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SERVICE MANUAL

MULTIPLE OUTPUT LINEAR SYSTEM DC POWER SUPPLY AGILENT MODELS 6625A, 6626A, 6628A, and 6629A

Agilent Part No 06626-90003

Agilent Model 6625A, Serial 3738A-01389 through 01408
US37380101 and up

Agilent Model 6626A, Serial 3737A-02259 through 02328
US37370101 and up

Agilent Model 6628A, Serial 3738A-00683 through 00727
US37380101 and up

Agilent Model 6629A, Serial 3738A-00968 through 00997
US37380101 and up

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



Agilent Technologies

Microfiche Part No. 06626-90004 **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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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.

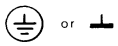
SAFETY SYMBOLS.



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).

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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. 06626-90001.

Wherever applicable, the service instructions given in this manual refer to pertinent information provided in the Operating Manual. The information in each manual covers model 6625A, 6626A, 6628A, and 6629A. 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 662xA (Agilent P/N 5957-6372).

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 Techonologies 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 week, and "A" designates the U.S.A. The second part of the serial number is a different sequential number assigned to each instrument.

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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 that is supplied with the manual add/or manual backdating changes in Appendix A of this manual define 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.

The serial number prefixes listed on the front of this manual indicate the versions of the supplies that were available when the manual was issued. If the serial prefix of your supply is not listed in this manual, the manual may include a yellow "Manual Changes" sheet. That sheet updates this manual by defining any differences between the version of your supply and the versions included here, and may also include information for correcting any manual errors. Note that because not all changes to the product require changes to the manual, there may be no update information required for your version of the supply.

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 supplies. 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. 06626-90001).

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 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; a4 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 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 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 and 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

The Agilent 6625A and 6628A contain two output boards and the Agilent 6626A and 6629A contain 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.

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

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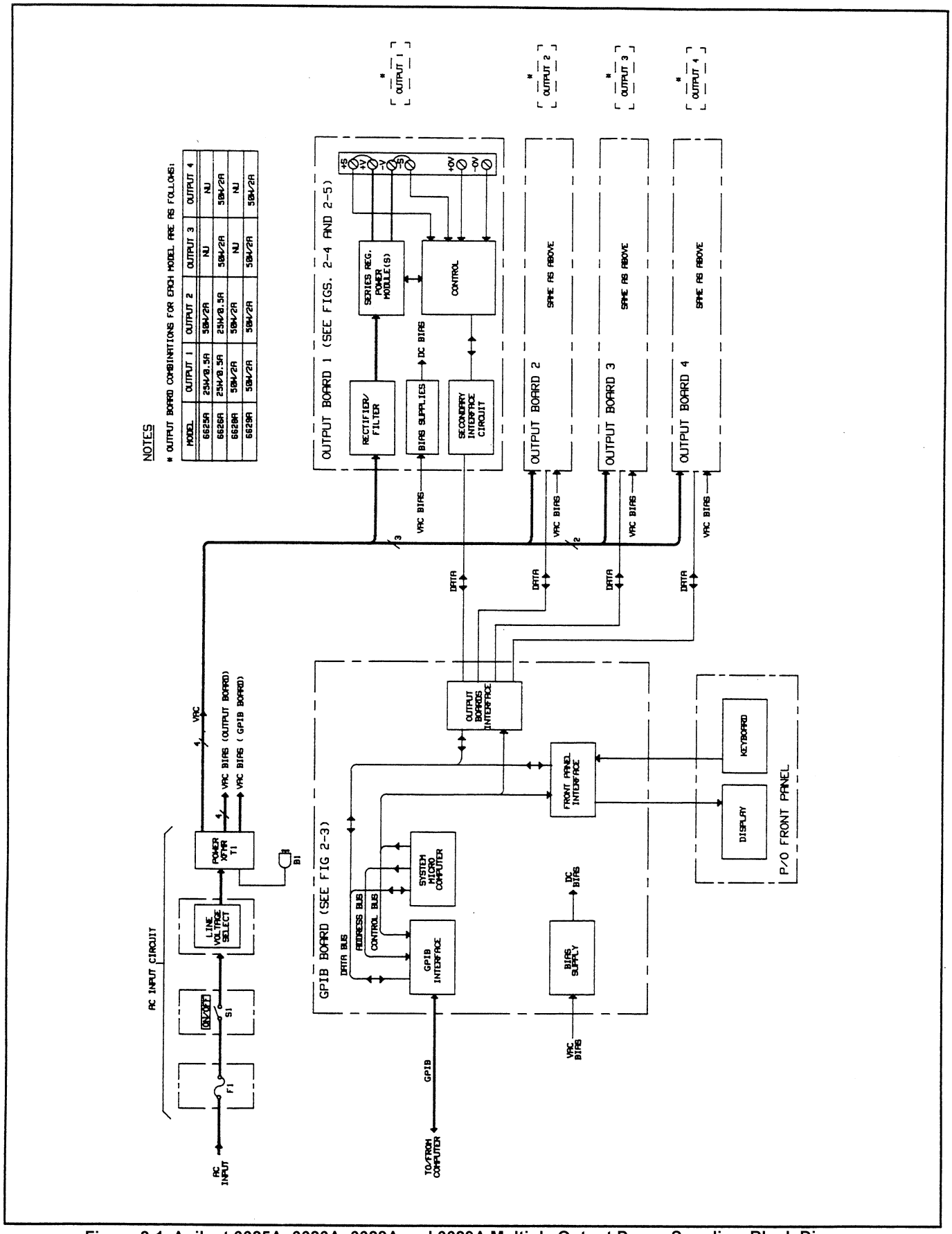


Figure 2-1. Agilent 6625A. 6626A, 6628A and 6629A Multiple Output Power Supplies, Block Diagram

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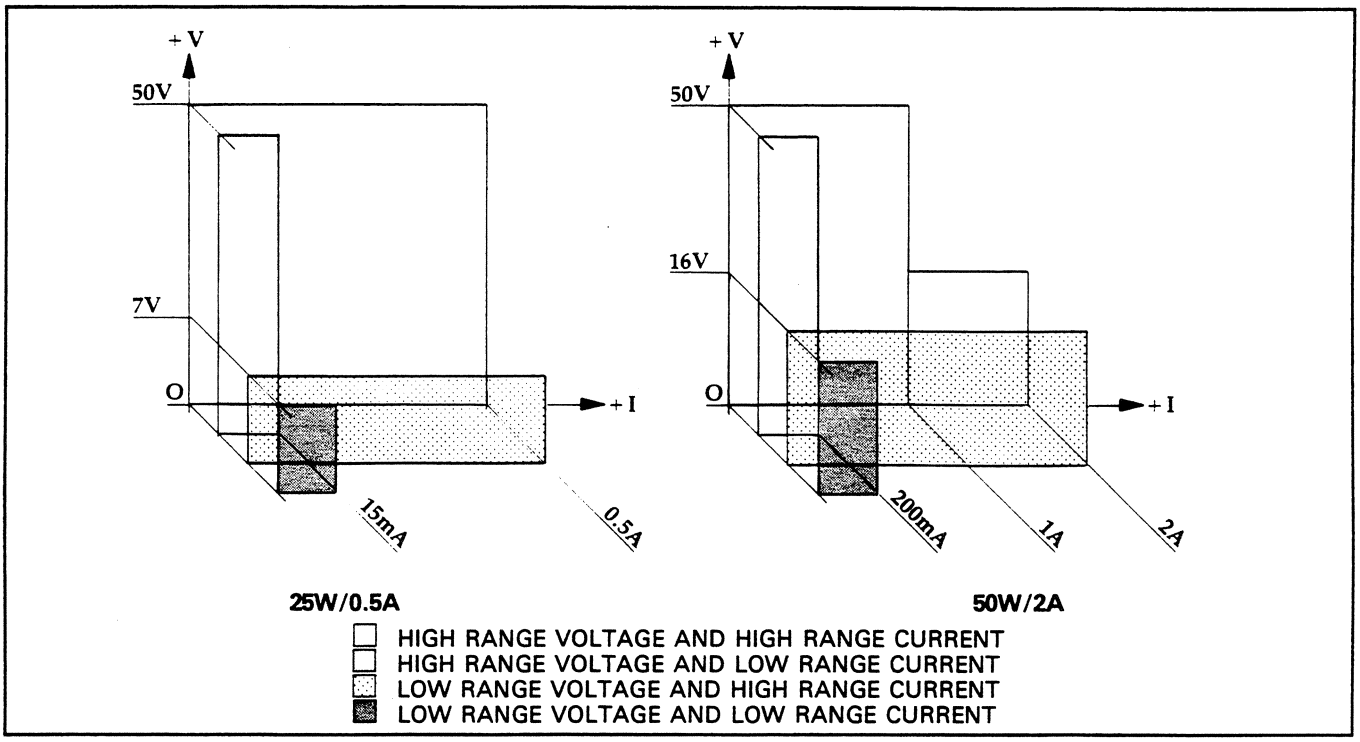


Figure 2-2. Output Operating Ranges for Agilent Models 6625A, 6626A, 6628A, and 6629A

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 slightly 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 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 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 (DIO1-DIO8) of the GPIB are reserved 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 (DIO1-DIO8). 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 other circuit.

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 form 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 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 though 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 32KK 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 board interface block of Figure 2-3, is the EEPROM (electrically erasable programmable memory). The EEPROM (U230) 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 optoisolators 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 art of the opto-isolators on the output boards. In addition to interfacing with the output boards, the latches/buffers interface with the 4 K bit serial EEPROM 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 appears on data bus lines D0-D3, respectively, and EEPROM

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serial output data appears on data bus line D7. Logic 0's will always appear on data bus lines D4-D6 when $\overline{CS3}$ is decoded because these buffer inputs are connected to COMMON. All buffer output are held in the high impedance state when $\overline{CS3}$ is not decoded.

2-18 Data Latches. These stages (U213) are edge-triggered D-type flip-flops. On the rising edge of the $\overline{CS2}$ 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 line D0-D3 are the serial data input lines for output boards 1-4, respectively. Data bus line D4 controls the $\overline{\text{TIMER ENABLE}}$ 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 4 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 (U230) is nonvolatile 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 data is read into RAM in the system microcomputer via data bus line D7.

The EEPROM's 4096 bits of read/write memory are divided into 2 pages of 8 X 256 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 a write cycle. The CHIP SELECT and CLOCK signals are use by the microprocessor to control the EEPROM's programming modes. AT power on, the EEPROM 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 panes (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 update/refresh the display.

Data bus line 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 $\overline{CS4}$ is decoded. As stated above, the microprocessor will use this information to determine which key was pressed. In addition buffers provide the following data on bus lines D0-D3 when $\overline{CS4}$ 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 0 indicates Remote Inhibit is true (OPTION 750).

D3 - A logic 1 indicates OPTION 750 is installed in power supply.

All buffer outputs are held in the high impedance state disconnecting it from the data bus when $\overline{CS4}$ 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 $\overline{PCLR}$ (power clear) and EEPON (EEPROM power on) signals when power is turned on. The $\overline{PCLR}$ signal is held low at power on to initialize the talker/listener and microprocessor chips. The EEPON signal is held low at power onto 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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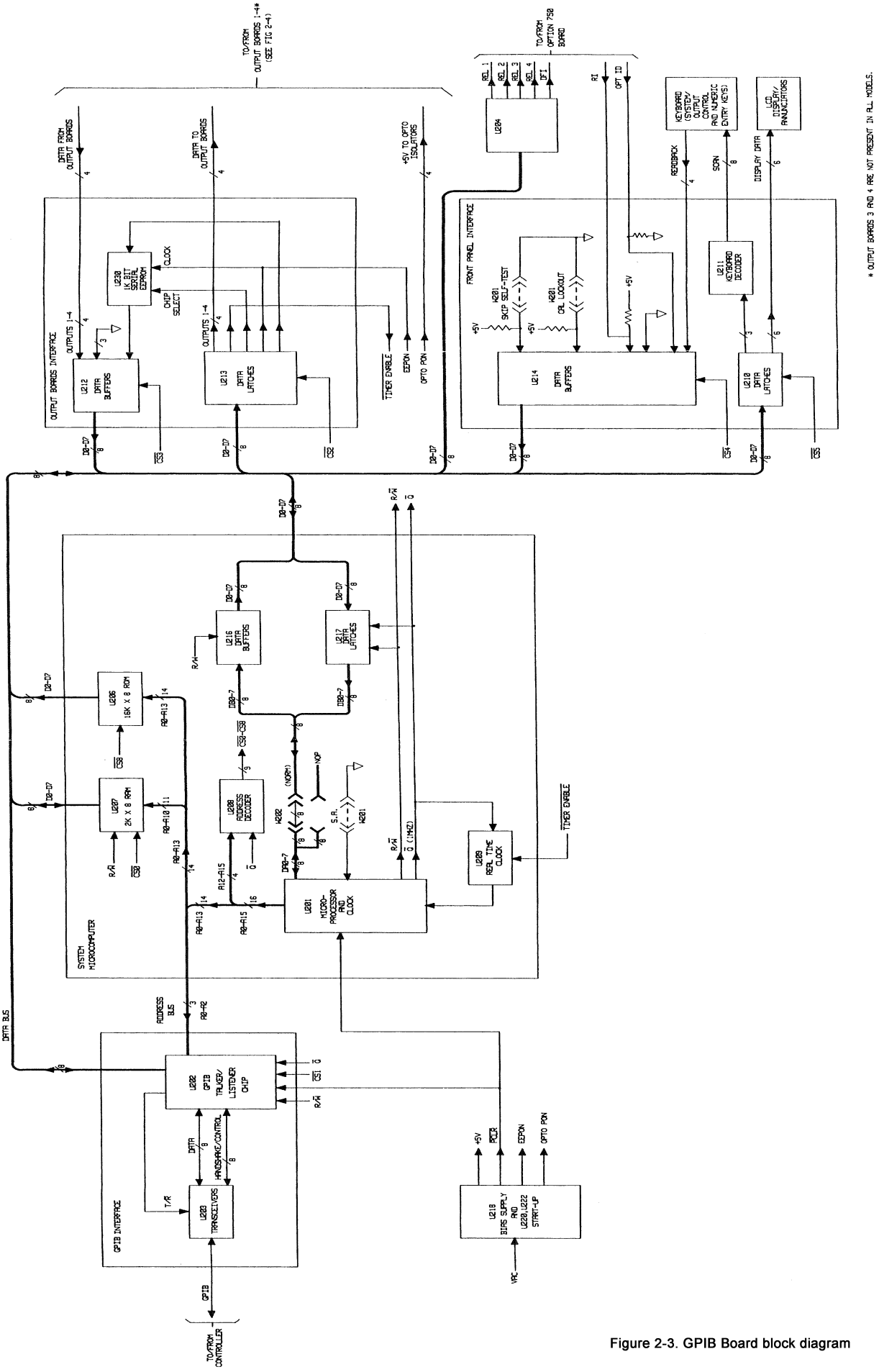


Figure 2-3. GPIB Board block diagram

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2-24 OUTPUT BOARD

The following paragraphs provide block diagram level descriptions of the output board. The descriptions cover the two output board types. Differences between the board types are given as required. Figure 2-1 shows which output board types are used in the power supplies.
The descriptions that follow are divided into two main block diagram discussions: Secondary Interface Circuits 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 bi-directional data bus to program DACs which control the output voltage, output current, overvoltage setting, and sets the readback DAC. 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 readback monitor switches (U365, U366, and U368) analog multiplexer (U323) and DAC (U321) to perform a successive 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 ($\overline{CS0}$ – $\overline{CS6}$) 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. $\overline{CS1}$-$\overline{CS4}$ determine which DAC will receive data. $\overline{CS1}$ selects the 14-bit CV (Constant Voltage) DAC, $\overline{CS2}$ selects the 14-bit CC (Constant Current) DAC, $\overline{CS3}$ selects the 14-bit Readback DAC and $\overline{CS4}$ selects the 8-bit OV (Over Voltage) DAC. $\overline{C55}$ selects the programming latches (U367), and $\overline{CS6}$ selects the readback monitor switches (U365, U366, and U368). The digital inputs (D0 – D7) to the DAC's are derived from the GPIB controller or from the front panel depending upon whether the supply is in the remote or local mode.

2-28 CV DAC. The 14-bit CV DAC (U313) and amplifier (U360) convert the digital input signal from D0 –D7 supplied through latches (U369) into an analog signal (CV PROG) in the range of 0 to – 10 Volts. This output signal is used as a reference voltage and is send to the voltage control circuits (see paragraph 2-46) to set the output voltage to the programmed value.

The most significant bits (MSB's) are loaded into the input register of U313 from the data bus when: address line A3 goes high, address line A4 goes low, and $\overline{CS1}$ goes low. The least significant bits (LSB's) are loaded into the input register of U313 from the data bus when: address line A3 goes low, address line A4 goes high, and $\overline{CS1}$ goes low. The data in the input register in transferred to the DAC of U313 when: address line A3 is high, address line A34 is high, and $\overline{CS1}$ is low.

CV PROG is also sent to the analog multiplexer so that it can be measured during power on self test.

U369 and U370 provide isolation between the 8-bit data bus and the CV/CC DAC's. This isolation assures that signals on the data bus will not be capacitively coupled through the CV and CC DAC's as noise.

2-29 CC DAC. The 14-bit CC DAC (U314) and amplifier (U361) convert the digital input signals in a similar manner as the CV DAC into a analog signal (CC PROG) in the range of 0 to - 10 Volts. This signal is used as a reference voltage and is sent to the current control circuits (see paragraph 2-47) to set output current to the programmed value.

The most significant bits (MSB's) are loaded into the input register of U313 from the data bus when: address line A3 goes high, address line A4 goes low, and $\overline{CS1}$ goes low. The least significant bits (LSB's) are loaded into the input register of U313 from the data bus when: address line A3 goes low, address line A4 goes high, and CS2 goes low.

This data in the input register is transferred to the DAC of U314 when: address line A3 is high, address line A4 is high and $\overline{CS2}$ is low. CC PROG signal is also sent to the analog multiplexer (U323) seo that it can be measured during power on self test.

2-30 OV DAC. The 8-bit OV DAC (U363) and amplifier (U319) convert the digital input into an analog signal (OV DAC) in the range of 0 to – 10 Volts. This signal is compared with the output voltage exceeds the programmed OV setpoint (see paragraph 2-44).

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The OV signals is also sent to the analog multiplexer so that it can be measured during power on self test.

2-31 Readback Amplifier and Analog Multiplexer. The analog multiplexer (U323) selects one of eight inputs (value of these inputs are from 0 to 10 Volts) to be applied to the readback signal comparator (U324) for the A-to-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)
VFS - Readback amp output (U315A)
V/I MUX - Range amp output (U315C)
CV DAC - voltage DAC output
CC DAC - current DAC output
OV DAC - overvoltage DAC output

U315C can be configured as an inverting or non-inverting amplifier. Swiches (U365) determine it's configuration as well as the input to amplify. U366 is use to determine the gain of the amplifier.

U315B is used as a buffer. For current readback, inputs from the 4 terminal shunt resistor R408 are select via U365. For voltage readback low range, U366 (D) is used as the input to U315C.

2-32 Readback DAC and Signal Comparator. The readback DAC (U321), amplifier (U362), readback signal comparator (U324), and analog multiplexer (U323) along with the microcomputer (U312) form an analog-to-digital converter (ADC) which monitors the output board signals sent to the analog multiplexer.

The readback DAC (U321) and amplifier U362 convert the digital input signal from the microcomputer to an analog signal in the range of 0 to – 10 volts. The DAC internally formulates the 14-bit DAC data from the 8-bit (DB0-DB7) data bus (same as the CV DAC described above).

The output of the DAC and the output of the analog multiplexer are applied to the signal comarator U324. The readback DAC, under the control of the microcomputer, successively approximates the value of the multiplexer's output to a 14-bit resolution,. Starting from the most significant bit, each bit is successively compare to the multiplexer's output and is kept or discarded depending on whether its value is less than (kept) or greater than (discarded) the multiplexer's output.

Each comparison (successive approximation) is evaluated by the microprocessor via its INT input. The microcomputer maintains a running total of the approximations (sum of the kept bits) which, when complete, represents the value of the analog multiplexer's output.

2-33 CV and CC Programming Range Switching. U367, U364, and resistor pack U381 determine the attenuation factor for the CV and CC signals. Programming range latchU367 receives information via the data bus (DO0 and DO1), which determines if the power supply will operate in the low or high voltage and current ranges. Using this information, U367 sets analog switches U364 for the proper divider tap for the desired range (full DAC output O to – 10 V for high range, or a portion of the 10 V for the low range).

2-34 Readback Range Switching. U365, U366, and U368 provide readback of the output of the power supply to the analog multiplexer (U323), except for the 50 V range (VFS). Readback latch U368 receives information via data lines DO0 and DO1 which set up monitor switches U365 and gain select switches U366 to readback the output parameters.

2-35 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 line, 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 $\overline{\text{CVO}}$, + $\overline{\text{CLO}}$, - $\overline{\text{CLO}}$, and $\overline{\text{UNREG}}$ outputs. $\overline{\text{UNREG}}$ 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 $\overline{\text{OV SENSE}}$ and $\overline{\text{THERM}}$ inputs. The $\overline{\text{THERM}}$ 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 $\overline{\text{OV SENSE}}$ 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 $\overline{\text{THERM}}$ and $\overline{\text{OV SENSE}}$ 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 ($\overline{\text{CVO}}$, $\overline{\text{CLO}}$, - $\overline{\text{CLO}}$, OV, OT, and $\overline{\text{UNREG}}$ are returned to the microcomputer via data bus lines D0-D5 when chip select $\overline{\text{CS0}}$ is decoded.

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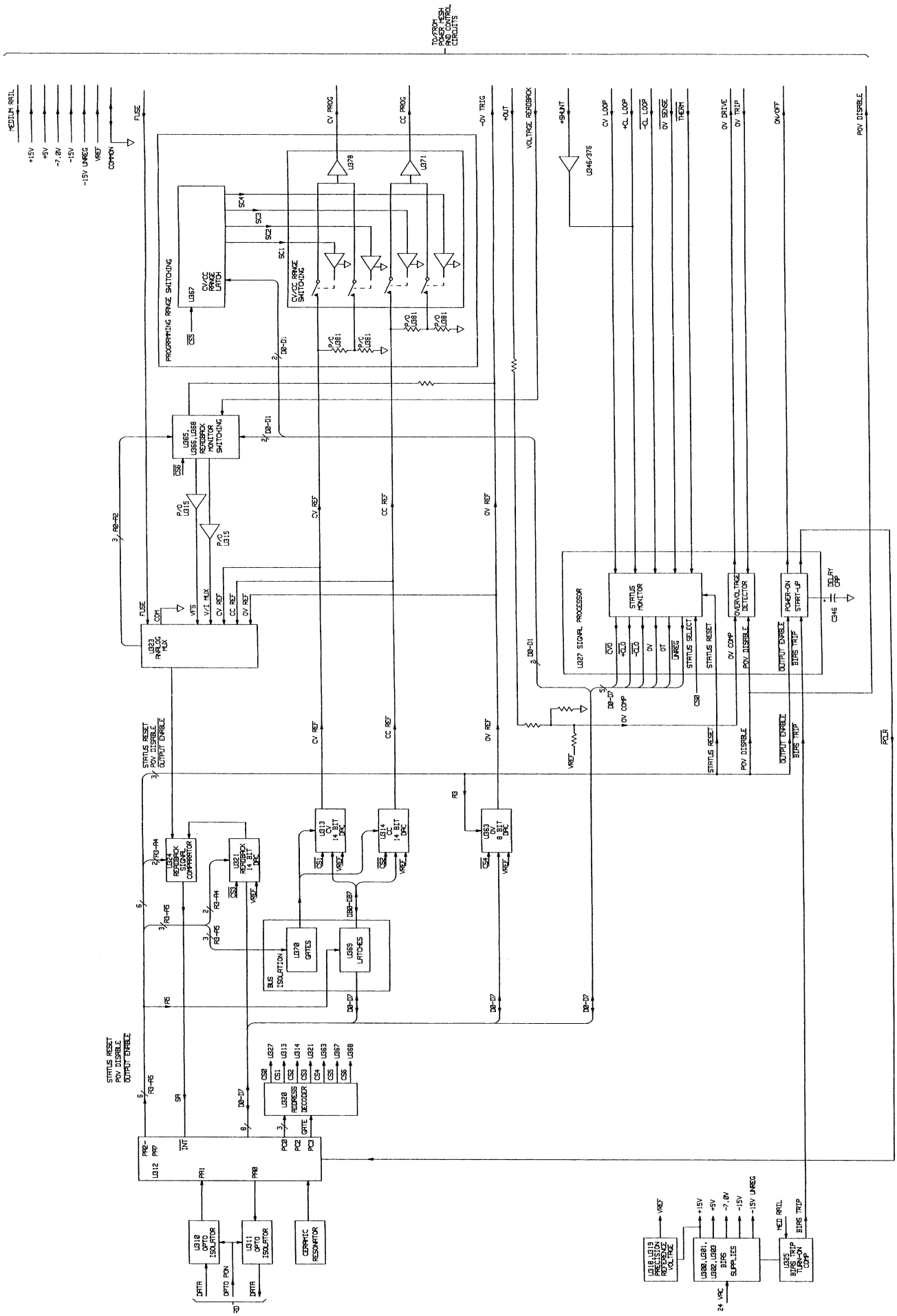


Figure 2-4. Output Board, Secondary Interface Circuits, Block Diagram

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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 PROG). 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 10 V (applies to remote sensing only).

3. A trip signal is received on the output's OV terminal.

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 initialization routine and set the OUTPUT ENABLE line low. This allows the ON/OFF signal to go high (+ 2.4 V) enabling the control circuit and current sources which allow power to reach the output terminals. Note that whenever the OUTPUT ENABLE signal 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.

2-36 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/C) operates from the + 15 V bias and generates the VREF outputs (10 V ± 0.5%) which are used by the DAC's and the control circuit.

2-37 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 (U338). 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.

2-38 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 o 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).

2-39 Power-On Circuit and Current Sources. The power-on circuit (Q318 and Q319) is used to turn on the current source transistors and the bleed circuit (see paragraph 2-43) which is connected across the output of the supply. The power –on circuit is activated when it receives the ON/OFF signal (2.4 V level) from the signal processor (U327).

The current sources U336) 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, in conjunction with the – DRIVE signal (see BASE DRIVE CIRCUIT description below), control the conduction of the series pass elements and shunt (- CL) in the power module.

2-40 Power Module Reference Voltage. When the current sources have been turned on, this circuit (P/O U340 and U337) provides a reference voltage (about 2 V 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 sources apply power, a programmable reference (U337) which provides the reference voltage, and bypass capacitors C366 and C367.

2-41 Power Module. The power module hybrid U338 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.

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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 described 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 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 down programming the output voltage to about 2 V. An external FET down programmer circuit (see paragraph 2-49), 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.

2-42 Peak Current Limit. This circuit Q321, Q322, R407, P/0 U340, 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). When the voltage across R407 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 2-47).

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 (U376) will be quickly activated through P/O U340, CR341, U376 and R405 to take control of the current limiting action.

2-43 Bleed Circuit. This circuit (Q341, R456, etc.), connected from + V to - 7 V, provides a fixed current of about 15 mA 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.

2-44 Sense Protect Circuit. This circuit (P/O U375 and P/O U351) monitors the voltage from + V to + S and from - S to - V. If either of these voltages exceeds 1.0 V, the sense protect circuit will generate a signal which will fire the overvoltage protection circuits and shut down the output (see paragraph 2-50). This circuit prevents the output voltage from being regulated at a value higher than the maximum value for which it was designed.

2-45 Base Drive Circuit. When activated (ON/ OFF is at approximately 2.4 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).

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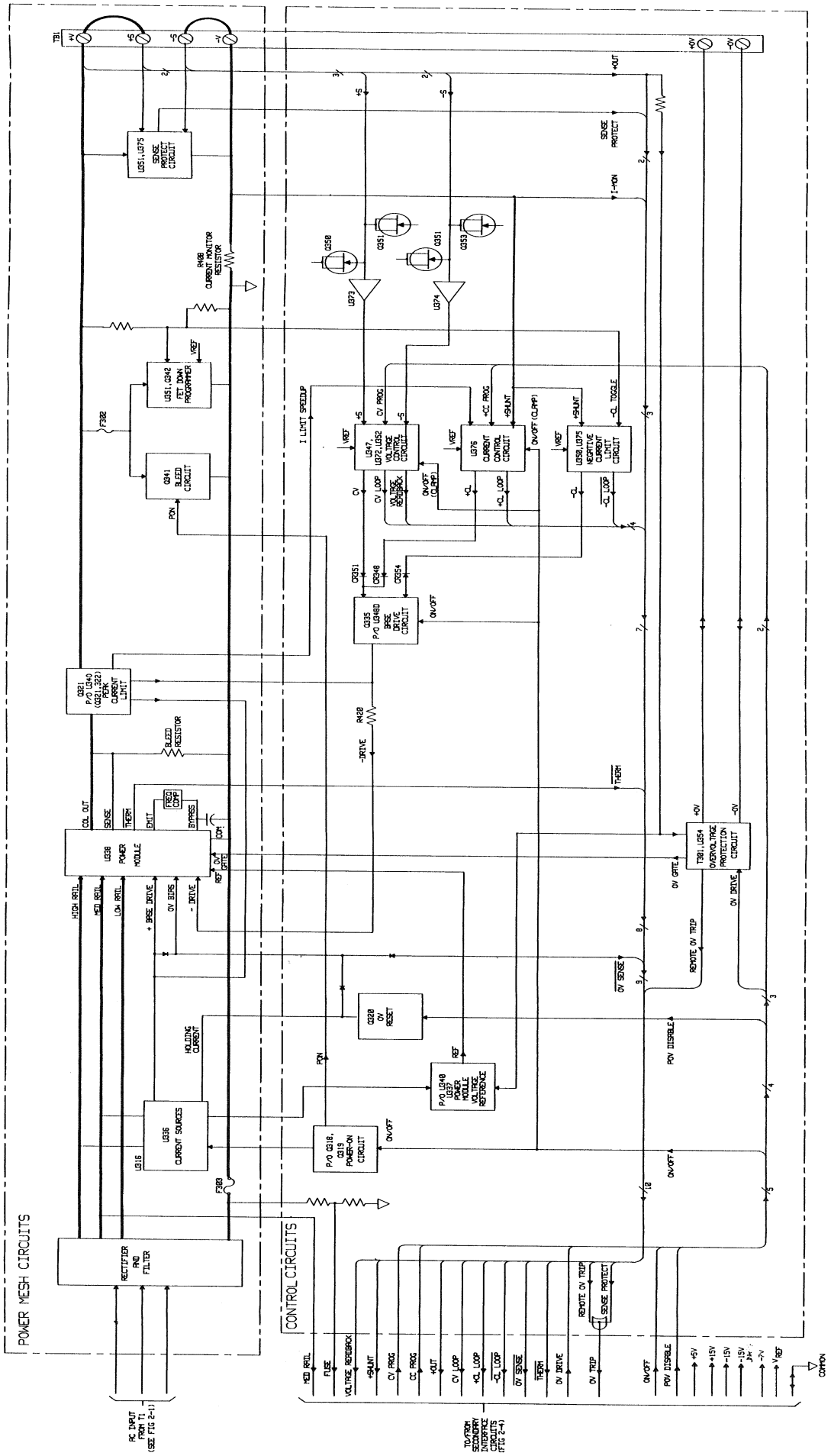


Figure 2-5. Output Board, Power Mesh and Control Circuits, Block Diagram

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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 (VV) circuit and the current control (+CL) circuit is described in paragraphs 2-46 and 2-47, 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 2-48. The maximum – Base Drive is reached when the drop across R428 reaches. 6 volts, turning on part of U348 which limits the base drive to Q335.

2-46 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

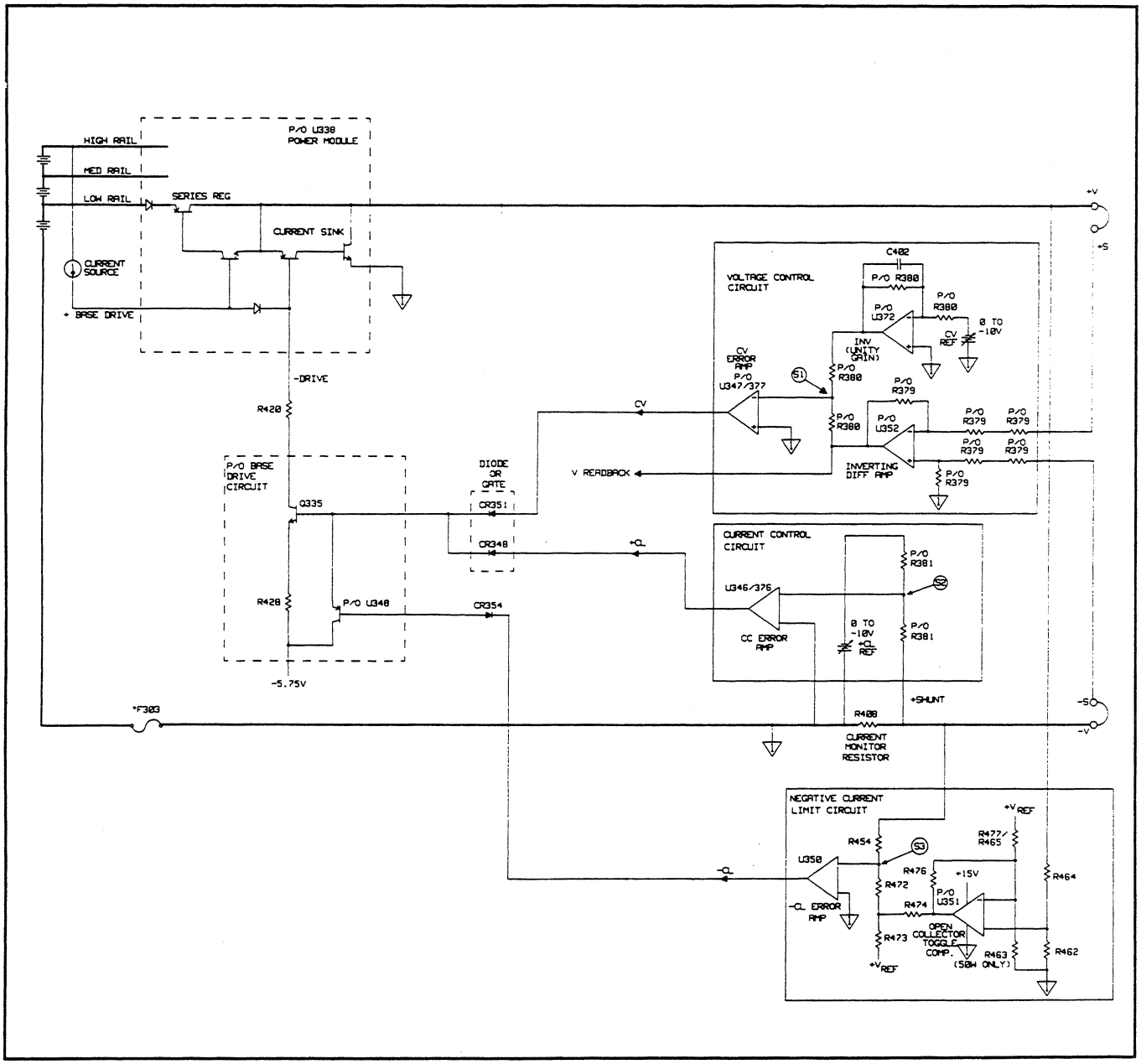


Figure 2-6. Voltage and Current Control Circuits, Simplified Schematic Diagram

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LOOP signal is sent back to the secondary interface circuit to indicate that the output is in the constant voltage mode of operation. The voltage control circuit compares the output voltage to the programmable reference voltage CV PROG 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 buffer (U378 and inverter amplifier U372), output sence buffer U373 (who used for – 5 guard), inverting differential amplifier U352A, and CV error amplifier U347. The reference voltage (CV PROG, 0 to –10 V) is applied to U372 which produces a 0 to + 10 V signal feeding into the summing junction S1 (U347-2). 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 goes negative, causing U347/U377 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 module's + 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.

