
U342-344	NOT USED			
U345-347	1826-0493	IC-OPAMP LO-BIAS-H-IMP	27014	LM308AN
U348	1826-0083	IC-OP AMP	28480	
U349	NOT USED			
U350	1826-0493	IC-OPAMP LO-BIAS-H-IMP	27014	LM308AN
U351	1826-0412	IC COMPARATOR PRCN DUAL	27014	LM393N
U352	1826-1409	IC-OPAMP LO-BIAS-H-IMP	27014	LM308AN
U353,354	NOT USED			
U355	1826-1255	IC-V RGLTR-OV-V-SEN 8-DIP	28480	MC3423P1
VR300-304	NOT USED			
VR305	1902-1377	DIO-ZNR 6.19V 2% PD=.4mW	28480	
VR306	1902-0182	DIO-ZNR 20.5V 5% PD=.4mW	28480	
VR307-314	NOT USED			
VR315	1902-0057	DIO-ZNR 6.49V 5% PD=.4mW	28480	
VR316				
40WLV,80WLV	NOT USED			
40WHV,80WHV	1902-1392	DIO-ZNR 30V 2% PD=.4mW	28480	
VR317-389	NOT USED			
		* For the 80WLV and 80WHV boards U338 and U339 are matched pairs. The part number listed contains both U338 and U339.		

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Table 5-7 Output BoardParts List (continued)

Desig.	Agilent Part No.	Description		Mfg. Code	Mfg. Part No.
VR390					
40WLV,80WLV	1902-0766	DIO-ZEN 18.2V 5% PD= .4mW		28480	
40WHV,80WHV	1902-3323	DIO-ZEN 42.2V		28480	
Y300	0410-1627	CERAMIC RESONATOR			
		Mechanical Parts			
	0380-1704	STDF-RIVET	REF U334,335		
	0515-0906	SCR-MACH M4X0.7	REF HEAT SINK		
	0515-0981	SCR-MACH M4X0.7	REF U334,335		
	0515-0885	SCR-MACH M4X0.7	REF U338 (MOD TO HS)		
			REF U339 (MOD TO HS)		
	0515-0906	SCR-MACH M4X0.7	REF U338 (HS TO PCB)		
			REF U339 (HS TO PCB)		
	0515-0910	SCR-MACH M4X0.7	REF MOD/HS M4X8L		
	0535-0023	NUT-HEX DBL CHAM	REF U388 TO PCB		
	1200-0181	INSUL-XSTR	REF Q321,325		
	1205-0282	HEAT SINK	REF LM317		
			REF U302		
	1205-0707	HEAT SINK	REF U301		
			REF Q340		
			REF Q341		
	1205-0350	HEAT SINK	REF U300		
	1205-0766	HEAT SINK	REF U335		
	2190-0586	WASHER-LK	REF U338 (4)		
			REF HS TO PCB (2)		
			REF U335 TO HS (1)		
			REF OUTPUT BD (2 PER)		
	2110-0269	FUSE CLIP	REF F304,F308,F309		
	3050-0893	WASHER-FLT	REF U334		
	2190-0421	WASHER-FLT	REF U338,339		
	5040-1672	BUSHING	REF U338,339		
	7120-8214	WARNING LABEL	REF U338,339		

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Section VI
CIRCUIT DIAGRAMS

6-1 INTRODUCTION

This section contains functional schematic diagrams and component location diagrams for the power supply.

6-2 FUNCTIONAL SCHEMATIC DIAGRAMS

The power supply circuits are shown on Figure 6-1 through 6-5. The schematics consists of one or more foldout sheets that illustrate the circuits functionally.

Figure 6-1 shows the ac power input and distribution for all five models 6621A-6624A and 6627A. Power transformer connections and cable assembly part numbers for each model are included on pages 6-2 and 6-3.

Figure 6-2 illustrates the circuits on the GPIB board. This board is identical in all five models 6621A-6624A, and 6627A.

Figure 6-3, 6-4 and 6-5 illustrate the circuits on the 40 Watt Low Voltage (40WLV), 40 Watt High Voltage (40WHV), 80 Watt Low Voltage (80WLV), and 80 Watt High Voltage (80WHV) Output board types. The output board configuration for each model is as follows:

Model	Output 1	Output 2	Output 3	Output 4
6621A	80WLV	80WLV	-	-
6622A	80WHV	80WHV	-	-
6623A	40WLV	80WLV	40WHV	-
6624A	40WLV	40WLV	40WHV	40WHV
6627A	40WHV	40WHV	40WHV	40WHV

Figure 6-3 (Sheets 1 through 4) show the following circuits and cover all 40W output board types. Differences between the types are indicated on the schematic.

Sheet 1 - Secondary interface circuits.
Sheet 2 - Bias, Turn-on, and Overvoltage circuits.
Sheet 3 - Control circuit, FET downprogrammer, Bleed and Sense Protect circuits.
Sheet 4 - Power Mesh circuits.

Figure 6-4 (Sheets 1 through 4) are similar to Figure 6-3 and cover all 40W output board types. Differences between the types are indicated on the schematic.

Figure 6-5 (Sheets 1 through 4) are similar to Figures 6-3 and 6-4, and cover all 80W output board types. Differences between the types are indicated on the schematic.

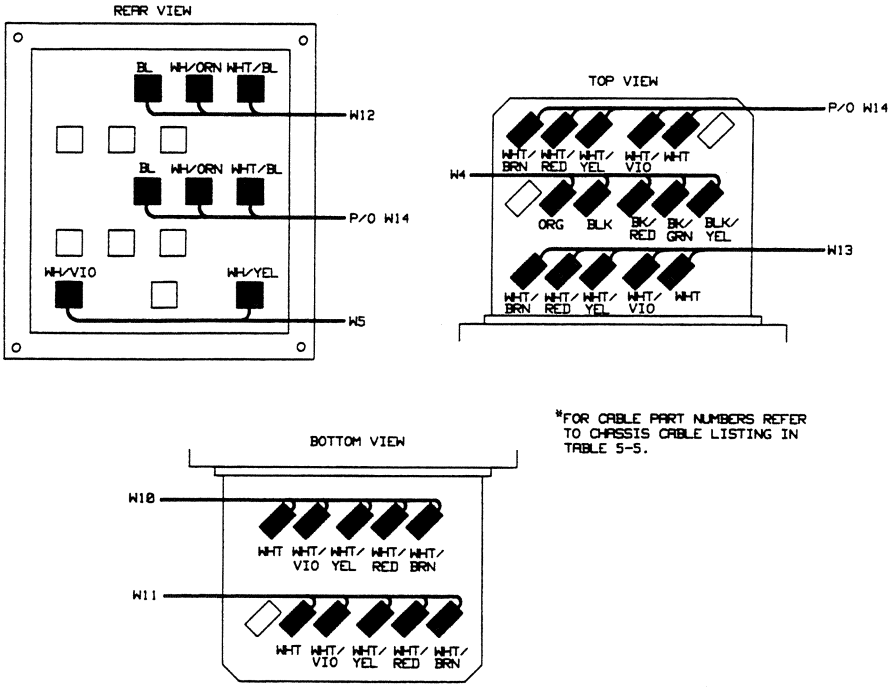
6-3 COMPONENT LOCATION ILLUSTRATIONS

6-4 The component location diagrams show the physical location of parts mounted on each assembly.

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MODEL 6621A

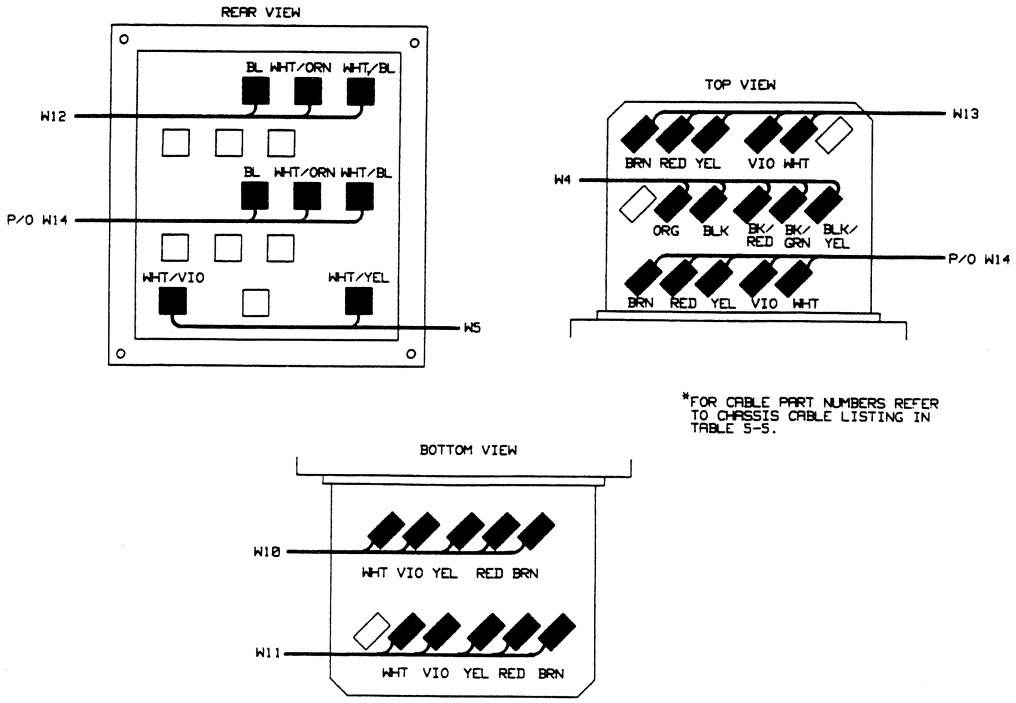
TRANSFORMER T1 CONNECTIONS*



*FOR CABLE PART NUMBERS REFER TO CHASSIS CABLE LISTING IN TABLE 5-5.

MODEL 6622A

TRANSFORMER T1 CONNECTIONS*

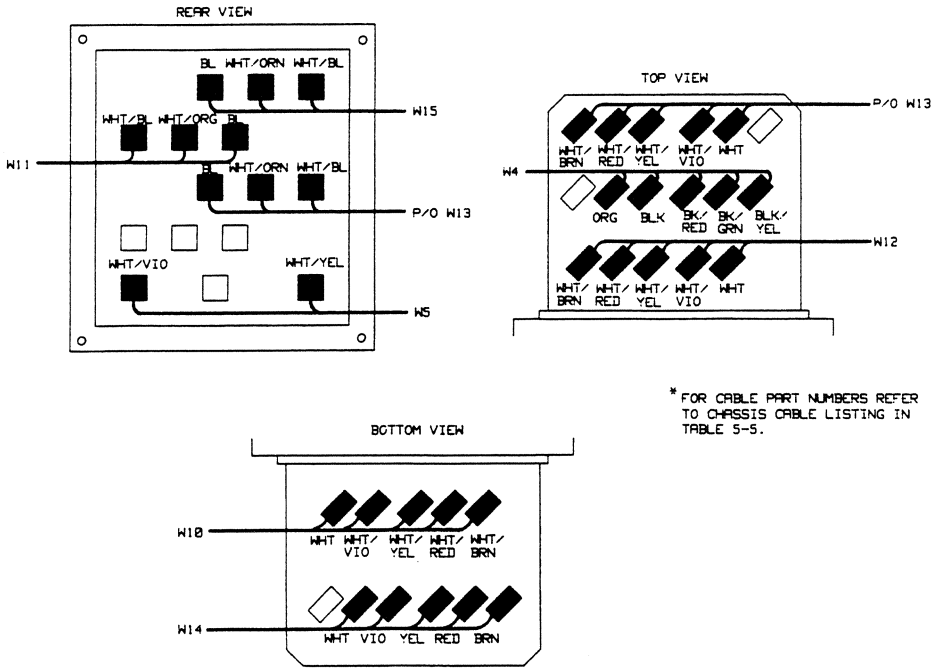


*FOR CABLE PART NUMBERS REFER TO CHASSIS CABLE LISTING IN TABLE 5-5.

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MODEL 6623A

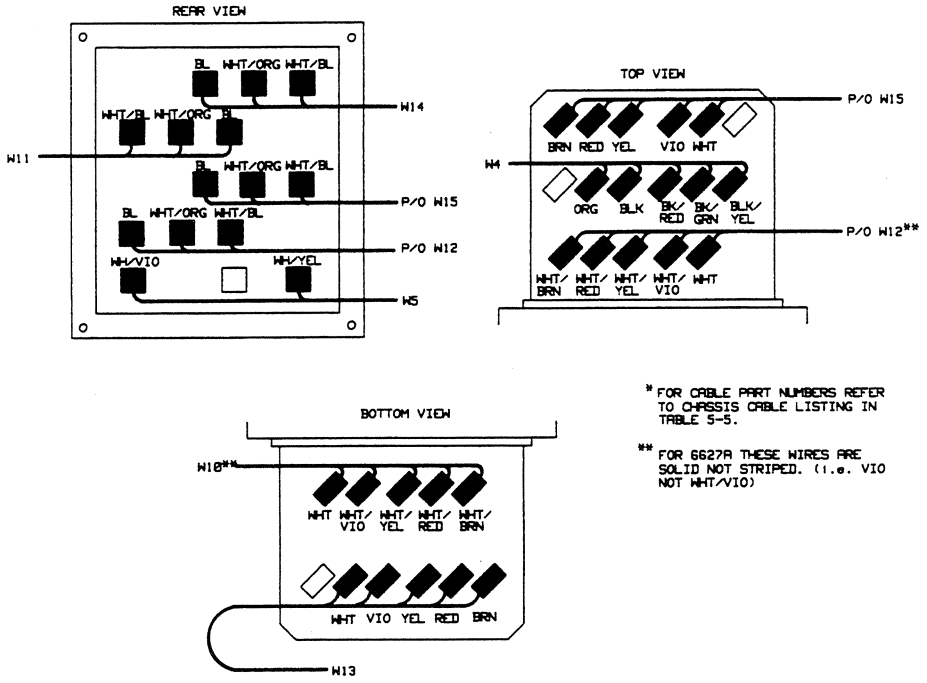
TRANSFORMER T1 CONNECTIONS*



* FOR CABLE PART NUMBERS REFER TO CHASSIS CABLE LISTING IN TABLE 5-5.

MODEL 6624A AND 6627A**

TRANSFORMER T1 CONNECTIONS*



* FOR CABLE PART NUMBERS REFER TO CHASSIS CABLE LISTING IN TABLE 5-5.