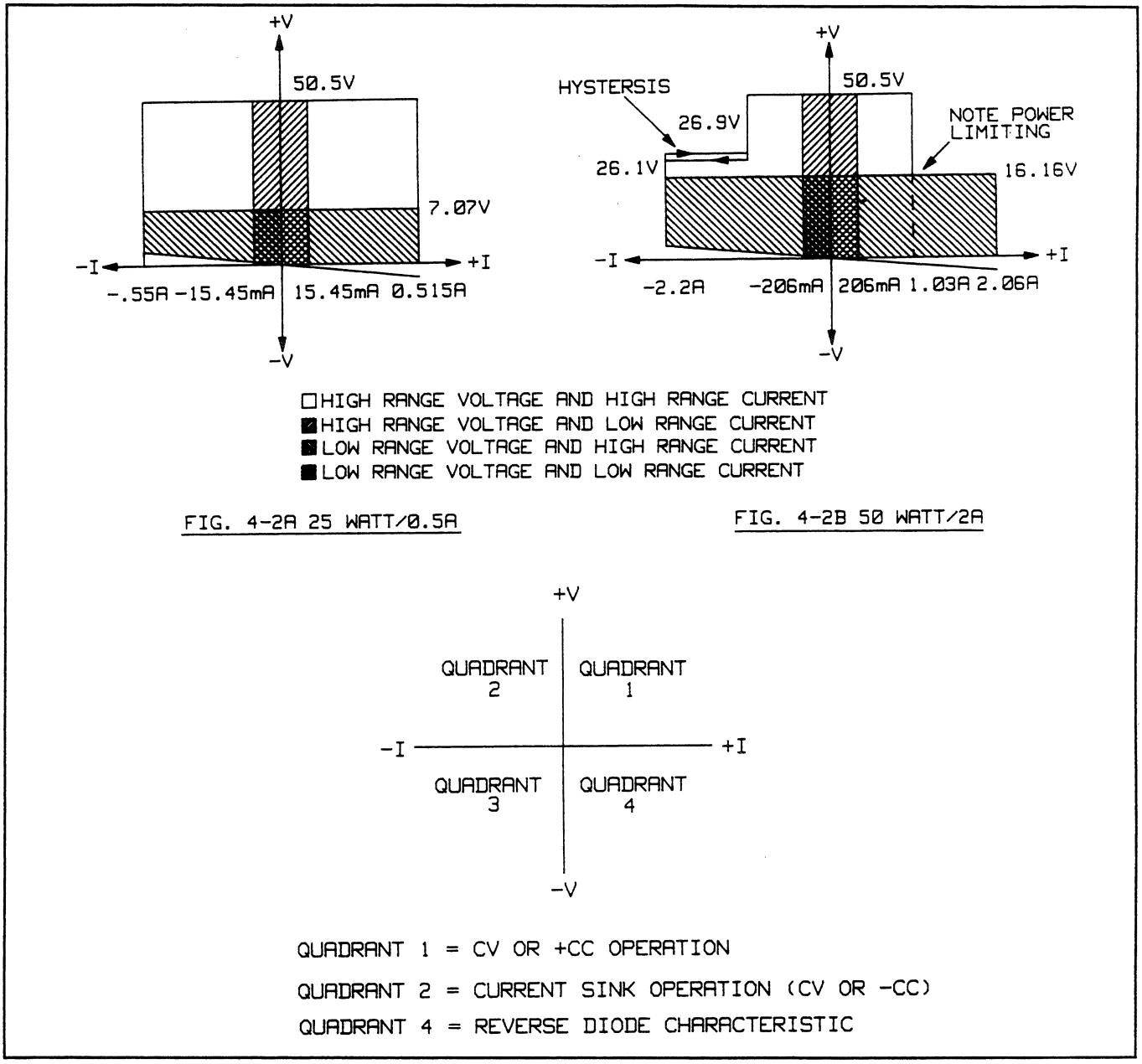


Figure 2-7. Typical Output Range Characteristics

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If the output voltage is less than the programmed voltage ,the junction goes positive causing U347/377 to produce a negative going CV control signal . For this condition ,the base drive circuit will conduct less allowing more current to flow into the +BASE DRIVE input. This will cause the power module' s series regulator to conduct more and thus increase the output voltage.

2-47 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 applies 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 circuit to indicate that the output is in the constant current mode of operation.

The current control circuit compares the output current to a programmable reference voltage (CC PROG). This comparison produces the + CL control signal. In order to make this comparison, the circuit monitors the voltage (+ SHUNT) across current monitoring resistor R408. This voltage drop is proportional to the amount of output current. The +SHUNT and +CL PROG signal are connected through scaling resistors to summing point S2 for application to U346 (CC Error Amplifier) as show in figure 2-6. Based on this summing action, U346 generates the +CL control signal which is applied to the base drive circuit via buffer amplifier U376 and 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 +SHUNT signal is also sent back to the secondary interface to indicate the magnitude of the output current.

The current control circuit receives an input from peak current limit circuit (in the current sourcing mode only) as shown in figure 2-5. When the peak current limit circuit (see paragraph 2-42) is activated, it immediately limit the conduction of the series regulators in the power module.

2-48 Negative Current Limit Circuit. This circuit provides a limit to the amount of current that the supply can sink. The circuit may be activates, if a current source such as another power supply (or energy storage capacitor) is connected across the output terminals and its voltage is greater that the programmed output voltage.

When the output is in negative current limit, this circuit generates the – CL control and the – $\overline{\text{CL LOOP}}$ signal. 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 an open collector toggle comparator (part of U351) and –CL error amplifier (U350).

U375 acts as a clamp to ensure the –CL Summing junction (S3) does not exceed +10mV.

The voltage drop (+SHUNT-which is a negative voltage when sinking current) 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.

For the 50W outputs, comparator U351 toggles the reference voltage between the 1.1 and 2.2 Amp range levels. This is required because the output board has two fixed ranges (a high voltage/low current and a low voltage /high current). As you can see in Fig.2-7, a 50W output can sink up to 2.2A when its output is below 26V, and up to 1.1 A when its output is approximately 26V.

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 of –1.1A. If the output voltage is in the low range, the collector output of U351 will be 15V, resulting in a higher sink current limit (about –2.2A). R476 provides a small amount of positive feedback (hysteresis) to prevent "jitter" at the switch point

2-49 FET Downprogrammer. When the output voltage drops below approximately 4V (approximately 2 volts for the 50W outputs), the Down Programming circuit comes on (current sinking characteristics are shown in Figure 2-8). The FET Downprogrammer circuit (part of U351A/Q342,R456), is connected across the output. Divider R464/R462 senses when the output falls below 4 Volts (approximately 2V for the 50W outputs). This turns on U351A and FET Q342 and connects R457 across the output to aid downprogramming.

Notice in Figure 2-8 on the 25W/.5A graph, the 15 ohm slope {approximate} (11 ohms for the 50W/2S outputs), is due to the resistor R457 in series with FET Q342 and the – 0.01 Amps at VOUT equals zero volts, represents the bleed current in Q341.

2-50 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) and divider (R357/R359) that compares the OV DAC signal to the output voltage, signal processor U327, diodes CR356-CR360, and pulse transformer (T301) that couples 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 in 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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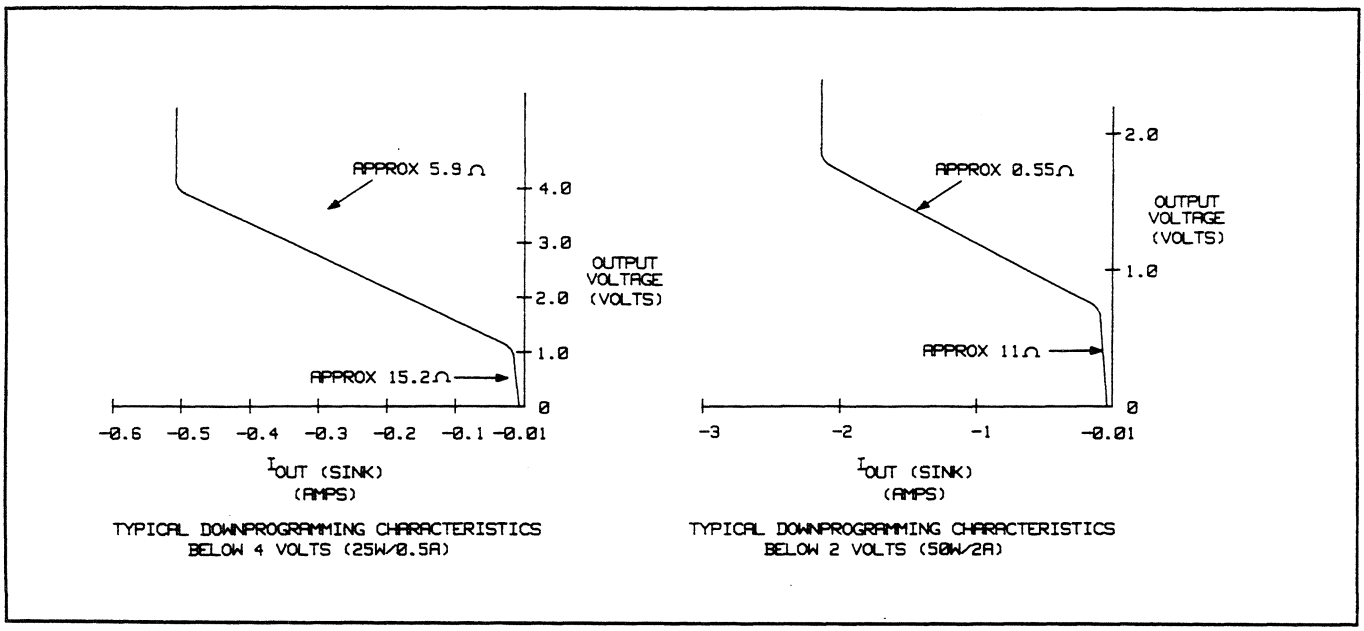


Figure 2-8. Typical Downprogramming Characteristic Below 2.0 V

If the output voltage from +V (R359) exceeds the programmed overvoltage setting (derived from OV REF through R357), the overvoltage comparator signal (OV COMP) goes positive and activates the OV DRIVE and will fire the SCR provided that the POV DISALE 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 gate and can be activated by either the SENSE PROTECT signal (as described in paragraph 2-44) 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.

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.

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 and shut down the supply.

2-51 Guard Bands. Guard Bands are employed on the + Shunt track, the – Sense track, and Common track (pin 3 of R408) on the PC board. The guard bands shield these traces ensuring they are not affected by DC leakage currents from adjacent tracks.

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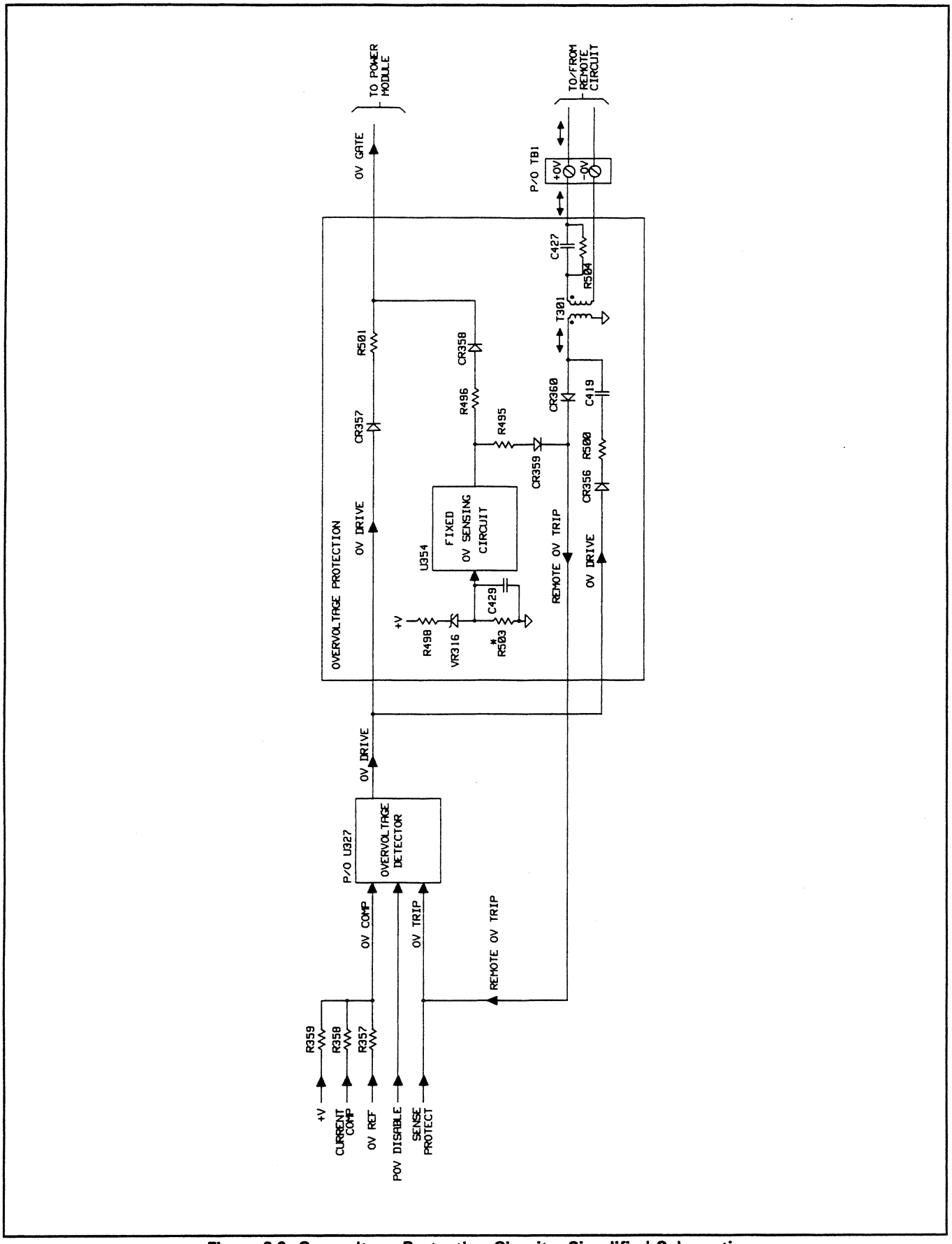


Figure 2-9. Overvoltage Protection Circuits, Simplified Schematic

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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 verity 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. 06626-90001).

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.

NOTE

For mechanical reasons, there are two different assemblies for the 50W/2A output boards When ordering replacement output boards, determine the appropriate assembly number from "Chassis Boards" section of Table 5-5. Note that the replaceable parts on both 50W/2A assemblies are the same (see Tale 5-7).

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 GP IB. An Agilent Series 200 or 300 computer is used as the GP IB 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 of these tests, the output of the supply being tested may 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, paragraphs 3-3 thru 3-9, 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 3-18)
Current Programming and Readback Accuracy (paragraph 3-21)
CC Load Effect (paragraph 3-23)

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 1-2 of the Operating manual. The procedures cover all models 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.

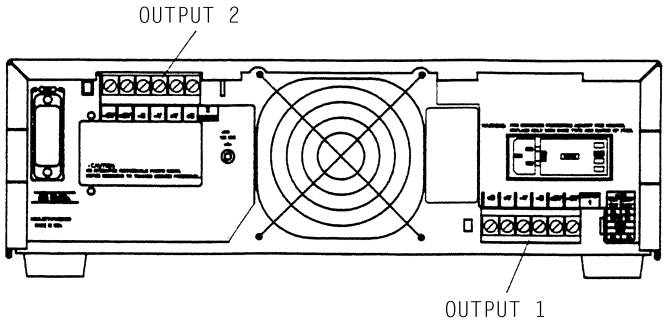
The test procedures that follow give settings and results for each type of output that may be tested. There are two types of outputs: 25 Watt and 50 Watt. Make sure that you use the test settings and results listed for the particular output

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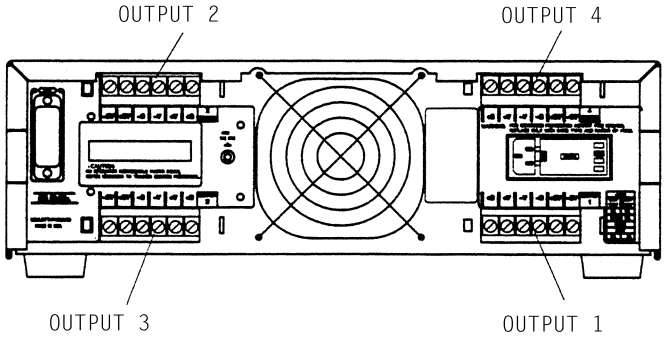
Table 3-1. Test Equipment Required for Verification

Type	Required Characteristics	Recommended Model
GPIB Controller	Full GPIB capabilities	Agilent 9825, 85 or series 200/300 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	Rhode and Schwarz Model URE or 3400A
Digital Voltmeter	DVC Resolution: 1μV @ .2 V 100 μV @ 50 V Accuracy: 13PPM @ .2 V DCA Resolution: 100 mA @ 500 mA Accuracy: 140PPM @ 500 mA @ 1/2 digit	Agilent 3458A
Current Monitor Resistor	Value: 0.1 ohm, 2 amp Accuracy: .005% or better	GUIDLINE 9330/0.1/Agilent L&N 4221-B
Resistor (Figures 3-4 and 3-5)	2 K ohms, 2 W, ±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)	64 V, 0.1 A 30 V, 3 A	Agilent 6115A Agilent 6296A
Electronic Load	Voltage Range: 50 V minimum Current Range: 3 A minimum Power Range: 50W minimum Open and Short switches variable at 60 Hz rate.	Agilent 6060A
or		
Variable Load Resistors and Load Switch	0 to 150 ohms, 100 W minimum 500 Ω10W 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	Agilent 0811-1909 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
Alignment Software	5.25'' Disc 3.5'' Disc	Agilent 06626-10001 Agilent 06626-10002

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Agilent 6625A/Agilent 6628A



Agilent 6626A/Agilent 6629A

Model	Output 1	Output 2	Output 3	Output 4
Agilent 6625A	25 W	50 W	—	—
Agilent 6626A	25 W	25 W	50 W	50 W
Agilent 6628A	50 W	50 W	—	—
Agilent 6629A	50 W	50 W	50 W	50 W

Figure 3-1. Operating Ranges Available in Agilent Models 6625A, 6626A, 6628A and 6629A

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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 3-26).

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. 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 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.

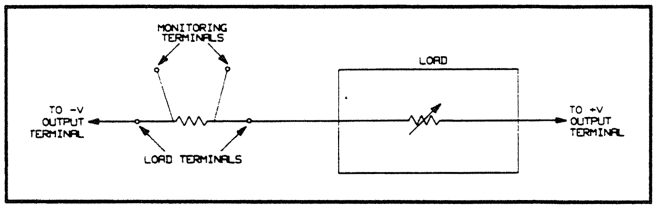


Figure 3-2. Current Monitoring Resistor Setup

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 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 Table 3-2.

Table 3-2. Programmable Voltage and Current Values

Output Board	Full Scale Voltage	Max. Prog. Voltage	Full Scale Current	Max. Prog. Current
25W Lo Rng	7 V	7.07 V	15 mA	15.45 mA
50W Lo Rng	16 V	16.16 V	200 mA	206 mA
25W Hi Rng	50 V	50.5 V	500 mA	515 mA
50W Hi Rng	50 V	50.5 V	2 A	2.06 A

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 the readback accuracy portions of 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). SELECT the low voltage range using the range command:

VRSET < ch >, < 7(25W) or 16(50W)

or press range and volt ↓ buttons.

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)
25W	0 V ±1.5 mV	DVM ±2 mV
50W	0 V ±3 mV	DVM ±3.5 mV

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

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


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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)
25W	DVM ±2 mV
50W	DVM ±3.5 mV

g. Program the selected output's voltage to the Low Range Full Scale value (7 V for 25W or 16 V for 50W outputs) by sending the following string:

VSET <ch>, <7 or 16>

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)
25W	7 V ±2.6 mV	DVM ±3.1 mV
50W	16 V ±5.5 mV	DVM ±6 mV

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

Output	Readback Accuracy (Controller Display)
25W	DVM ±3.12 mV
50W	DVM ±6.06mV

j. Select the high voltage range using the range command:

VSET <ch>, 50

Or Press range and volt ↑ buttons

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

VSET <ch>, 0

l. Record the output voltage readings on the digital voltmeter (DVM) and the front panel display. The readings should be within the limits specified below. 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.

Prog. Accuracy (DVM Reading)	Display Accuracy (Front Panel LCD)
0 V ±10 mV	DVM ±10 mV

m. Read back the output voltage from the selected channel over the GPIB by running the program from step e.

n. Record the value displayed on the controller. This value should be within the DVM reading noted in step 1 ± 10 mV.

o. Program the selected output's voltage to 50 V by sending the following string:

VSET <ch>, 50

p. Record the output voltage readings on the DVM and the front panel display. The readings should be within the limits specified below.

Prog. Accuracy (DVM Reading)	Display Accuracy (Front Panel LCD)
50 V ±18 mV	DVM ±18 mV

q. Run the program listed in step e. Record the value displayed bye the controller. This value should be within the DVM reading ± 18 mV.

r. Repeat steps a through q for each output present in your supply.

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.

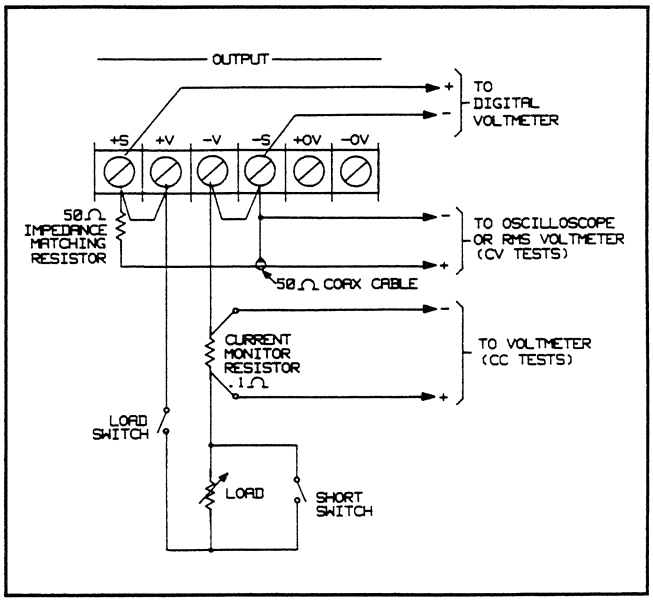


Figure 3-3. Basic Test Setup

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 values below by sending the following strings:

25W ISET <ch>, 0.515
VSET <ch>, 50
50W ISET <ch>, 1.03
VSET <ch>, 50

d. Adjust the load for 0.5 Amp (25W) or 1 Amp (50W) 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 0.5 mV.

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

3-14 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 et output to be tested (OUTPUT SELECT key on the front panel).
e. Program the current and voltage of the selected output to the value below by sending the following strings:

ISET <ch>, <0.515(25W) or 1.03(50W)>
VSET <ch>, <50>

f. Adjust the load for 0.5 A (25W) or 1 A (50W) 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 0.5 mV.
j. Repeat steps b through I for each output in your supply. Be sure to turn off supply before performing step b.

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 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 and output voltage to the values below:

ISET <ch>, <0.515(25W) or 1.03(50W) >
VSET <ch>, 50

d. Adjust the load for 0.5 or 1 Amp as indicated on the front panel display. The CV annunciaor 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 Transient Recovery Time. This test measures the time for the output voltage to recover to within 75 mV following a change from 100 mA to 0.5 Amp(25W) or 1 Amp(50W).

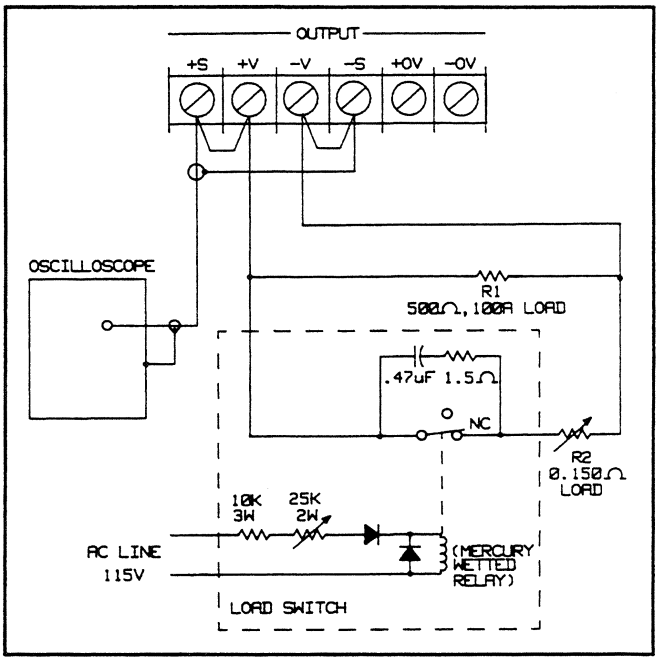


Figure 3-4. Transient Recovery Time Test Setup

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. Program the selected output's voltage to 50 V and the current to 0.515(25W) or 1.03(50W).
d. With R2 disconnected, connect R1 and ensure the output is 100 mA as indicate on the front panel display.
e. Connect R2 and adjust the output to read 0.5 Amp(25W) or 1Amp(50W) on the front panel display. Note that the CV annunciator should be on. If it is not on, readjust R2 until it is on.

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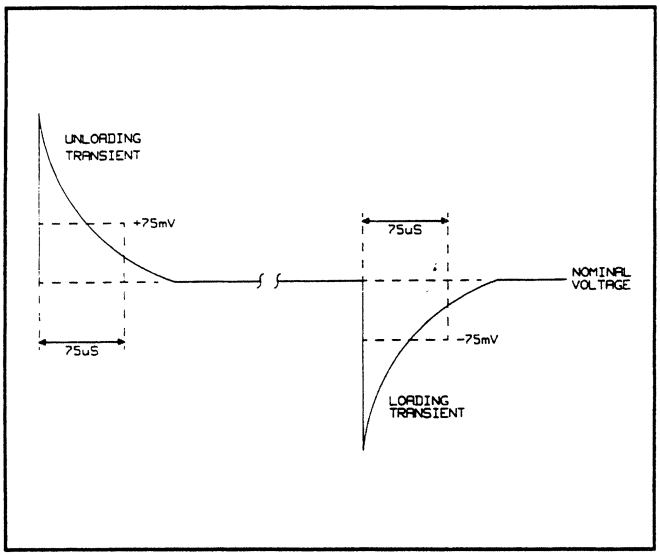


Figure 3-5. Transient Response Waveform

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 100 mA and 0.5 Amp(25W) or 1 Amp(50W). 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 3-5 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 3-5).
j. Repeat steps a through I for each output in your supply.

3-17 Turn On/Off Overshoot. This test measure 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.

3-18 Programmable OV Accuracy Test. This test checks the overvoltage (OV) programming accuracy. Taking the OV programming accuracy and the voltage programming accuracy into account.

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 49 V. Send the following string:
OVSET <ch>, <49>
d. Program the output voltage to 48.44 volts by sending the following string:
VSET <ch>, <48.44>
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 49.55 by sending the following string:
VSET <ch>, <49.55>
g. Note that the overvoltage has tripped as indicated by the display showing "OVERVOLTAGE".
h. Reset the output by setting the OV to 55V and resetting the OV circuit as shown below:
OVSET <ch>, <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.

3-19 Constant Current (CC) Tests

3-20 CC Setup. Follow the general setup instructions of paragraphs 3-5 through 3-9 and the specific instructions given in the following paragraphs.

3-21 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 the READBACK accuracy part of this test. The accuracy of the current monitoring resistor must be 0.005% 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. Select the low current range and program the output voltage to 5 V and the current to zero by sending the following strings:
IRSET <ch>, <.015(25W) or .2(50W)>
VSET <ch>, 5
ISET <ch>, 0

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d. Divide the voltage drop across the current monitoring resistor by the value 0.1 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 30.1)	Display Accuracy (Front Panel LCD)
25W	0 ±15 μA	Io ±15 μA
50W	0 ±185 μA	Io ±250 μA

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

```
10 OUTPUT 750; "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)
25W	Io ±15 μA
50W	Io ±250 μA

g. Program the selected output's voltage to 5 V and the current to the Low Range Full Scale Current value by sending the strings:

VSET <ch>, 5
ISET <ch>, <.015(25W) or .2(50W)>

h. Divide the voltage drop across the current monitoring resistor by the value (0.1) 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 ÷0.1)	Display Accuracy (Front Panel LCD)
25W	15 mA ±21 μA	Io ±20 μA
50W	.2 A ±265 μA	Io ±330 μA

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)
25W	Io ±19.5 μA
50W	Io ±330 μA

j. Select the high current range and program the voltage to 5 volts and the current to zero by sending the following strings:

IRSET <ch>, <0.5(25W) or 2(50W)>
VSET <ch>, 5
ISET <ch>, 0

k. Divide the voltage drop across the current monitoring resistor by the value 0.1 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 0.1)	Display Accuracy (Front Panel LCD)
25W	0 ±100 μA	Io ±130 μA
50W	0 ±500 μA	Io ±550 μA

l. Read back the output current from the selected channel over the GPIB to the controller by running the program in step e.

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

Output	Readback Accuracy (Controller Display)
25W	Io ±130 μA
50W	Io ±550 μA

n. Program the selected output's voltage to 5 V and the current to the High Range Full Scale Current value by sending the strings:

VSET <ch>, 5
ISET <ch>, <0.5(25W) or 2(50W)>

o. Divide the voltage drop across the current monitoring resistor by the value (0.1) 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 ÷0.1)	Display Accuracy (Front Panel LCD)
25W	0.5 A ±300 μA	Io ±280 μA
50W	2 A ±1.3 mA	Io ±1.35 mA

p. 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)
25W	Io ±280 μA
50W	Io ±1.35 mA

q. Repeat steps a through p for each output in your supply.

3-22 Negative Constant Current (- CC) Operation. This test verifies the readback and display are accurate when the output is in negative current limit operation. It also checks that the negative current limit of the 50 watt outputs have two different values depending upon the output voltage.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-6.

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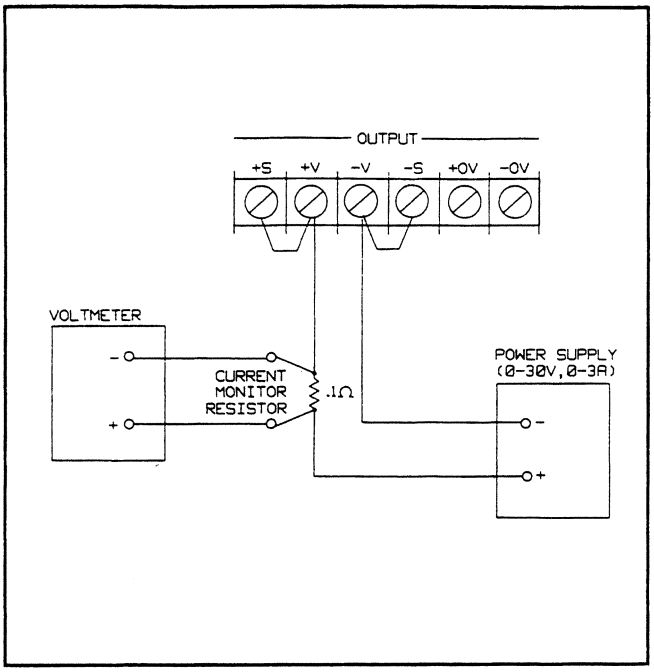


Figure 3-6. Negative Current Limit (– CC) Readback Accuracy

b. Set the external power supply to 5V and its current limit to .75 amps for a 25 watt output or 3 amps for a 50 watt output.
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 OV by sending the string:

VSET <ch>, 0

e. Divide the voltage drop across the current monitoring resistor by the value 0.1 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 ÷0.1)	Display Accuracy (Front Panel LCD)
25W	0.52 to 0.55 A	Is ±.3 mA
50W	2.08 to 2.20 A	Is ±1.4 mA

f. Read back the sink current from the selected channel over the GPIB by entering and running the program listed in paragraph 3-21.
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)
25W	Is ±.3 mA
50W	Is ±1.4 mA

h. For the 50 watt outputs only, raise the voltage of the external supply up top approximately 30 V as indicated on your supply's front panel LCD and Note that the sink current (Is) changes from the previous value to between 1.04 and 1.10 amps.

i. Read back the sink current from the selected channel over the GPIB by entering and running the program listed in paragraph 3-21.
j. Read the value displayed on the controller. This value should be Is (from step e) ± 0.9 mA.
k. Repeat this test (steps a through j for each output in your supply.

3-23 CC Load Effect. This test measures the change in output current for a change in the load from 50 Volts 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 50.5 volts by sending the following strings:

ISET <ch>, <0.5(25W) or 1(50W)>
VSET <ch>, <50.5>

d. Adjust the load for High Range Full Scale current and 50 Volts 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 ÷0.1).
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 value listed below for the particular output being tested.

Output	CC Load Effect
25W	5 μA
50W	10 μA

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

3-24 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).

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e. Program the current of the selected output to the High Range Full Scale Current value and the output voltage to 50.5 volts by sending the following strings:

ISET <ch>, <0.5(25W) or 2(50W)>
VSET <ch>, <50.5>

f. Repeat the load for High Range Full Scale current and 50 volts 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 ÷ 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
25W	5 μA
50W	10 μA

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

3-25 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).
c. Program the current of the selected output to the High Range Full Scale Current value and the output voltage to 50.5 volts by sending the following strings:

ISET <ch>, 0.5
VSET <ch>, 16

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 30 ohms so that the output voltage is close to 15 volts. Check that the CC annunciator is on.
e. Note that the reading on the rms voltmeter should be less than 5 mV (equivalent to 0.1 mA RMS).
f. Repeat this test (steps a through e) for each output in your supply.

3-26 Performance Test Record

All of the performance test specifications for the power supply are listed in Tables 3-3 and/or 3-4. Table 3-3 covers the 25 watt outputs; Table 3-4 covers the 50 watt outputs.

3-27 EXTENDED TESTS

These tests are similar to the Performance Tests except they have a much longer duration, are conducted with controlled temperature conditions or test supplemental characteristics.

3-28 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.

3-29 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 selected output to 50 volts and 0.515 Amps(25W) or 1.03 Amps(50W)
d. Adjust the load for 0.5 Amps(25W) or 1 Amp(50W) 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 and record the output voltage value again. The difference in the readings taken in steps I and j should be less than 2 millivolts.
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 2 millivolts.
i. Open the load switch and immediately record the output voltage reading.
j. Wait 30 minutes and again record the output voltage reading. The difference in the readings taken in steps and j should be less than 2 volts.
k. Repeat steps a through j for each output in your supply.

3-30 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.

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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 500 mA for 25 Watt outputs or 2 Amps for 50 Watt outputs and the output voltage to 7 Volts.
d. Adjust the load until the output enters the CC mode with the displayed output voltage slightly less than 7 volts. The CC annuciator must be on.
e. Adjust the transformer to 13% below the nominal voltage.
f. Wait 30 minutes for the output to stabilize under these conditions and record the output current (DVM reading ± 0.1 (shunt resistance)).
g. Adjust the transformer to 6% above the nominal 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 70µA(25W) or 260 µA(50W).
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 70 µA(25W) or 260 µA(50W).
k. Repeat steps a through j for each output in the supply.

3-31 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 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 selected output to 50 volts and 0.515 Amps(25W) or 1.03 Amps(50W).
d. Adjust the load for slightly less than 0.5 Amps (25W) or 1 Amps(50W) 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 5 mV.
g. Repeat steps a through f for each output in your supply.

3-32 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 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 cross 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 0.5 Amps(25W) or 2 Amps(50W) and the output voltage to 7 volts.
d. Adjust the load until the output enters the CC mode with the displayed output voltage slightly less than 7 volts 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 ÷ 0.1 (Shunt resistance)).
f. Observe and record the output current reading periodically over an 8 hour period. The difference between any two readings should be less than 70µA(25W) or 260 µA(50W).
g. Repeat steps a through f for each output in your supply.

3-33 TEMPERATURE COEFFICIENT (TC) TESTS

These tests check 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.

3-34 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 selected output to 50 volts and 0.515Amps(25W) or 1.03 Amps(50W).
d. Adjust the load for 0.5 Amps(25W) or 1.03 Amps(50W) 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.

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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. The difference between the readback voltage should be less than the change in output ± 15 mV.

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

3-35 Output Current and Readback Current TC

a. Repeat steps a through d of paragraph 3-34.
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 ÷ 0.1 (Shunt resistance)).
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 in output current should not be more than 240 µA(25W) or 1.2 mA(50W). The difference between the readback currents should be less than the change in output ± 265 µA(25W) or 1.15 mA(50W).

Output	Current TC Spec.	Current Readback TC Spec.
25W	240 µA	265 µA
50W	1.2 mA	1.15 mA

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

3-36 Negative Current Limit (- CC) Readback TC

a. Repeat steps a through d of paragraph 3-22.
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 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 temperature change. The differences should not be more than the change I the sink current ± 265 µA(25W) or 1.15 mA(50W).

3-37 CV Down Programming Speed. This test measures the time required for the output voltage to fall 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 50 mV (response time).

a. Turn off the supply and connect the output to be tested as shown in Figure 3-7.

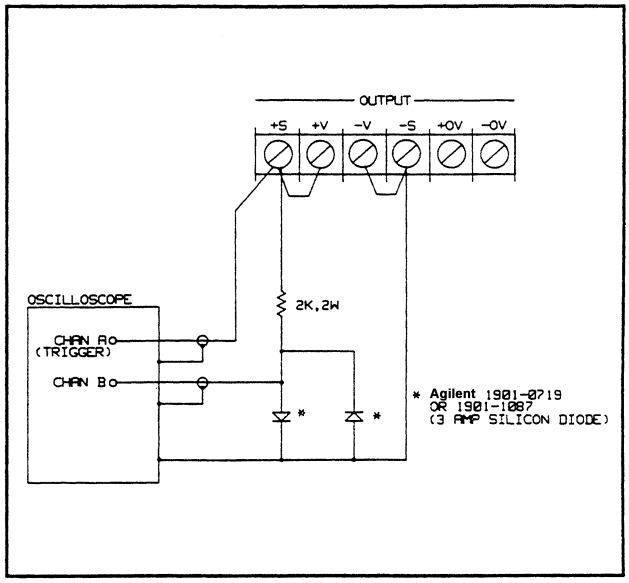


Figure 3-7. Down Programming Speed Test Setup

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 10 V/div, 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 50 volts by running the program listed below.

```
10 OUTPUT 705;"ISET <ch>, <0.515(25W)
                or 1.03(50W) >
20 OUTPUT 705;"VSET <ch>,0"
30 WAIT 0.05
40 OUTPUT 705;"VSET <ch>, 50"
50 WAIT 0.05
60 GOTO 20
70 END
```

NOTE

The tested output's CV annnciator 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 lose as possible to the time when the output voltage just begins to fall.

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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 constant check by insuring that the output voltage falls to about (37%) 18.5 V in less than 750 µS. Refer to the Channel A waveform shown in Figure 3-8.

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 3-7 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 50 mV of its final settling value on the bottom horizontal line in less than 6 msec. Refer to the Channel B waveform shown in Figure 3-8.

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

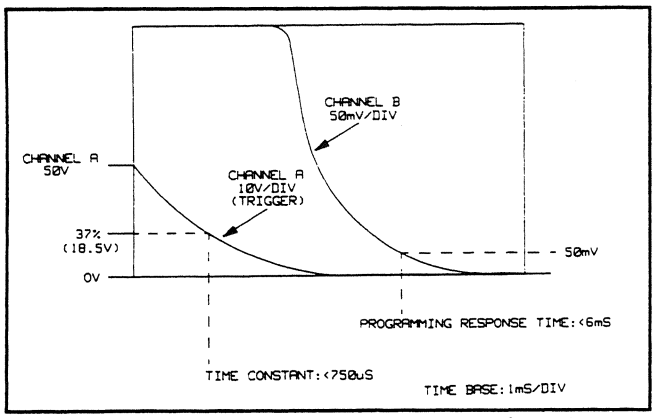


Figure 3-8. CV Down Programming Speed Test Waveforms

3-38 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 50 mV (response time).

a. Turn off the supply and connect the output to be tested as shown in Figure 3-9.

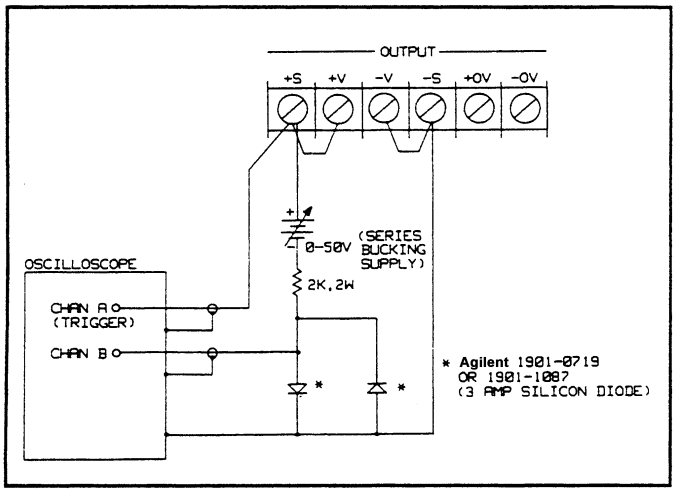


Figure 3-9. CV UP Programming Speed Test Setup.

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 50 volts by sending the following string:

VSET < ch>, 50

d. Set the vertical sensitivity switch of Channel A on the oscilloscope to 10 V/div. With the oscilloscope's input switch in 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.

g. Program the output voltage in a loop which alternately programs the output voltage between 0.4 V and 50 V by running the following program:

```
10 OUTPUT 705;"ISET <ch>, <0.515(25W)
                or 1.03(50W) >
20 OUTPUT 705;"VSET <ch>,50"
30 WAIT 0.05
40 OUTPUT 705;"VSET <ch>, 4"
50 WAIT 0.05
60 GOTO 20
70 END
```

NOTE

The tested output's CV annnciator 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 50 volts. Look for a smooth exponential waveform with no by insuring that the output voltage rises to about 31.5 volts (63%) in less than 750 µsec. Refer to the Channel A waveform shown in Figure 3-10.

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 approzimately – 0.6 V and rises to the top horizontal line when the output voltage is at full

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Scale. The diodes (see Figure 3-9) 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 50 mV of its final settling value on the top horizontal line is less than 6 msec.

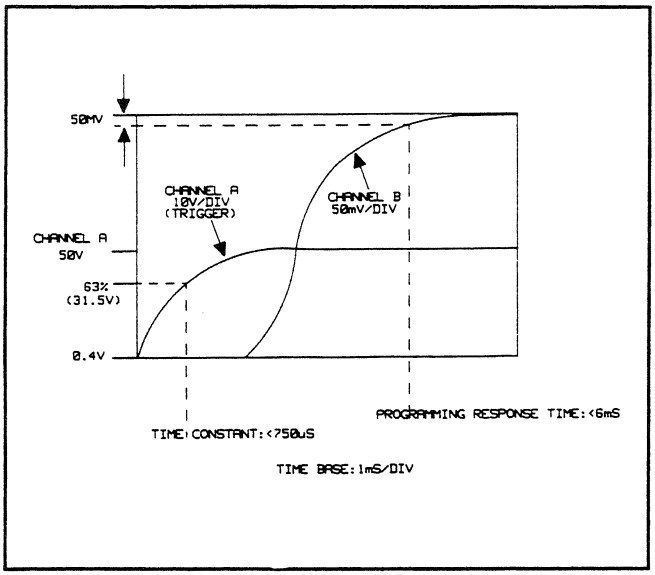


Figure 3-10. CV Up Programming Speed Test Waveforms

K. Repeat steps a through j for each output in the supply.

3-39 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 3-11.

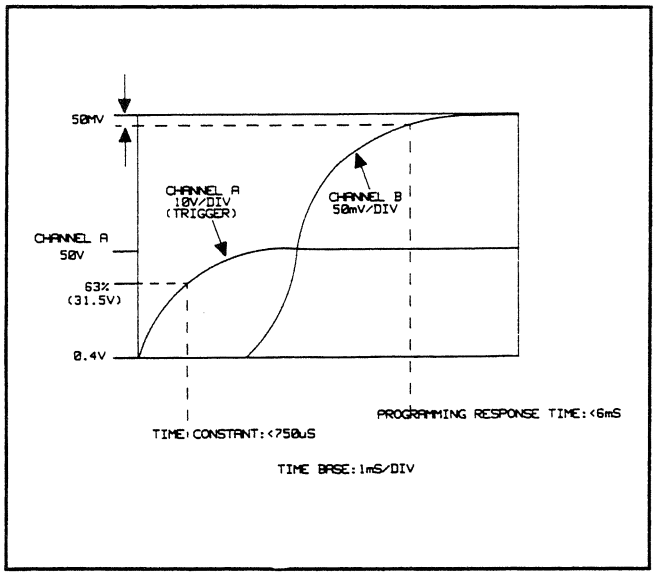


Figure 3-10. CV Up Programming Speed Test Waveforms

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 50 V.
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 56.8 V and 63.5 V.
e. Repeat steps a through d for each output in your supply.

3-40 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 3-12 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 for each channel, until all supply's outputs have been checked.

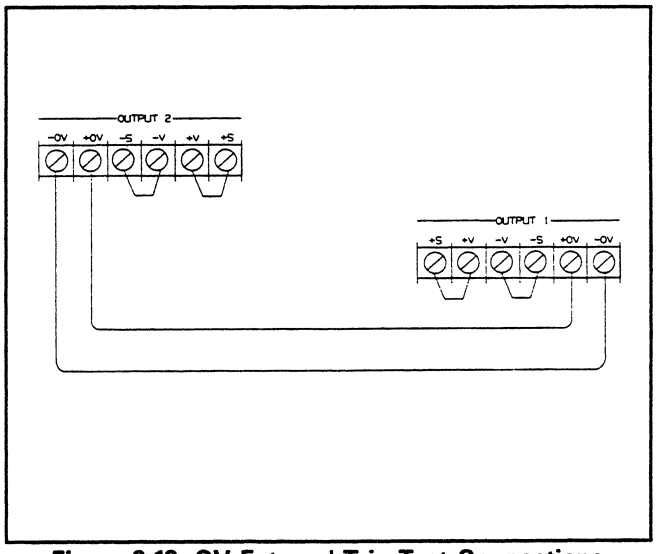


Figure 3-12. OV External Trip Test Connections

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Table 3-3. Performance Test Record for Agilent 6625A and 6628A

Serial No._____ **Temperature**_____ **Pre Cal** _____ **Post Cal** _____

Test Performed by_____ **Humidity**_____ **Date**_____

Para.	Test	Specifications are shown in parenthesis	OUTPUT 1	OUTPUT 2
3-12	CV PROGRAMMING @ 0 Volts	Output Accuracy (DVM Reading):		
		25W: High Range (0 ± 10 mV)	_____	
		Low Range (0 ± 1.5 mV)	_____	
		50W: High Range (0 ± 10 mV)	* _____	_____
		Low Range (0 ± 3 mV)	* _____	_____
		Display and Readback Accuracy:		
		25W: High Range (DVM ± 10 mV)	_____	
		Low Range (DVM ± 2 mV)	_____	
		50W: High Range (DVM ± 10 mV)	* _____	_____
		Low Range (DVM ± 3.5 mV)	* _____	_____
3-12	CV PROGRAMMING @ Full Scale	Output Accuracy (DVM Reading):		
		25W: High Range (50 V ± 18 mV)	_____	
		Low Range (7 V ± 2.6 mV)	_____	
		50W: High Range (50 V ± 18 mV)	* _____	_____
		Low Range (16 V ± 5.5 mV)	* _____	_____
		Display and Readback Accuracy:		
		25W: High Range (DVM ± 18 mV)	_____	
		Low Range (DVM ± 3.1 mV)	_____	
		50W: High Range (DVM ± 18 mV)	* _____	_____
		Low Range (DVM ± 6.06 mV)	* _____	_____
3-13	CV LOAD EFFECT	(.5 mV)	_____	_____
3-14	CV SOURCE EFFECT	(.5 mV)	_____	_____
3-15	CV NOISE (PARD)	Peak to Peak (3 mV)	_____	_____
		RMS (500 μV)	_____	_____
3-16	TRANSIENT RECOVERY @ 75 mS	(75 mV)	_____	_____
3-17	TURN ON/OFF OVERSHOOT	(0 V ± 100 mV)	_____	_____
3-19	OVERVOLTAGE PROTECTION	(programmable @ 49 V)(48.44 to 49.55 V)	(✓) _____	(✓) _____
3-20	CC PROGRAMMING @ 0 Amps	Output Accuracy (Io):		
		25W: High Range (0 mA ± 100 μA)	_____	
		Low Range (0 mA ± 15 μA)	_____	
		50W: High Range (0 mA ± 500 μA)	* _____	_____
		Low Range (0 mA ± 185 μA)	* _____	_____
		Display and Readback Accuracy:		
		25W: High Range (Io ± 130 μA)	_____	
		Low Range (Io) ± 15 μA)	_____	
		50W: High Range (Io ± 550 μA)	* _____	_____
		Low Range (Io ± 250 μA)	* _____	_____
3-22	CC PROGRAMMING @ Full Scale	Output Accuracy (Io):		
		25W: High Range (500 mA ± 300 μA)	_____	
		Low Range (15 mA ± 21 μA)	_____	
		50W: High Range (2 A ± 1.3 mA)	* _____	_____
		Low Range (.2 A ± 265 μA)	* _____	_____
		Display and Readback Accuracy:		
		25W: High Range (Io ± 280 μA)	_____	
		Low Range (Io ± 19.5 μA)	_____	
		50W: High Range (Io ± 1.35 mA)	* _____	_____
		Low Range (Io ± 330 μA)	* _____	_____
3-24	– CC	Current Limit (Is):		
		25W: High Range (.52 A to .55 A)	_____	
		Low Range (same as High Range)	_____	
		50W: High Range (0.7 A to 1.30 A)	* _____	_____
		Low Range (2.08 A to 2.20 A)	* _____	_____
		Display and Readback Accuracy:		
		25W: High Range (Is ± .3 mA)	_____	
		Low Range (same as High Range)	_____	
		50W: High Range (Is ± .9 mA)	* _____	_____
		Low Range (Is ± 1.4 mA)	* _____	_____
3-25	CC LOAD EFFECT	25W (5 μA)	_____	
		50W (10 μA)	* _____	_____
3-26	CC SOURCE EFFECT	25W (5 μA)	_____	
		50W (10 μA)	* _____	_____
3-27	CC NOISE (RMS)	(100 μA)	_____	_____

* For model Agilent 6628A output 1 is 50 watt (for Agilent 6625A output 1 is 25 watt).

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Table 3-4. Performance Test Record for Agilent 6626A and 6629A

Serial No._____ **Temperature**_____ **Pre Cal** _____ **Post Cal** _____

Test Performed by_____ **Humidity**_____ **Date**_____

Para.	Test	Specifications are shown in parenthesis	OUTPUT 1	OUTPUT 2	OUTPUT 3	OUTPUT 4
3-12	CV PROGRAMMING @ 0 Volts	Output Accuracy (DVM Reading): 25W: High Range (0 ± 10 mV) Low Range (0 ± 1.5 mV) 50W: High Range (0 ± 10 mV) Low Range (0 ± 3 mV)				
		Display and Readback Accuracy: 25W: High Range (DVM ± 10 mV) Low Range (DVM ± 2 mV) 50W: High Range (DVM ± 10 mV) Low Range (DVM ± 3.5 mV)				
3-12	CV PROGRAMMING @ Full Scale	Output Accuracy (DVM Reading): 25W: High Range (50 V ± 18 mV) Low Range (7 V ± 2.6 mV) 50W: High Range (50 V ± 18 mV) Low Range (16 V ± 5.5 mV)				
		Display and Readback Accuracy: 25W: High Range (DVM ± 18 mV) Low Range (DVM ± 3.1 mV) 50W: High Range (DVM ± 18 mV) Low Range (DVM ± 6.06 mV)				
3-13	CV LOAD EFFECT	(.5 mV)				
3-14	CV SOURCE EFFECT	(.5 mV)				
3-15	CV NOISE (PARD)	Peak to Peak (3 mV) RMS (500 µV)				
3-16	TRANSIENT RECOVERY @ 75 mS	(75 mV)				
3-17	TURN ON/OFF OVERSHOOT	(0 V ± 100 mV)				
3-19	OVERVOLTAGE PROTECTION	(programmable @ 49 V)(48.44 to 49.55 V)	(✓)	(✓)	(✓)	(✓)
3-20	CC PROGRAMMING @ 0 Amps	Output Accuracy (Io): 25W: High Range (0 mA ± 100 µA) Low Range (0 mA ± 15 µA) 50W: High Range (0 mA ± 500 µA) Low Range (0 mA ± 185 µA)				
		Display and Readback Accuracy: 25W: High Range (Io ± 130 µA) Low Range (Io) ± 15 µA) 50W: High Range (Io ± 550 µA) Low Range (Io ± 250 µA)				
3-22	CC PROGRAMMING @ Full Scale	Output Accuracy (Io): 25W: High Range (500 mA ± 300 µA) Low Range (15 mA ± 21 µA) 50W: High Range (2 A ± 1.3 mA) Low Range (.2 A ± 265 µA)				
		Display and Readback Accuracy: 25W: High Range (Io ± 280 µA) Low Range (Io ± 19.5 µA) 50W: High Range (Io ± 1.35 mA) Low Range (Io ± 330 µA)				
3-24	– CC	Current Limit (Is): 25W: High Range (.52 A to .55 A) Low Range (same as High Range) 50W: High Range (1.04 A to 1.10 A) Low Range (2.08 A to 2.20 A)				
		Display and Readback Accuracy: 25W: High Range (Is ± .3 mA) Low Range (same as High Range) 50W: High Range (Is ± .9 mA) Low Range (Is ± 1.4 mA)				
3-25	CC LOAD EFFECT	25W (5 µA) 50W (10 µA)				
3-26	CC SOURCE EFFECT	25W (5 µA) 50W (10 µA)				
3-27	CC NOISE (RMS)	(100 µA)				

* For model Agilent 6629A, outputs 1 and 2 are 50 watt (for Agilent 6626A, they are 25 watt).

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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. 06626-90001) be reviewed before attempting to troubleshoot the unit.

If a component is found to be defective, replace it and reconduct 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 (ionizedair 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).

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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.

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 highvelocity air blowers (unless ionized).

k. Keep the work area free of non-conductive objects such as Styrofoam-type cups, polystyrenefoam, polyethylene 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).

l. 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 illustrated in Figure 4-1. The major differences between the models are the quantity and type of output boards they contain. Figure 4-1 shows the output 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:

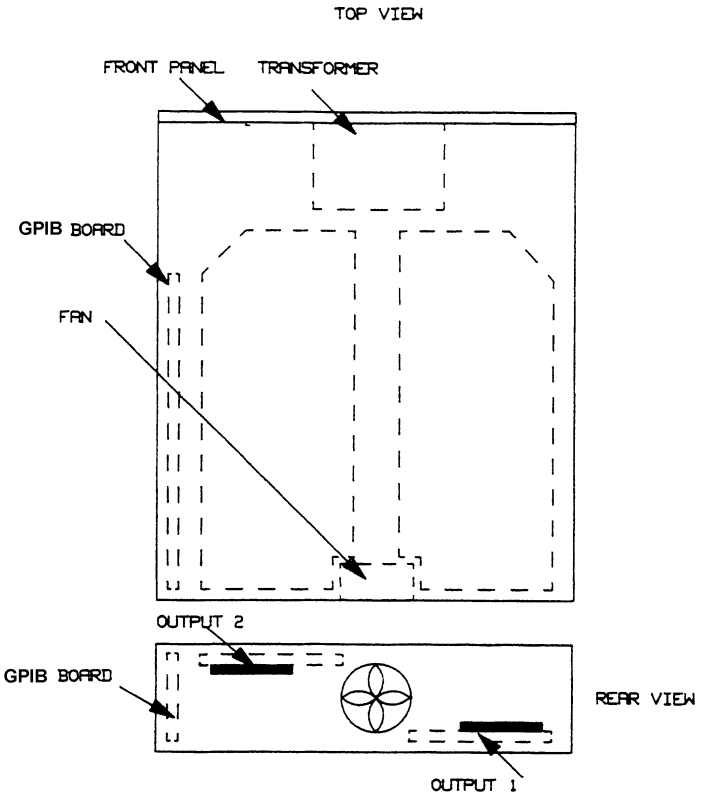
a. Remove the four screws which hold the carrying straps.
b. Spread the bottom rear of the cover slightly and pull back to disengage it from the front panel.
c. Remove the top cover. Note that you can use the top cover assembly as a support when you open the top chassis in the next procedure.

4-5 Gaining Access to Assemblies in the Supply

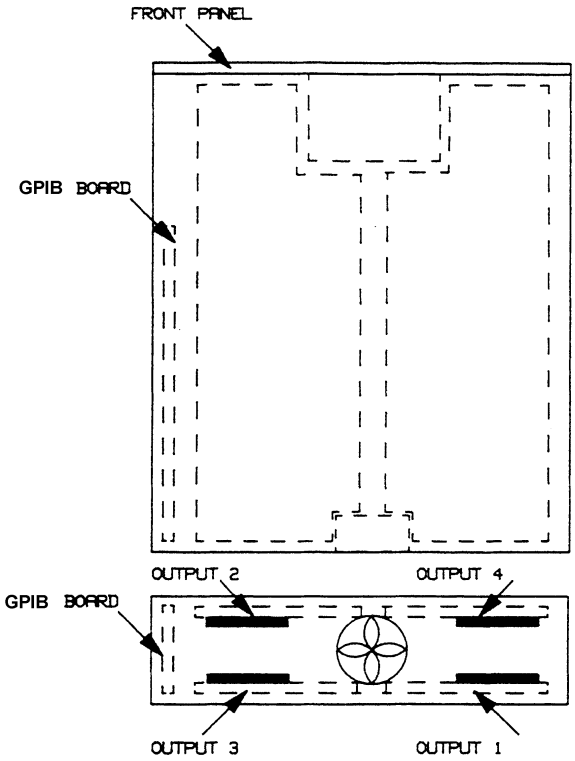
As shown in Figure 4-1, each power supply model contains an GPIB board and at least two output boards. The output boards are mounted on an upper chassis assembly and in the lower section of the main chassis. The upper chassis assembly is hinged and its output boards are mounted with the components facing 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.

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Agilent 6625A/Agilent 6628A



Agilent 6626A/Agilent 6629A

Figure 4-1. Agilent 6625A, 6626A, 6628A, and 6629A Multiple Output Power Supplies,Assembly Locations

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4-6 GPIB Board Removal

Looking at the unit form 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 units. 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 to be removed since their position may affect the supply's ripple performance.
b. Remove two hex standoffs form 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 ¼ inch to disengage the keyed standoffs.
e. Lift board out of chassis.

4-7 Output Board Removal

Model 6625A and 6628A has two Output boards located in the main chassis and Model 6626A and 6629A have four Output boards: two boards are mounted in the upper chassis assembly and two are mounted in the main chassis. To remove an Output board, proceed as follows:

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 DUSTCOVERS

This instrument employs plastic covers to protect a number of components on each output board. The covers provide a constant temperature environment for the sensitive components below them. Before installing these covers, be sure to eliminate any static charge which may have accumulated on them. Removing static charge can be accomplished using an ionized air source directed across the covers.

CAUTION

After performing maintenance (and before performing any calibration), be sure to replace the plastic covers on the output boards(s). Failure to replace the cover(s) may allow thermal conditions to affect components in these areas. This can result in incorrect voltages within the power supply, and greatly degrade performance specifications. Be sure to remove any static charge on the covers prior to installing them on the output board.

4-9 Replacing the Power Module U338

Use the following procedure when it has been determined that the power module (U338) is defective and must be replaced:

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. Check the heat sink thermal conductor surface. For minor damage, apply a thin layer of heat sink compound to the back surface of the replacement power module. For major damage replace the heatsink.
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.

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 fine switch are replaceable components. You will 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.

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b. Remove the rack ears or vinyl trim from the sides of the front panel.

c. Remove the two screws on each side of front panel.

d. 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 output board fuse locations are shown in Figures 4-3 and 4-4. 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 Series 200 or 300 Controller
Signature Analyzer	Test most of the circuits on the GPIB board	Agilent 5005A
Digital Voltmeter	Check various voltage levels.	Agilent 3458A
30 V, 3 A Power Supply	Check current sink operation and negative current limit.	Agilent 6296A
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	0-150 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
GPIB Board, Figure 6-2			
F201	Bias supply fuse (Soldered to board)	4 A, 125 V	2110-0712
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	0.5 A, 125 V	2110-0716
F303	Output return fuse	7 A, 125 V	2110-0685
F304	Secondary ac input fuses	10 A, 125 V	2110-0713
F308, F309	Bias AC Input Fuses	2 A, slo-blo	2110-0303
F307	NOT USED		

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.

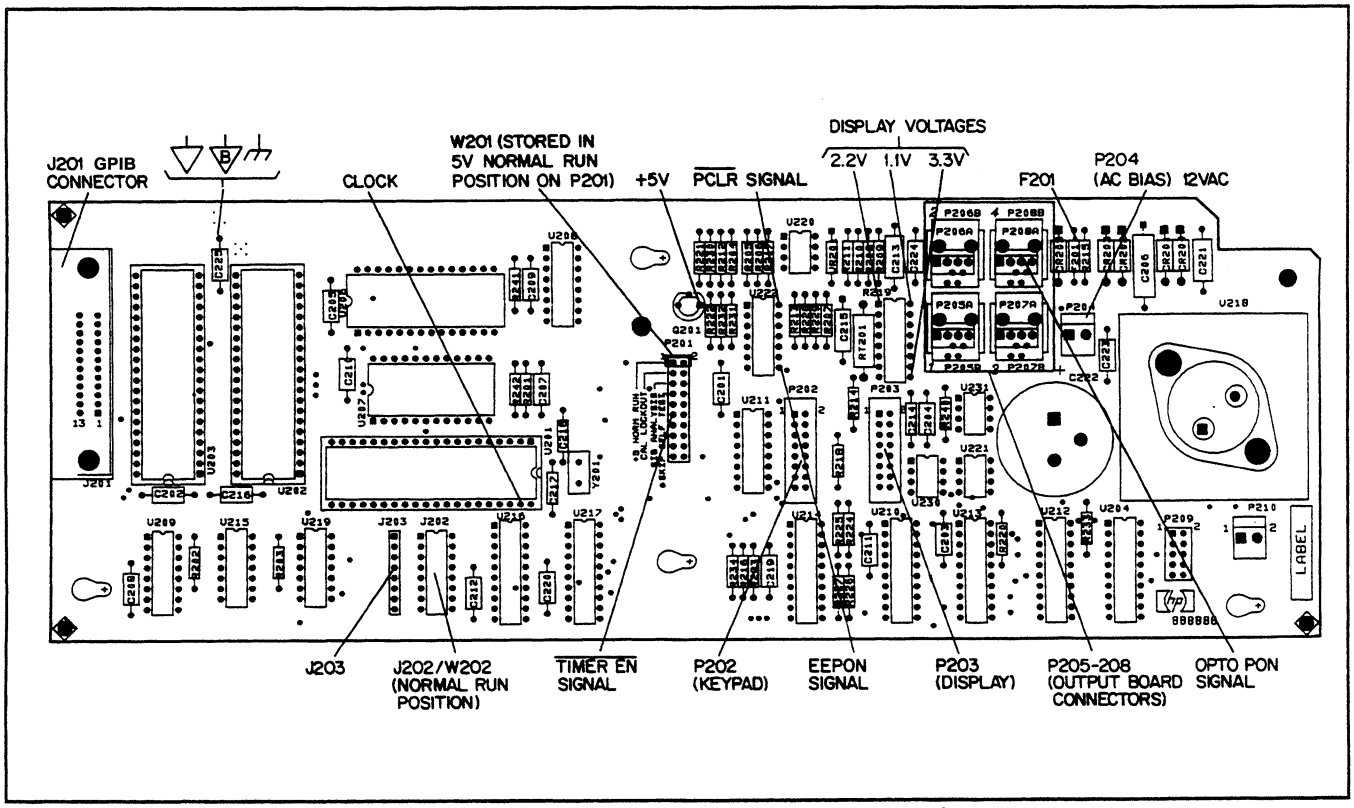


Figure 4-2. GPIB Board, Fuse and Test Point Locations

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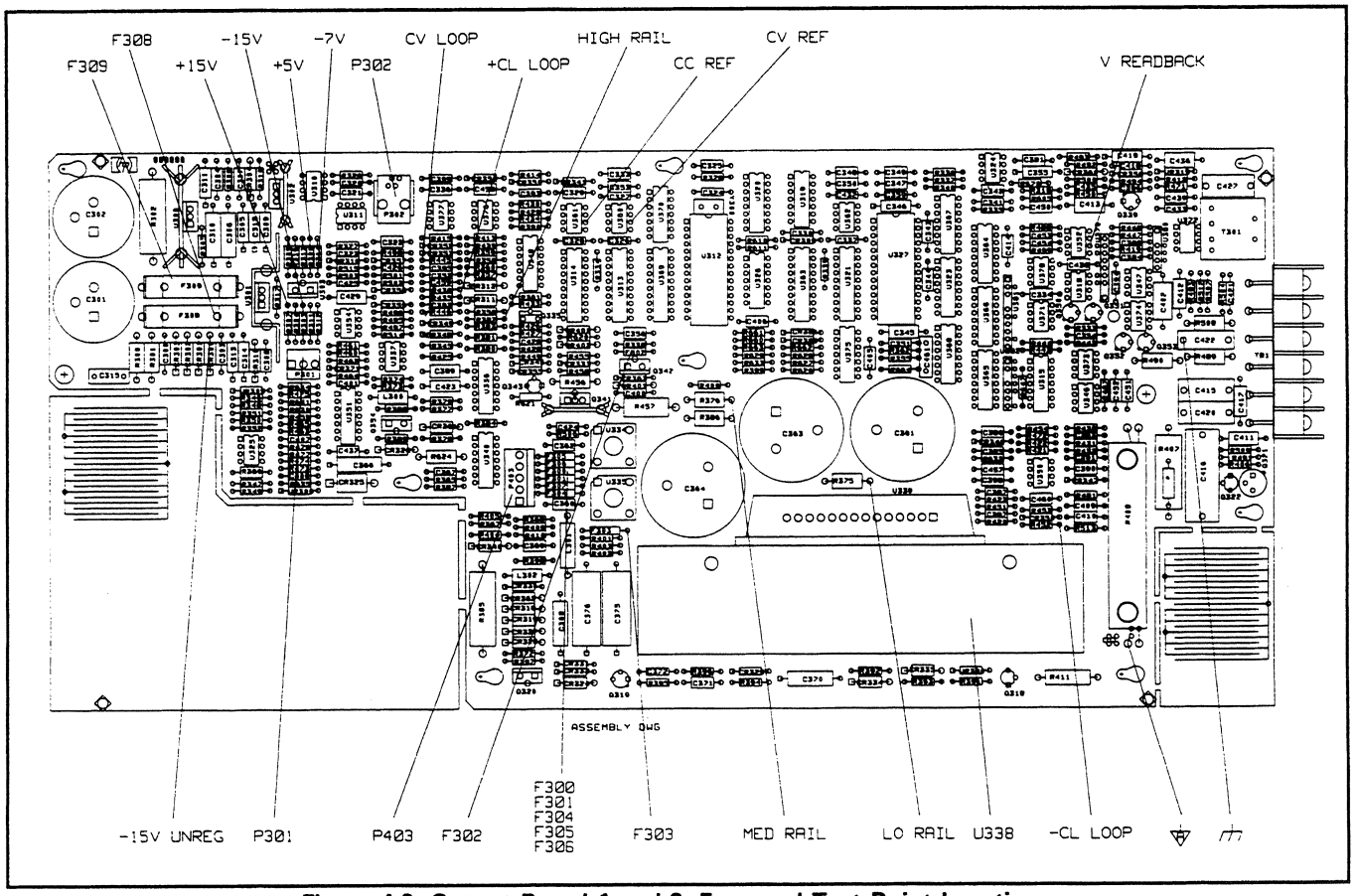


Figure 4-3. Output Board 1 and 2, Fuse and Test Point Locations

4-14 INITIAL TROUBLESHOOTING AND BOARD ISOLATION PROCEDURES

Initial troubleshooting procedures for the power supply are given in the flow chart of Figure 4-5. 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 test (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 $\overline{\text{OUTPUT ENABLE}}$ 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 o 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 SELF TEST, 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 4-5 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 position 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 GP IB 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 mode (see Appendix A, calibration 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 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 4-5 and other troubleshooting flow charts provided in this section.

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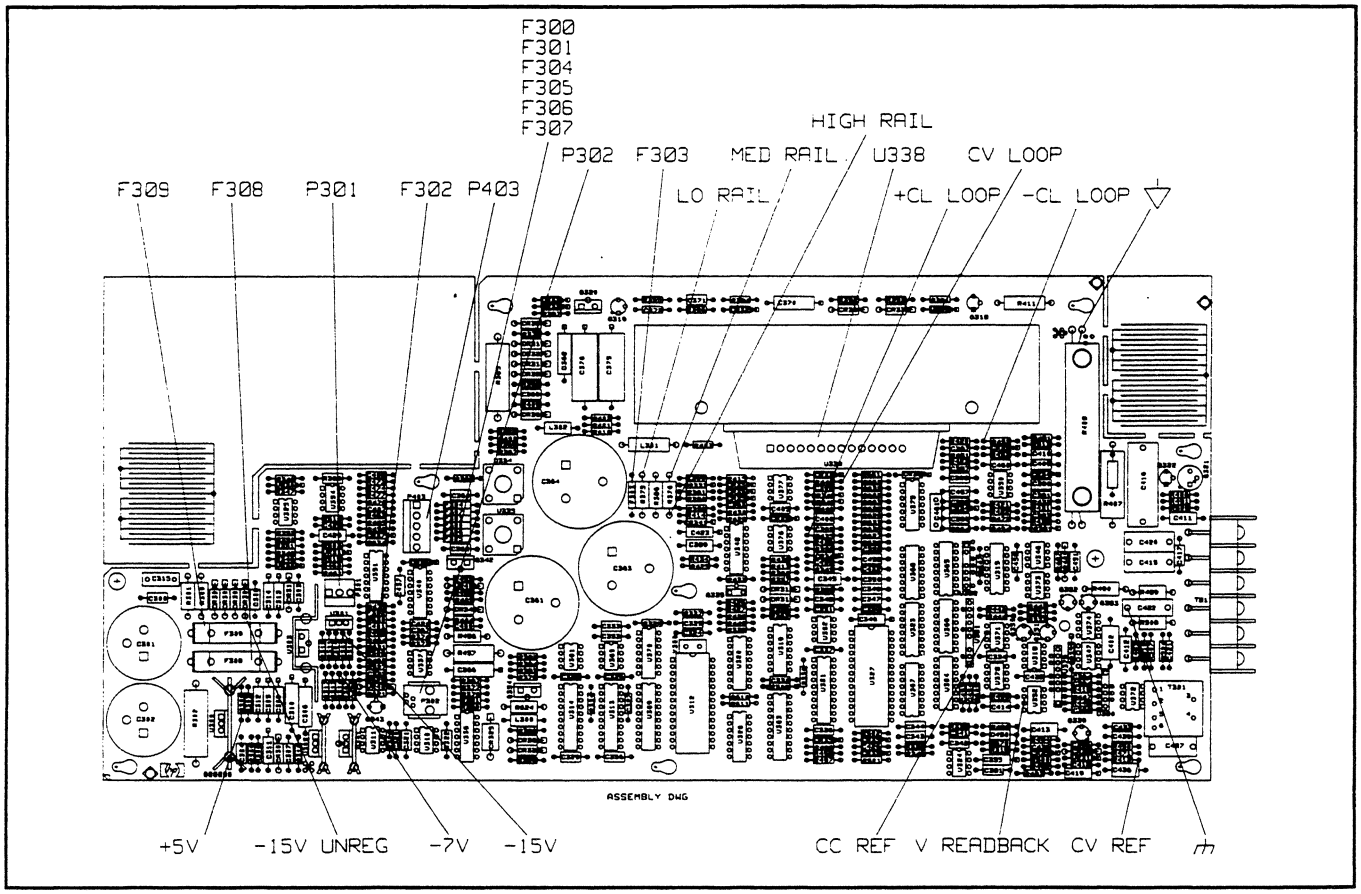


Figure 4-4. Output Board 3 and 4, Fuse and Test Point Locations

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/U360) 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/U361) on the specified output board probably failed. Perform the output board troubleshooting procedures (see paragraph 4-25).
OV DAC CH <ch> *	The overvoltage (OV) DAC (U363/U319D) 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 4-5.

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

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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).
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 (U230 or U231) 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 4-5 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 an incorrect calibration sequence is done or if a CAL command is sent with CAL MODE off. 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). See CAUTION under CAL LOCK. Error 5 can occur during calibration.

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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 GPIB board (see Figure 4-2). Install W201 in the NORM RUN position and recalibrate if desired. **CAUTION** *If W201 has been installed in the CAL LOCKOUT position of connector P201 on the GPIB board (see Figure 4-2), and any calibration commands are sent to the power supply, an error will occur. The "CAL LOCK" message would be displayed if the error was queried. However, if a second calibration command was sent to the power supply, an error will again be generated and the write over the previous CAL LOCK error. The message "CAL ERROR" will be displayed when the ERR key is depressed.*
Error codes that can be sent back over the GPIB in response to TEST? TEST? initiates a limited 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.	0	No errors were detected.
	20	The timer on the GPIB board failed. Microprocessor (U201) or real time clock (U208) could be defective. Perform the GPIB troubleshooting procedures (see paragraph 4-18).
	21	The RAM (U207) on the GPIB board failed self-test (see paragrph 4-18).
	27	The ROM (U206) on the GPIB 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 4-6. 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 (U230 or U231), 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) GP IB 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 6626A) 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 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 GP IB board or repair an GPIB board by changing its EEPROM chip, 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 an Agilent Model 6626A.

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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 6626A"
30 OUTPUT 705;"CMODE 0"
40 OUTPUT 705;"CLR"
50 END
```