** FOR 6627A THESE WIRES ARE SOLID NOT STRIPED. (i.e. VIO NOT WHT/VIO)

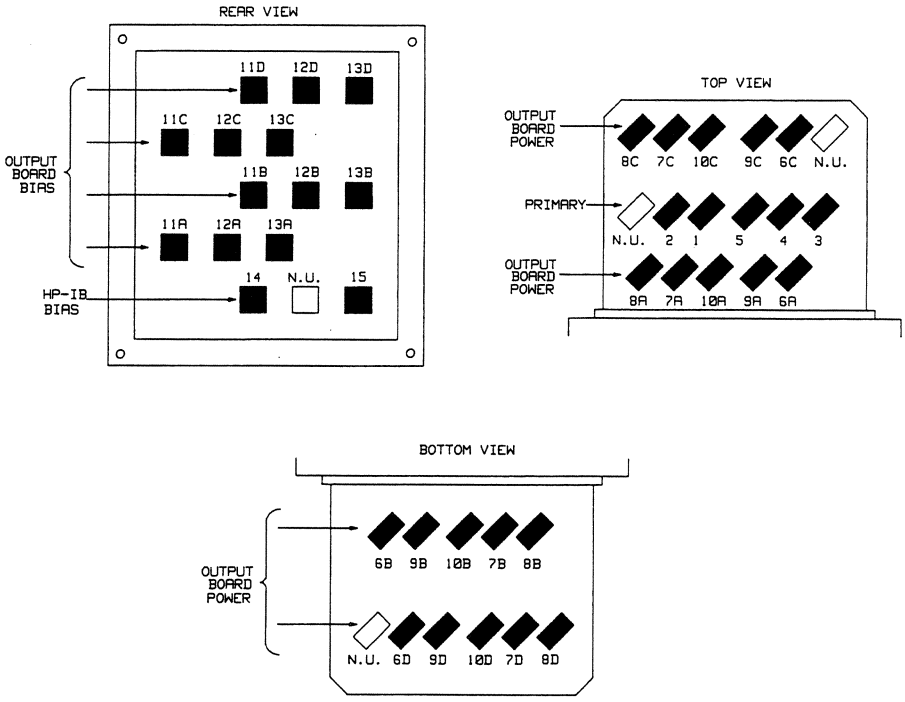
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Schematic Notes For Figure 6-1

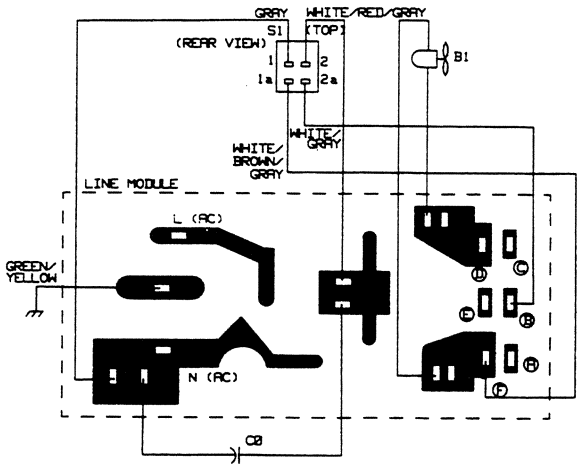
1. Fuse F1 is 8A for 100/120 Vac input or 4A for 220/240 Vac input.

2. Before connecting the supply to the power source, check that the position of the line voltage selector card matches the nominal line voltage source (100, 120, 220, or 240 Vac). See Section II in the Operating Manual (Agilent Part No. 5957-6377) for details.

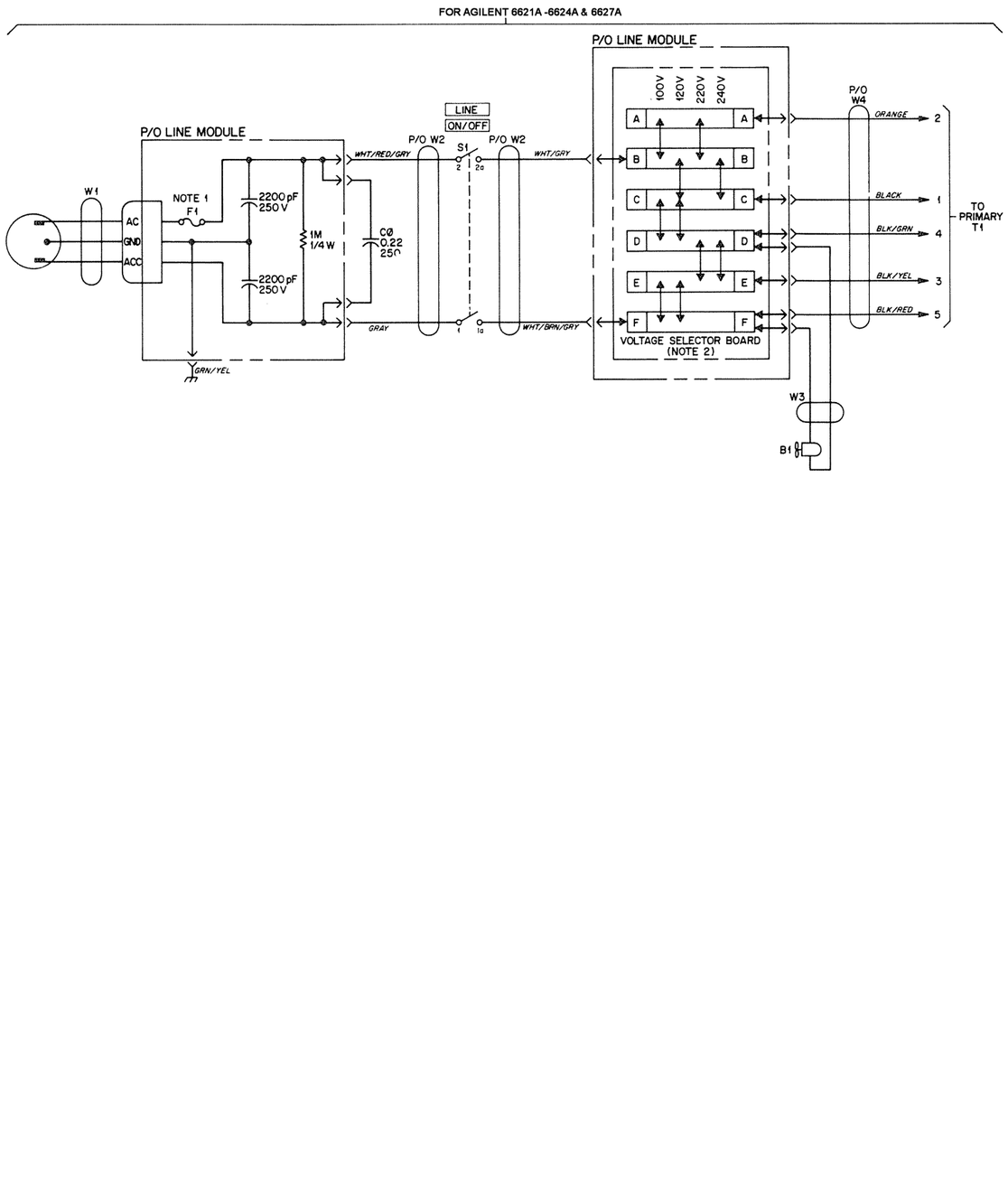
3. The reference designators (W1, W2, etc.) for the cable assemblies are for schematic reference only. Use the Agilent part numbers to physically identify cables in the supply. Each cable is marked with the appropriate Agilent Part No. The illustration below shows the transformer T1 terminal designations. The illustrations on pages 6-2 and 6-3 show the transformer T1 connections and cable part numbers for each model.



4. The line module connections are shown below.



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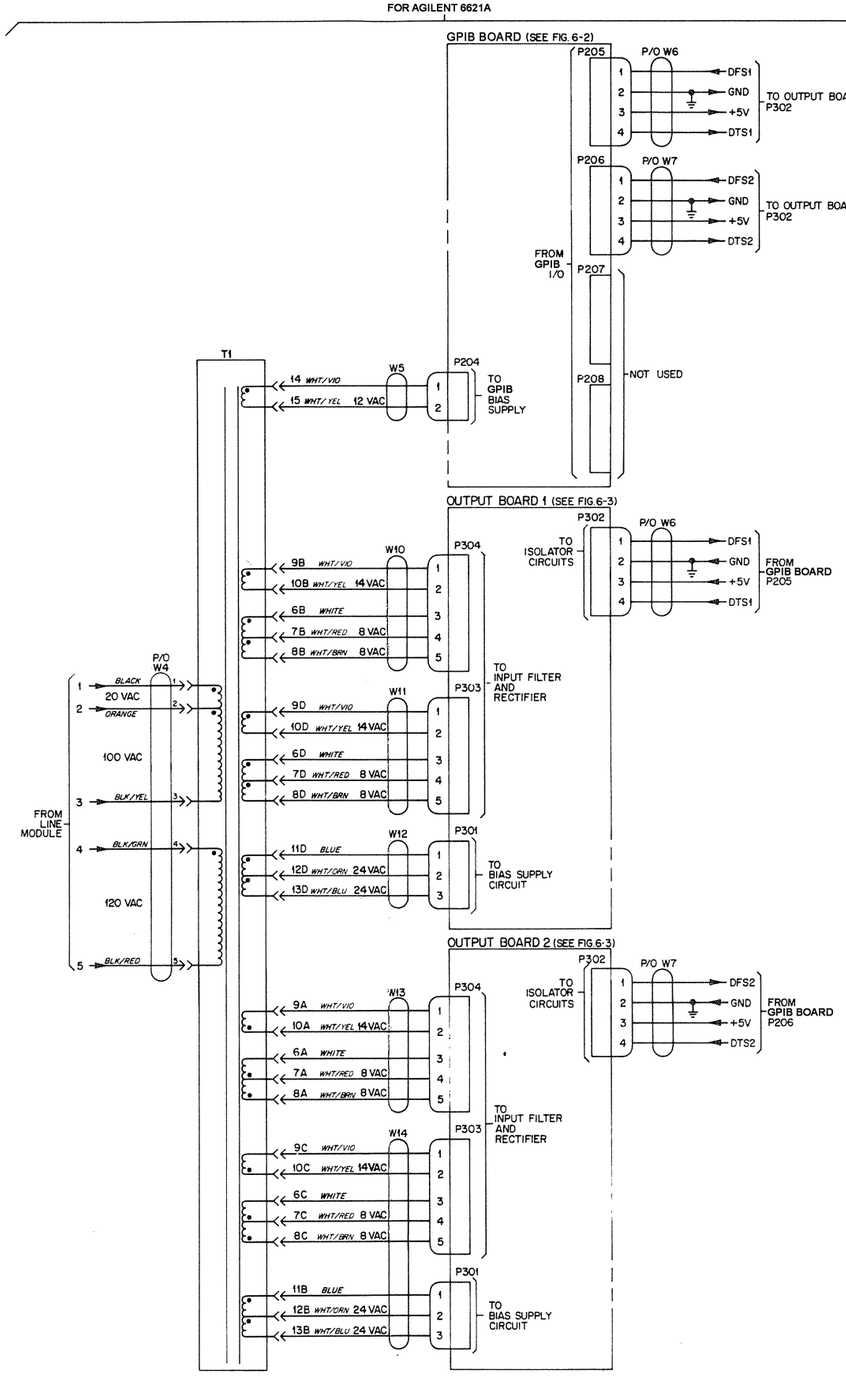
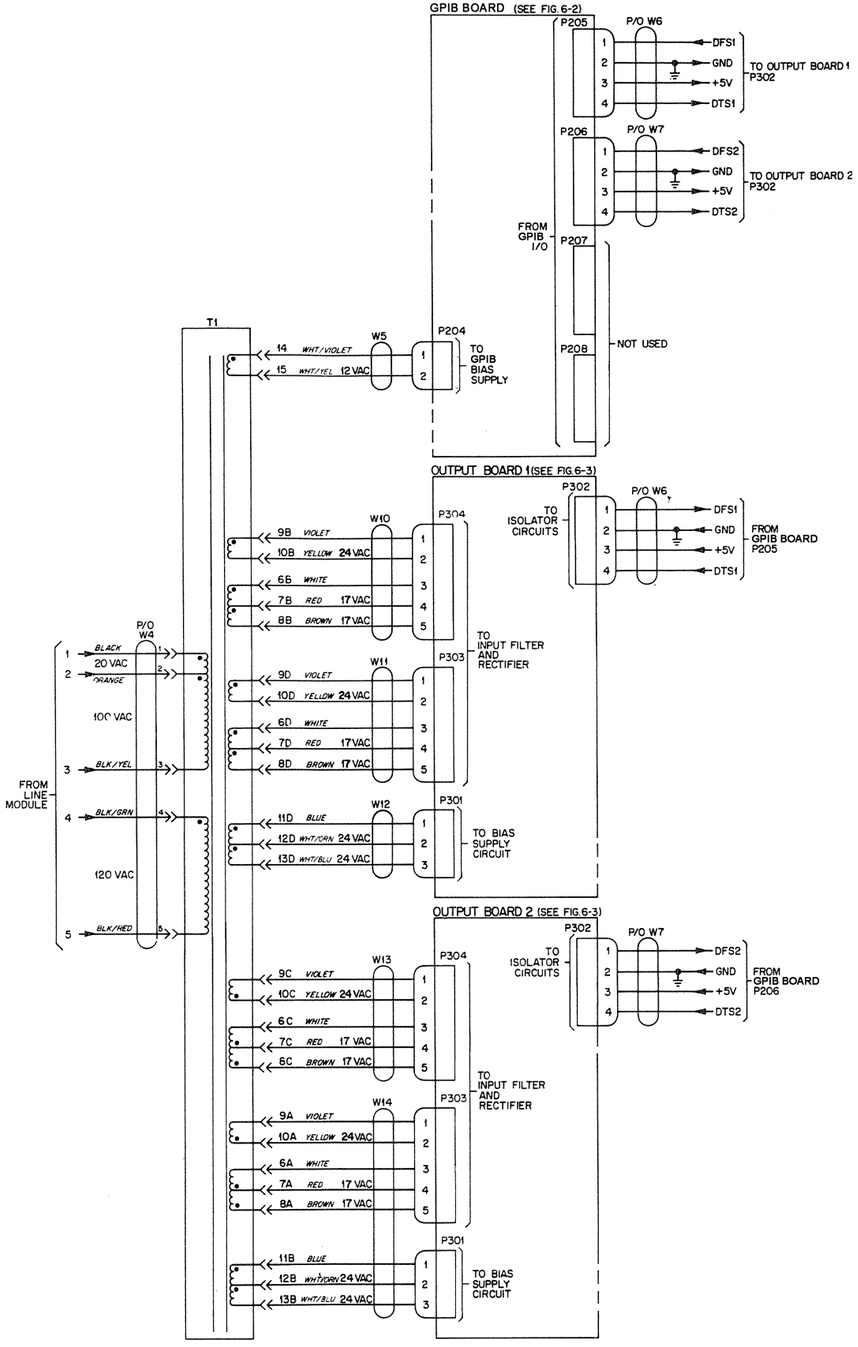


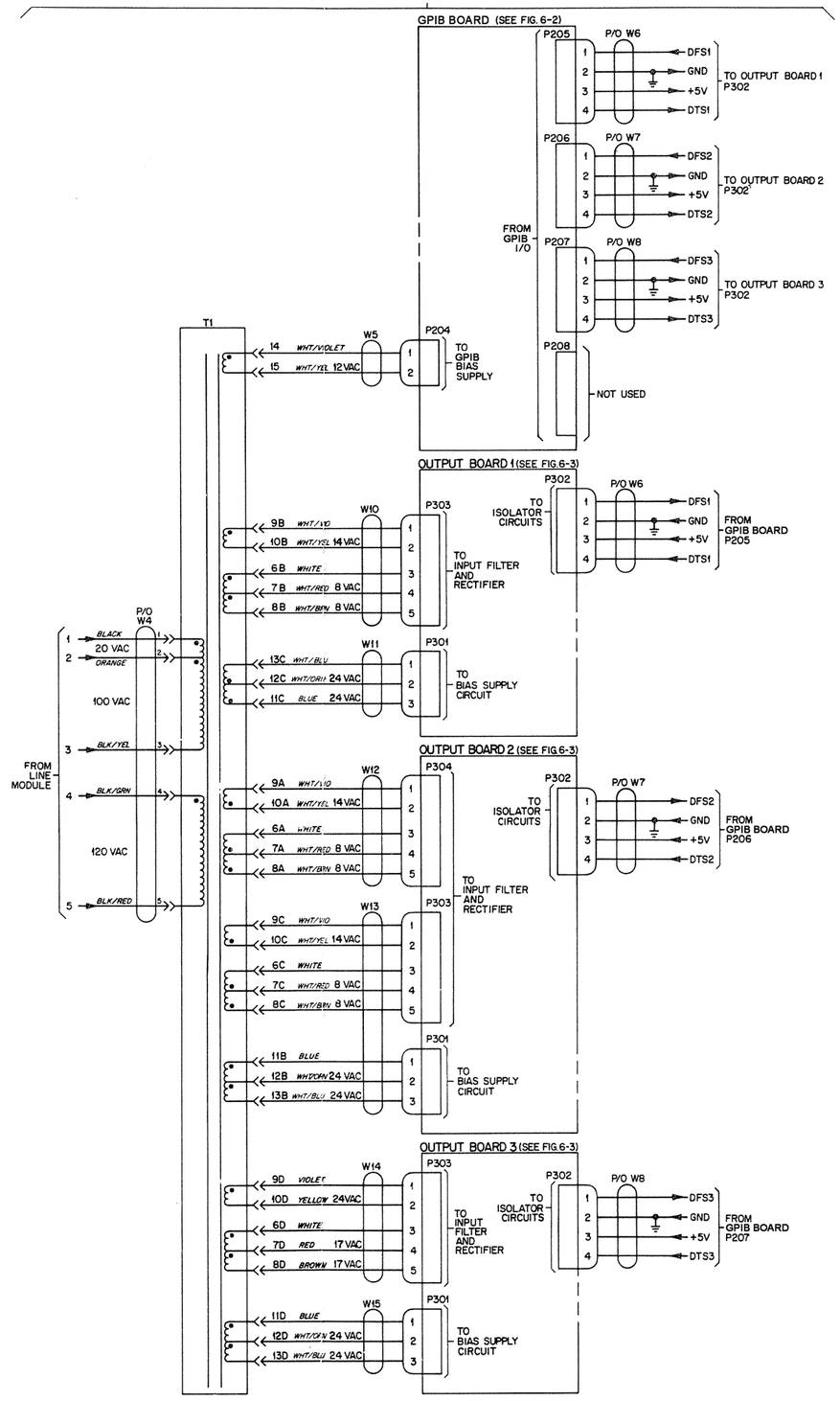
Figure 6-1. Power Distribution Schematic (sheet 1 of 2) 6-5

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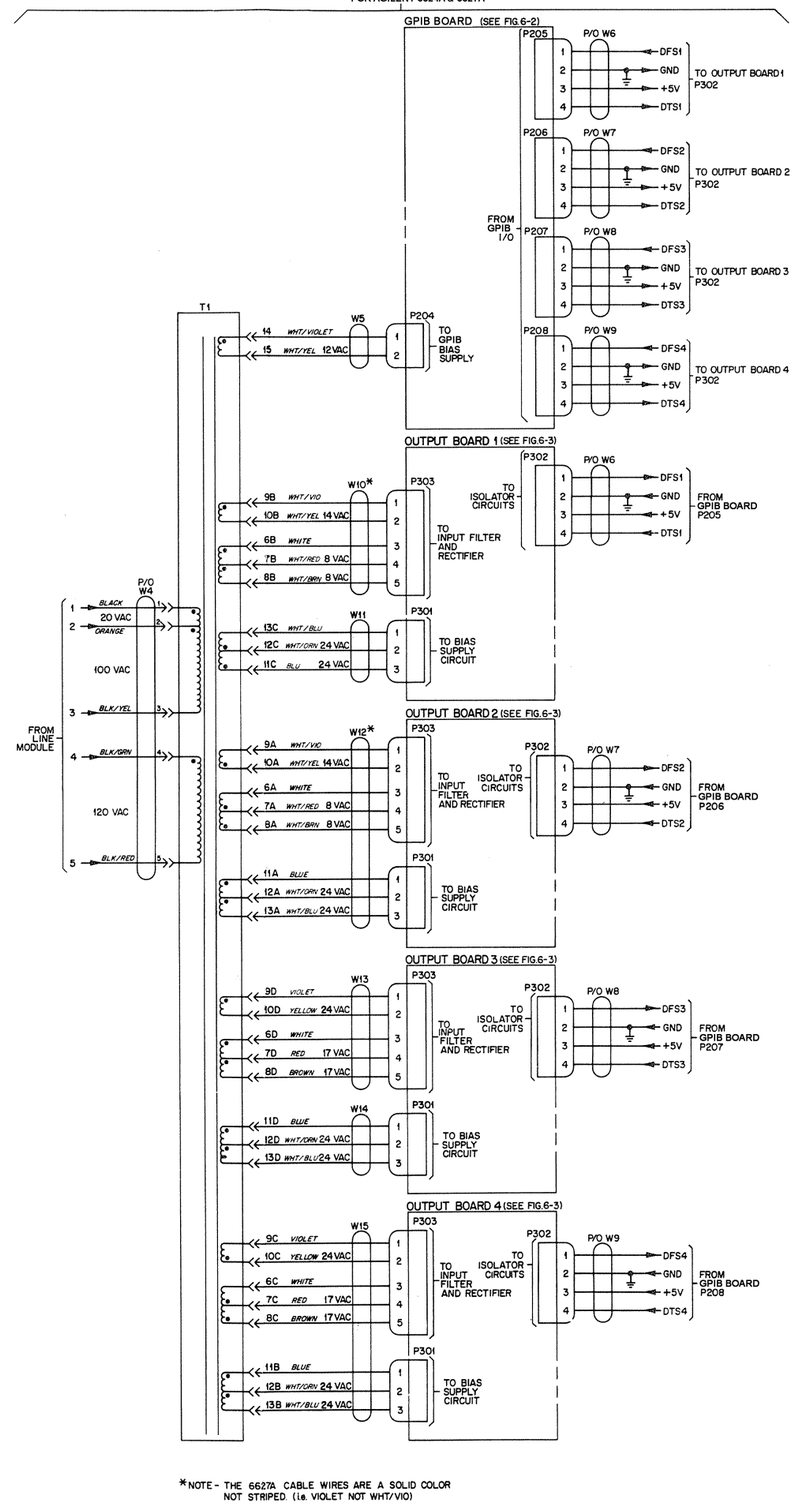
FOR AGILENT 6622A



FOR AGILENT 6623A



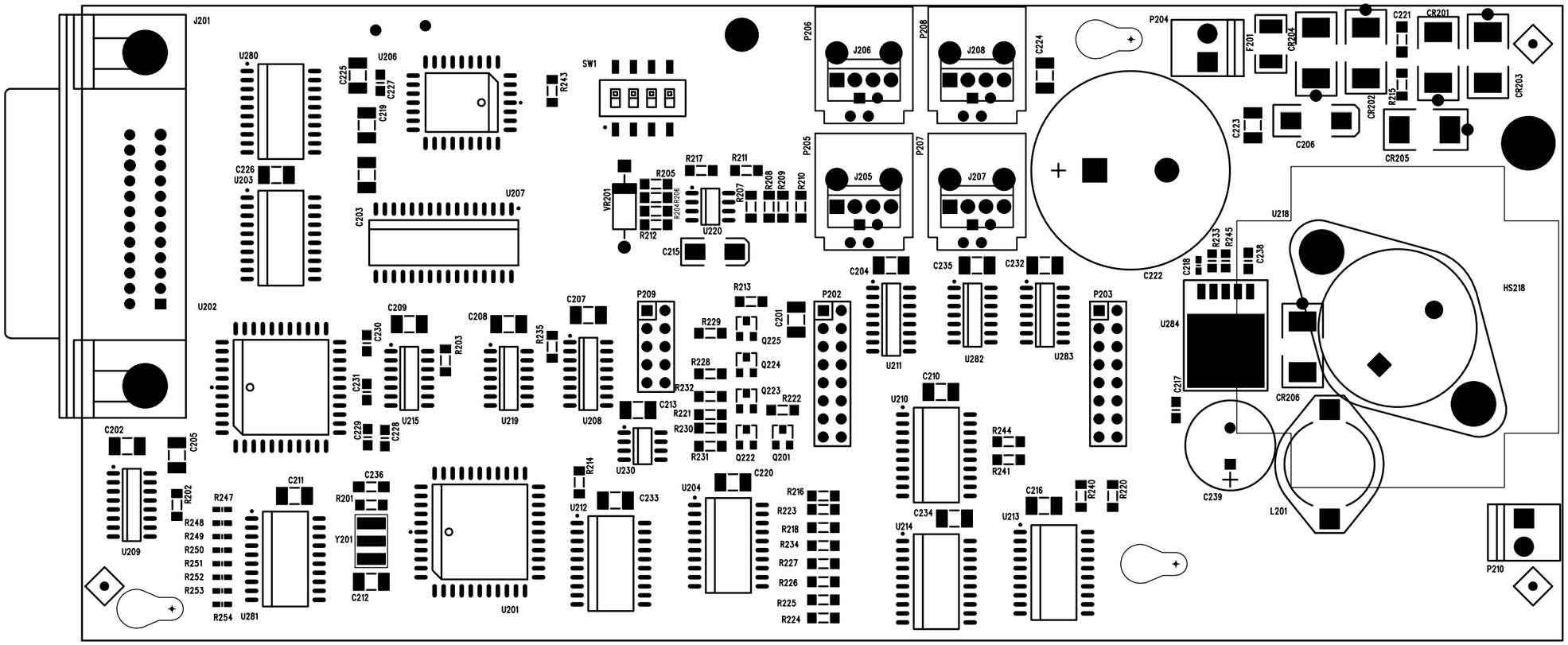
FOR AGILENT 6624A & 6627A*



*NOTE - THE 6627A CABLE WIRES ARE A SOLID COLOR NOT STRIPED. (i.e. VIOLET NOT WHT/VIO)

Figure 6-1. Power Distribution Schematic (sheet 2 of 2) 6-6

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NOTES:
This surface-mount GPIB assembly applies to models starting with the following serial numbers and up:
6621A 3737A03086-up
6622A 3736A04021-up
6623A 3736A05451-up
6624A 3735A13801-up
6627A 3735A02356-up

Electrically and functionally, this assembly differs somewhat from the previous GPIB assembly. The surface-mount GPIB assembly is not repairable to the component level, so a parts lists is not provided. Signature analysis repair is not available for the surface-mount GPIB assembly.

This board has a 4-position switch on it (located next to U206) that replaces the function of connector P201 described on page 4-8 of this manual. The switch selects the following functions:

Switch 1 - the model function. ON selects models 6621A, 6622A, 6623A, 6624A, and 6627A. OFF selects models 6625A, 6626A, 6628A, and 6629A.
As-shipped position = ON

Switch 2 - selects calibration lockout. ON locks out front panel calibration. OFF enables front panel calibration.
As-shipped position = OFF

Switch 3 - selects skip self test. ON skips self test at turn on. OFF enables self test at turn on.
As-shipped position = OFF

Switch 4 - not used

Figure 6-2. GPIB Board, Component Location 6-7

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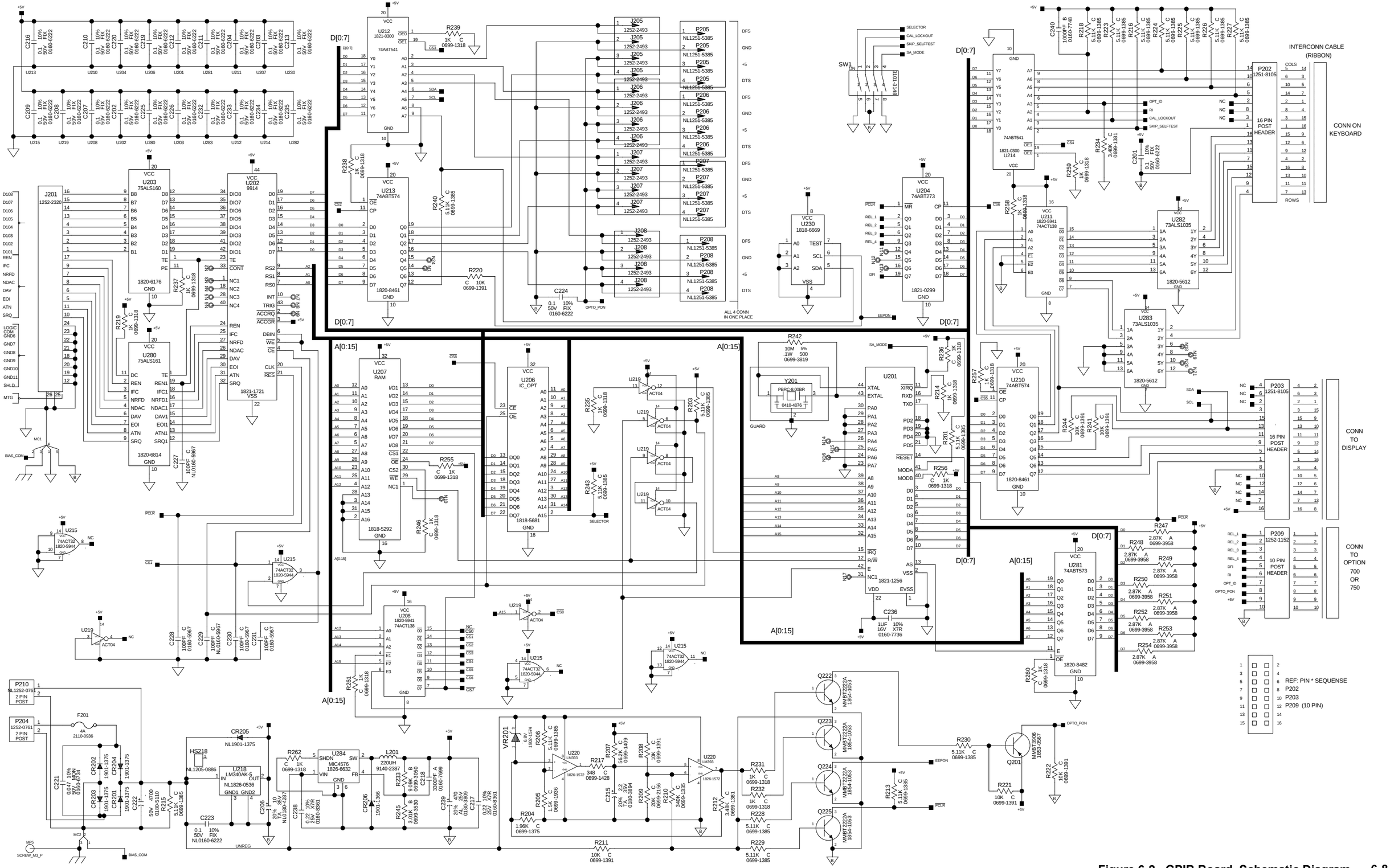