After sending the above program, wait until "SAVING CAL" is no longer displayed. 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.00 (date 2839), 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 (+ 5V) 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 4-7 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 4-7. 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 4-7.
c. Short pins 1 and 4 together on connectors P205 through P208 as shown in Figure 4-7.
d. Check that jumper pack W202 is in the proper position specified by the particular S.A. test. Figure 4-7 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 4-7)
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. test, 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.00 is 2839; where 28 specifies 1988 and 39 is the week number. To query the revision date of the firmware (ROM) in your supply, run the short program list below.

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

The computer should display the revision date; e.g. "2839"

Note that the signatures in Table 4-6 (GPIB Board S.A. Test No. 2) for the ROM are for revision A.00 and will be different for different revisions. Signautres for other date codes may be found in the change page accompanying this manual. The secondary ROM revision can be queried by replacing "ROM" with "SROM" in fine 10.

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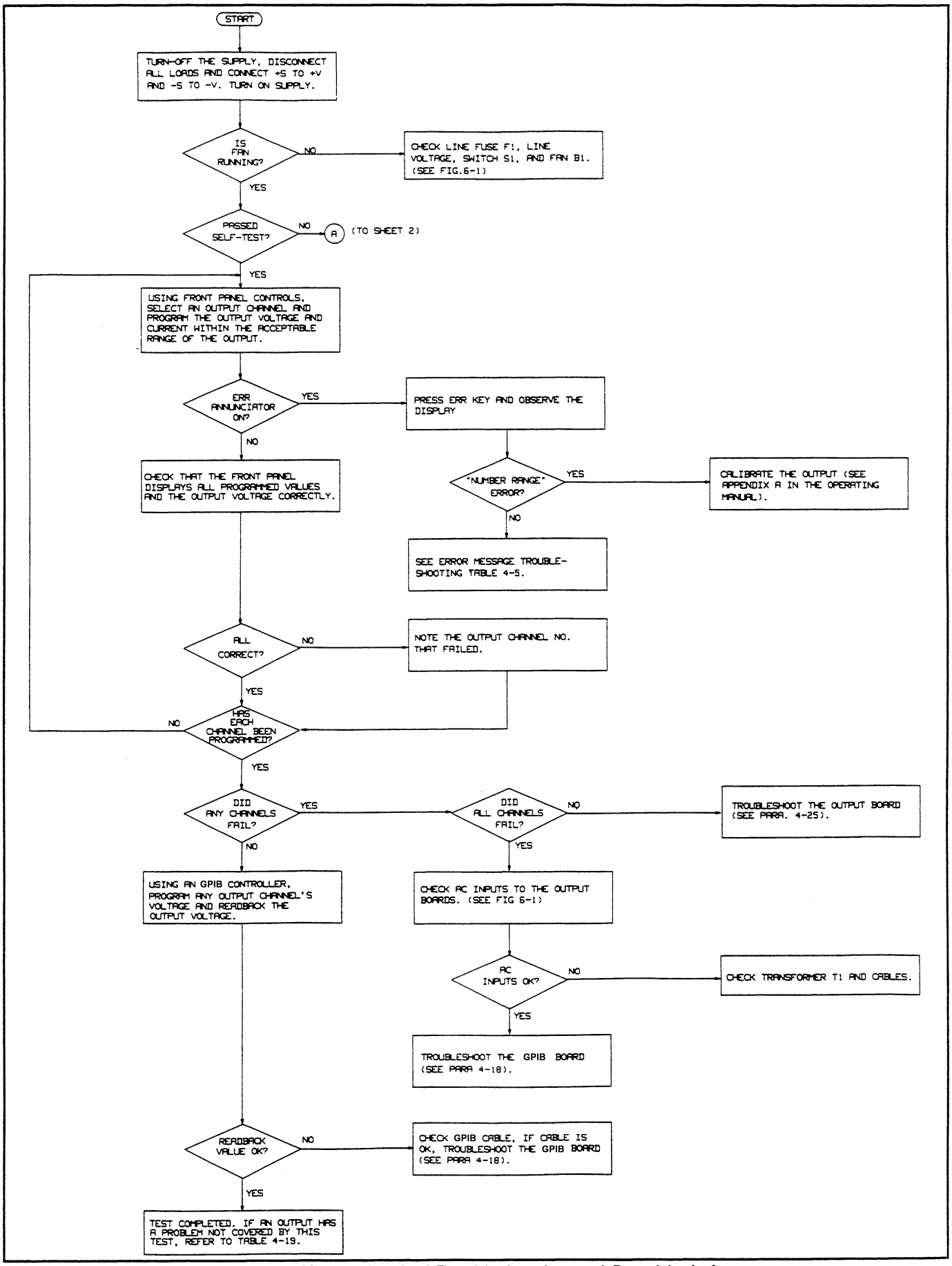


Figure 4-5 (Sheet 1). Initial Troubleshooting and Board Isolation

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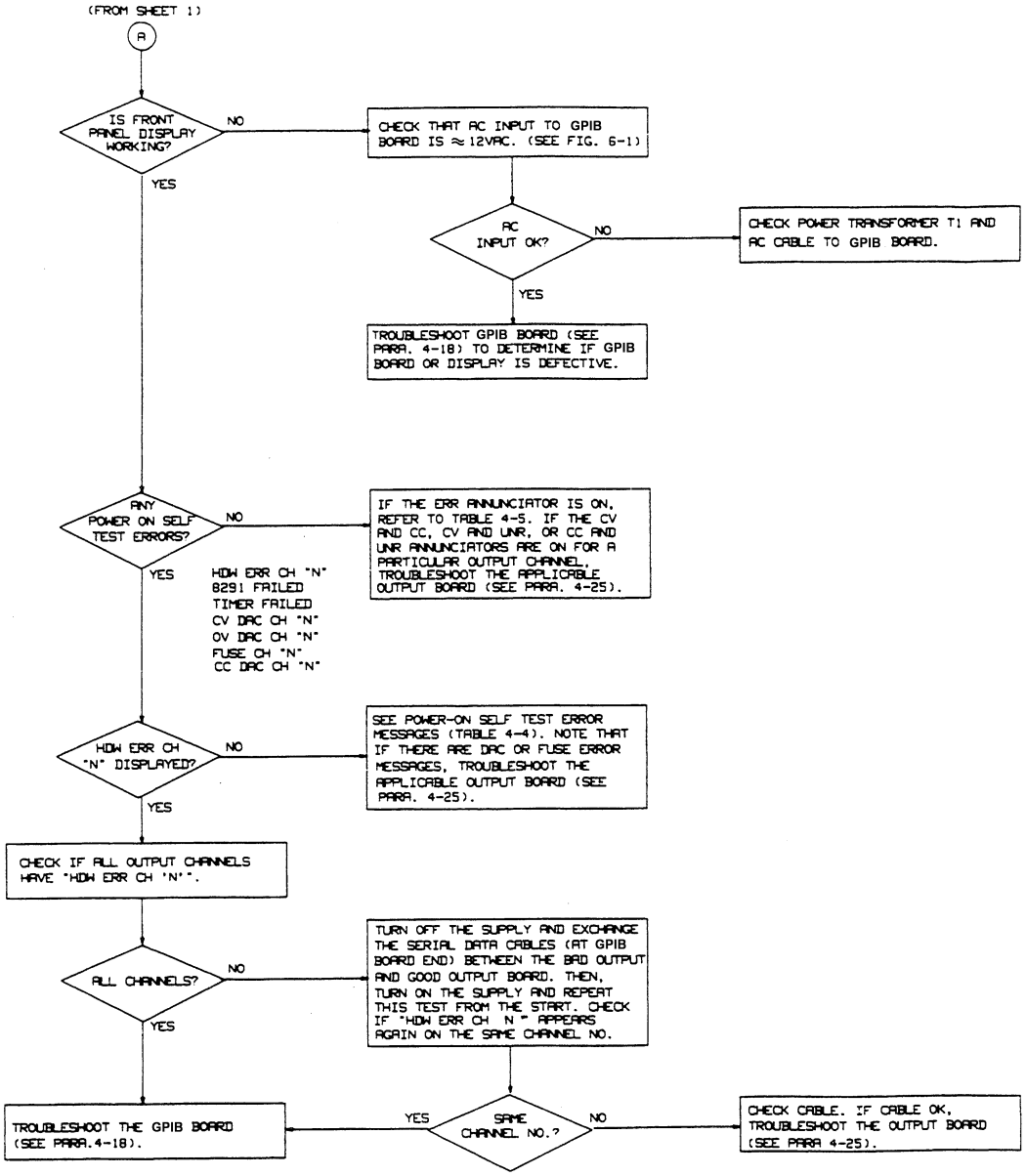


Figure 4-5 (Sheet 2). Initial Troubleshooting and Board Isolation

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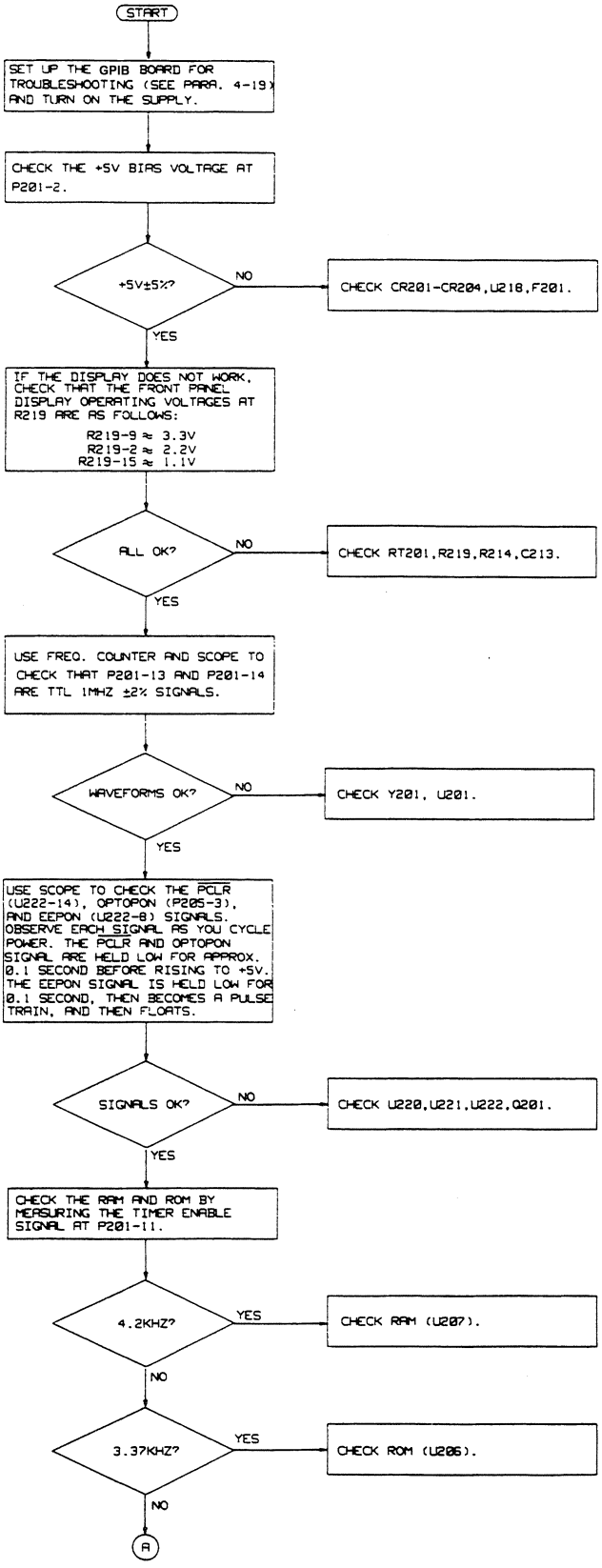


Figure 4-6 (Sheet 1). GPIB Board and Front Panel Troubleshooting

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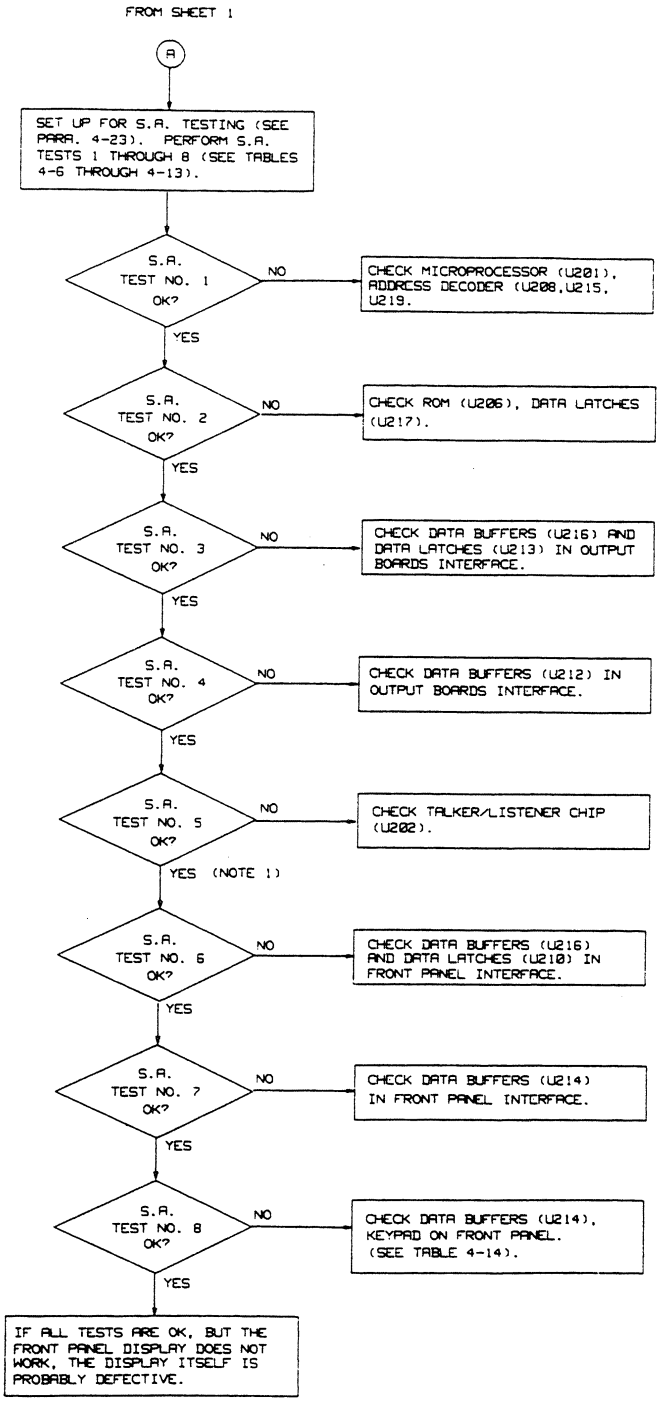


Figure 4-6 (Sheet 2). GPIB Board and Front Panel Troubleshooting and Board Isolation

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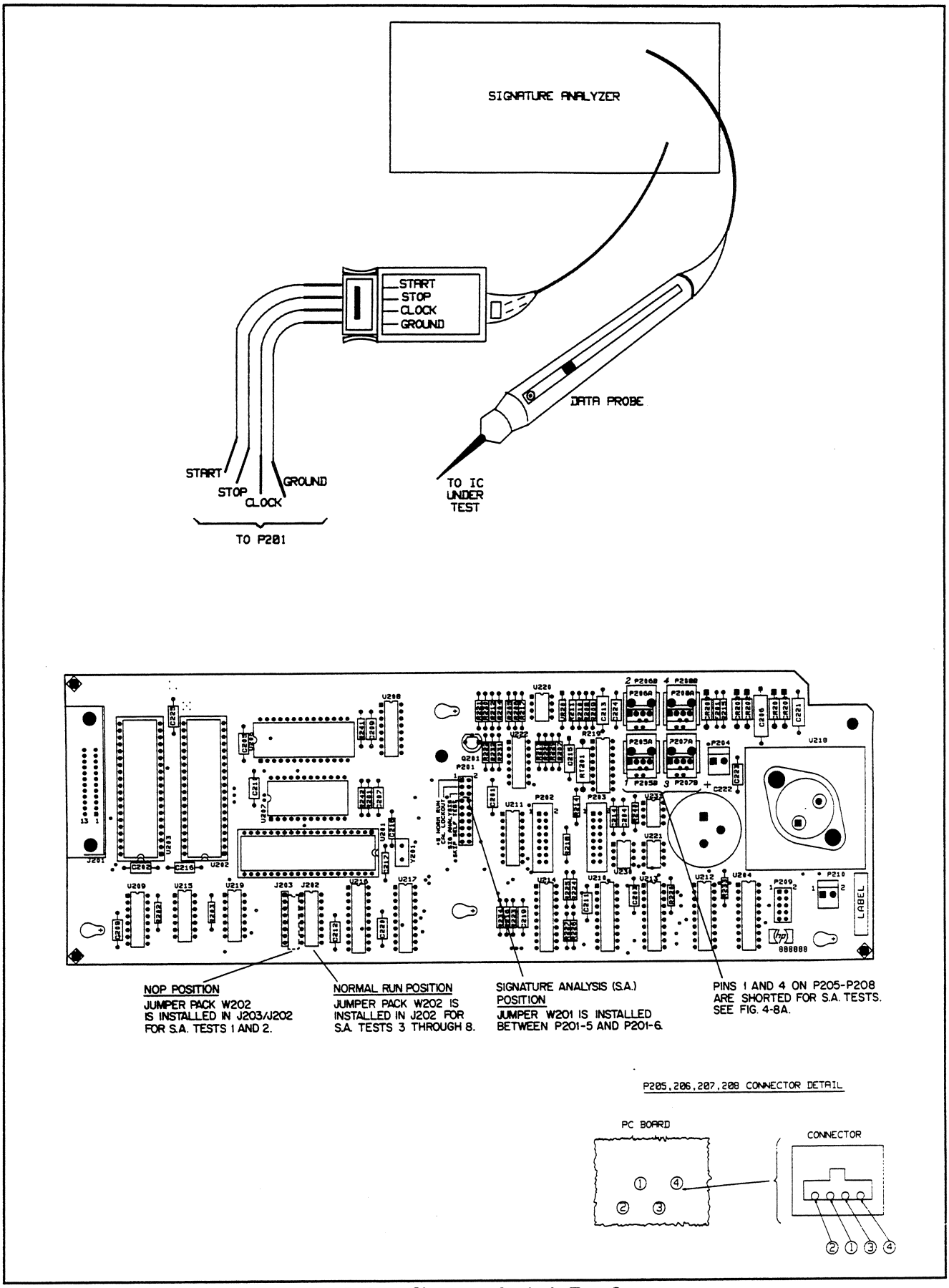


Figure 4-7. GPIB Signature Analysis Test Setup

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

Description: This test checks Microprocessor (U201) address lines AO-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 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 key at the output pins listed below.

Circuit	Output	Signature
+5	P201-1	0003
Microprocessor Address Bus Lines	U201-8	UUUU
	U201-9	FFFF
	U201-19	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 revisions listed. Refer to Appendix A for previous versions.

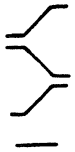
Date code -->		2839	2919	2943	2944	3029	3028
Revision #-->		A.00.00	A.00.01	A.00.00	A.00.02	A.00.01	A.00.03
Part Number ->		06626-80005	06626-80005	5080-2141	06626-80005	5080-2141	06626-80005
Circuit	**Output**	**Signatures**					
+5	P201-1	0001	0001	0001	0001	0001	0001
	U206-11	SHUH	14P1	HP34	2H39	UUHA	HU27
	U206-12	F8HA	1853	8U21	PAAP	7H3U	4F2U
ROM U206	U206-13	9A9U	FHF9	U81U	HHFA	9007	12PC
Data Bus Lines	U206-15	6153	P4C0	1U38	FAUA	255H	395F
	U206-16	739A	7HU2	3H18	FPFA	3H18	FPFA
	U206-17	7UU5	7250	1H95	6F1U	1H95	6F1U
	U206-18	8P57	9682	A911	72HU	132A	F8P4
	U206-19	2156	312P	A77H	7067	A77H	7067
	U217-2	APUU	8A71	6U1C	969H	UUPF	PU92
	U217-5	646F	8F28	F791	7556	CP9P	A616
U217 System	U217-6	FH4P	P6P5	7F0P	PPP4	4802	8974
Microcomputer	U217-9	C0A8	U259	8U9H	P57F	12AU	1FAU
Data Latches	U217-12	39FF	CPU8	1P8H	P764	198H	P764
	U217-15	CUUC	C929	0PFC	360P	0PFC	6473
	U217-16	F72A	4C40	5489	C96P	8994	F8P4
	U217-19	10AA	9896	53CU	3832	53CU	3832

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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 Inteface Circuit.

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		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
+5			P201-1	3U9F
	U216-2	1561		
	U216-4	OFHU		
SYSTEM	U216-6	03F6		
DATA BUFFERS	U216-8	0020		
U216	U216-11	3U9H		
(Data Bus Lines)	U216-13	0008		
	U216-15	0004		
	U216-17	0002		
	U213-3	1561	U213-2	OACO
	U213-4	OFHU	U213-5	066U
OUTPUT BOARDS	U213-7	03F6	U213-6	01P3
INTERFACE	U213-8	0020	U213-9	0010
DATA LATCHES	U213-13	3U9H	U213-12	3U9F
U213	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 NOP 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.

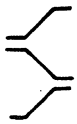
Circuit	Input	Signature	Output	Signature
+5			P201-1	3U9F
	U212-2	1561	U212-3	0003
	U212-4	OFHU	U212-5	0000
OUTPUT BOARD	U212-6	03F6	U212-7	0000
INTERFACE	U212-8	0020	U212-9	0000
DATA BUFFERS	U212-11	0000	U212-12	0020
U212	U212-13	0000	U212-14	03F6
	U212-15	0000	U212-16	0FHU
	U212-17	0003	U212-18	1561

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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 NOP 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 and output pins listed below.

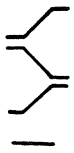
Circuit	Input	Signature
+5	P201-1	7U39
	U201-12	60U7
	U202-13	183H
GPIB	U202-14	060U
TALKER/LISTENER	U202-15	0183
U202	U202-16	0060
(Bidirectional Bus)	U202-17	0018
	U202-18	0000
	U202-19	0006

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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 NOP 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
+5			P201-1	3U9F
	U216-2	1561		
	U216-4	OFHU		
SYSTEM	U216-6	03F6		
MICROCOMPUTER	U216-8	0020		
DATA BUFFERS	U216-11	0010		
U216	U216-13	0008		
	U216-15	0004		
	U216-17	0002		
	U210-3	1561	U210-2	OAC0
	U210-4	OFHU	U210-5	066U
FRONT PANEL	U210-7	03F6	U210-6	01P3
INTERFACE	U210-8	0020	U210-9	0010
DATA LATCHES	U210-13	0010	U210-12	0008
U210	U210-14	0008	U210-15	0004
	U210-17	0004	U210-16	0002
	U210-18	0002	U210-19	0001

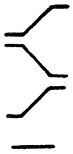
Note: The output of U210 to keyboard is not tested during S.A.

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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 despressed.

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		11
STOP		12
CLOCK		18
GND		4

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

Circuit	Input	Signature	Output	Signature
+5			P201-1	3U9F
	U214-2	3U9F	214-18	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	U214-12	0000
U214	U214-13	3U9F	U214-00	
			08	
	U214-15	0004		
	U214-17	0002		

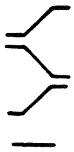
Note: The output of U210 to keyboard is not tested during S.A. Errors in input signature to U214 may be caused by U210.

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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 NOP 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 singatures 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 schematicaly.

KEY	SIGNATURES							
	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	3U96
STO	3U9F	3U9F	3C96	3U9F	3U9F	3C96	3U9F	3U9F
RCL	3U9F	3U9F	3UIH	3U9F	3U9F	3UIH	3U9F	3U9F
RANGE	3U9F	3U9F	3U9F	3UIH	3UIH	3U9F	3U9F	3U9F
OVSET	3788	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	3788
CP	3U9F	3UIH	3U9F	3U9F	3U9F	3U9F	3UIH	3U9F
RESET	3U9F	3U9F	3788	3U9F	3U9F	3788	3U9F	3U9F
VOLT ↑	3U9F	3U9F	3U9F	3788	3788	3U9F	3U9F	3U9F
VOLT ↓	2UC5	3U9F	3U9F	3U9F	3U9F	3U9F	3U9F	2UC5
CURR ↑	3U9F	3788	3U9F	3U9F	3U9F	3U9F	3788	3U9F
CURR ↓	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	3C96
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
VOLT ↑	11	11 and 14	11
RANGE V/J	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
VOLT ↓	10	10 and 7	17
OVSET	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
CURR ↑	11	11 and 5	15
OCP	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
CURR ↓	10	10 and 3	13
RESET	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 4-8. 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 4-8 will isolate the problem to a component(s) on the defective output board or will refer you to other troubleshooting charts (Figures 4-10 to 4-14) to continue troubleshooting. Figure 4-9 illustrates waveforms on the output card to aid you in troubleshooting. Figure 4-10 provides troubleshooting procedures when a problem has been isolated to one to the DAC/amplifier circuits on the defective output board. Figures 4-11 through 4-14 provide troubleshooting procedures for various trouble symptoms which may be encountered.

In addition to the troubleshooting flow charts described above, subsequent paragraph 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, amplifier, signal comparator) on the output board are replaced, the associated output channel must be recalibrated as described in Appedix 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 6 (+5) must be tied to pin 7 (timer) before the supply is turned on.

This short may be removed once the routine starts (≈ 1 sec.). To return the supply to normal operation the AC must be cycled off then back on.

Immediately following turn-on, the RAM and ROM self tests on U312 are performed provided that the $\overline{\text{PCLR}}$ signal from the signal processor (U327) goes High. Then, the self exercise routine begins. This routine runs independently of the GP IB board which is ignored by an output board operating in this mode. During the routine, the display indicates "HDWERR 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 4-8.

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, U321, and U363. Each DAC is programmed from zero to –5V. This is accomplished by starting with the LSB and turning on each successive bit. The DAC output is programmed back to zero.