Figure 6-2. GPIB Board, Schematic Diagram 6-8

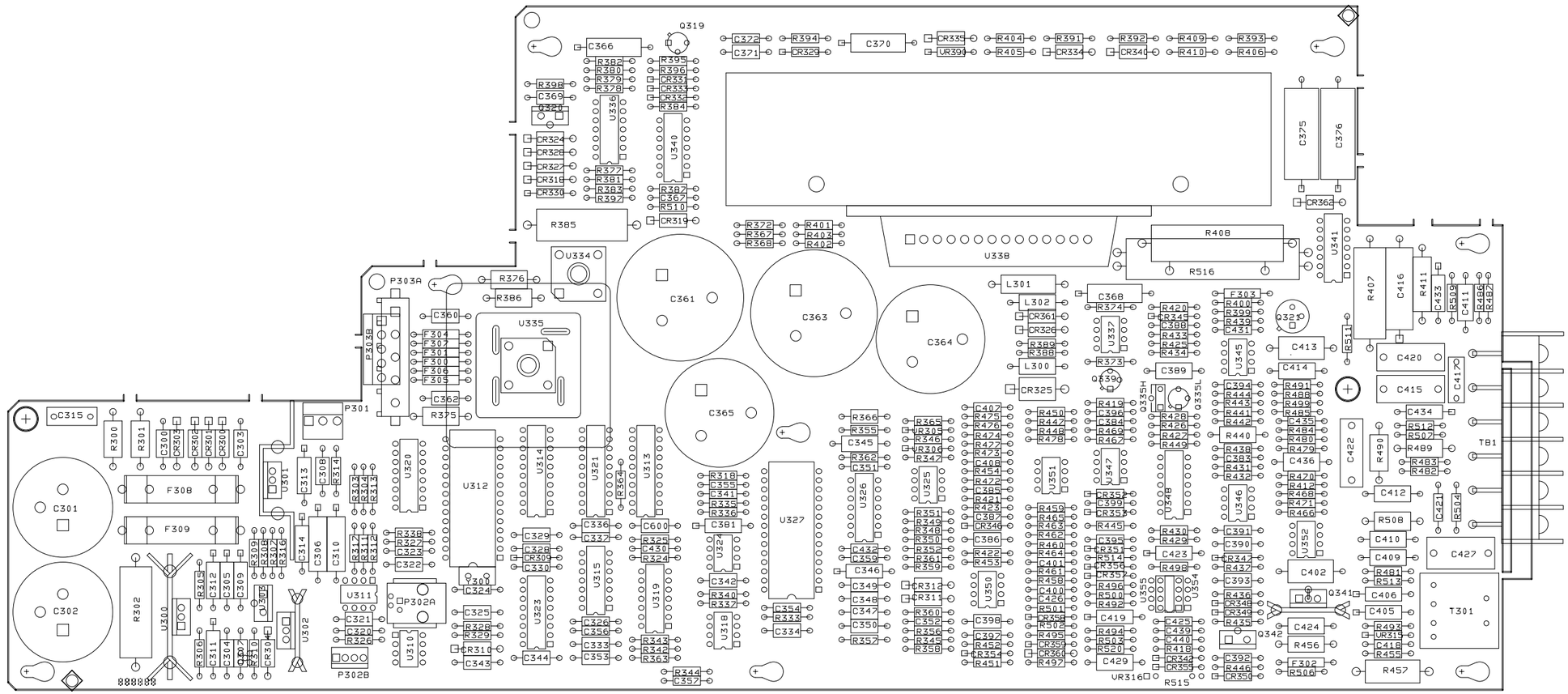
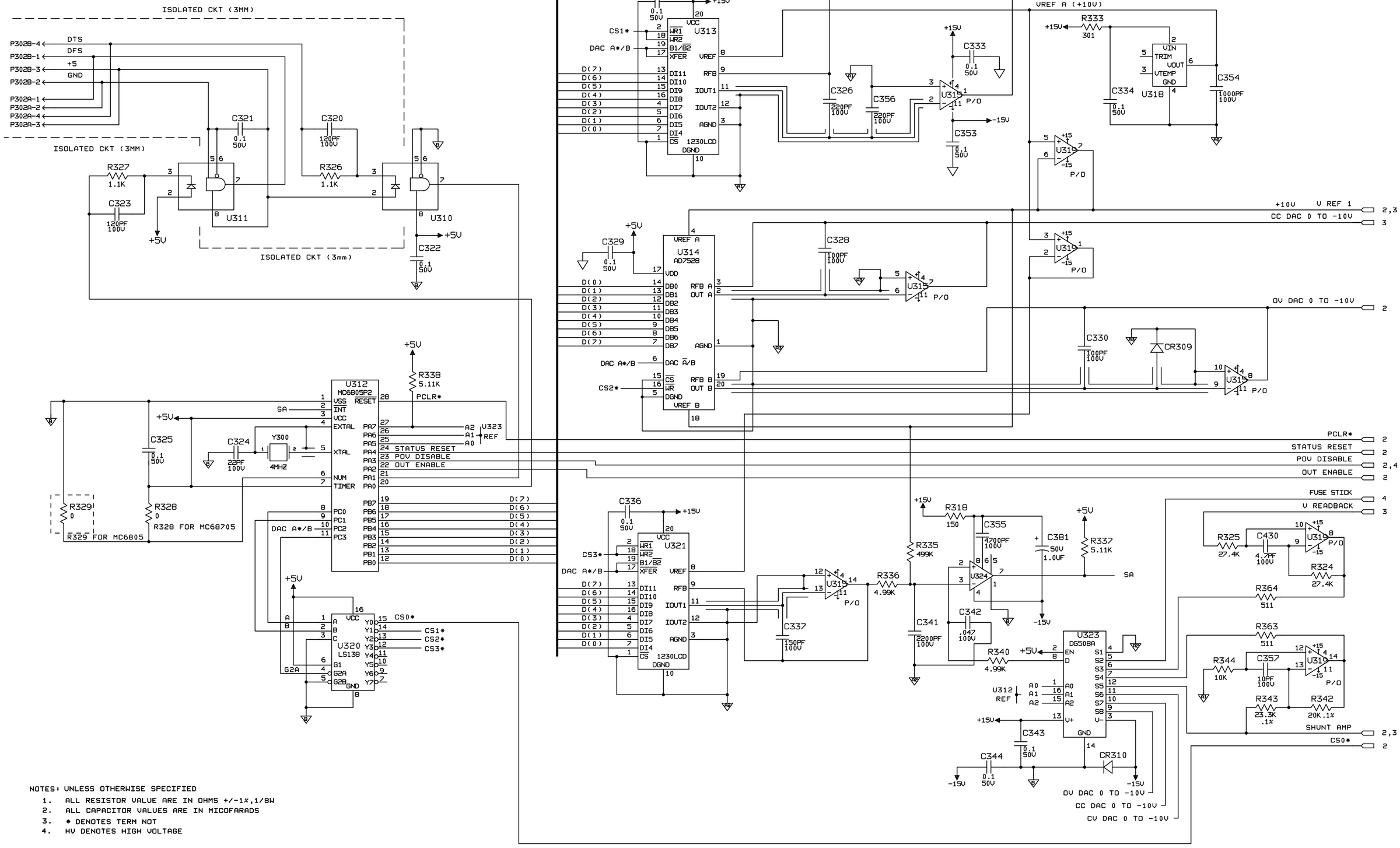


Figure 6-3. Output 1 & 2 Board, Component Location 6-9



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUE ARE IN OHMS +/-1%,1/8W
2. ALL CAPACITOR VALUES ARE IN MICOFARADS
3. * DENOTES TERM NOT
4. HV DENOTES HIGH VOLTAGE

Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 1 of 4) 6-10

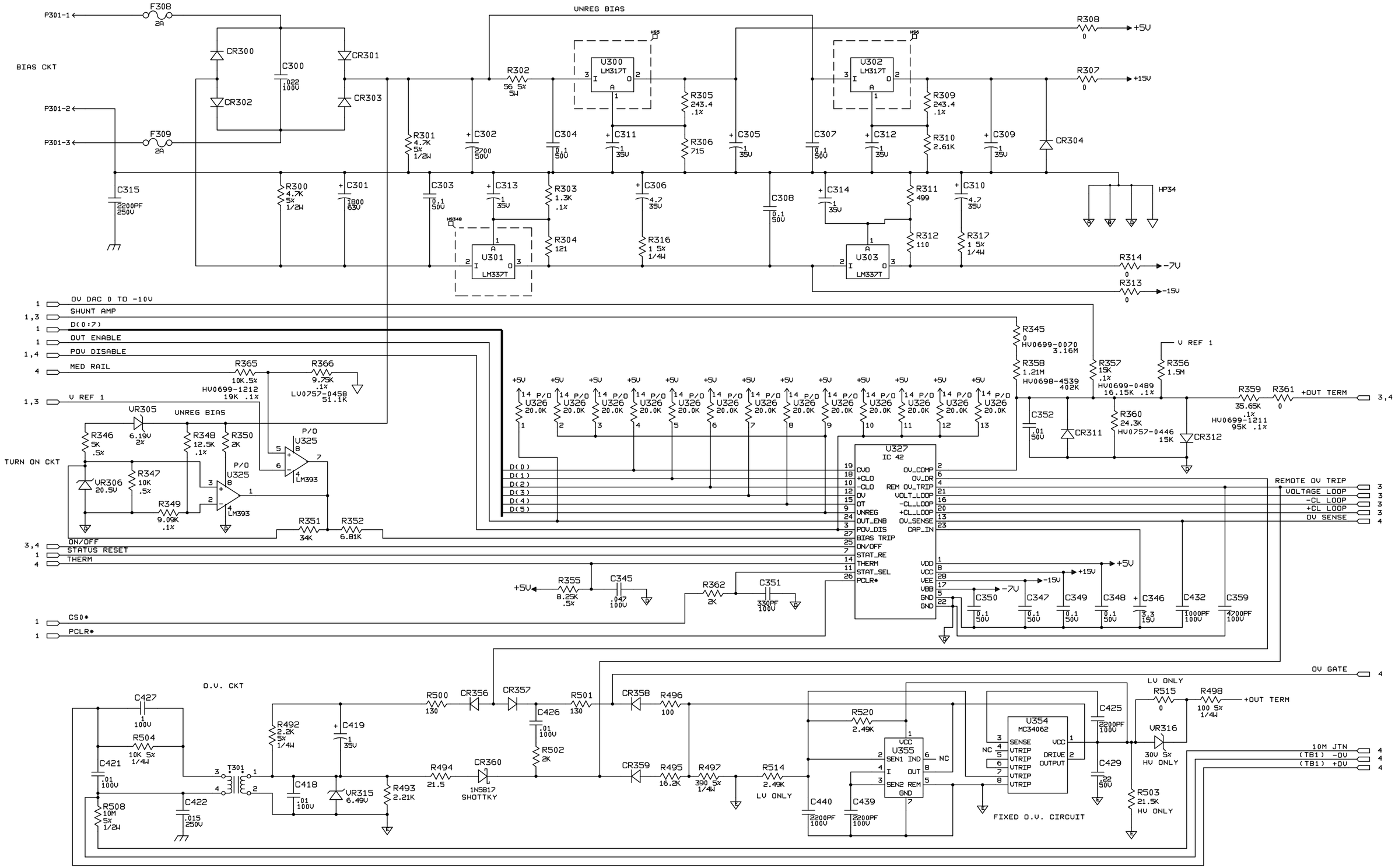


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 2 of 4) 6-11

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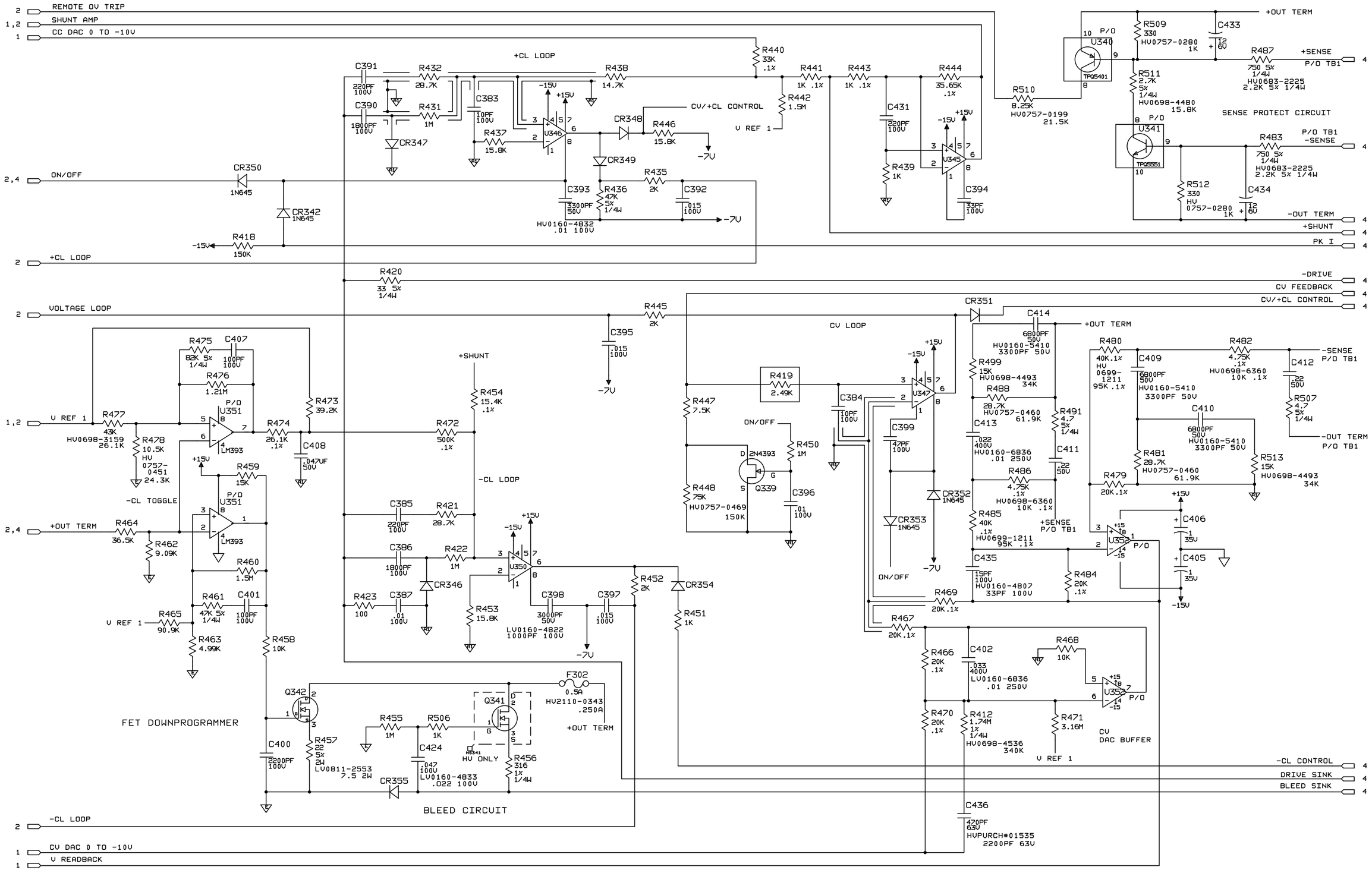