Table 4-15 lists the signals that should be present on pins 1 through 28 of U312 during the self exercise routine. Figure 4-9 illustrates the waveforms that should be observed at various points on the output board during the self exercise routine. The waveforms shown on these figures are referenced in the troubleshooting procedures of Figure 4-8.

Figure 4-9 shows what the output of the CV DAC (U360 pins 6), CC DAC (U361, pin6), and Readback DAC (U362 pin 6) should look like (19 steps total in waveform). Figure 4-9 shows what the output of the OV DAC (U319D pin14) should look like (8 steps total).

All inputs and outputs of U367 and U368 (Programming and readback range address decoders) are execised. The output of the analog multiplexer U323 may be exercised using the VMUX? command.

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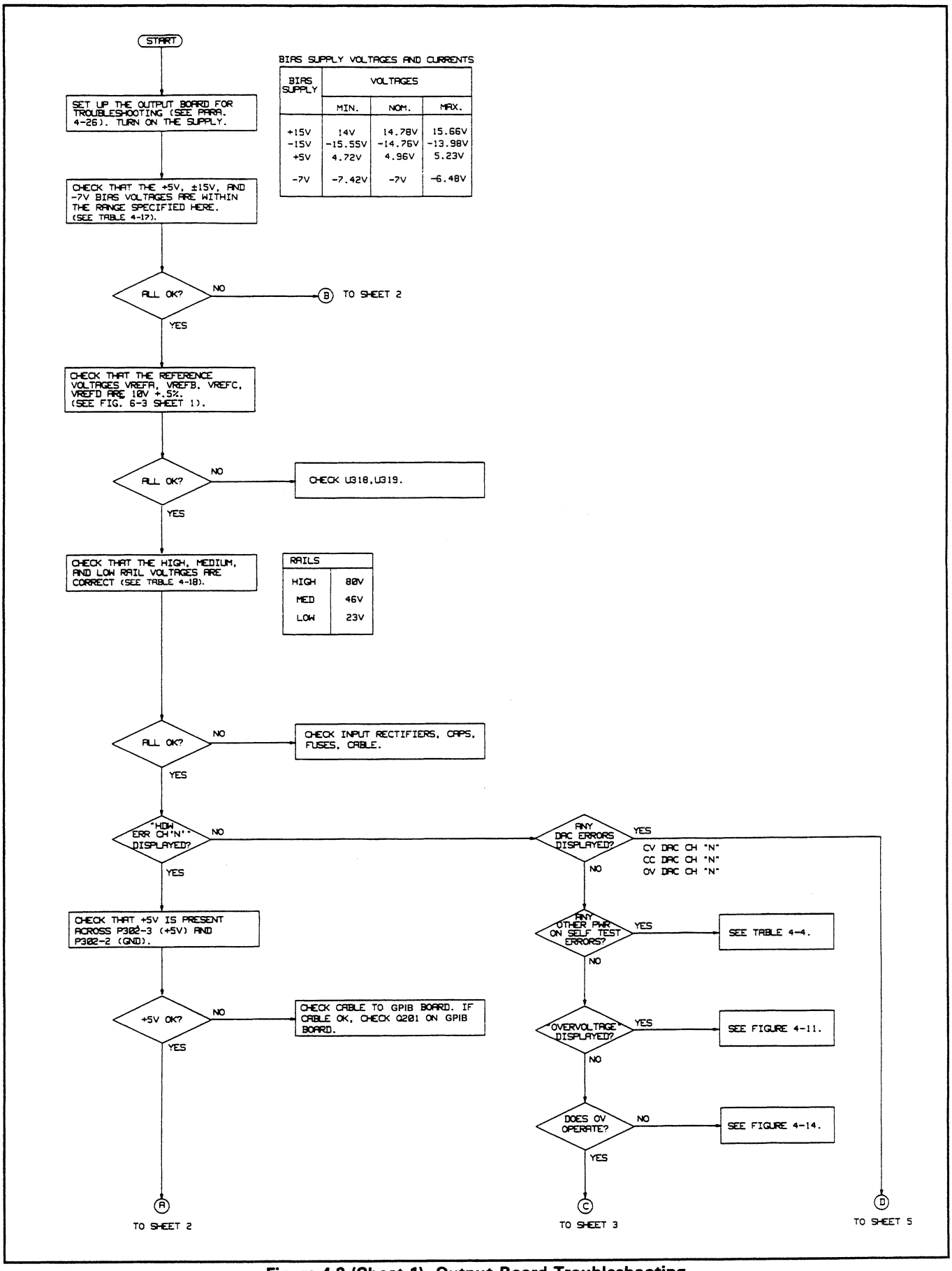


Figure 4-8 (Sheet 1). Output Board Troubleshooting

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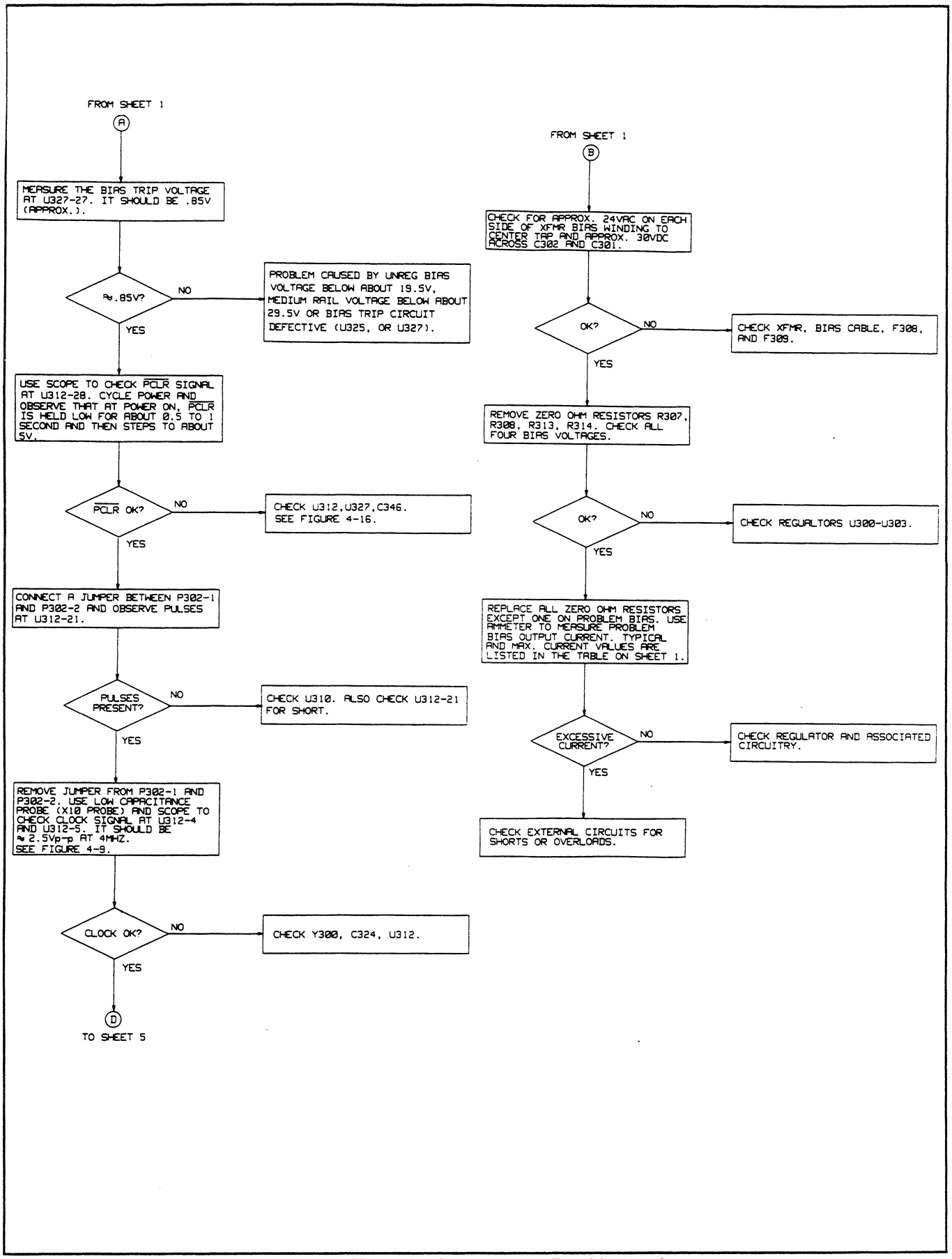


Figure 4-8 (Sheet 2). Output Board Troubleshooting

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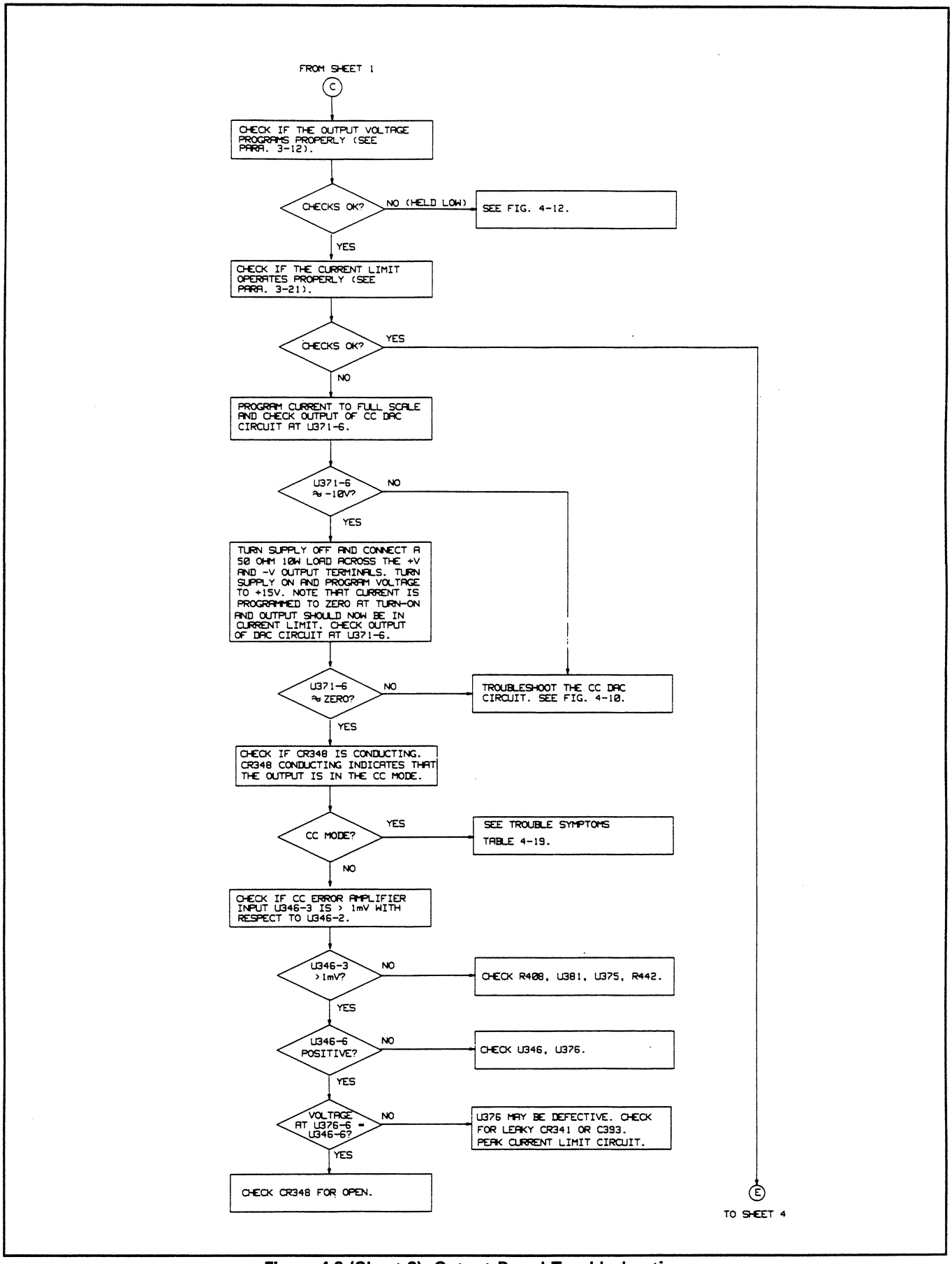


Figure 4-8 (Sheet 3). Output Board Troubleshooting

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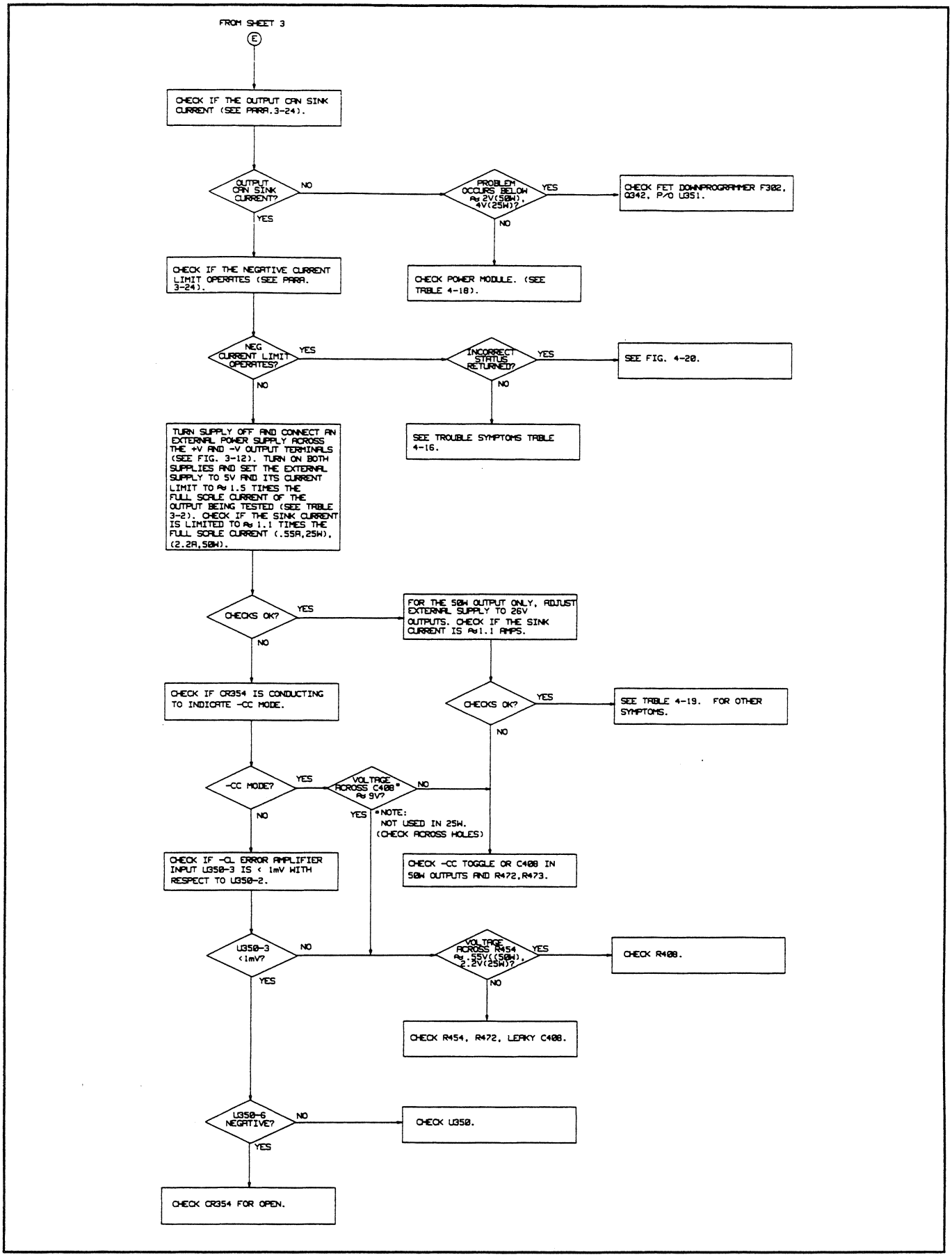


Figure 4-8 (Sheet 4). Output Board Troubleshooting

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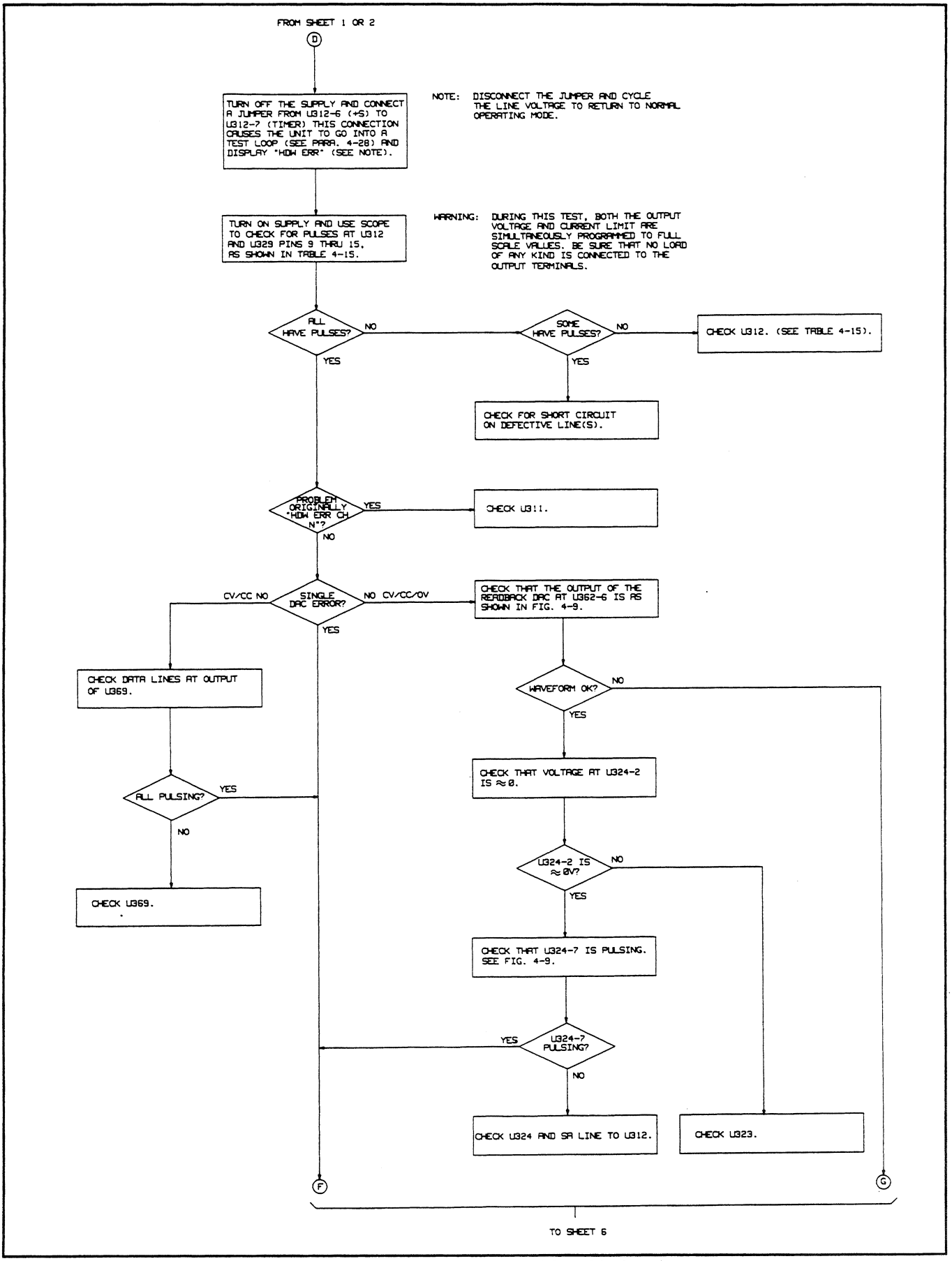


Figure 4-8 (Sheet 5). Output Board Troubleshooting

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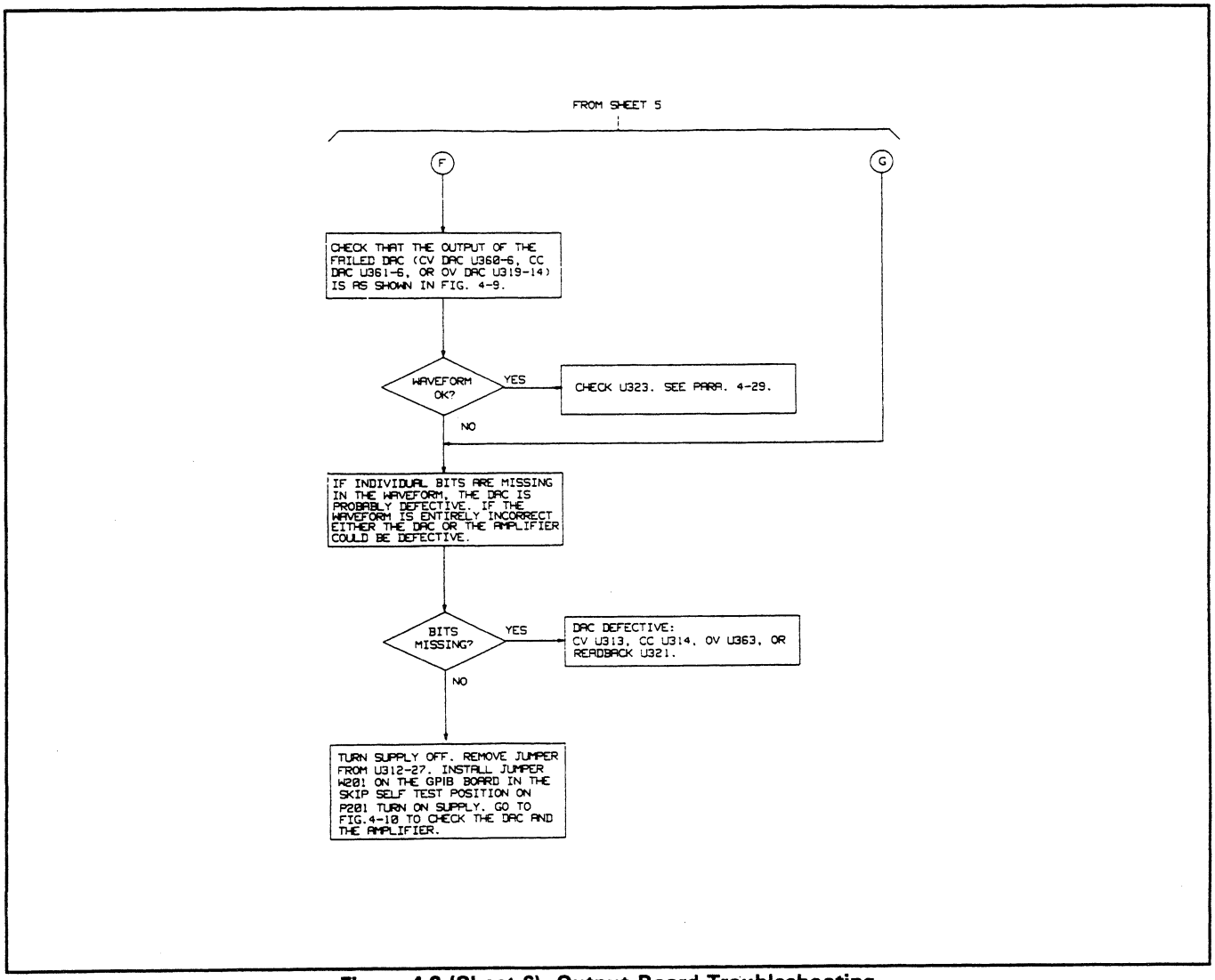
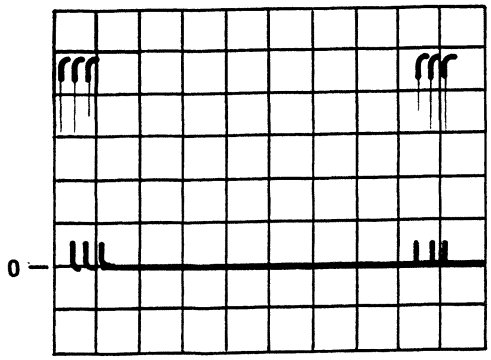
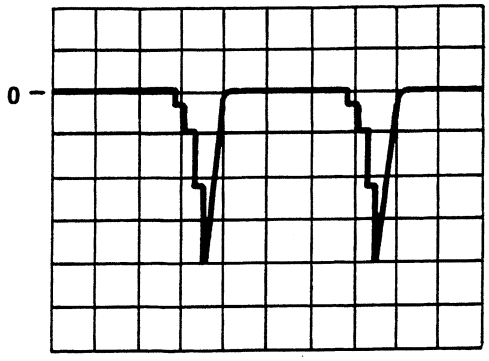


Figure 4-8 (Sheet 6). Output Board Troubleshooting

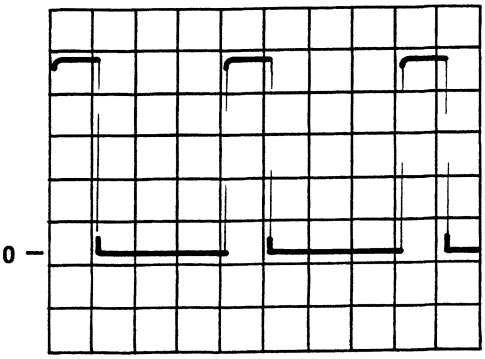
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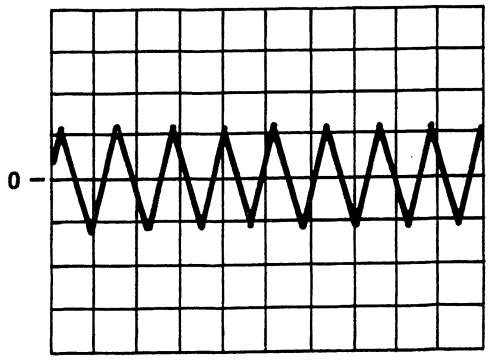
A. Typical Dataline U3R (17 shown)
1 V/cm, 5 mS/cm



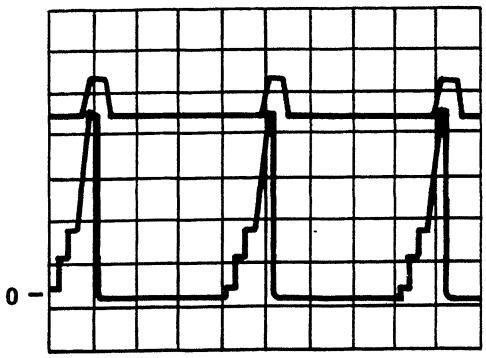
B. Differental Amplifier U352-6
1 V/cm, 5 mS/cm



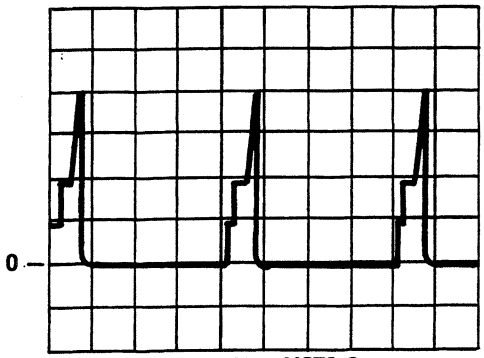
C. Readback Sign Comparator U324-7
1 V/cm, 5 mS/cm



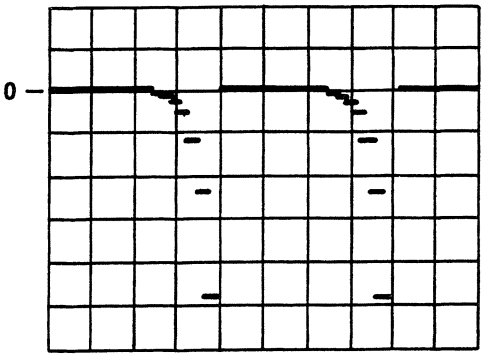
D. 4 MHz Oscillator U312-5
1 V/cm, 0.2 μS/cm
(AC coupled)



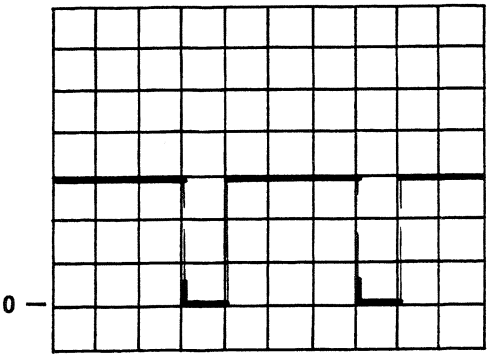
E. 1 Bypass U338-5, 2 +Output
5 V/cm, 5 mS/cm



F. CV DAC Buffer U372-6
1 V/cm, 5 mS/cm



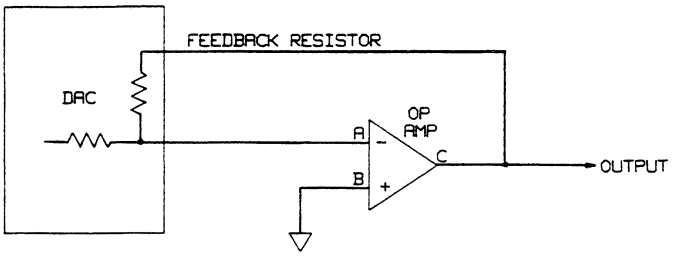
G. DAC's U378-6, U371-6, U362-6, U319-14
(8 Bit) 1 V/Cm, 5 mS/cm



H. FET Downprogrammer Q342 Gate
5 V/cm, 5 mS/cm

Figure 4-9. Output Board Waveforms During Self Test 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	U360
CL	U314	U361
OV	U363	U319
READBACK	U32'	U362

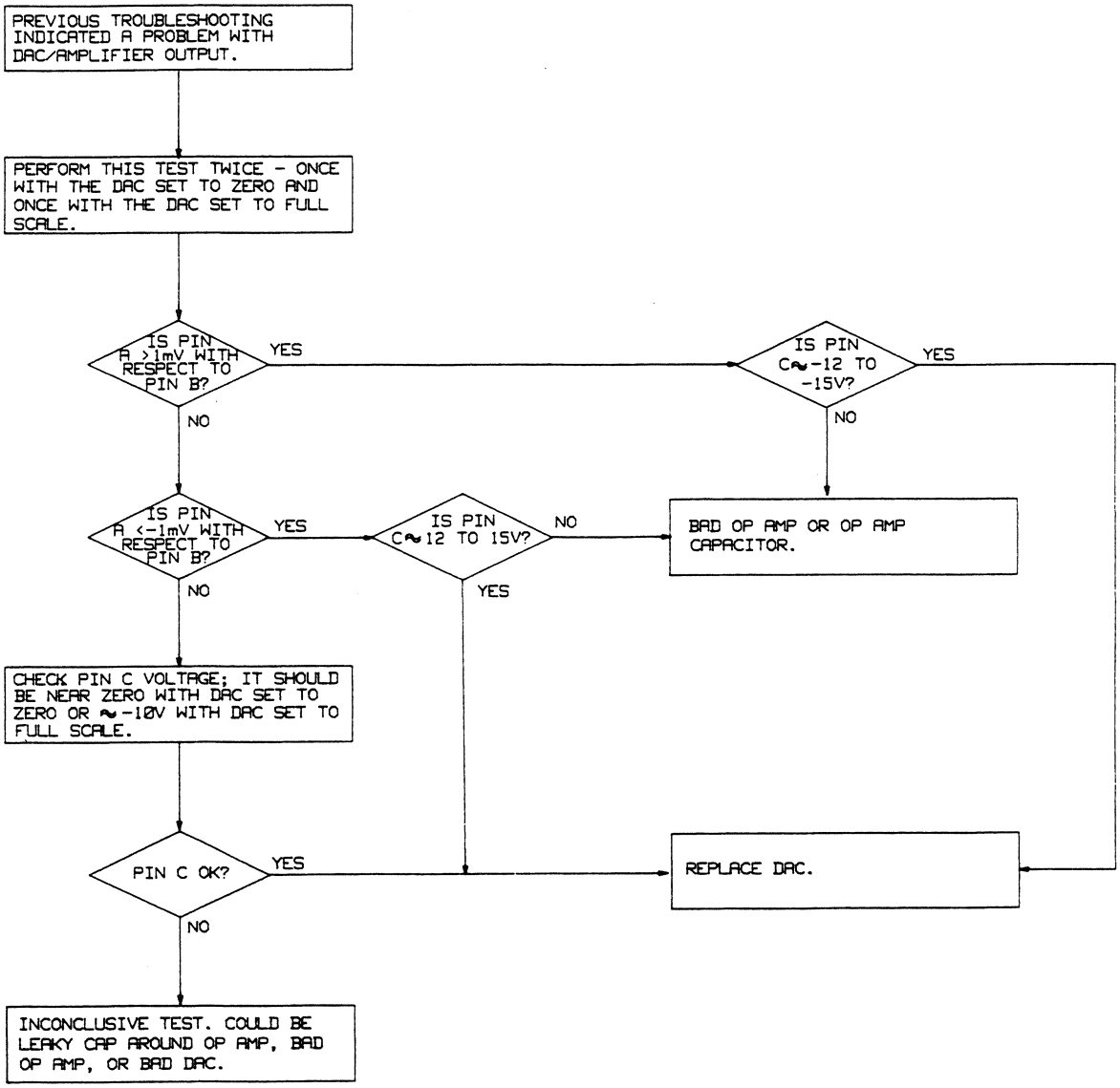


Figure 4-10. DAC/Amplifier Circuit Troubleshooting

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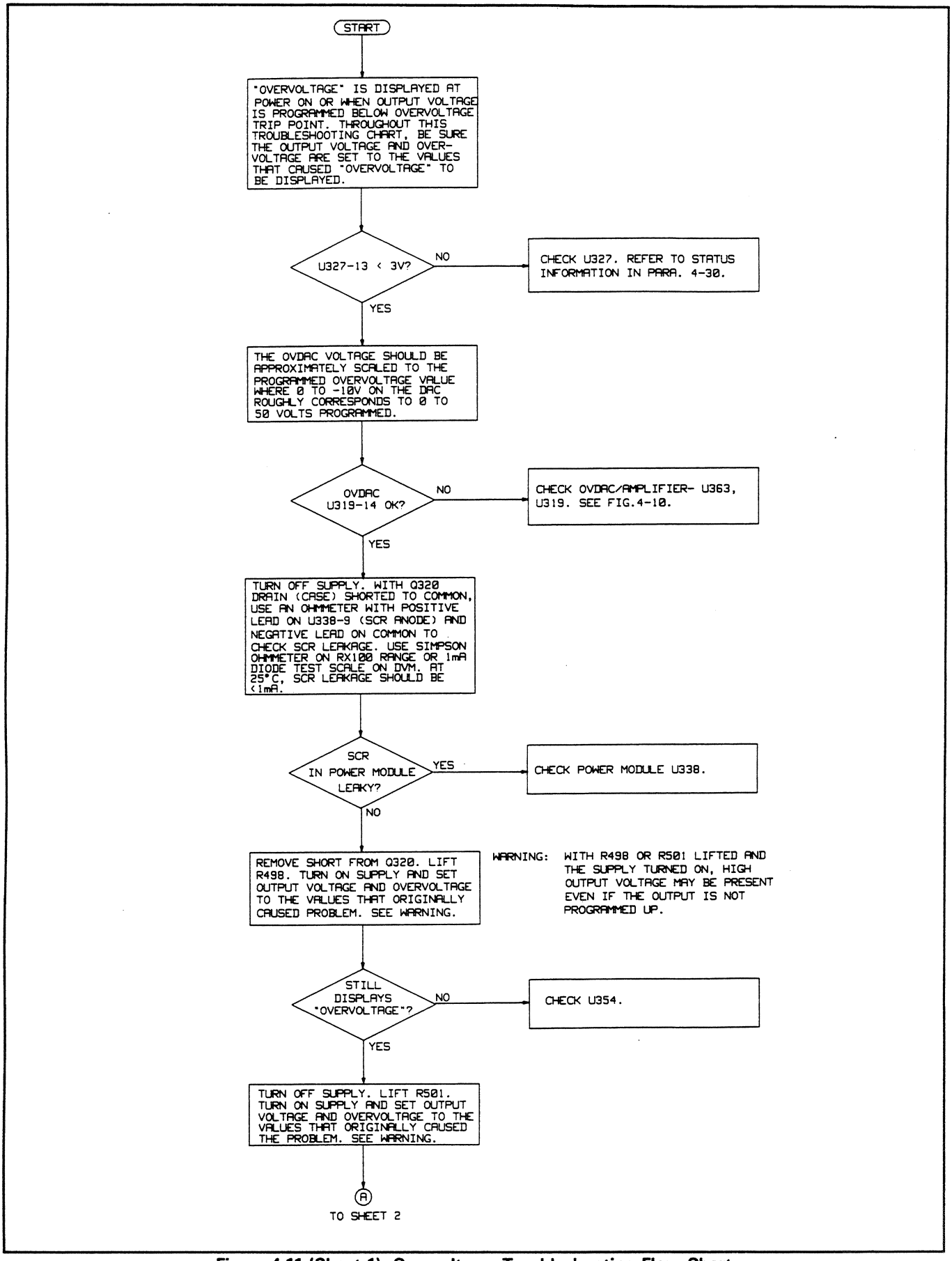


Figure 4-11 (Sheet 1). Overvoltage, Troubleshooting Flow Chart

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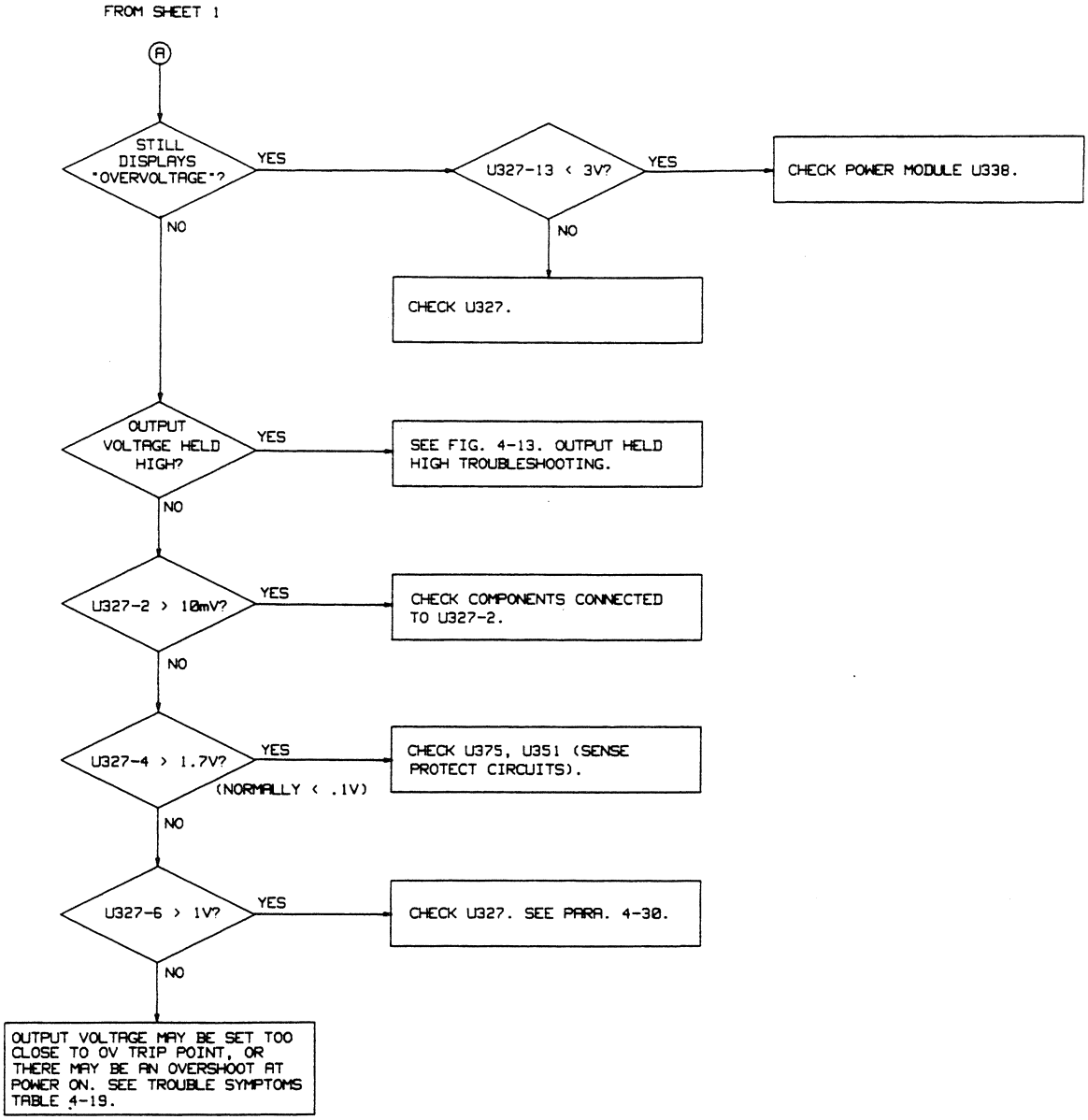


Figure 4-11 (Sheet 2). Overvoltage, Troubleshooting Flow Chart

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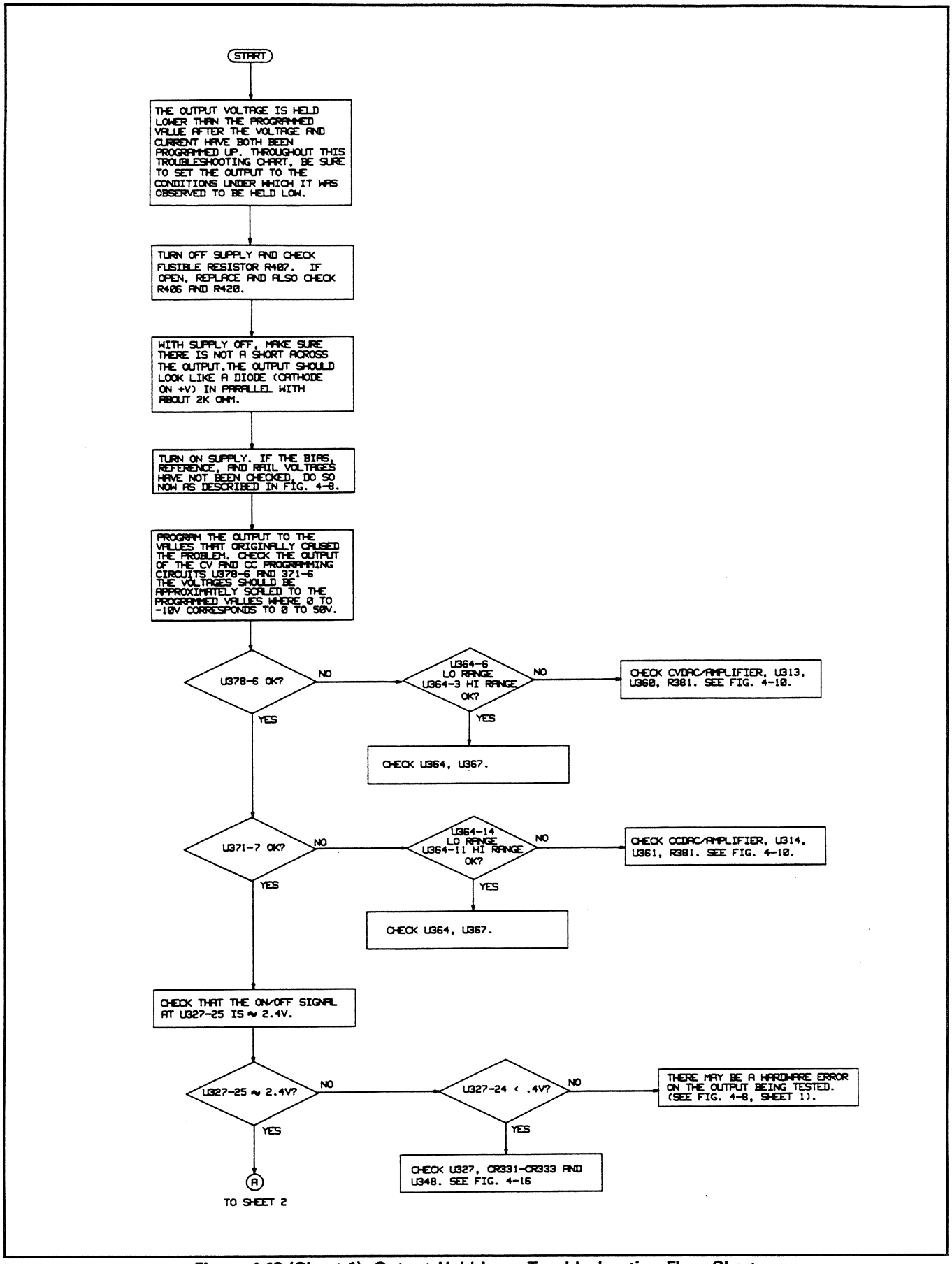


Figure 4-12 (Sheet 1). Output Held Low, Troubleshooting Flow Chart

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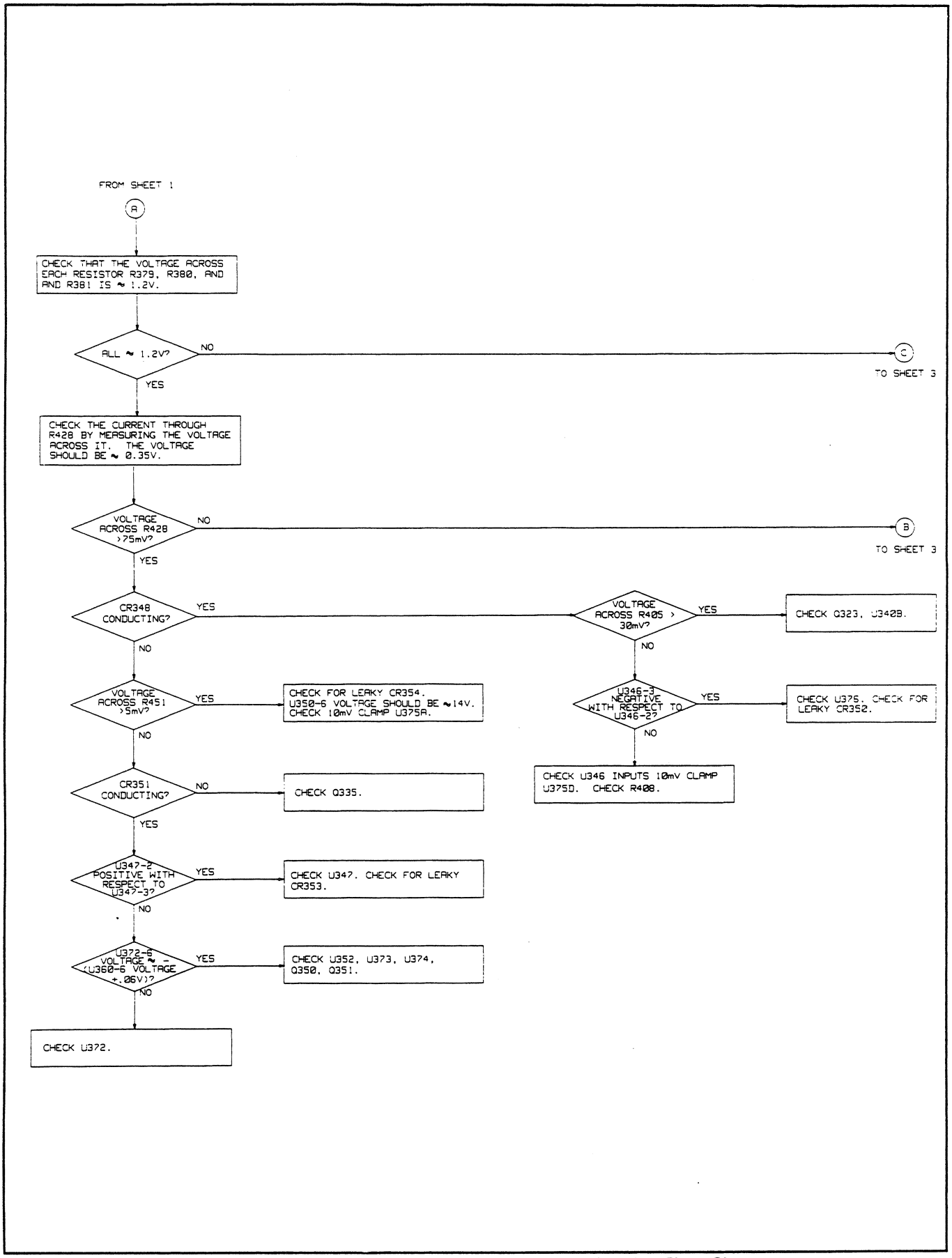


Figure 4-12 (Sheet 2). Output Held Low, Troubleshooting Flow Chart

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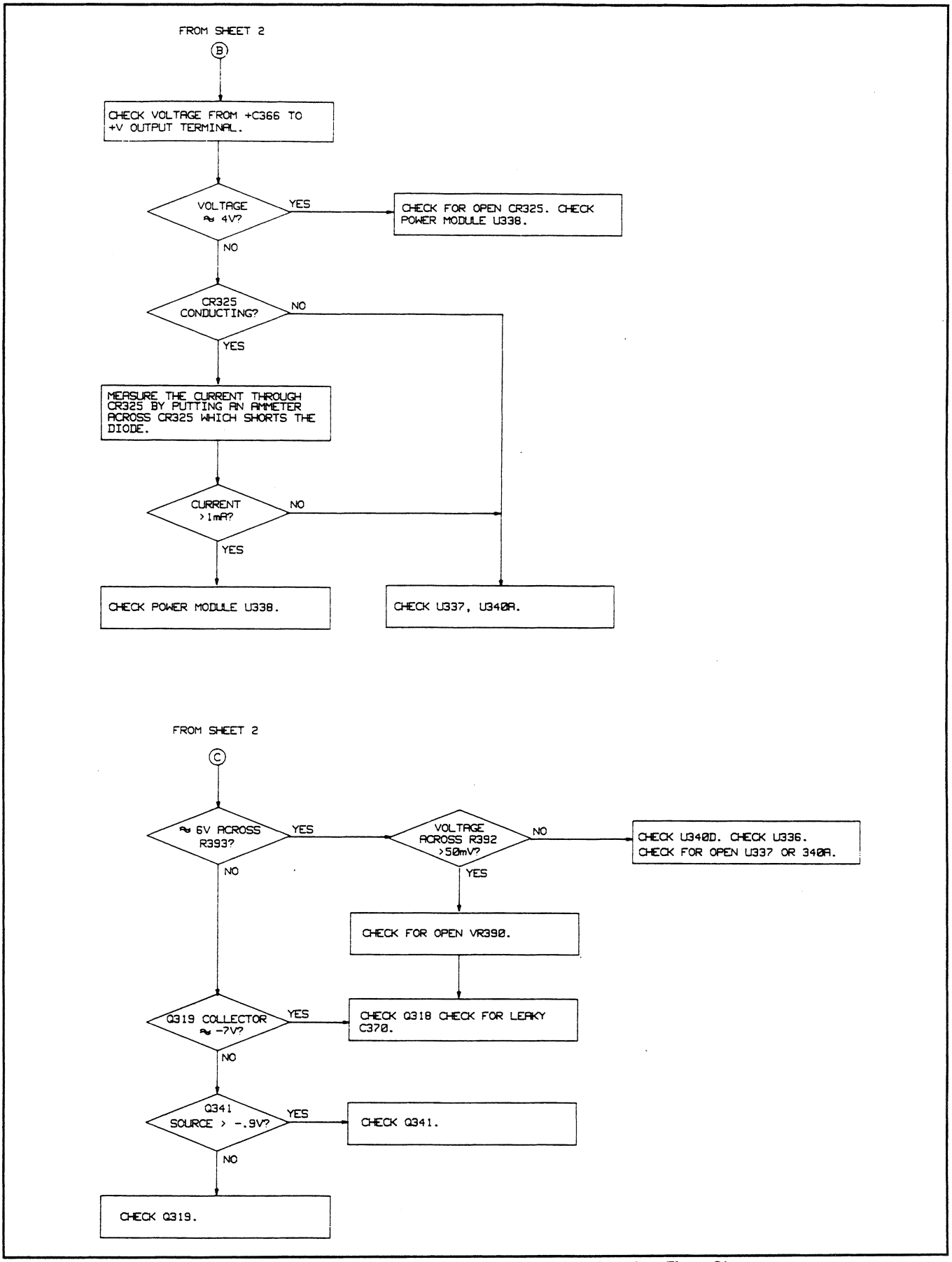


Figure 4-12 (Sheet 3). Output Held Low, Troubleshooting Flow Chart

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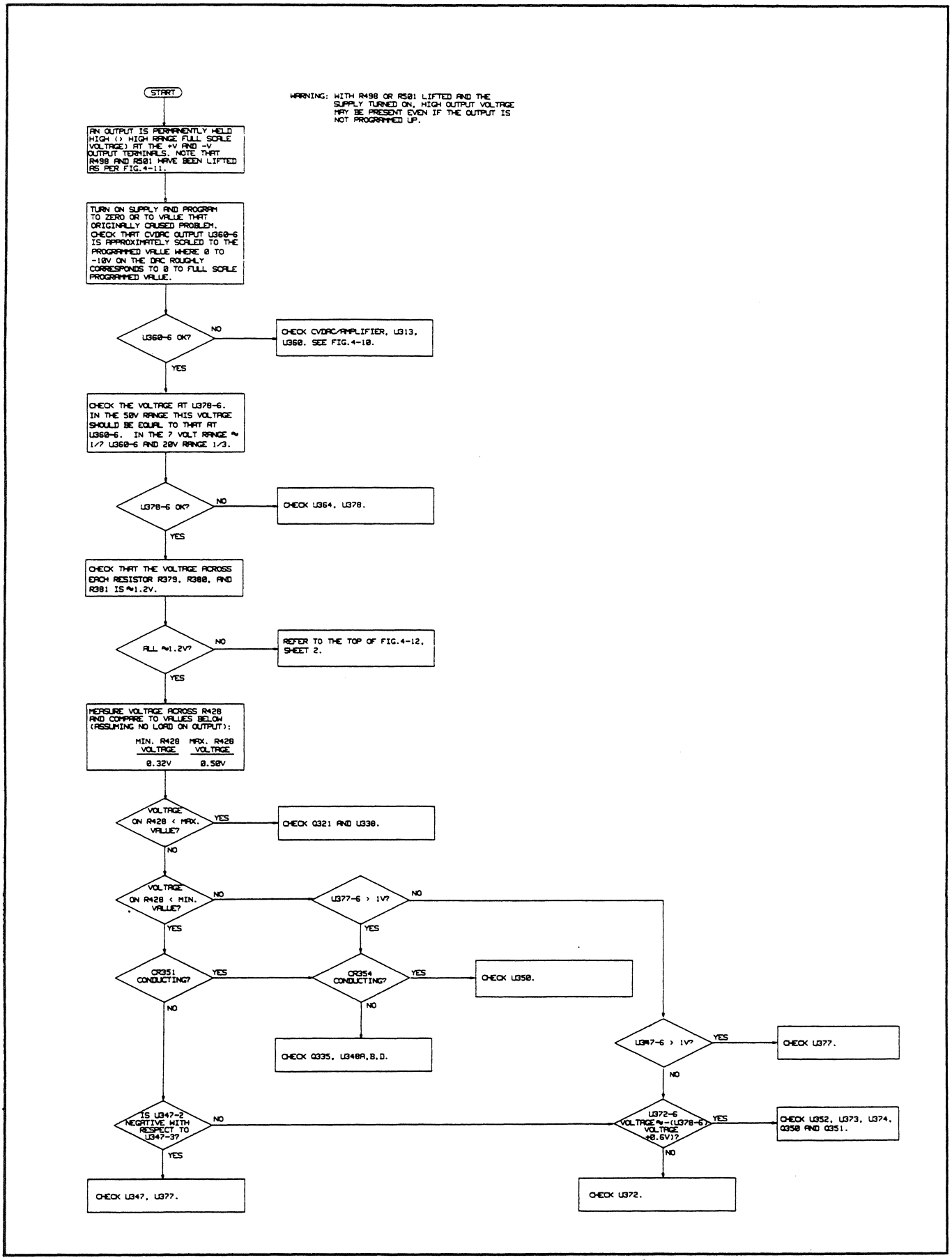


Figure 4-13. Output Held High Troubleshooting

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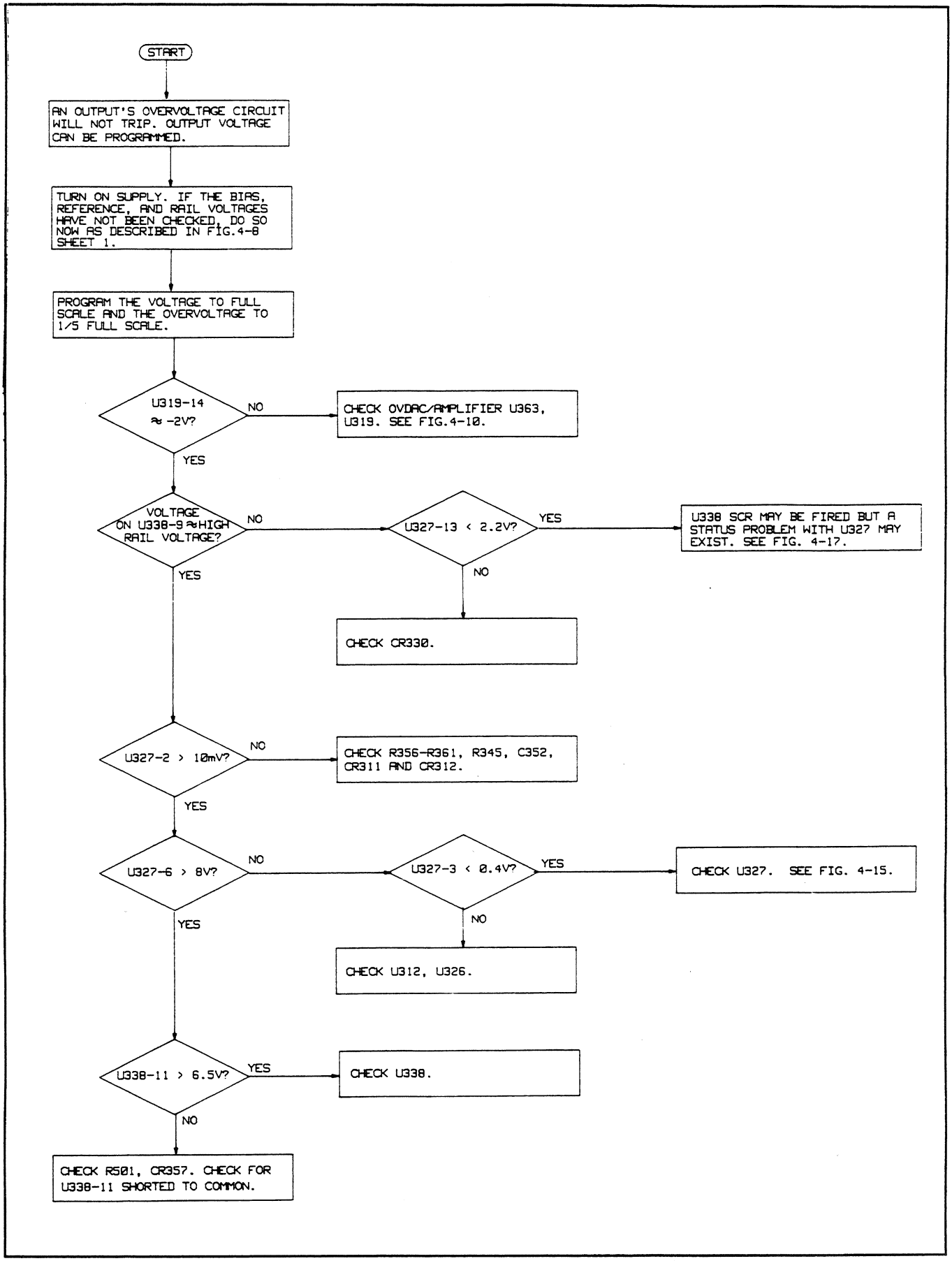


Figure 4-14. OV Will Not Trip, Troubleshooting Flow Chart

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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	Low
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	(Pulses ≈ 1/sec.)
22	Low
23	High
24	Pulses
25	Pulses
26	Pulses
27	Pulses
28	Low to High @ Turn on

* Referenced to ▽ (Common)

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

Analog multiplexer U323 and readback switches U365/U366 directs one of several 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 4-16). The syntax for the VMUX? command is as follows:

VMUX? <ch>, <code>

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.DDDD (see Table 5-2 in the Operating Manual of an explanation of these abbreviations). The resolution of the returned voltage reading is approximately 0.5 mV.

The analog multiplexer circuit is shown on the functional schematic of Figure 6-3, Sheet 1 and on he block diagram of Figure 2-4. The eight input signals to the analog multiplexer U323 are shown in table 4-16.

The VMUX? command reads back approximately – 1.05 times the voltage that appears on the selected input. Its readback range is limited to approximately + 0.2 V to – 10.5 V on the input pins. However, any positive voltage from approximately + 0.1 V to + 10 V on the input pins will readback about – 0.2 V.

After the VMUX? command is processed, the selected switches and MUX 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.

The next program* uses a FOR/NEXT loop to read the 18 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 program run which follows).

```
10 FOR X=1 TO 18
20 OUTPUT 705;"VMUX? 1";X
30 ENTER 705;V
31 OUTPUT 723;"FIR2T1"
32 ENTER 723;Vm
40 PRINT "VMUX? Response";X;" = ";V;"VM reads";Vm
50 NEXT X
60 END
```


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A typical program run is shown below.

VMUX? Response 1 = .2179 VM reads .009
VMUX? Response 2 = .2283 VM reads 0
VMUX? Response 3 = .2179 VM reads 6.548
VMUX? Response 4 = .2179 VM reads .196
VMUX? Response 5 = .2179 VM reads .949
VMUX? Response 6 = .2179 VM reads 6.705
VMUX? Response 7 = .2179 VM reads 9.404
VMUX? Response 8 = .2179 VM reads 9.419
VMUX? Response 9 = .2179 VM reads 13.336
VMUX? Response 10 = .2179 VM reads 6.548
VMUX? Response 11 = .2179 VM reads 3.98
*VMUX? Response 12 = .2179 VM reads 13.844
**VMUX? Response 13 = .2179 VM reads 5.171
**VMUX? Response 14 = .2179 VM reads 13.64
VMUX? Response 15 = .2179 VM reads 0
VMUX? Response 16 = .2179 VM reads .009
VMUX? Response 17 = .2179 VM reads 0
VMUX? Response 18 = .2179 VM reads .949

* Exceed – 10 V limit because value exceeds low range limit.
** Positive voltage due to op amp saturation.
Note that there is a 200 mV offset in "V" which allows for negative voltage.

The Table 4-16 shows the 18 input voltage values as well as the VMUX? response for a typical calibrated 25 WATT output (300 mA Load) whose voltage and current has been programmed to the Low voltage range and high current. The output is set to 5 volts and 0.5 Amps.

If all of the inputs read back by the VMUX? command are incorrect, the analog multiplexer U323 and/or the readback circuitry is probably defective. If only on 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 4-17 which lists the voltage levels and defines the low and high states. This information in used in conjunction with the pin description (paragraph 4-31) and simplified schematics to troubleshoot the signal processor's overvoltage (Figure 4-15), power-on/start-up (Figure 4-16), and status monitor circuits (Figure 4-17). Additional troubleshooting information for the status monitor circuit is given in paragraph 4-32 and Figure 4-18.

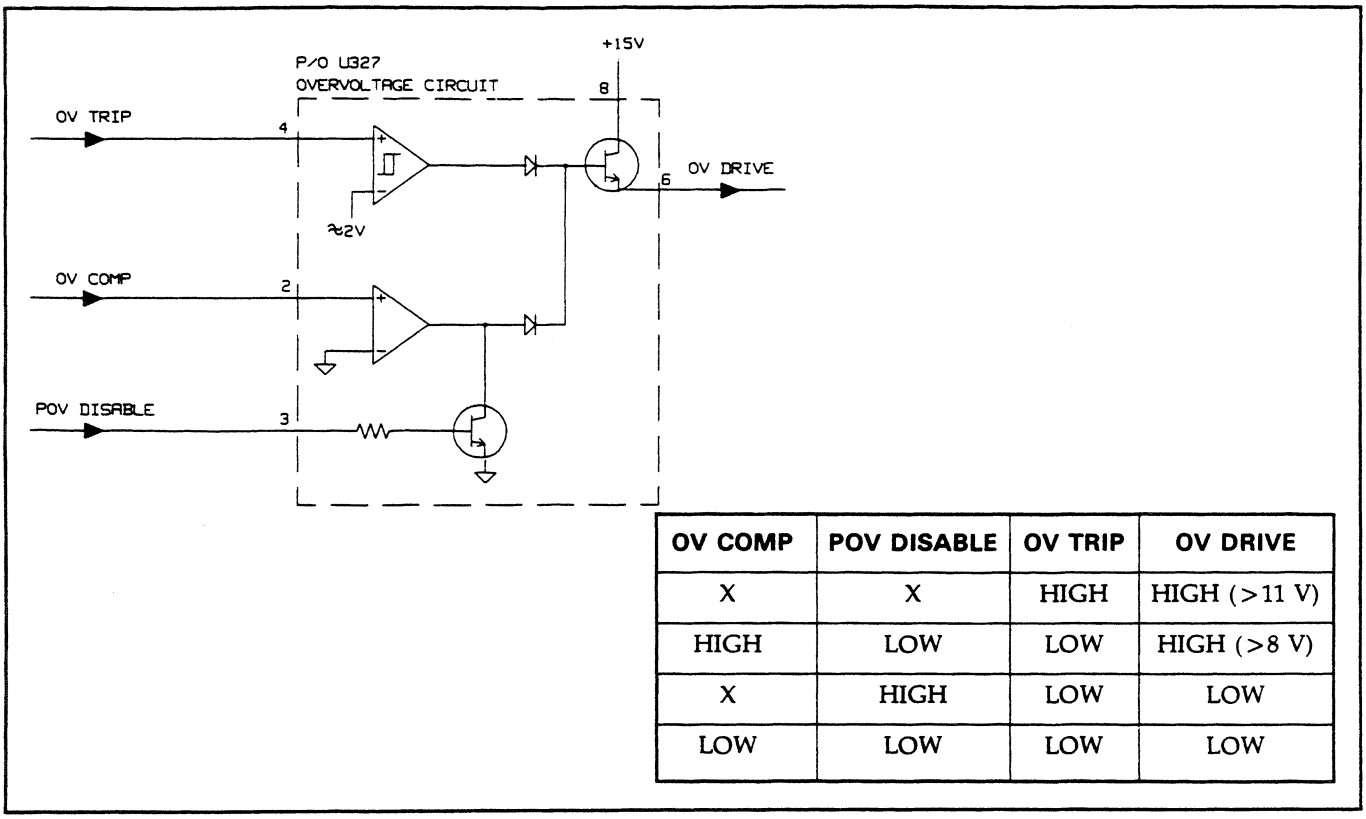
4-31 Signal Processor (U327) Pin Function Description. The signal processor's circuits are shown on the functional schematic of Figure 6-3, sheet 1, and on the block diagram of Figure 2-4. The 28 Signal processor pins are described as follow.