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 3 of 4) 6-12

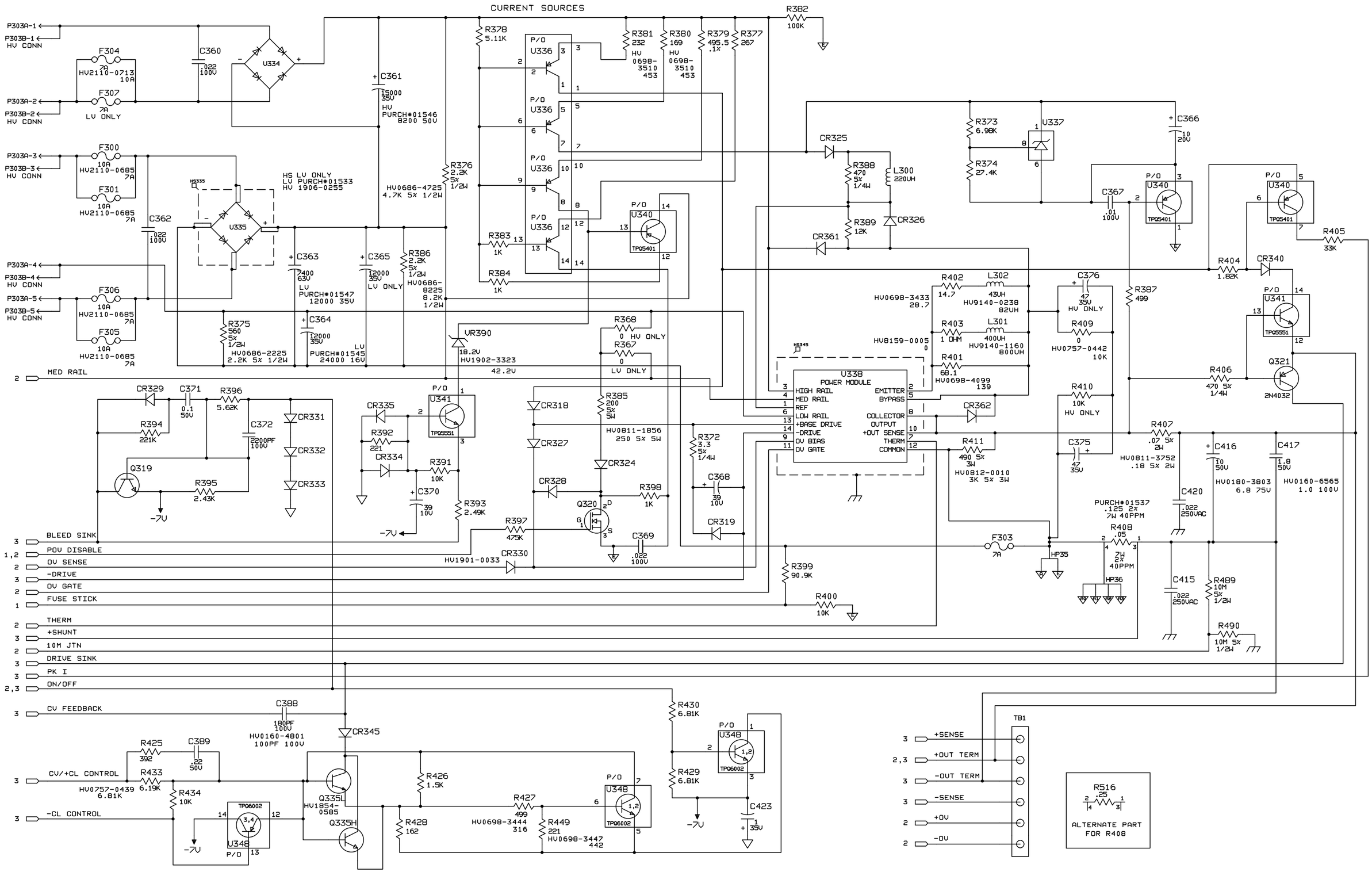


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 4 of 4) 6-13

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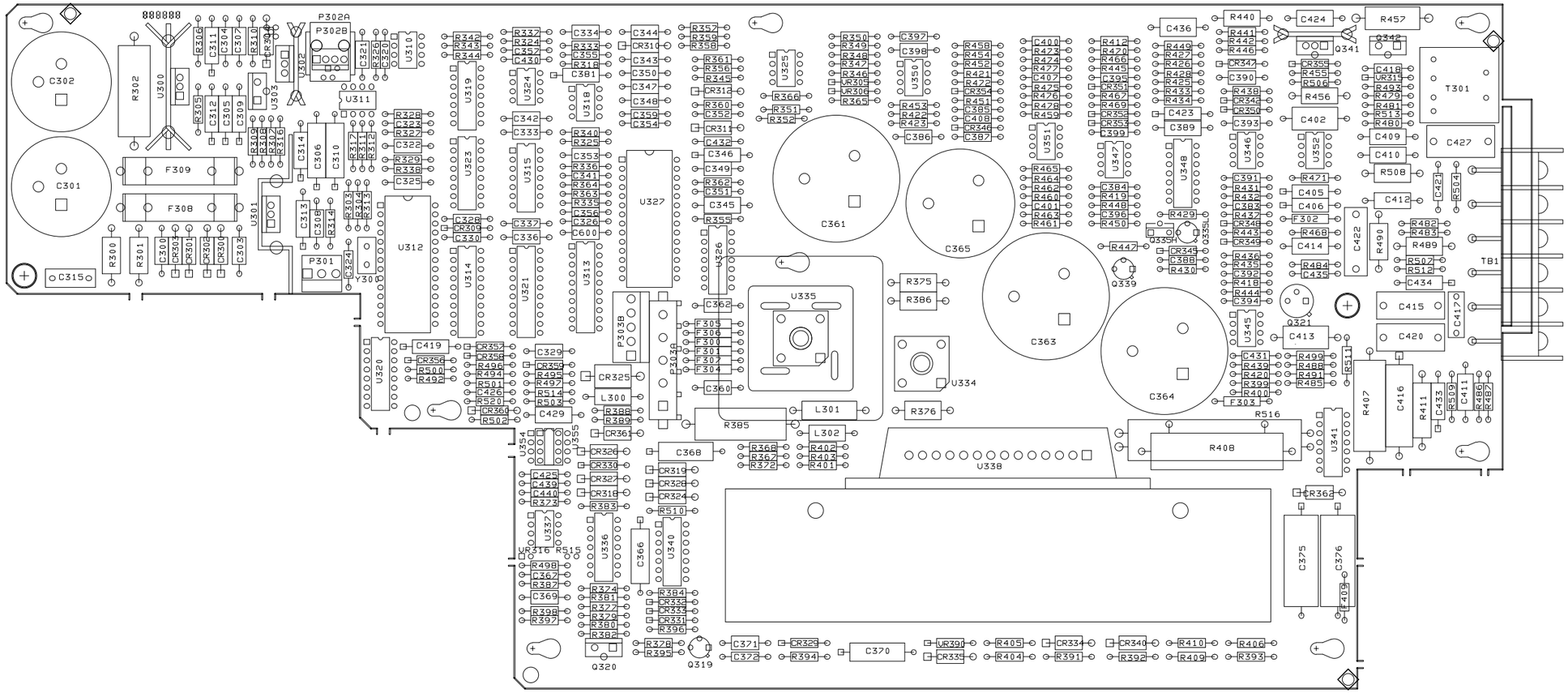
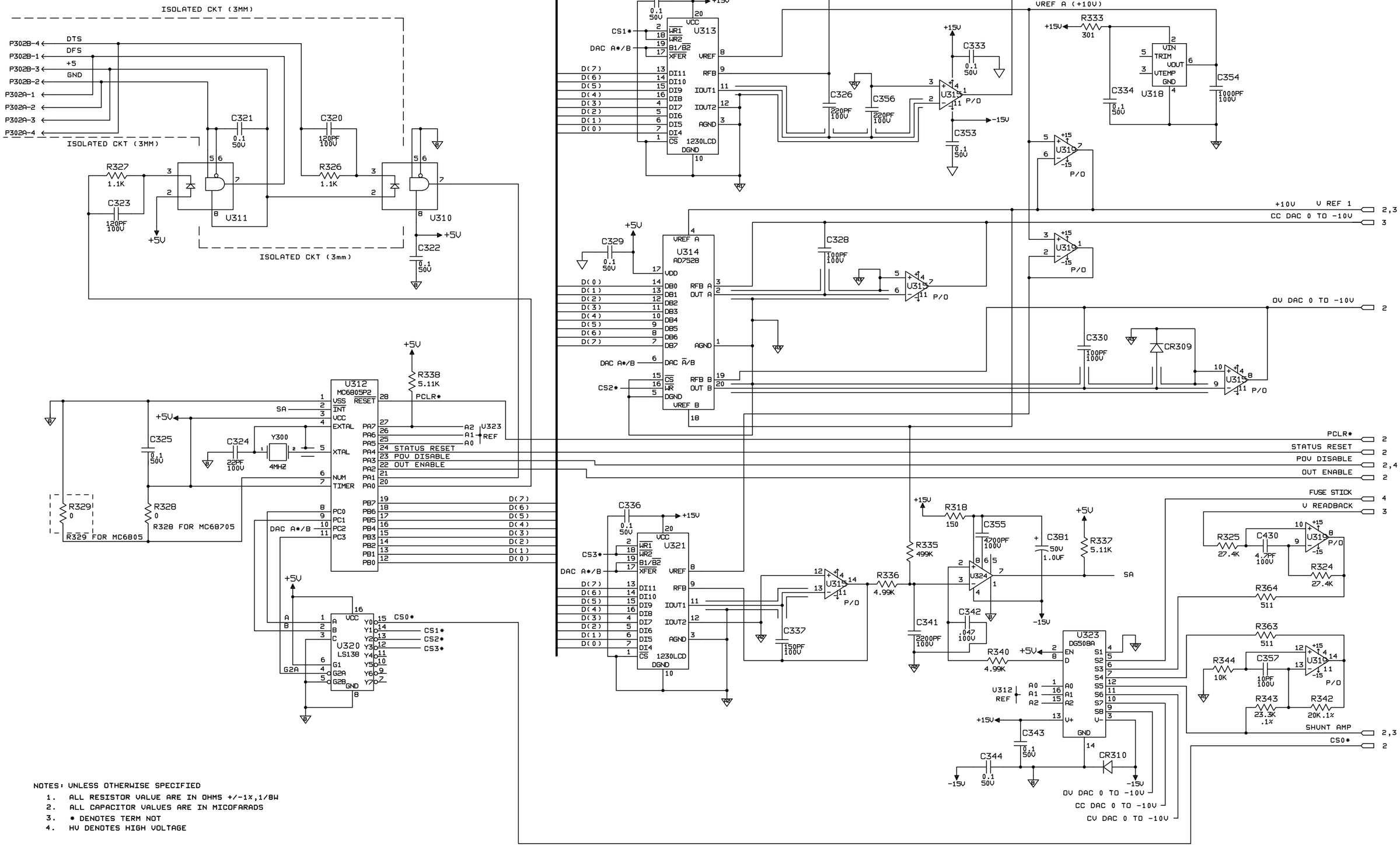


Figure 6-4. Output 3 & 4 Board, Component Location

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NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUE ARE IN OHMS +/-1%,1/8W
2. ALL CAPACITOR VALUES ARE IN MICOFARADS
3. * DENOTES TERM NOT
4. HV DENOTES HIGH VOLTAGE

Figure 6-4. Output 3 & 4 Board, Schematic Diagram (sheet 1 of 4) 6-16

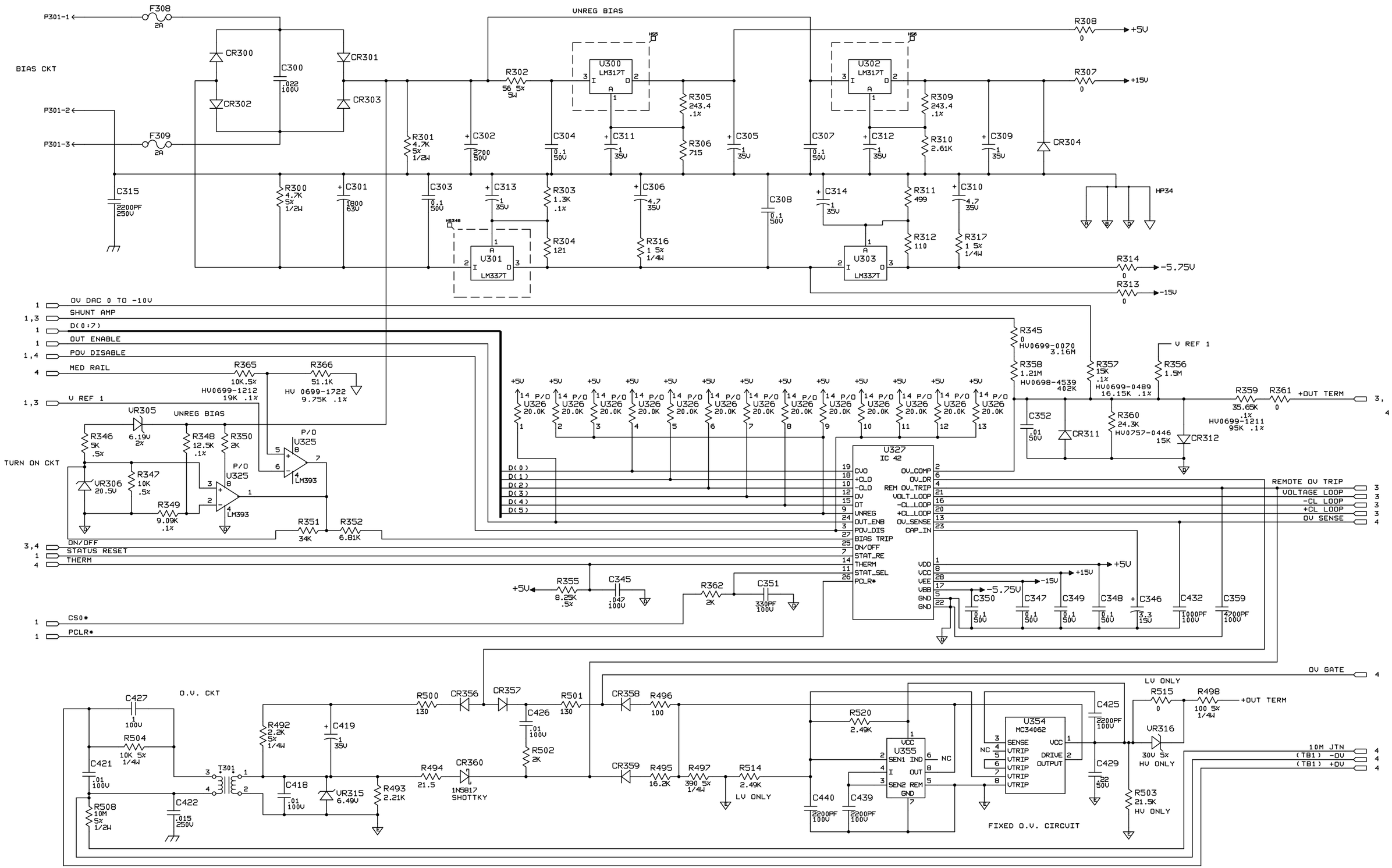


Figure 6-4. Output 3 & 4 Board, Schematic Diagram (sheet 2 of 4) 6-17

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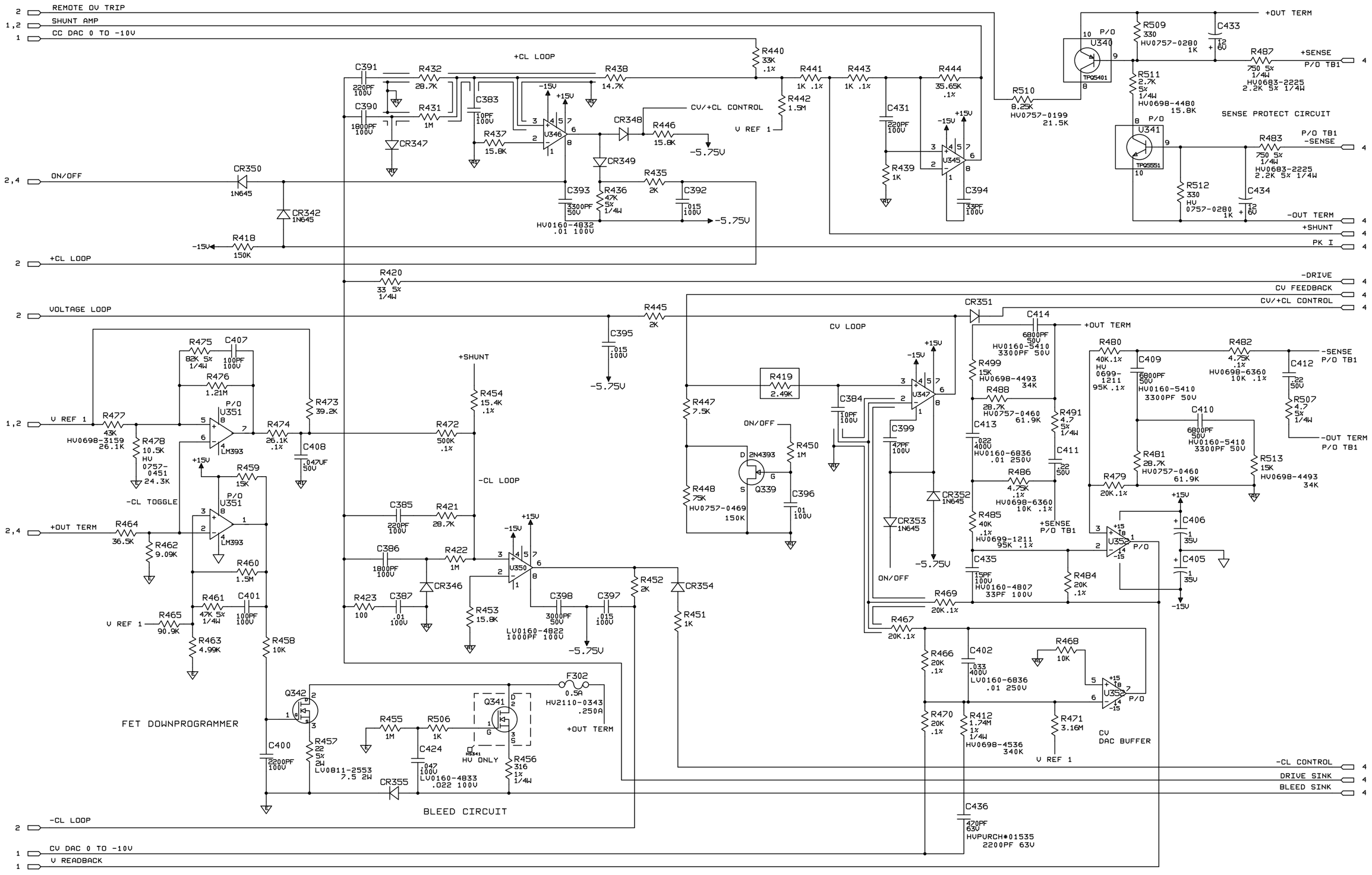