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

Table 4-16 U368 MEASUREMENTS

VMUX CODE	(Measured Parameter) FUNCTION	SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12	U323 INPUT	Approx. Vm
		Switches are neg. true (0 = Closed)									
1	COM									1	0
2	FUSE									2	0 (–0.75 to –10 = Blown Fuse)
3	Vin									3	0 to –10
4	NOT USED									––	––
5	Vfs (50V range)									5	0 to –10
6	CV DAC									6	0 to –10
7	CC DAC									7	0 to –10
8	OV DAC									8	o to –10
9	CLR	1	1	1	1	1	1	1	1	3	0 to –10
10	V (low range)	1	0	1	1	0	1	1	0	3	0 to –10
11	+I (high range)	0	1	1	0	1	1	0	1	3	0 to –10
12	+I (low range)	0	1	1	0	1	0	1	1	3	0 to –10
13	–I (high range)	1	0	0	1	1	1	0	1	3	0 to –10
14	–I (low range)	1	0	0	1	1	0	1	1	3	0 to –10
15	I (high zero)	0	0	1	1	1	1	0	1	3	0
16	I (low zero)	0	0	1	1	1	0	1	1	3	0
17	V (zero)	0	0	1	1	0	1	1	1	3	0
18	V (high range)	1	0	1	1	0	1	1	0	5	0 to –10

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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 4-15. Signal Processor U327, Overvoltage Circuit, Simplified Schematic Diagram

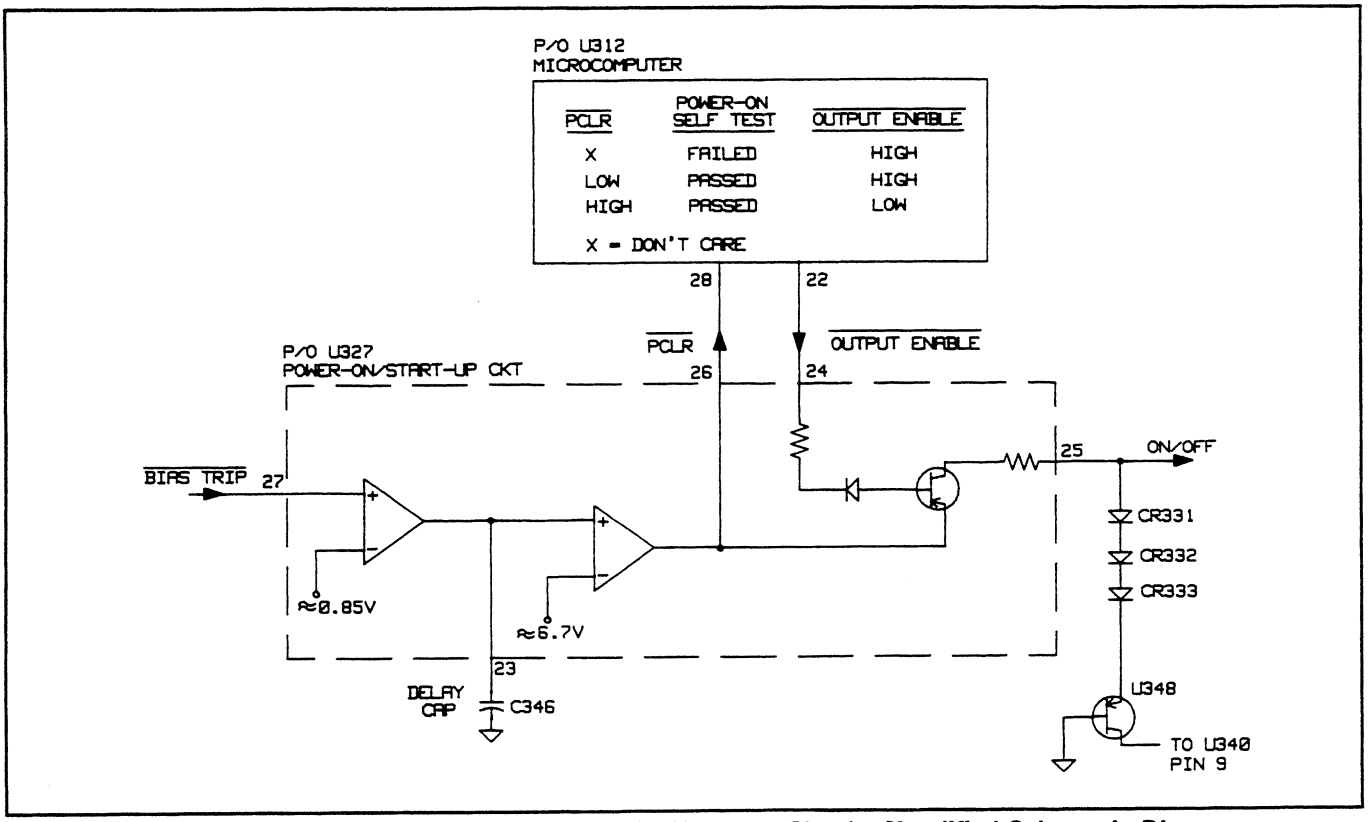


Figure 4-16. Signal Processor U327, Power-On/Start-Up Circuit, Simplified Schematic Diagram

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Table 4-17. 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(↑)	0 V	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	$\overline{\text{OT}}$	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	−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 >0.85 V±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 fro pin 25 would read < 6.8 V (which is 0.1 V lower than – 6.7 V).
3. **See OV DRIVE (pin6) 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 ± 0.15 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., THERM, pin 14, is LOW only when the voltage decreases to a level <2.5 V ± 0.15 V).

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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 4-15).

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 4-17 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 indicate when – $\overline{\text{CLO}}$ is Low. Figure 4-17 shows the condition 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 ($\overline{\text{CVO}}$, $\overline{\text{+ CLO}}$, - $\overline{\text{CLO}}$, $\overline{\text{UNREG}}$, OV, and OT). When $\overline{\text{STATUS SELECT}}$ is High, the six output pins are open-circuited.

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

$\overline{\text{OV SENSE}}$ (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 $\overline{\text{STATUS SELECT}}$ (pin 11) is Low.

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

OT (pin 15): This open collector output signal goes High when both the STATUS SELECT (pin 11) and $\overline{\text{THERM}}$ (pin 14) inputs are Low indicating an OT (overtemj2erature) condition. OT is open-circuited when STATUS SELECT is High.

-$\overline{\text{CL LOOP}}$ (pin 16): This input signal, when Low, indicates that the supply's output is in negative current limit. Figure 4-17 shows how this signal is decoded causing $\overline{\text{- CLO}}$ (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.

$\overline{\text{+ CLO}}$ (pin 18): This open-collector output signal takes on the state of the internal + CC flip-flop when $\overline{\text{STATUS SELECT}}$ (pin 11) is Low. Figure 4-17 shows the conditions that cause $\overline{\text{+ CLO}}$ to be Low. The + CC mode is indicated when $\overline{\text{+ CLO}}$ is Low. $\overline{\text{+ CLO}}$ is open-circuited when $\overline{\text{STATUS SELECT}}$ is High.

$\overline{\text{CVO}}$ (pin 19): This open collector output signal takes on the state of the internal CV flip-flop when $\overline{\text{STATUS SELECT}}$ is Low. Figure 4-17 shows the conditions that cause $\overline{\text{CVO}}$ to go Low. The CV mode is indicated when $\overline{\text{CVO}}$ is Low. $\overline{\text{CVO}}$ is open-circuited when $\overline{\text{STATUS SELECT}}$ 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 $\overline{\text{+ CLO}}$ (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 4-17). A High level at pin 21 indicates that the output is unregulated. Figure 4-17 shows how the CV LOOP signal is decoded causing $\overline{\text{CVO}}$ (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 $\overline{\text{BIAS TRIP}}$ (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 $\overline{\text{PCLR}}$ (pin 26) to go High. When $\overline{\text{BIAS TRIP}}$ is Low, this signal causes a quick discharge of the external delay capacitor (see Figure 4-16).

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

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ON/OFF (pin 25): This output pin goes High when PCLR (pin 26) is High and OUT ENABLE (pin 24) is Low (see Figure 4-16). 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 4-16). 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 4-17. To troubleshoot status problems, set up an oscilloscope as described below and refer to Figure 4-17 and the troubleshooting procedures of Figure 4-18.

a. Connect oscilloscope Channel A at 2 volts/div to STATUS SELECT (U327, pin 11).
b. Trigger on Channel A, negative slope. Set time base to 10 µS/div.
c. The 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 4-17 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 4-17 for the voltage values that correspond to a particular input line being High or Low.
e. Follow the procedures outline Figure 4-18.

4-33 Power Module Signals

Table 4-18 gives the function and typical signal levels at each pin for a properly operating power module (U338). 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.

Table 4-18. Typical Power Module U338 Voltage Levels

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

Notes: 1. Conditions:
   a. Output voltage set to maximum programmable value (20V or 50V).
   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. 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.

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.

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Table 4-19. Miscellaneous Trouble Symptoms

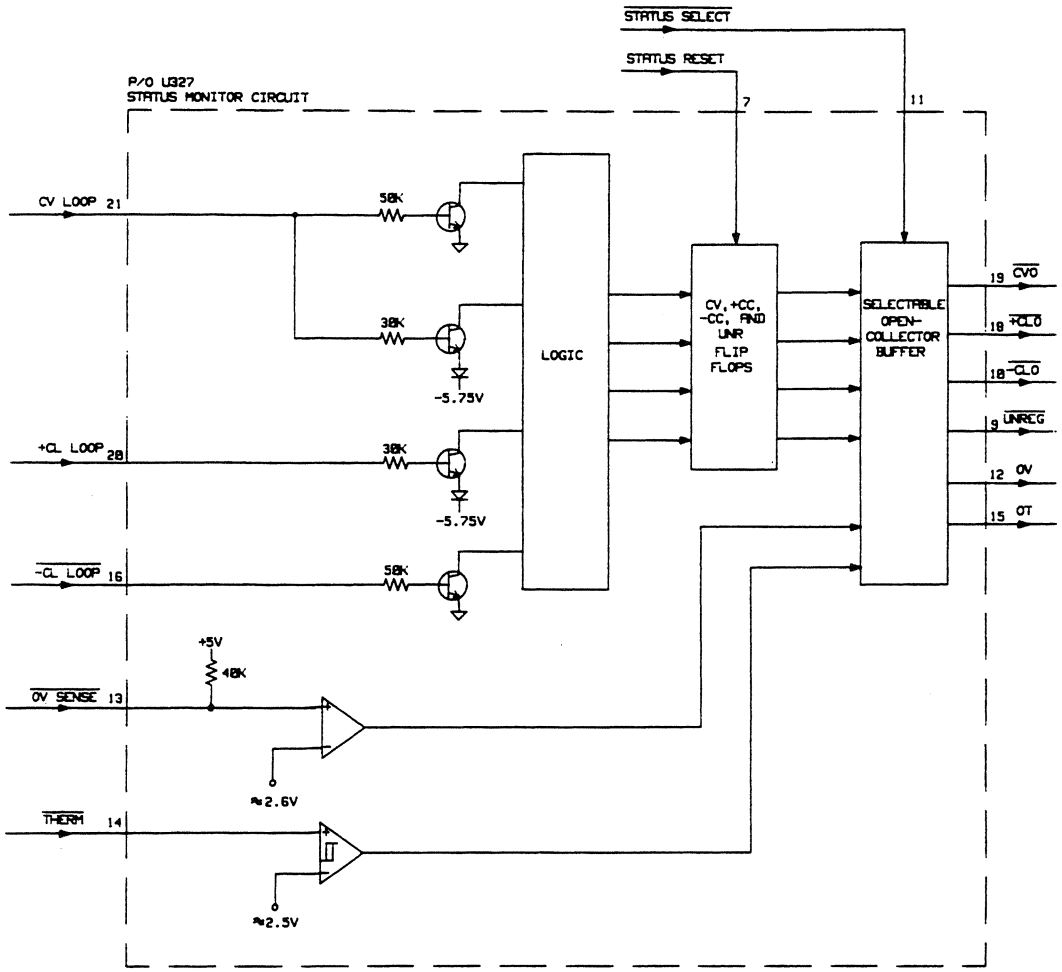
Trouble Symptom	Remedy
Spikes on output	See paragraph 3-15 for proper noise measurement technique. Check dress of GPIB board cabling. Check GPIB board and output board for loose ground screws. Check for sense lead pick up (see paragraph 4-12 in the Operating Manual).
Ripple on output	Check for ripple 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 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, U372-U374, U377 and U347. 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. Check guard amplifiers U373, U374, U375 and 10 mV clamp U375.
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. If current readback error, 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. If in the 50 V range only CHECK VFS input U323. If in other voltage or current ranges check U365, U366, U315 U382. See Table for switch closures.
Overshoot or overvoltage at turn on (output may apparently work properly after turn on)	Check for proper operation of FET Q339 and transistor U348A. Check for slow turn on of Q319 as controlled by C371. Check for leaky current sources U336, U340D boards, by shorting U327-23 (delay cap) to common to turn off Q319 and Q318. 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 C437 in the sense protect circuit. Check for open C429, C359. 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 U372 CV DAC buffer circuit. Check CR347 in the CC loop. When not in the CC mode, check that U376-6 is approximately −14 volts, so that the CC loop will not interfere with up programming. Check C393. If unit down programs slowly, check U348B, R428, −CC Circuit U350 and FET Down Programmer Q342.

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Table 4-19. Miscellaneous Trouble Symptoms

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.
''OVERTEMP'' displayed	Check for proper fan operation. Check that the power module is screwed down tightly to the heatsink. Check voltage on U327-14 against Table 4-16 (see paragraph 4-30). Check R355 and C345. If the over temperature condition occurs rapidly after application of output load, power module U338 may be defective.
Fuse F303 in the output return line blows after being replaced	Check for shorted capacitor(s) C375, C376 from power module pin 5 to common. Check for open CR327. Check power module U338.

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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 4-17. Signal Processor U327, Status Monitor Circuit, Simplified Schematic Diagram

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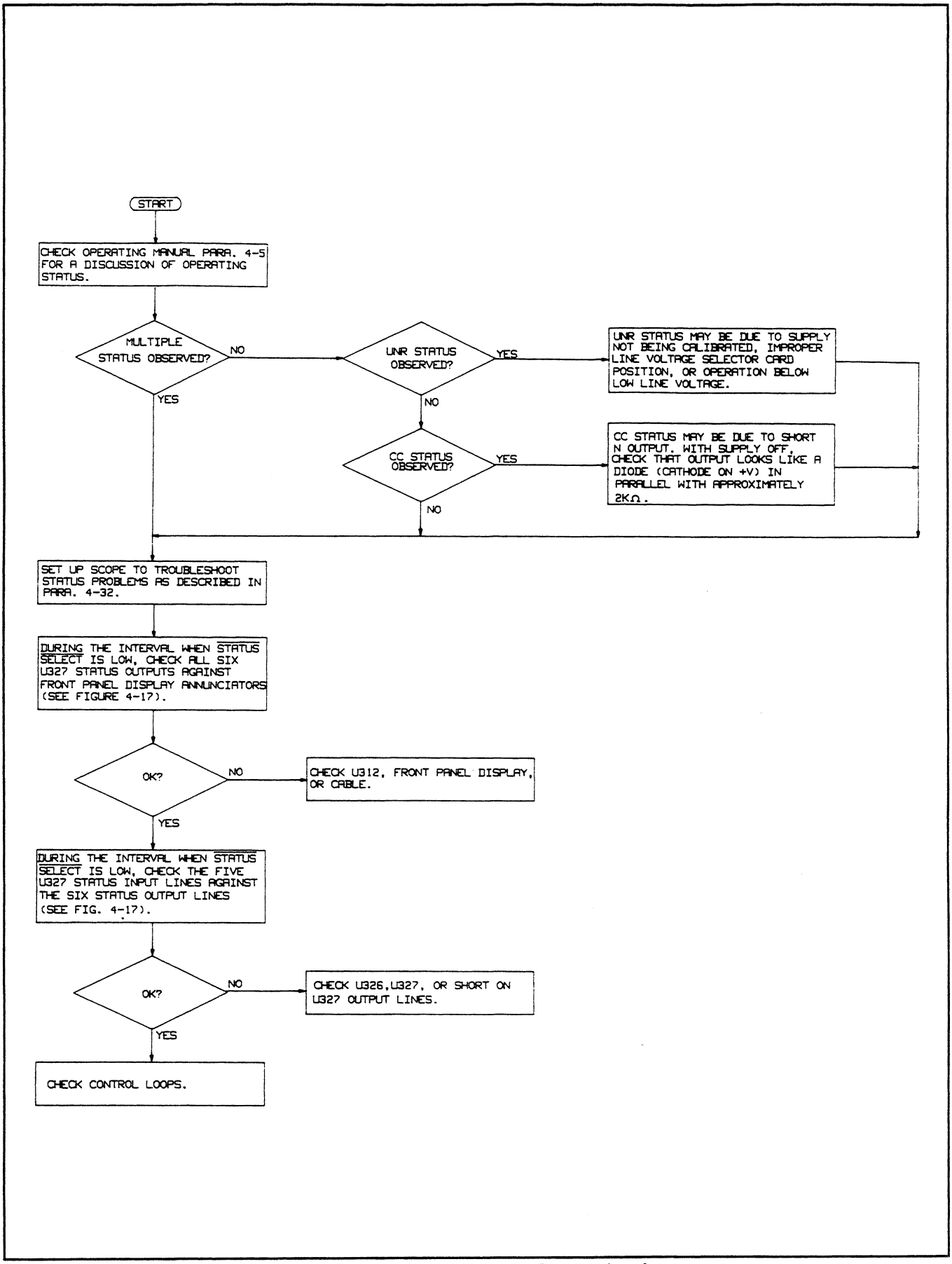


Figure 4-18. Status Problems Troubleshooting

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Section V
REPLACEABLE PARTS

5-1 INTRODUCTION

This section contains information on ordering replacement parts. Tables 5-5 through 5-8 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 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 for all models.

Table 5-7 lists all of the electrical and mechanical parts on the 25W/0.5 Amp output board. Table 5-8 lists all the electrical and mechanical parts on the 50W/2 Amp board. 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
6625A	25W/0.5A	50W/2A	NU	NU
6626A	25W/0.5A	25W/0.5A	50W/2A	50W/2A
6628A	50W/2A	50W/2A	NU	NU
6629A	50W/2A	50W/2A	50W/2A	50W/2A

5-2 HOW TO ORDER PARTS

You can order parts from your local Agilent 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 part number.
b. A description of the part.
c. The quantity desired.
d. The model number 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
S	—	Switch
T	—	Transformer
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
DHR	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
MACHL	Machine
META	Metalized Paper
METPOL	Metalized Polycarbonate
MOD	Module
MOS	Metal Oxide Semiconductor
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

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Table 5-3. Description of Abbreviations (continued)

RGLTR	REGULATOR
ROM	Read Only Memory
SCR	Screw
SHLD	Shoulder
STDF	Standoff
TAN	Tantalum
TBAX	Tube, Axial
VAR	Variable
VLTG REG	Voltage Regulator
WASH	Washer
WW	Wire Would
XFMR	Transformer
XSTR	Transistor
ZNR	Zener

Table 5-4. Federal Manufacturer Codes

Code	Manufacturer	
01121	Allen Bradley Company	Mlwaukee, WI
16299	Corning Glass Works	Raleigh, NC
07263	Fairchild Semiconductor Corp.	Hicksville, NY
28480	Agilent Technologies	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, MA
01281	TRW Inc.	Philadelphia, PA
01295	Texas Instruments Inc. (Semi Div)	Dallas, TX

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Table 5-5. CHASSIS Replacement Parts List

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
		Chassis – Boards		
	06626-61026	**GPIB BOARD** Assembly (see Table 5-6)	28480	
		Output Board 1		
	06626-61020	Models 6625A, 6626A (25W/.5A)(see Table 5-7)	28480	
	06626-61023	Models 6628A, 6629A (50W/2A)(see Table 5-8)	28480	
		Output Board		
	06626-61023	Models 6625A, 6628A, 6629A (50W/2A)(see Table 5-7)	28480	
	06626-61020	Model 6626A (25W/.5A)(see Table 5-8)	28480	
		Output Board 3		
	Not Used	Models 6625A, 6628A	28480	
	06626-61021	Models 6626A, 6629A (50W/2A)(see Table 5-8)		
		Output Board 4		
	Not Used	Models 6625A, 6628A	28480	
	06626-61021	Models 6626A, 6629A (50W/2A)(see Table 5-8)		
		Chassis – Cabling		
W1	8120-1345	LINE CORD	28480	
W2	5060-3273	TRANSFORMER TO AC LINE SWITCH	28480	
W3	5060-3110	FAN WIRE	28480	
W4	5060-3264	XFMR ASSY (PRIMARY)	28480	
W5	5060-3271	XFMR - GPIB BIAS	28480	
W6	8120-5174	GPIB - OUTPUT BD.	28480	
W7	8120-5177	GPIB - OUTPUT BD.	28480	
W8	**6625A, 6628A**			
	NOT USED		28480	
	6626A, 6629A			
	8120-5175	GPIB - OUTPUT BD.		
W9	**6625A, 6628A**		28480	
	NOT USED		28480	
	6626A, 6629A		28480	
	8120-5176	GPIB - OUTPUT BD.	28480	
W10	5060-3268	XFMR (POWER 25W/.5A)		
W11	5060-3269	XFMR (BIAS)	28480	
W12	06627-80006	XFMR (POWER 50W/2A - BIAS)		
W13	**6625A, 6628A**			
	NOT USED		28480	
	6626A, 6629A			
	5060-3268	XFMR (POWER 50W/2A)		
W14	**6625A, 6628A**		28480	
	NOT USED		28480	
	6626A 6629A			
	5060-3269	XFMR (BIAS)		
W15	**6625A, 6628A**			
	NOT USED			
	6626A, 6629A			
	5060-3266	XFMR (POWER 50W/2A - BIAS)		
W16	06624-80011	FRONT PANEL HARNESS		

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Table 5-5. CHASSIS Replacement Parts List (continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
		Chassis - Mechanical/ Electrical		
TB001	0360-2195	BARRIER BLOCK 6-TERM THRMP 2.307-IN-L 1642 8	28480	
	06624-20007	BARRIER BLK COVER	28480	
	0360-2310	JUMPER (REF BARRIER BLK)	28480	
	0380-0643	STANDOFF-HEX .225 IN	28480	
	0380-1670	SPCR SNAP IN (REF DUST COVER)	28480	
	0403-0085	B M N P FT PRS-I N	28480	
	0515-0885	SCR MACH M4X0.7 (REF XFMR, F.P. GND)	28480	
	0515-0890	SCR MACH M3X0.5	28480	
	0515-0897	SCR MACH M3X0.5	28480	
	0515-0906	SCR MACH M4X0.7 (REF SCR U338)	28480	
	0515-0920	SCR MACH M3X0.5	28480	
	0515-0932	SCR MACH M5X0.8 (REF ASSY-CHAS,XFMR)	28480	
	2190-0421	WASHER-FLAT (REF U338)	28480	
	0515-1132	SCR MACH M3X0.8	28480	
	0515-1146	SCR MACH M3X6MM	28480	
	0535-0023	NUT HEX DB L CRAM	28480	
	0535-0031	NUT HEX W/LKWR	28480	
	0590-0534	NUT SELF THD (REF ASSY-FT PNL)	28480	
	06621-80003	LABEL REAR (6625A)	28480	
	06624-80009	LABEL REAR (6626A)	28480	
	06624-00013	COVER	28480	
	06626-40001	COVER-DUST	28480	
	06624-00009	CHASSIS MAIN	28480	
	5040-1672	BUSHING (REF U338)	28480	
	06626-40001	DUSTCOVER (REF OUTPUT BOARDS)		
	06626-80006	LABLE (REF DUSTCOVER (06626-40001)		
	1200-0180	INSULATOR XSTR (REF Q321)	28480	
	1200-0181	INSULATOR-XSTR NYLON (REF 0321)	28480	
P301	1251-4246	CONN-POST TYPE .156-PIN-SPCG 3-CONT	28480	
	1251-8105	CONN-POST-TP-HDR (REF PC ASSY-FT PNL) 40	28480	
P403	1252-1670	CONN-POST TYPE .156-PIN-SPCG 5-CONT 0077 9	28480	
REF0321	1200-0181	INSUL 41	28480	
P302	1252-2493	0077 9 42	28480	
	2110-0269	FSHLDR-CLP-TYP.25D-FUSE (REF FC308,9) 1306 0	28480	
	2190-0586	WSHR-LK HLCL LW PCBHS 4.0MM (REF U338)	28480	
	3050-0893	WSHR-FL MTLC FLW (REF U338)	28480	
	5001-0539	TRIM SIDE (REF CABINET)	28480	
	5041-8801	FEET (REF CABINET)	28480	
	5041-8819	CAP STRAP (REF CABINET HANDLE)	28480	
	5041-8820	CAP STRAP (REF CABINET HANDLE)	28480	
	5060-3221	ASSY WIRE KIT (REF PC ASSY-FT PNL)	28480	
	5060-3270	CABLE ASSY	28480	
	5060-3272	CABLE ASSY	28480	
	5062-3704	STRAP (REF CABINET)	28480	
	7120-8214	LABEL-WARNING (REF U338)	28480	
	9320-5540	LABEL-INFO	28480	

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Table 5-5. CHASSIS Replaceable Parts List (continued)

Design.	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
		Chassis Electrical		
T1				
6626A	9100-4591	TRANSFORMER - BIAS/POWER	28480	
6625A	9100-4720	TRANSFORMER - BIAS/POWER	28480	
	2110-0303	FUSE 2A 250V TD FE UL (REF F308,9)	28480	
	3160-0092	FINGER GUARD (REF COOLING FAN)	28480	
	3160-0097	COOLING FAN	28480	
	9135-0419	LINE MODULE	28480	
C0	5060-3218	CAP ASSY (REF LINE MODULE)	28480	
	0160-4259	.22µF CAP (REF 5060-3218)	28480	
F1	2110-0342	LINE FUSE FOR 110V/120V (8A 250VAC)	28480	
	2110-0055	LINE FUSE FOR 220V/240V (4A 250VAC)	28480	
		Chassis Misc.		
	5080-2120	PAD-FOAM	28480	
	9211-5421	CONTAINER, CORRUGATED	28480	
	06626-90001	MANUAL - OPERATING	28480	
		Miscellaneous		
	5040-1660	FRONT FRAME		
	06625-60002	ASSEMBLY - FRONT PANEL (6625A)	28480	
	06626-60002	ASSEMBLY - FRONT PANEL (6626A)	28480	
	06625-00002	FRONT PANEL - LETTERED (6625A)	28480	
	06626-00002	FRONT PANEL - LETTERED (6626A)	28480	
	5063-2304	LCD DISPLAY used with through-hole GPIB assemblies	28480	
	5063-3472	LCD DISPLAY used with surface-mount GPIB assemblies	28480	
	1400-0611	CABLE CLAMP (REF FRONT PANEL)	28480	
	3101-2862	SWITCH, LINE (REF FRONT PANEL)	28480	
	5040-5448	WINDOW LCD	28480	

Table 5-6A. GPIB Board, Replaceable Parts (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 5-6B. GPIB Through-hole Replacement Parts List

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C201-05	1060-4835	FXD CER. 0.1µf 10% 50VdC	28480	
C206	0180-0374	FXD ELECT. 10µf 10% 20Vdc	56289	150D106X9020B2
C207-12	1060-4835	FXD CER. 0.1µf 10% 50Vdc	28480	
C213	1060-4834	FXD CER. 0.047µf 10% 100Vdc	28480	
C214	1060-4808	FXD CER. 470pf 5% 100Vdc	28480	
C215	0180-0405	FXD ELECT. 1.8µf 10% 20Vdc	56289	150D185X9020A2
C216	1060-4835	FXD CER. 0.1µf 10% 50Vdc	28480	
C217,18	1060-4807	FXD ELECT .33pF 100V 5%	28480	
C219,20	1060-4835	FXD. CER. 0.1µf 10% 50Vdc	28480	
C221	1060-4834	FXD CER. 0.047µf 10% 100Vdc	28480	
C222	0180-3798	CAP 47001µF 25VDC	28480	
C223-25	1060-4835	FXD CER. 0.1µf 10% 50Vdc	28480	
CR201-05	1901-0731	DIODE PWR. RECT. 400V 1A	28480	
F201	2110-0712	FUSE 4A	28480	
Q201	1853-0099	TRANSISTOR PNP SI	28480	
R201-03	0757-0438	FXD FILM 5.11K 1 % 1/8W	24546	CT4-1/8-TO-6811-F
R204	0698-0083	FXD FILM 1.96K 1 % 1/8W	24546	CT4-1/8-TO-1961-F
R205	0757-0427	FXD FILM 1.5K 1 % 1/8W	24546	CT4-1/8-TO-1501-F
R206	0757-0438	FXD FILM 5.11K 1 % 1/8W	24546	CT4-1/8-TO-6811-F
R207	0757-0459	FXD FILM 56.2K 1 % 1/8W	24546	CT4-1/8-TO-5622-F
R208	0757-0442	FXD FILM 10K 1 % 1/8W	24546	CT4-1/8-TO-1002-F
R209	0757-0449	FXD FILM 20K 1 % 1/8W	24546	CT4-1/8-TO-2002-F
R210	0698-4536	FXD FILM 340K 1 % 1/8W	28480	
R211	0757-0442	FXD FILM 10K 1 % 1/8W	24546	CT4-1/8-TO-1002-F
R212	0698-4440	FXD FILM 3.4K 1 % 1/8W	24546	CT4-1/8-TO-3401-F
R213	0757-0438	FXD FILM 5.11K 1 % 1/8W	24546	CT4-1/8-TO-6811-F
R214	0698-3359	FXD FILM 12.7K 1 % 1/8W	24546	CT4-1/8-TO-1272-F
R215-16	0757-0438	FXD FILM 5.11 K 1 % 1/8W	24546	CT4-1/8-TO-6811-F
R217	0757-0411	FXD FILM 332 1 % 1/8W	24546	CT4-1/8-TO-322R
R218	0757-0438	FXD FILM 5.11K 1 % 1/8W	24546	CT4-1/8-TO-6811
R219	1810-0560	RES-NETWORK 16-DIP 5.6Kx8	28480	
R220-22	0757-0442	FXD FILM 10K 1 % 1/8W	24546	CT4-1/8-TO-1002-F
R223-30	0757-0438	FXD FILM 5.11K 1 % 1/8W	24546	CT4-1/8-TO-6811-F
R231,32	0757-0280	FXD FILM 1K 1 % 1/8W	24546	CT4-1/8-TO-1001-F
R233	0757-0438	FXD FILM 5.11K 1 % 1/8W	24546	CT4-1/8-TO-6811-F
R234	0698-4440	FXD FILM 3.4K1% 1/8W	24546	CT4-1/8-TO-3401-F
R235-41	NOT USED			
R242	8159-0005	RESISTOR-ZERO OHMS		
R243	8159-0005	RESISTOR-ZERO OHMS		
R244-407	NOT USED			
R408	0811-3821	RESISTOR		
RT201	0837-0412	THERMISTOR ROD	28480	
U201	1820-2490	IC MPU	04713	MC6809
U202	1820-2549	IC 8291A TALKER/LISTENER	28480	
U203	1LH4-00010	GPIB TRANSCEIVER	28480	
U204	1820-1730	IC SN74LS273N		
U205	NOT USED			
U206	5080-2093	PRGMD-EPROM (STANDARD)	28480	
U207	1818-1845	IC NMOS (16K) STAT RAM	34335	AM9128-10PC
U208	1820-1216	IC DCDR TTL LS 3-TO-8 LINE	01395	SN74LS138N

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Table 5-6B. GPIB Through-hole Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
U209	1820-0935	IC COUNTER CMOS BIN	04713	MC14020BCP
U210	1820-3848	IC FF CMOS D-TYPE	04713	MM74HCT374N
U211	1820-1427	IC DCDR TTL LS 2 TO 4 LINE	01295	SN74LS156N
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	I C INVERTER TTL LS HEX	01295	SN74LS04N
U220	1826-0412	IC COMPARATOR PRCN DUAL	27014	LM393N
U221	NOT USED			
U222	1858-0032	XSTR-ARRAY 14-PIN PLSTC DIP	27014	LM3146
U230	1818-3921	EEPROM, 1 K	28480	
U230	1818-4015	IN NMOS 4096	28480	
VR201	1902-1377	DIO-ZNR 6.19V-2% PD = .4W MAX	28480	
Y201	0410-1627	RESONATOR Ceramic 4.0 MHz	28480	
		GPIB - MECHANICAL. PARTS		
	0380-1679	STDF-HEX HEAD REF U218	28480	
	0515-0886	SCR-MACH M3X0.5 REF U218	28480	
	0535-0004	NUT-HEX DBL CHAM REF J201	28480	
	0535-0025	NUT-HEX DBL -CHAM	28480	
	06624-60002	LCD ASS'Y	28480	
	1205-0366	HEAT SINK REF U218	28480	
	2190-0584	WASHER-LK HLCL REF J201(2),U218(2)	28480	
	5080-2101	ROM-LABEL	28480	
	9320-4957	LABEL-LINE PRINT	28480	
	1252-0268	CONNECTOR FEMALE 24-CONT.	28480	
	1200-0607	IC-SOCKET 16-CONT. REF W202	28480	
	1200-0940	SOCKET STRIP 8-CONT.	28480	
	1251-5240	CONN-POST-TYPE-HDR 20 CONT.	28480	
	1251-8105	CONN-POST-TYPE-HDR 16 CONT.	28480	
	1251-4245	CONN-POST-TYPE-HDR 2 CONT.	28480	
	1251-5385	CONN-POST-TYPE-HDR 4 CONT.	28480	
	1252-1152	OPTION JACK (OPTION 750)	28480	
	1258-0189	JUMPER	28480	
	1251-4787	SHUNT-DIP 8 POSIT REF J202	28480	

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Table 5-7. 25W/0.5A BOARD Replacement Parts List