Figure 6-4. Output 3 & 4 Board, Schematic Diagram (sheet 3 of 4) 6-18

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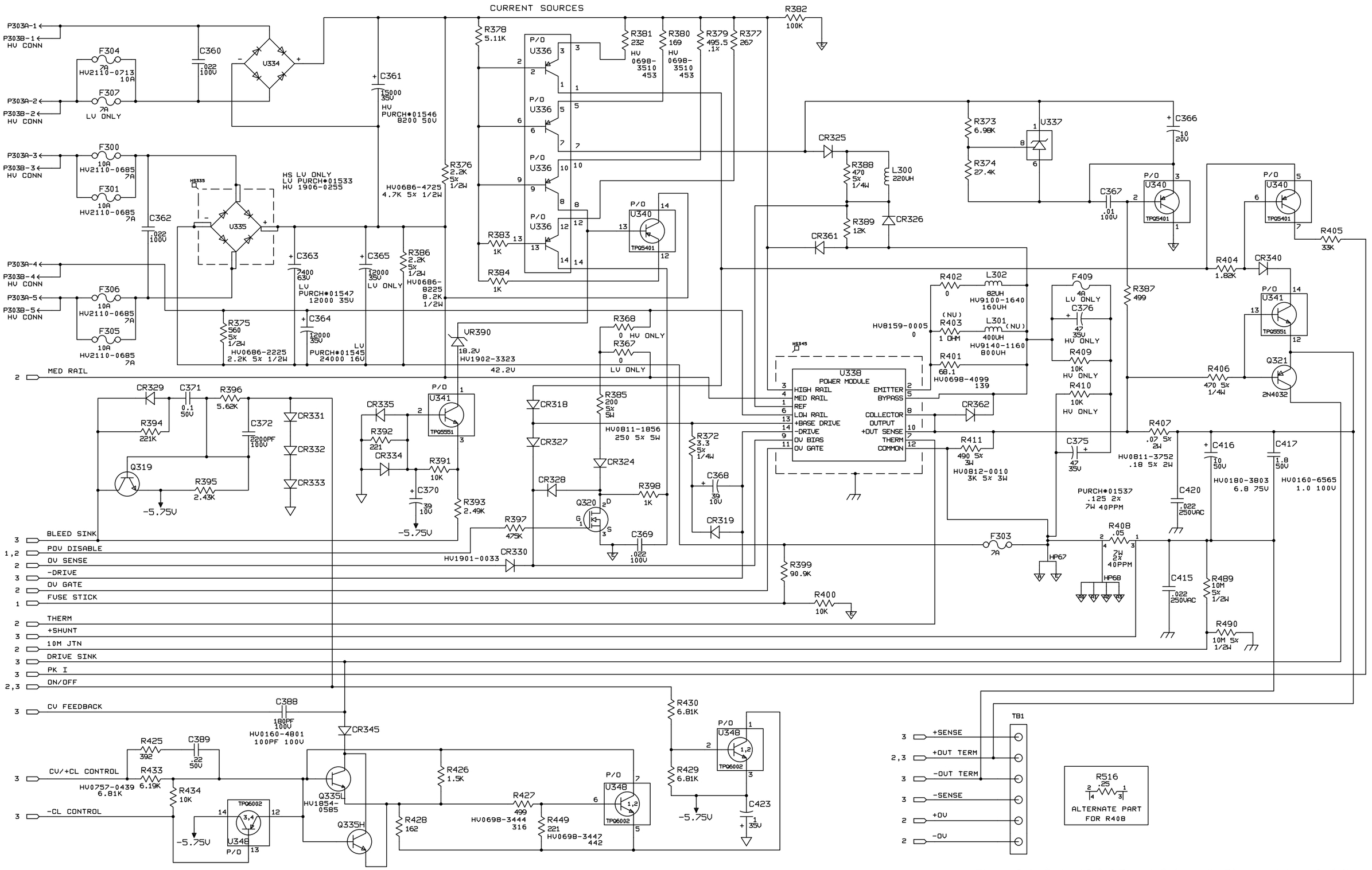


Figure 6-4. Output 3 & 4 Board, Schematic Diagram (sheet 4 of 4) 6-19

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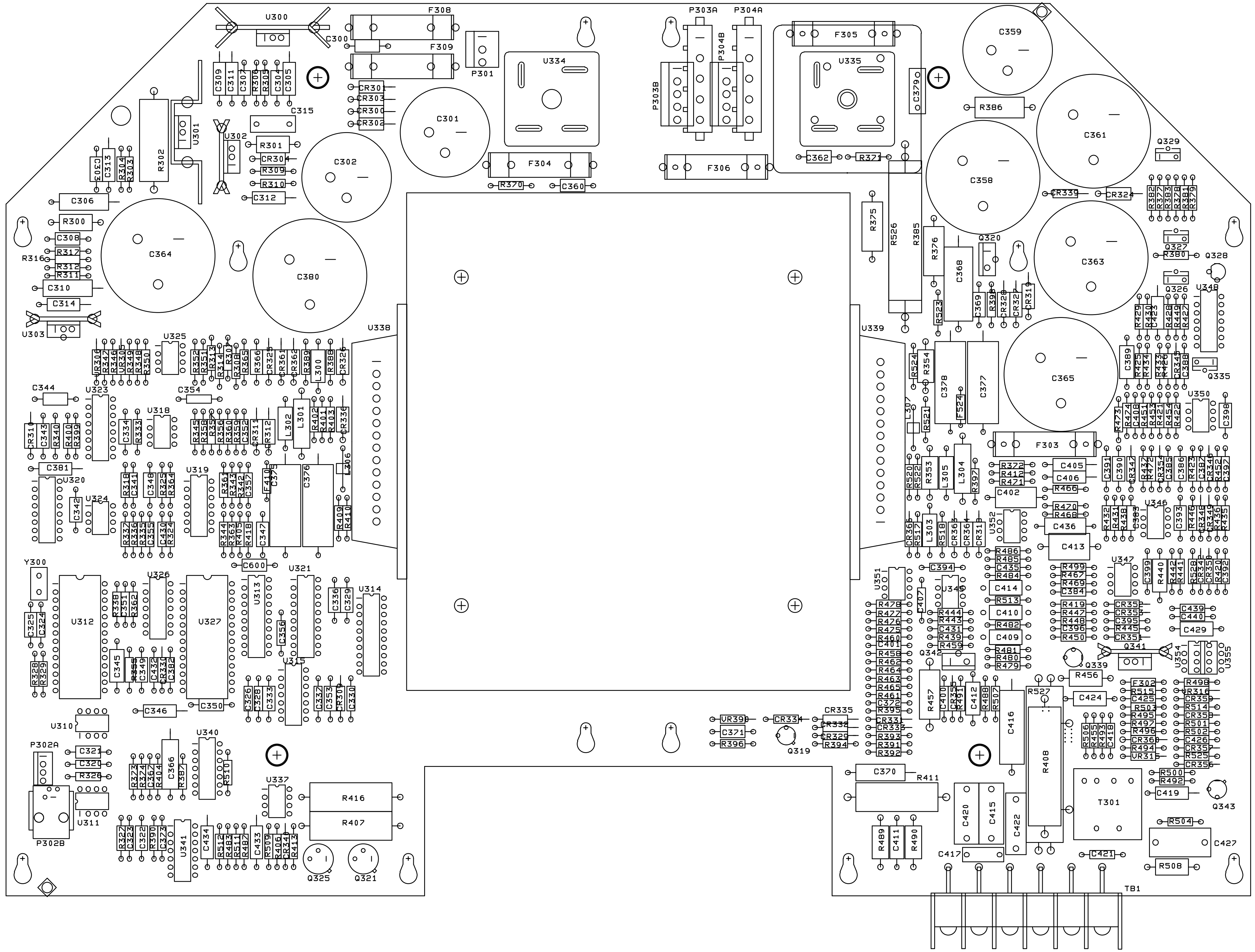


Figure 6-5. Output 1 & 2 80W Board, Component Location 6-21

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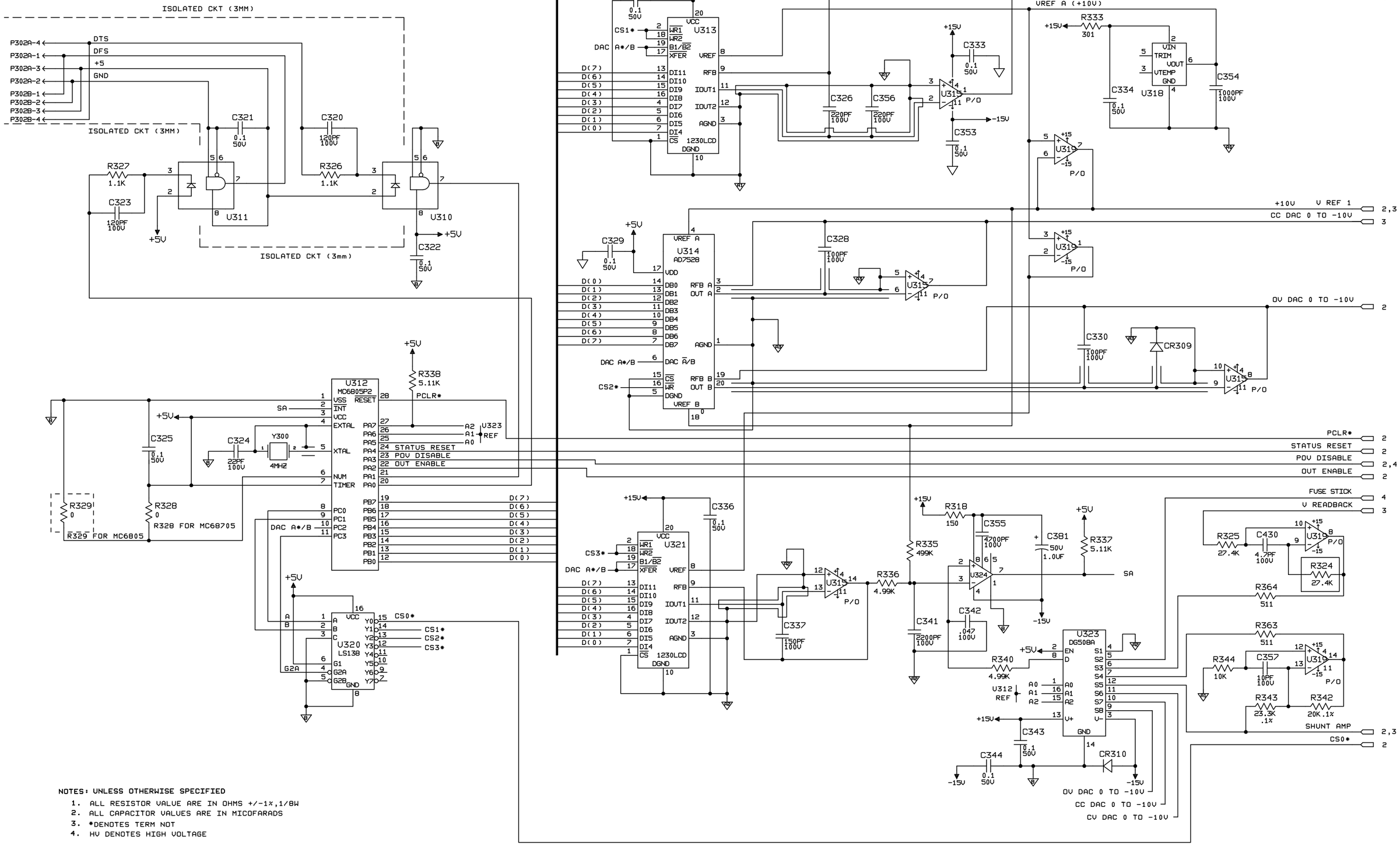


Figure 6-5. Output 1 & 2 80W Board, Schematic Diagram (sheet 1 of 4) 6-22

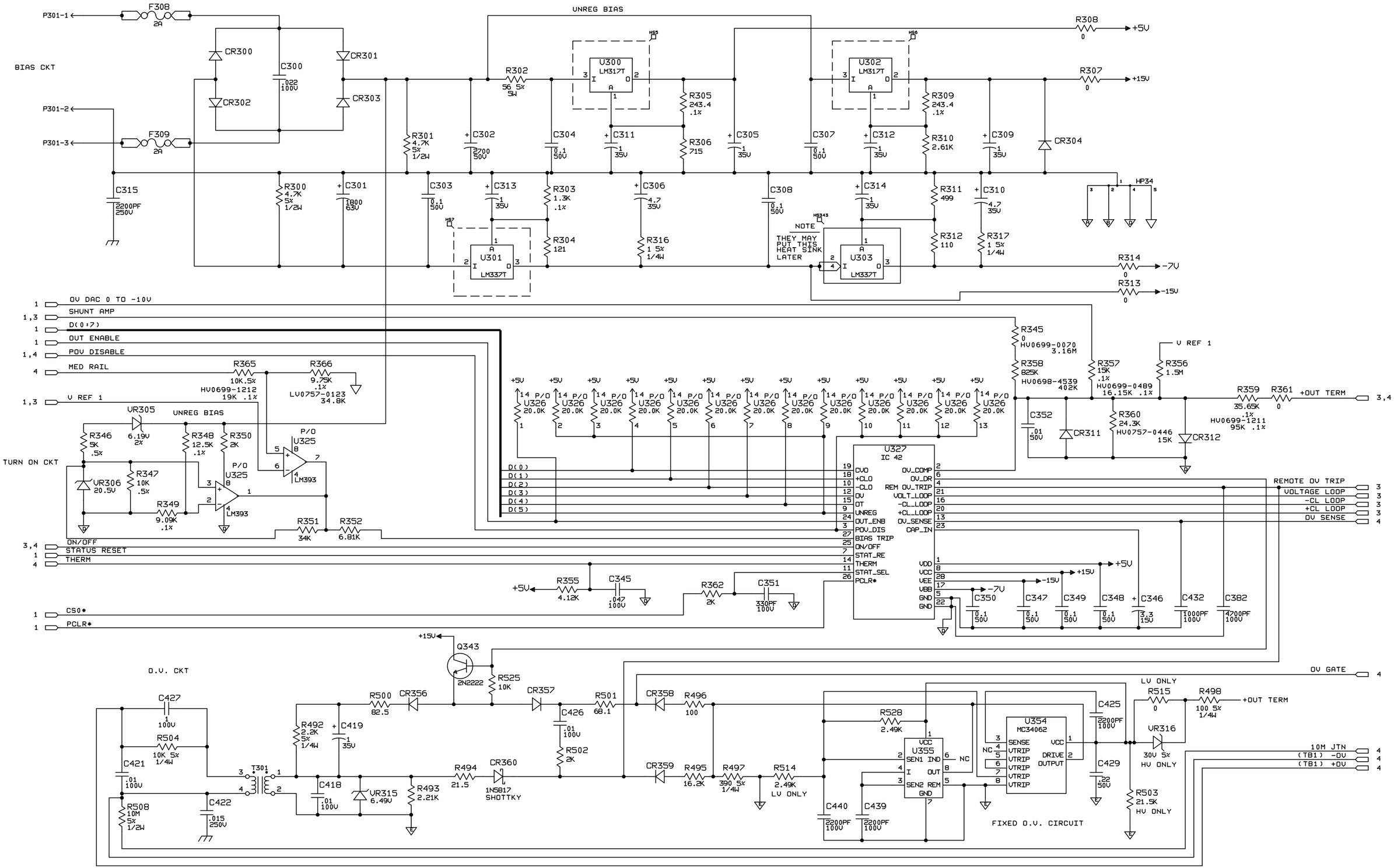


Figure 6-5. Output 1 & 2 80W Board, Schematic Diagram (sheet 2 of 4) 6-23

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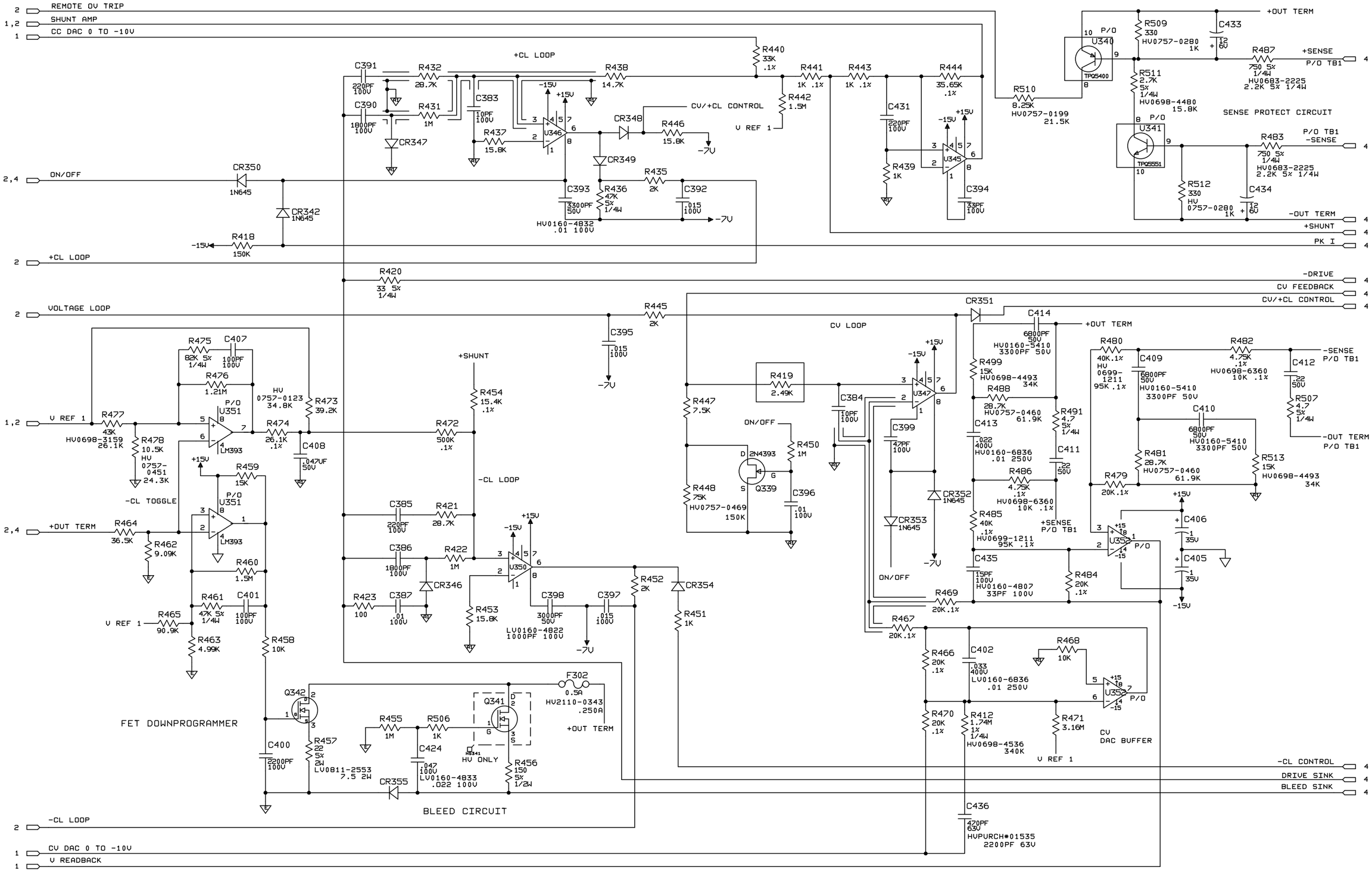


Figure 6-5. Output 1 & 2 80W Board, Schematic Diagram (sheet 3 of 4) 6-24

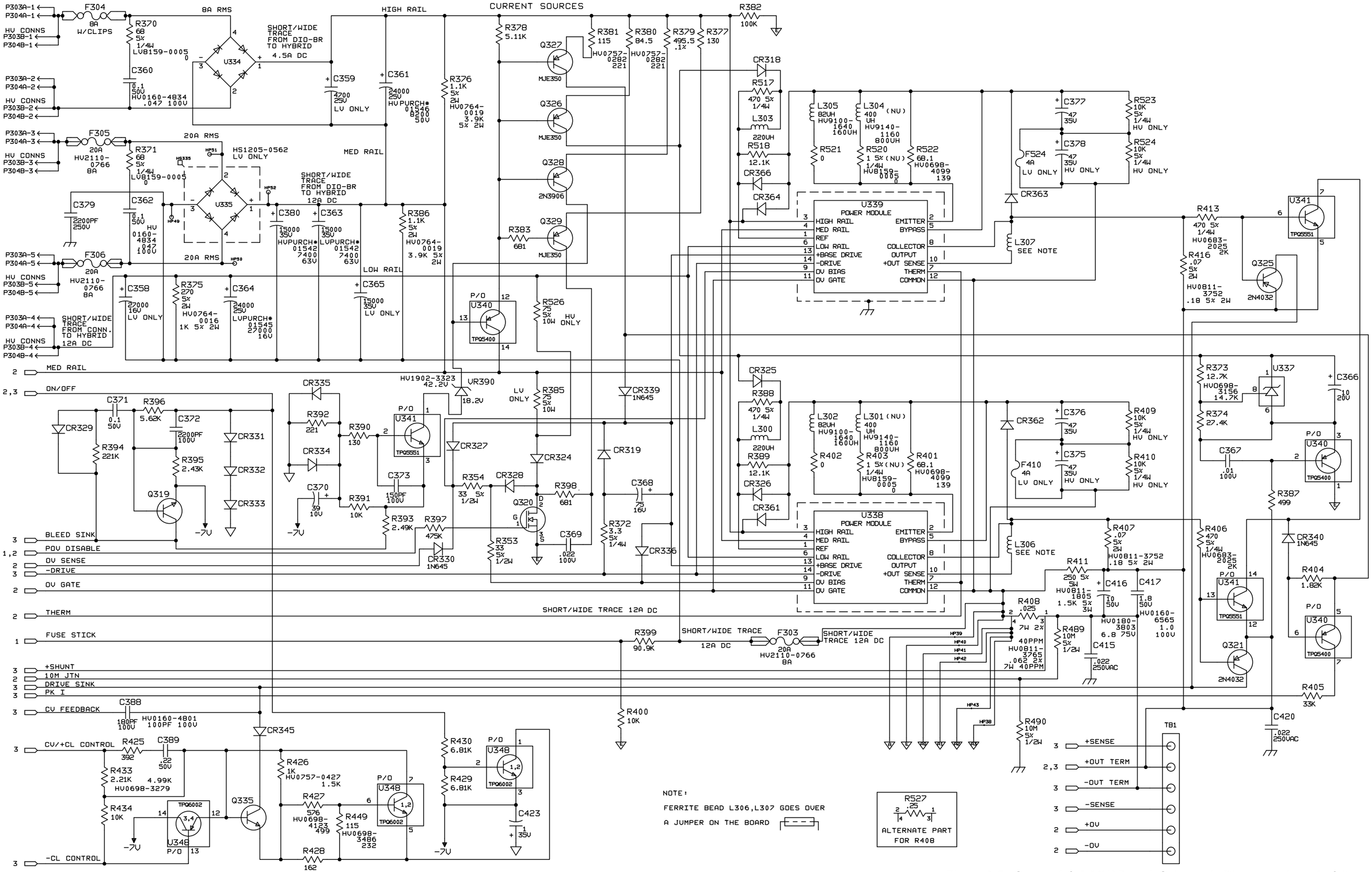


Figure 6-5. Output 1 & 2 80W Board, Schematic Diagram (sheet 4 of 4) 6-25

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Appendix A
LOGIC SYMBOLOGY

The logic symbols used in this manual are based on ANSI/IEEE Std 91-1984 (or later), which is a revision of ANSI Y32.14. The following paragraphs and illustrations provide a brief description of the symbology to aid in interpreting the symbols. When referring to the symbols, it should be remembered that:

1. Power supply and ground connections usually are not shown on the symbols, but are listed separately on the schematic.

2. Items in brackets [ ] are not part of the symbol, but are included to help the user interpret the symbol.

3. Unless arrows indicate otherwise, inputs are on left, outputs are on right, and signal flow is from left to right.

4. In an array of two or more identical elements, only the first (top) element is shown in full detail.

5. When shown individually on a schematic rather than as part of an array, basic logic gates (AND, OR, buffer) are shown by distinctive-shape outlines (see Figure A-1).

Qualifier and Functional Labels. FigureA-1 shows qualifiers and functional labels. Qualifiers denote basic logic function. For example, "&" denotes the AND function. Functional labels, such as DEMUX for a demultiplexer, identify complex devices.

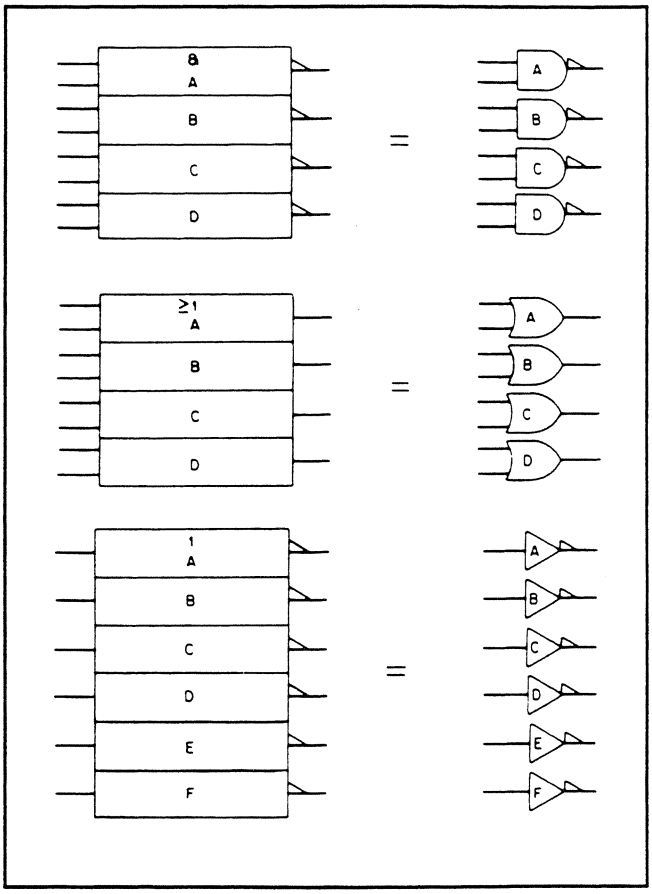


Figure A-1. Distinctive-Shape Outlines

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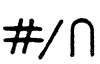
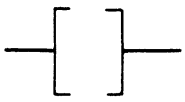
FF	**Flip-Flop** - Binary element with two states, set and reset. When the flip-flop is set, its outputs will be in their active states. When the flip-flop is reset, its outputs will be in their inactive states.
&	**AND** - All inputs must be active for the output to be active.
≥1	**OR** - One or more inputs being active will cause the output to be active.
=1	**EXCLUSIVE OR** - Output will be active when one (and only one) input is active.
1	**Buffer or Inverter** - Without special amplification.
=m	**m and only m** - Output will be active when m (and only m) inputs are active (m is replaced with a number).
=	**Logic Identity** - Output will be active only when all or none of the inputs are active (i.e., when all inputs are identical, output will be active).
	**Amplifier** - The output will be active only when the input is active (can be used with polarity or logic indicator at input or output to signify inversion).
X/Y	**Signal Level Converter or Code Converter** Input level(s) are different than output level(s), or input code (X) is converted to output code (Y) per weighted values or table.
CTR	**Counter** - Produces one output pulse each time it receives a specific number of input pulses.
MUX	**Multiplexer** - The output is dependent only on the selected input.
DEMUX	**Demultiplexer** - Only the selected output is a function of the input.
REG	**Register** - Array of unconnected flip-flops that form a simple register or latch.
SRG*	**Shift Register** - Register in which data can be shifted from one stage to the next, the asterisk indicates the number of stages.
COMP	**Comparator** - The active output indicates which of two or more sets of inputs is of greatest magnitude.
1⎍	**Monstable (One-Shot) Multivibrator** - Output becomes active when the input becomes active. Output remains active (even if the input becomes inactive) for a period of time that is characteristic of the device and/or circuit.
BIN/OCT	**Binary-to-Octal Decoder**- Converts a three-line binary code to eight-line octal code.
HPRI/BIN	**High-Priority-to-Binary Encoder** - Encodes the address of the highest active of eight inputs to three-line binary code.
	**Digital-to-Analog Converter** - Output current is a linear product of a digital word.
RAM	**Random Access Memory** - Addressable memory with read-in and read-out capability.
ROM	**Read Only Memory** - Addressable memory with read-out capability only.
EPROM	**Erasable Programmable Read Only Memory** - Similar to a ROM in normal use, but can be erased and programmed with special equipment.

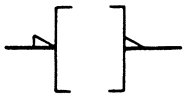
Figure A-2. Qualifiers and Functional Labels

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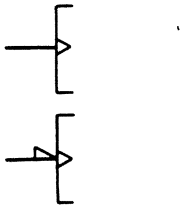
Indicator Symbols. Inidicator symbols identify the active state of a devices input or output, shown in Figure A-3.



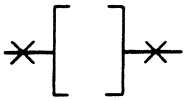
Implied Indicator - Absence of polarity indicator (see below) implies that the active state is a relative high voltage level.



Polarity Indicator - The active state is a relative low voltage level.



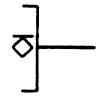
Dynamic Indicator - The active state is a transition from a relative low to a relative high voltage level, or from a high to a low voltage level if a polarity indicator is shown outside symbol.



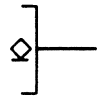
Non-Logic Indicator - Input or output does not carry logic information (e.g. RC inputs to a one-shot multivibrator).



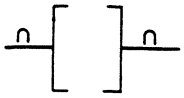
Open-Circuit Output, general symbol.



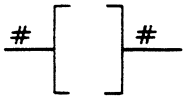
Open-Circuit Output, H Level - NPN open emitter, PNP open collector, P-channel FET open drain, N-channel FET open source.



Open-Circuit Output, L Level - NPN open collector, PNP open emitter, P-channel FET open source, N-channel FET open drain.



Analog Input or Output - Used only when necessary to distinquish analog signals.



Digital Input or Output - Used only when necessary to distinguish digital signals.



Data Input - Always enabled by another input (generally a C input-see Dependency Notation). Any D input is associated with storage.



Shift Right (Down) Input - When active, causes the contents of a shift register to shift to the right or down "m" places (m is replaced with a number).

NOTE

If m = 1, it is omitted.



Postponed Output - Output delayed until input returns to its initial state.



Three-State Output- Indicates outputs that can have a high-impedance (disconnect) state in addition to the normal binary logic states.



Bithreshold Input - Input characterized by hysteresis; one threshold for positive-going signals and a different threshold for negative-going signals.



Greater-Than - Input or Output of a magnitude comparator.

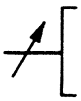


Less-Than - Input or Output of a magnitude comparator.

Equal Input or Output - Of a magnitude comparator.



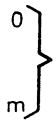
Extension Input or Extender Output - Connected between devices to extend the number of inputs.



Multiplier Input - Analog input used to control a variable characteristic of a function (e.g. range).



Content - Indicates the value of an input or output when active.



Binary Grouping - m is highest power of 2.



Input Line Grouping - Two or more terminals implement a single logic input.

Figure A-3. Input and Output Indicators

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Contiguous Blocks. Two symbols may share a common boundary parallel or perpendicular to the direction of signal flow. Note that in the example shown in Figure A-4 there is generally no logic connection across a horizontal line, but there is always an implied logic connection cross a vertical line. Notable exceptions to this rule are the horizontal lines beneath control blocks and between sections of shift registers and counters.

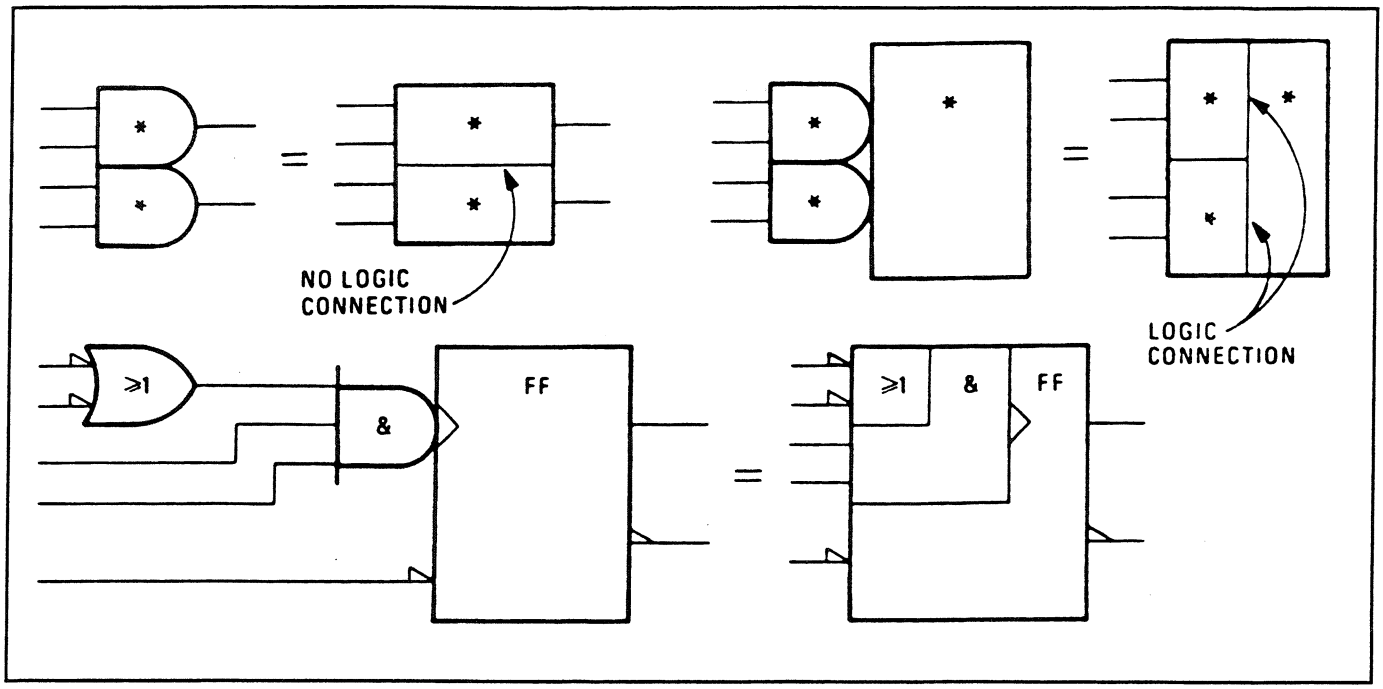


Figure A-4. Contiguous Blocks

Common Control Block. The Control block is used in conjunction with an array of related symbols in order to group common logic lines. Figure A-5 shows how the Control block is usually represented. Figure A-6 shows a quad D-type flip-flop with reset. This can be redrawn as shown in Figure A-7. Note that the more complex representation shown in Figure A-6 can be used when the flip-flops are functionally scattered around the schematic (i.e., not used as a quad unit).

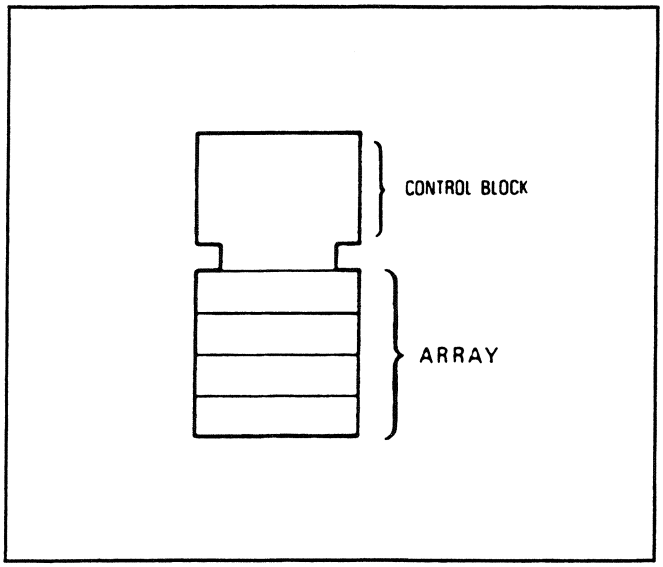


Figure A-5 Common Control Block

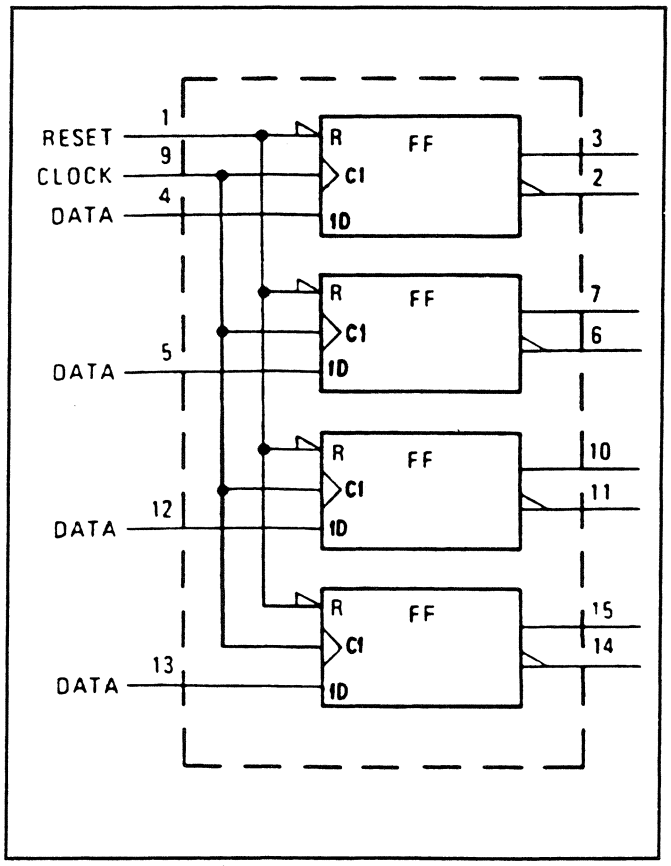


Figure A-6. Quad D-Type Latch (Individual)

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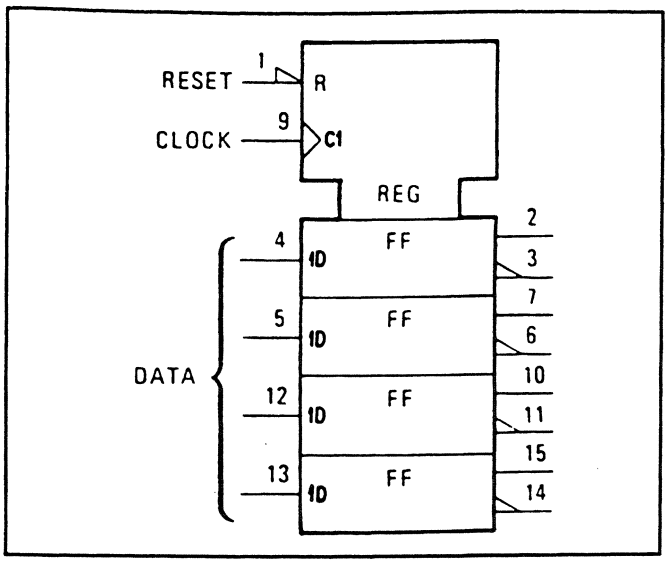


Figure A-7. Quad D-Type Latch (Combined)

Dependency Notation. Dependency notation simplifies symbols for complex integrated circuit elements by defining the interdependencies of inputs or outputs without actually showing all the elements and interconnections involved. (See Figure A-8 and A-9 for examples of AND dependency and enable dependency.)

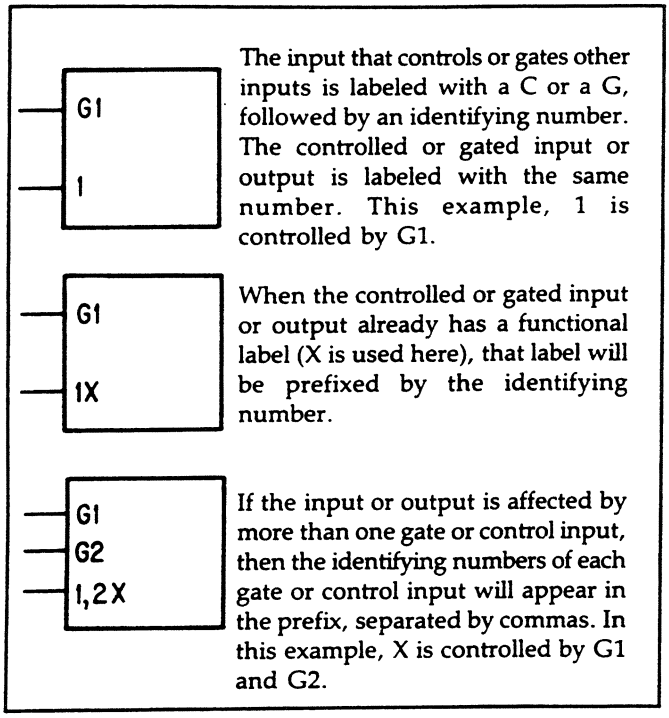


Figure A-8. AND Dependency Notation

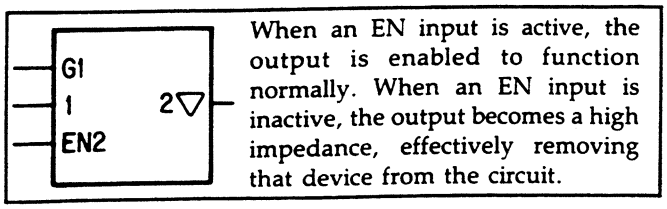


Figure A-9. Enable Dependency Notation

Application of dependency notation is accomplished by:

1. labelling the input affecting other inputs or outputs with the letter symbol denoting the relationship involved followed by an appropriately chosen identifying number, and
2. labelling each input or output affected by the affecting input with that same number.

If it is the complement of the internal logic state of the affecting input or output that does the affecting, a bar is placed over the identifying number at the affected input or output.

If the affected input or output requires a label to denote its function, this label shall be prefixed by the identifying number of the affecting input.

If an input or output is affected by more than one affecting input, the identifying numbers of each of the affecting inputs shall appear in the label of the affected one separated by commas. The left-to-right reading order of these identifying numbers is the same as the sequence of the affecting relationships.

Two affecting inputs labelled with different letters shall not have the same identifying number, unless one of the letters is A.

If two affecting inputs have the same letter and the same identifying number they stand in an OR relationship to each other.

If the labels denoting the functions of affecting inputs or outputs must be numbers (e.g., outputs of a coder), the identifying numbers to be associated with both affecting inputs and affected input or outputs shall be replaced by another character selected to avoid ambiguity (e.g., Greek letters).

An affecting input affects only the corresponding affected inputs and outputs of the symbol.

Note that dependency notation is usually indicated by numbers. The numbers themselves have no value; they simply relate two or more points having the same number. However, sometimes an input or output has a weighted value (e.g., 1,2,4,8); in these cases a non-numeric symbol (e.g., ∝) may be used to avoid confusion between a weighted value and the dependency notation.

Eleven types of dependencies are listed below:

A **Address** - Identifies the address inputs of a memory.

C **Control** - Identifies an input, such as a timing or clock input, that produces action, and indicates which other inputs are controlled by it. Used for sequential elements (flip-flops, registers), and may imply more than a simple AND relationship.

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EN **Enable** - Identifies an input that enables outputs, and indicates which outputs are affected by it. Acts as a connect switch when active, and a disconnect switch when inactive.

G **Gate (AND)** - Identifies an input having an AND relationship with other inputs or outputs having the same identifier number (or symbol).

M **Mode** - Identifies an input that selects the mode of operation, and indicates which inputs and outputs depend on that mode.

N **Negate** - Identifies an input that when active, complements other inputs or outputs, and identifies which inputs and outputs are affected.

R **Reset** - When active, causes a flip-flop to reset.

S **Set** - When active, causes a flip-flop to reset.

V **OR** - Identifies an input having an OR relationship with other inputs or outputs having the same identifier number (or symbol).

X **Transmission** - Identifies an input that makes or breaks bidirectional connections between affected input/output ports.

Z **Interconnection** - Identifies a point that is internally connected to another input, output, internal input, or internal output having the same identifier number (or symbol).

Miscellaneous Terms and Symbols. Figure A-10 shows miscellaneous terms and symbols that are used in conjunction with the logic symbols, function tables, and truth tables used in this section.

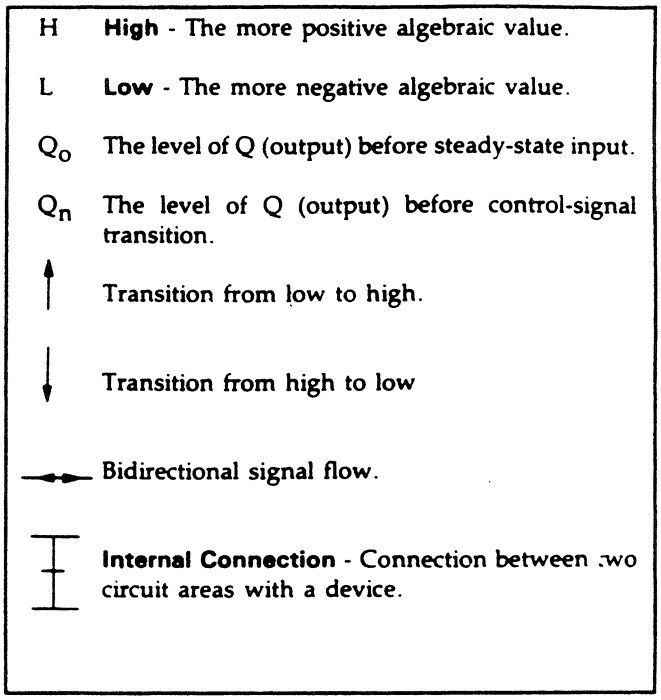


Figure A-10. Miscellaneous Terms and Symbols

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