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C300	0160-4833	CAPACITOR-FXD .022µF ± 10% 100VDC CER	16299	
C301	0180-3801	CAPACITOR-FXD 1800µF+30-10% 63VDC AL	56289	
C302	0180-3799	CAPACITOR-FXD 2700µF+30-10% 50VDC AL	56289	
C303,04	0160-4835	CAPACITOR-FXD .1µF±10% 50VDC CER	16299	
C305	0180-0291	CAPACITOR-FXD 1µF±10% 35VDC TA	56289	150D105X9035A2
C306	0180-0100	CAPACITOR-FXD 4.7µF±10% 35VDC TA	56289	150D475X903582
C307	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C309	0180-0291	CAPACITOR-FXD 1µF±10% 35VDC TA	56289	150D105X9035A2
C310	0180-0100	CAPACITOR-FXD 4.7µF ± 10% 35VDC TA	56289	150D475X9035B2
C311-14	0180-0291	CAPACITOR-FXD 1µF ± 10% 35VDC TA	56289	150D105X9035A2
C315	0160-4281	CAPACITOR-FXD 2200PF ±20% 250VAC(RMS)	C0633	PME271Y422
C316-19	NOT USED			
C320	0160-4800	CAPACITOR-FXD 120PF ±5% 100VDC CER	16299	
C321,22	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C323	0160-4800	CAPACITOR-FXD 120PF ±5% 100VDC CER	16299	
C324	0160-4787	CAPACITOR-FXD 22PF ±5% 100VDC CER	16299	
C325	0160-4835	CAPACITOR-FXD 1µF ±10% 50VDC CER	16299	
C326	0160-4807	CAPACITOR-FXD 33PF ±5% 100VDC CER	16299	
C327	0160-4801	CAPACITOR-FXD 100PF ±5% 100VDC CER	16299	
C328	0160-4807	CAPACITOR-FXD 33PF ±5% 100VDC CER	16299	
C329	0160-4835	CAPACITOR-FXD 1µF ±10% 50VDC CER	16299	
C330	0160-4801	CAPACITOR-FXD 100PF ±5% 100VDC CER	16299	
C331,32	NOT USED			
C333,34	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C335	NOT USED			
C336	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C337	0160-4807	CAPACITOR-FXD 33PF ±5% 100VDC CER	16299	
C338-40	NOT USED			
C341	0160-4819	CAPACITOR-FXD 2200PF ±5% 100VDC CER	16299	
C342	0160-4835	CAPACITOR-FXD .1µF ± 10% 50 VDC CER	96733	
C343,44	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	96733	
C345	0160-4834	CAPACITOR-FXD .047µF ± 10% 100VDC CER	16299	
C346	0180-2264	CAPACITOR-FXD 3.3µF±5% 15VDC TA	56289	150D335X5015A2
C347-50	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C351	0160-4810	CAPACITOR-FXD 330PF ±5% 100VDC CER	16299	
C352	0160-4554	CAPACITOR-FXD .01µF ±20% 50VDC CER	04222	
C353	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C354	0160-4822	CAPACITOR-FXD 1000PF ±5% 100VDC CER	16299	
C355	0180-0291	CAPACITOR-FXD 1µF ± 10% 35VDC TA	56289	150D105X9035A2
C356	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C357-58	NOT USED			
C359	0160-4831	CAPACITOR-FXD 4700PF ± 10% 100VDC CER	16299	
C360	0160-4833	CAPACITOR-FXD .022µF ±10% 100VDC CER	16299	
C361	0180-4039	CAPACITOR-FXD8200µF+30-10% 50VDC AL	19701	
C362	0160-4833	CAPACITOR-FXD .022µF ± 10% 100VDC CER	16299	
C363	0180-4035	CAPACITOR-FXD 7400µF+30-10% 63VDC AL	19701	
C364	0180-4040	CAPACITOR-FXD .012F+30-10% 35VDC AL	19701	
C365	NOT USED			
C366	0180-0374	CAPACITOR-FXD 10µF±10% 20VDC TA	56289	150D106X9020B2
C367	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	16299	

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Table 5-7. 25W/0.5A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C368-70	0180-0393	CAPACITOR-FXD 39µF±10% 10VDC TA	56289	150D396X9010B2
C372	0160-4830	CAPACITOR-FXD 2200PF ± 10% 100VDC CER	16299	
C373,74	NOT USED			
C375,76	0180-3804	CAPACITOR-FXD 47µF±20% 35VDC TA	56289	
C377-80	NOT USED			
C381	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C382	NOT USED			
C383,84	0160-4791	CAPACITOR-FXD 10PF ±5% 100VDC CER	16299	
C385	0160-4812	CAPACITOR-FXD 220PF ±5% 100VDC CER	16299	
C386	0160-4820	CAPACITOR-FXD 1800PF ±5% 100VDC CER	16299	
C387	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	16299	
C388	0160-4807	CAPACITOR-FXD 33PF ±5% 100VDC CER	16299	
C389	0160-5098	CAPACITOR-FXD .22µF ±10% 50VDC CER	16299	CAC05X7R224J050A
C390	NOT USED			
C391	0160-4812	CAPACITOR-FXD 220PF ±5% 100VDC CER	16299	
C392	0160-5166	CAPACITOR-FXD .015µF ±20% 100VDC CER	16299	
C393	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	16299	
C394	NOT USED			
C395	0160-5166	CAPACITOR-FXD .015µF ±20% 100VDC CER	16299	
C396	0160-4832	CAPACITOR-FXD 01µF ±10% 100VDC CER	16299	
C397	0160-5166	CAPACITOR-FXD .015µF ±20% 100VDC CER	16299	
C398	0160-5409	CAPACITOR-FXD 3000PF ±5% 50VDC CER	16299	
C399	0160-4787	CAPACITOR-FXD 22PF ±5% 100VDC CER	16299	
C400	0160-4830	CAPACITOR-FXD 2200PF ± 10% 100VDC CER	16299	
C401	0160-4801	CAPACITOR-FXD 100PF ±5% 100VDC CER	16299	
C402	0160-7319	CAPACITOR-FXD OF	84411	
C403,04	NOT USED			
C405	0160-4835	CAPACITOR-FXD .1uF ±10% 50VDC CER	16299	
C406	0160-4835	CAPACITOR-FXD .1uF ±10% 50VDC CER	16299	
C407,08	NOT USED			
C409	0160-4822	CAPACITOR-FXD 1000PF ±5% 100VDC CER	16299	
C410	NOT USED			
C411,12	0160-5098	CAPACITOR-FXD .22µF ± 10% 50VDC CER	16299	CAC05X7R224J050A
C413	0160-7320	CAPACITOR-FXD .01µF ± 10% 25OVDC	D5243	
C414	0160-5410	CAPACITOR-FXD 3300PF ± 5% 50VDC CER	16299	
C415	0160-4048	CAPACITOR-FXD .022µF ±20% 250VAC(RMS)	C0633	
C416	0160-7097	CAPACITOR-FXD 4.7µF 100V		
C417	0160-4834	CAPACITOR-FXD .047µF ± 10% 100VDC CER	16299	
C418	0160-4832	CAPACITOR-FXD .01µF ± 10% 100VDC CER	16299	
C419	0180-0291	CAPACITOR-FXD 1µF±10% 35VDC TA	56289	150D105X9035A2
C420	0160-4048	CAPACITOR-FXD .022µF ±20% 250VAC(RMS)	C0633	
C421	0160-4832	CAPACITOR-FXD .01µF ± 10% 100VDC CER	16299	
C422	0160-3969	CAPACITOR-FXD .015µF ±20% 250VAC(RMS)	C0633	
C423	0180-0291	CAPACITOR-FXD 1µF±10% 35VDC TA	56289	150D105X9035A2
C424	0160-5422	CAPACITOR-FXD .047µF ±20% 50VDC CER	16299	
C425	0160-4830	CAPACITOR-FXD 2200PF ± 10% 100VDC CER	16299	
C426	0160-4832	CAPACITOR-FXD .01µF ± 10% 100VDC CER	16299	
C427	0160-4966	CAPACITOR-FXD 1µF ±10% 100VDC MET-POLYC	28480	
C428	0160-5422	CAPACITOR-FXD .047µF ±20% 50VDC CER	16299	
C429	0160-5098	CAPACITOR-FXD .22µF ± 10% 50VDC CER	16299	CAC05X7R224J050A

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Table 5-7. 25W/0.5A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C430,31	NOT USED			
C432	0160-4822	CAPACITOR-FXD 1000PF ±5% 100VDC CER	16299	
C433	0160-4791	CAPACITOR-FXD 10PF ±5% 100VDC CER	16299	
C434,35	NOT USED			
C436	0160-6999	CAPACITOR-FXD 2200PF ±5% MET-POLYE	84411	
C437	0160-4554	CAPACITOR-FXD .01µF ±20% 50VDC CER	04222	
C438,39	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C440-49	NOT USED			
C450-52	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C453,54	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	1629	
C455,56	NOT USED			
C457,58	0160-4835	CAPACITOR-FXD 0.1µF 10% 50V	28480	
C459	0160-4822	CAPACITOR-FXD 100PF 5%	28480	
C460	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C461	0160-5101	CAPACITOR-FXD 1µF ± 10% 63VDC MET-POLYE	28480	
CR300-04	1901-0731	DIODE-PWR RECT 400V 1A	S0562	
CR305-08	NOT USED			
CR309	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR310	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR311,12	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR313-17	NOT USED			
CR318,19	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR320-23	NOT USED			
CR324	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR325	1901-0719	DIODE-PWR RECT 400V 3A	04713	MR854
CR326	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR327	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR328	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR329	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR330	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR331-35	1901-1098	DIODE-SWITCHING 50V 200MA	15818	1N4150
CR336-39	NOT USED			
CR340	1901-0731	DIODE-PWR RECT 400V 1A	04713	
CR341	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR342-44	NOT USED			
CR345	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR346	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR347	NOT USED			
CR348	1901-0050	DIODE-SWITCHING 80V 200MA	9N 171	1N4150
CR349	1901-0518	DIODE-SCHOTTKY SM SIG	71785	5082-2800
CR350	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR351	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR352,53	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR354	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR355	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR356-59	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR360	1901-1080	DIODE-SCHOTTKY 20V 1A	04713	1N5817(RELAXED)
CR361,62	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR363	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR364-70	NOT USED			
CR371	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150

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Table 5-7. 25W/0.5 BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
CR380,81	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
D407	0812-0010	RESISTOR-FXD	28480	
F300	2110-0916	FUSE-SUBMINIATURE 7AT 125V	75915	
F302	2110-0716	FUSE-SUBMINIATURE .5A 125V	75915	
F303	2110-0685	FUSE-SUBMINIATURE 7A 125V	75915	
F304	2110-0713	FUSE-SUBMINIATURE 10A 125V	75915	
F305	2110-0916	FUSE-SUBMINIATURE 7AT 125V	75915	
F307	NOT USED			
F308,09	2110-0303	FUSE 2A 250V TD	16428	
L300	9140-0129	INDUCTOR 220UH 5%	28480	
L301	NOT USED			
L302	9100-1640	INDUCTOR 160UH 5%	99800	
Q300-17	NOT USED			
Q318	1854-0474	TRANSISTOR NPN SI	04713	2N5551
Q319	1854-0477	TRANSISTOR NPN SI	14433	2N2222A
Q320	1855-0665	TRANSISTOR MOSFET	3L585	RFP2N12L
Q321	1853-0320	TRANSISTOR PNP SI	07263	2N4032
Q322	1854-0087	TRANSISTOR NPN SI	56289	
Q323-34	NOT USED			
Q335	1854-0585	TRANSISTOR NPN SI	04713	MJE182
Q336-38	NOT USED			
Q339	1855-0414	TRANSISTOR J-FET	17856	2N4393
Q340	NOT USED			
Q341	5060-3211	ASSY RGLTR & HS	28480	
Q342	1855-0549	TRANSISTOR MOSFET	9M011	IRF512
Q343	1854-0474	TRANSISTOR NPN SI	04713	2N5551
Q344-49	NOT USED			
Q350,53	1855-0414	TRANSISTOR J-FET	17856	2N4393
Q354	1853-0423	TRANSISTOR PNP SI	04713	MPS U-60
R300,01	0686-4725	RESISTOR 4.7K 5% .5W CC	01121	EB4725
R302	0811-0610	RESISTOR 56 5% 5W PW	07088	
R303	0698-8911	RESISTOR 1.3K .1% .125W TF	19701	
R304	0757-0403	RESISTOR 121 1% .125W TF	24546	CT4-1/8-TO-121 R-F
R305	0698-8672	RESISTOR 243.4 .1% .125W TF	19701	
R306	0698-3700	RESISTOR 715 1 % .125W TF	24547	CT4-1/8-TO-715R-F
R307,08	8159-0005	RESISTOR-ZERO OHMS	72982	
R309	0698-8672	RESISTOR 243.4 .1% .125W TF	19701	
R310	0698-0085	RESISTOR 2.61K 1% .125W TF	24546	CT4-1/8-TO-2611-F
R311	0698-4123	RESISTOR 499 1% .125W TF	24546	CT4-1/8-TO-499R-F
R312	0757-0402	RESISTOR 110 1% .125W TF	24546	CT4-1/8-TO-111-F
R313,14	8159-0005	RESISTOR-ZERO OHMS	72982	
R315	NOT USED			
R316,17	0699-0208	RESISTOR 1 5% .25W CF	01121	
R318	0757-0284	RESISTOR 150 1% .125W TF	24546	CT4-1/8-TO-151-F
R319-25	NOT USED			
R326,27	0757-0424	RESISTOR 1.1K 1% .125W TF 100	24546	CT4-1/8-TO-1001-F
R328	8159-0005	RESISTOR-ZERO OHMS	72982	
R329-32	NOT USED			
R333	0757-0410	RESISTOR 301 1% .125W TF ± 100	24546	CT4-1/8-TO-301R-F
R334	NOT USED			

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Table 5-7. 25W/0.5A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R335,36	0757-0473	RESISTOR 221K 1% .125W TF	28480	CT4-1/8-TO-2371-F
R337,38	0757-0438	RESISTOR 5.1K 1% .125W TF	24546	CT4-1/8-TO-5111-F
R339	8159-0005	RESISTOR 0 OHMS	28480	
R340	0757-0430	RESISTOR 2.21K 1% .125W TF	24546	CT4-1/8-TO-2211-F
R341-44	NOT USED			
R345	8159-0005	RESISTOR-ZERO OHMS	72982	
R346	0698-5579	RESISTOR 5K .5% .125W TF	03888	
R347	0698-3329	RESISTOR 10K .5% .125W TF	03888	PME55-1/8-TO1002-D
R348	0698-6533	RESISTOR 12.5K .1% .125W TF	19701	
R349	0698-7929	RESISTOR 9.09K .1% .125W TF	19701	5033R-1/8-TO-9091-B
R350	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R351	0698-4493	RESISTOR 34K 1% .125W TF	24546	CT4-1/8-TO-3402-F
R352	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R353,54	NOT USED			
R355	0698-3328	RESISTOR 8.25K .5% .125W TF	03888	PME55-1/8-TO-8251-D
R356	0698-8913	RESISTOR 1.5M 1% .125W TF	07716	
R357	0699-0489	RESISTOR 16.15K .1% .1W TF	19701	
R358	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-F
R359	0699-1211	RESISTOR 95K .1% .1W TF	19701	
R360	0757-0447	RESISTOR 16.2K 1% .125W TF	24546	CT4-1/8-TO-1622-F
R361	8159-0005	RESISTOR-ZERO OHMS	72982	
R362	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R363,64	NOT USED			
R365	0699-1212	RESISTOR 19K .1% .125W TF	91637	
R366	0699-1722	RESISTOR 9.75K .1% .125W TF	91637	
R367	NOT USED			
R368	8159-0005	RESISTOR-ZERO OHMS	20940	
R369-71	NOT USED			
R372	0683-0335	RESISTOR 3.3 5% .25W CF	19701	(CR-25) 1-4-5P-3E3
R373	0698-4470	RESISTOR 6.98K 1% .125W TF	24546	CT4-1/8-TO-6981-F
R374	0757-0452	RESISTOR 27.4K 1% .125W TF	24546	CT4-1/8-TO-2742-F
R375	0686-2225	RESISTOR 2.2K 5% .5W CC	01121	EB2225
R376	0686-4725	RESISTOR 4.7K 5% .5W CC	01121	EB4725
R378	0698-4446	RESISTOR 267 1% .125W TF	24546	CT4-1/8-TO-267R-F
R378	0757-0438	RESISTOR 5.11K 1% .125W TF	24546	CT4-1/8-TO-5111-F
R379	0698-5347	RESISTOR 495.5 .1% .125W TF	19701	
R380,81	0698-3510	RESISTOR 453 1% .125W TF	24546	CT4-1/8-TO-453R-F
R382	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R383,84	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R385	0811-1217	RESISTOR 150 5% 5W PW	07088	
R386	0686-8225	RESISTOR 8.2K 5% .5W CC	01121	EB8225
R387	0698-4123	RESISTOR 499 1% .125W TF	24546	CT4-1/8-TO-499R-F
R388	0683-4715	RESISTOR 470 5% .25W CF	01121	CB4715
R389	0698-5088	RESISTOR 12K 1% .125W TF	24546	CT4-1/8-TO-1202-F
R390	NOT USED			
R391	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R392	0757-0282	RESISTOR 221 1% .125W TF	24546	CT4-1/8-TO-221R-F
R393	0698-4435	RESISTOR 2.49K 1% .125W TF	24546	CT4-1/8-TO-2491-F
R394	0757-0473	RESISTOR 221K 1% .125W TF	24546	CT4-1/8-TO-2213-F
R395	0757-0431	RESISTOR 2.43K 1% .125W TF	24546	CT4-1/8-TO-2431-F

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Table 5-7. 25W/0.5A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R396	0757-0200	RESISTOR 5.62K 1% .125W TF	24546	CT4-1/8-TO-5621-F
R397	0757-0481	RESISTOR 475K 1% .125W TF	19701	5033R-1/8-TO-4753-F
R398	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R399	0757-0464	RESISTOR 90.9K 1% .125W TF	24546	CT4-1/8-TO-9092-F
R400	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R401	0698-4099	RESISTOR 139 1% .125W TF	07716	
R402	8159-0005	RESISTOR-ZERO OHMS	72982	
R403	NOT USED			
R404	0757-0429	RESISTOR 1.82K 1% .125W TF	24546	CT4-1/8-TO-1821-F
R405	0698-5089	RESISTOR 33K 1% .125W TF	24546	CT4-1/8-TO-3302-F
R406	0683-4715	RESISTOR 470 5% .25W CF	01121	CB4715
R407	NOT USED			
R408	0811-3822	RESISTOR FXD		
R409,10	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R411	0812-0010	RESISTOR 3K 5% 3W PW	07088	
R412	0698-4536	RESISTOR 340K 1% .125W TF	07716	
R413	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R414	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-F
R415	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R416-18	NOT USED			
R419	0698-4435	RESISTOR 2.4K 1% .125W TF	24546	CT4-1/8-TO-2491-F
R420	0683-3305	RESISTOR 33 5% .25W	19701	(CR-25) 1-4-5P-33E
R421	0698-3449	RESISTOR 28.7K 1% .125W TF	24546	CT4-1/8-TO-2872-F
R422	0698-8827	RESISTOR 1M 1% .125W TF	03888	
R423	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R424	NOT USED			
R425	0757-0413	RESISTOR 392 1% .125W TF	24546	CT4-1/8-TO-392R-F
R426	0757-0427	RESISTOR 1.5K 1% .125W TF	24546	CT4-1/8-TO-1501-F
R427	0698-3444	RESISTOR 316 1% .125W TF	24546	CT4-1/8-TO-316R-F
R428	0757-0405	RESISTOR 162 1% .125W TF	24546	CT4-1/8-TO-162R-F
R429,30	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R431	NOT USED			
R432	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R433	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R434	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R435	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R436	0683-4735	RESISTOR 47K 5% .25W CF	19701	(CR-25) 1-4-5P-47K
R437	NOT USED			
R438	0698-3156	RESISTOR 14.7K 1% .125W TF	24546	CT4-1/8-TO-1472-F
R439	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R440,41	NOT USED			
R442	0699-0070	RESISTOR 3.16M 1% .125W TF	07716	
R443	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R444	0757-0447	RESISTOR 16.2K 1% .125W TF	24546	CT4-1/8-TO-1622-F
R445	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R446	0698-4480	RESISTOR 15.8K 1% .125W TF	24546	CT4-1/8-TO-1582-F
R447	0757-0440	RESISTOR 7.5K 1% .125W TF	24546	CT4-1/8-TO-7501-F
R448	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-F
R449	0698-3447	RESISTOR 422 1% .125W TF	24546	CT4-1/8-TO-422R-F
R450	0698-8827	RESISTOR 1M 1 % .125W TF	19701	

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Table 5-7. 25W/0.5A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R451	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R452	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R453	0698-4480	RESISTOR 15.8K 1% .125W TF	24546	CT4-1/8-TO-1582-F
R454	0698-6360	RESISTOR 10K .1% .125W TF	07716	
R455	0698-8827	RESISTOR 1M 1% .125W TF	19701	
R456	0698-0087	RESISTOR 316 1% .25W TF	24546	NA5-1/4-TO-3160-F
R457	0811-2553	RESISTOR 7.5 5% 2W PW	75042	BWH2-7R5-J
R458	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R459	0757-0446	RESISTOR 15K 1% .125W TF	24546	CT4-1/8-TO-1502-F
R460	0698-8913	RESISTOR 1.5M 1% .125W TF	07716	
R461	0683-4735	RESISTOR 47K 5% .25W CF	01121	CB4735
R462	0757-0288	RESISTOR 9.09K 1% .125W TF	19701	5033R-1/8-TO-9091-F
R463	0698-0084	RESISTOR 2.15K 1% .125W TF	24546	CT4-1/8-TO-2151-F
R464	0757-0124	RESISTOR 39.2K 1% .125W TF	07716	
R465	0698-4484	RESISTOR 19.1K 1% .125W TF	24546	CT4-1/ 8-TO-1912-F
R466-70	NOT USED			
R471	0699-0070	RESISTOR 3.16M 1% .125W TF	07716	
R472	0698-6363	RESISTOR 40K .1% .125W TF	07716	
R473	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-6811-F
474-6	NOT USED			
R477	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R478-80	NOT USED			
R481	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R482	NOT USED			
R483	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R484-86	NOT USED			
R487	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R488	0757-0460	RESISTOR 61.9K 1% .125W TF	24546	CT4-1/8-TO-6192-F
R489,90	0686-1065	RESISTOR 10M 5% .5W CC	01121	EB1065
R491	0683-0475	RESISTOR 4.7 5% .25W CF	01121	CB47G5
R492	0683-2225	RESISTOR 2.2K 5% .25W CF	19701	CR-25
R493	0757-0430	RESISTOR 2.21K 1% .125W TF	24546	CT4-1/8-TO-2211-F
R494	0698-3430	RESISTOR 21.5 1% .125W TF	03888	PME55-
R495	0757-0447	RESISTOR 16.2K 1% .125W TF	24546	CT4-1/8-TO-1622-F
R496	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R497	0683-3915	RESISTOR 390 5% .25W CF	01121	CB3915
R498	0683-1015	RESISTOR 100 5% .25W CF	01121	CB1015
R499	0698-4493	RESISTOR 34K 1% .125W TF	24546	CT4-1/8-TO-3403-F
R500,01	0757-0404	RESISTOR 130 1% .125W TF	24546	CT4-1/8-TO-131-F
R502	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R503	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R504	0683-1035	RESISTOR 10K 5% .25W CF	01121	CB1035
R505	NOT USED			
R506	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R507	0683-0475	RESISTOR 4.7 5% .25W CF	01121	CB47G5
R508,09	0686-1065	RESISTOR 10M 5% .5W CC	01121	EB1065
R510,11	NOT USED			
R512	0683-1065	RESISTOR 10M 5% .25W CC	01121	CB1065
R513	NOT USED			
R514	0698-4435	RESISTOR 2.49K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R515	0757-0452	RESISTOR 27.4K 1% .125W TF	24546	CT4-1/8-TO-2742-F

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Table 5-7. 25W/0.5A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R516-604	NOT USED			
R605	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R606-09	NOT USED			
R610,11	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R612-19	NOT USED			
R620	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R621	0683-1825	RESISTOR 1.8K 5% .25W CF	01121	CB1825
R622,23	NOT USED			
R624	0698-0087	RESISTOR 316 1 % .25W TF	24546	NA5-1/4-TO-3160-F
R625	NOT USED			
R626	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R627	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R628	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R629	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R630	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R631	0698-4435	RESISTOR 2.49K 1% .125W TF	24546	CT4-1/8-TO-2491-F
R632,33	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R634	0757-0200	RESISTOR 5.62K 1% .125W TF	24546	CT4-1/8-TO-5621-F
R635	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R636-46	NOT USED			
R647	0683-6855	RESISTOR 6.8M 5% .25W CC	01121	CB6855
R648-58	NOT USED			
R660	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R661,62	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-F
R663	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R664	0757-0438	RESISTOR 5.11K 1% .125W TF	24546	CT4-1/8-TO-5111-F
R665-69	NOT USED			
R670	0683-1065	RESISTOR 10M 5% .25W CC	01121	CB1065
T301	06624-80091	XFMR-PULSE	28480	
U300	5060-3212	ASSY RGLTR & HS	28480	
U301	5060-3260	IC V RGLTR-ADJ-NEG	28480	
U302	5060-2942	ASSY-HS	28480	
U303	1826-0527	ASSY-HS	27014	LM337T
U304-09	NOT USED			
U310,11	1990-0996	IC OPTO-ISOLATOR	28480	HCPL-2220
U312	5080-2128	IC MPU PROGM'D	28480	
U313,14	1826-1917	IC D/A 14-BIT	24355	AD7534KN
U315	1826-1590	IC OP AMP PRCN QUAD	10858	LT1014CN
U316-17	NOT USED			
U318	1826-1514	IC V RGLTR-V-REF-FXD	10858	LT1021BCN8-10
U319	1826-1590	IC OP AMP PRCN QUAD	10858	LT1014CN
U320	1820-1216	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
U321	1826-1917	IC D/A 14-BIT	24355	AD7534KN
U322	NOT USED			
U323	1826-1021	IC ANALOG MULTIPLEXER	17856	DG508ACJ
U324	1826-1475	IC COMPARATOR	10858	LT1011CN8
U325	1826-0412	IC COMPARATOR PRCN DUAL	27014	LM393N
U326	1810-0639	NETWORK-RES DIP	28480	
U327	1826-1842	IC ANALOG SPECIAL	28480	
U328-33	NOT USED			

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Table 5-7. 25W/0.5A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
U334,35	1906-0349	DIODE-FW BRDG 200V 6A	71744	KBPC602
U336	1858-0088	TRANSISTOR ARRAY	04713	MPQ7091
U337	1826-1843		04713	TL431IP
U338	5060-3567	IC POWER HYBRED	28480	
U339	NOT USED			
U340	1858-0127	TRANSISTOR ARRAY	56289	TPQA56
U341-45	NOT USED			
U346,47	1826-1895		10858	LT1001ACN9
U348	1858-0083	TRANSISTOR ARRAY	56289	TPQ6002
U349	NOT USED			
U350	1826-0493	IC OP AMP LOW-BIAS-H-IMPD	27014	LM308AN
U351	1826-0138	IC COMPARATOR GP QUAD	27014	LM339N
U352	1826-1896		10858	LT1001CN8
U353	NOT USED			
U354	1826-0468	IC V RGLTR-OV-V-SEN	04713	MC34062P1
U355-59	NOT USED			
U360-62	1826-1895		10858	LT1001ACN8
U363	1826-1068	IC D/A 8-BIT	27014	DAC0832LCN
U364-66	1826-2191		17856	DGP201ADJ
U367,68	1820-3344	IC SHF-RGTR CMOS/74HC ASYNCHRO SERIAL-IN	04713	MC74HC595H
U369	1820-2102	IC LCH TTL LS D-TYPE OCTL	01295	SN74LS373N
U370	1820-1201	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
U371,72	1826-1895		10858	LT1001ACN8
U373,74	1826-1896		10858	LT1001CN8
U375	1826-1302	IC OP AMP LP QUAD	27014	LF444ACN
U376,77	1826-0493	IC OP AMP LOW-BIAS-H-IMPD	27014	LM308AN
U378	1826-1895		10858	LT1001ACN8
U379	1810-1266	RESISTOR NETWORK	28480	
U380	1810-1267	RESISTOR NETWORK	28480	
U381	1810-1263	RESISTOR NETWORK	28480	
U382	1810-1262	RESISTOR NETWORK	28480	
VR300-4	NOT USED			
VR305	1902-1377	DIODE-ZNR 6.19V 2%	04713	
VR306	1902-0182	DIODE-ZNR 20.5V 5%	15818	
VR307-14	NOT USED			
VR315	1902-0057	DIODE-ZNR 6.49V 5%	15818	
VR316	1902-0244	DIODE-ZNR 30V 5%	07263	
VR317-89	NOT USED			
VR390	1902-3323	DIODE-ZNR 42.2V 5%	15818	
VR391-99	NOT USED			
VR400,1	1902-0783	DIODE-ZNR 16V 5%	04713	
VR402	1902-0064	DIODE-ZNR 7.5V 5%	04713	
Y300	0410-1627	RESONATOR-CERAMIC 4.0MHZ	28480	

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Table 5-8. 50W/2A BOARD Replacement Parts List

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C300	0160-4833	CAPACITOR-FXD .022µF ±10% 100VDC CER	16299	
C301	0180-3801	CAPACITOR-FXD 1800µF + 30-10% 63VDC AL	19701	
C302	0180-3799	CAPACITOR-FXD 2700µF + 30-10% 50VDC AL	19701	
C303,04	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C305	0180-0291	CAPACITOR-FXD 1µF ± 10% 35VDC TA	56289	150D105X9035A2
C306	0180-0100	CAPACITOR-FXD 4.7µF ± 10% 35VDC TA	56289	150D475X9035 B2
C307	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C309	0180-0291	CAPACITOR-FXD 1µF ± 10% 35VDC TA	56289	150D105X9035A2
C310	0180-0100	CAPACITOR-FXD 4.7µF ± 10% 35VDC TA	56289	150D475X9035B2
C311-14	0180-0291	CAPACITOR-FXD 1µF ± 10% 35VDC TA	56289	150D105X9035A2
C315	0160-4281	CAPACITOR-FXD 2200PF±20% 250VAC(RMS)	C0633	PME271Y422
C316-19	NOT USED			
C320	0160-4800	CAPACITOR-FXD 120PF ± 5% 100VDC CER	16299	
C321,22	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C323	0160-4800	CAPACITOR-FXD 120PF ± 5% 100VDC CER	16299	
C324	0160-4787	CAPACITOR-FXD 22PF ± 5% 100VDC CER	16299	
C325	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C326	0160-4807	CAPACITOR-FXD 33PF ± 5% 100VDC CER	16299	
C327	0160-4801	CAPACITOR-FXD 100PF ± 5% 100VDC CER	16299	
C328	0160-4807	CAPACITOR-FXD 33PF ±5% 100VDC CER	16299	
C329	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C330	0160-4801	CAPACITOR-FXD 100PF ± 5% 100VDC CER	16299	
C331,32	NOT USED			
C333,34	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C335	NOT USED			
C336	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C337	0160-4807	CAPACITOR-FXD 33PF ± 5% 100VDC CER	16299	
C338-40	NOT USED			
C341	0160-4819	CAPACITOR-FXD 2200PF ± 5% 100VDC CER	16299	
C342	0160-4835	CAPACITOR FXD .1µF ± 10% 50VDC CER	96733	
C343,44	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C345	0160-4834	CAPACITOR-FXD .047µF ± 10% 100VDC CER	16299	
C346	0180-2264	CAPACITOR-FXD 3.3µF ± 5% 15VDC TA	56289	150D335X5015A2
C347-50	0160-4835	CAPACITOR-FXD .1µF ± 10% 50 VDC CER	16299	
C351	0160-4810	CAPACITOR-FXD 330PF ± 5% 100VDC CER	16299	
C352	0160-4554	CAPACITOR-FXD .01µF ± 20% 50VDC CER	04222	
C353	0160-4835	CAPACITOR-FXD .1µF ± 10% 50 VDC CER	16299	
C354	0160-4822	CAPACITOR-FXD 1000PF ± 5% 100VDC CER	16299	
C355	0180-0291	CAPACITOR-FXD 1µF ± 10% 20VDC TA	56289	150D105X9035A2
C356	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C357,58	NOT USED			
C359	0160-4831	CAPACITOR-FXD 4700PF ± 10% 100VDC CER	16299	
C360	0160-4833	CAPACITOR-FXD .022µF ± 10% 100VDC CER	16299	
C361	0180-4039	CAPACITOR-FXD 8200µF±30–10% 50VDC AL.	56289	
C362	0160-4833	CAPACITOR-FXD .022µF ± 10% 100VDC CER	16299	
C363	0180-4035	CAPACITOR-FXD 7400µF + 30–10% 50VDC AL	56289	
C364	0180-4040	CAPACITOR-FXD .012F + 30 –10% 35VDC AL	56289	
C365	NOT USED			
C366	0180-0374	CAPACITOR-FXD 10µF ± 10% 20VDC TA	56289	150D106X9020B2
C367	0160-4832	CAPACITOR-FXD .01µF ± 10% 100VDC CER	16299	
C368	0180-0393	CAPACITOR-FXD 39µF ± 10% 10VDG TA	56289	150D396X9010B2

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C369	0160-4833	CAPACITOR-FXD .022µF ± 10% 100VDC CER	16299	
C370	0180-0393	CAPACITOR-FXD 39µF ± 10% 10VDC TA	56289	150D396X9010B2
C371	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C372	0160-4830	CAPACITOR-FXD 2200PF±10% 100VDC CER	16299	
C373,74	NOT USED			
C375,76	0180-3804	CAPACITOR-FXD 47µF±20% 35VDC TA	56289	
C377-80	NOT USED			
C381	0160-4835	CAPACITOR-FXD .1 uF ± 10% 50VDC CER	16299	
C382	NOT USED			
C383,84	0160-4791	CAPACITOR-FXD 10PF ±5% 10OVDC CER	16299	
C385	0160-4812	CAPACITOR-FXD 220PF ±5% 10OVDC CER	16299	
C386	0160-4820	CAPACITOR-FXD 1800PF ±5% 10OVDC CER	16299	
C387	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	16299	
C388	0160-4801	CAPACITOR-FXD 100PF ±5% 100VDC CER	16299	
C389	0160-5098	CAPACITOR-FXD .22µF ± 10% 50VDC CER	16299	CAC05X7R224J050A
C390	NOT USED			
C391	0160-4812	CAPACITOR-FXD 220PF ±5% 100VDC CER	16299	
C392	0160-5166	CAPACITOR-FXD .015µF ±20% 100VDC CER	16299	
C393	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	16299	
C394	0160-4807	CAPACITOR-FXD 33PF ±5% 100VDC CER	16299	
C395	0160-5166	CAPACITOR-FXD .015µF ±20% 100VDC CER	16299	
C396	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	16299	
C397	0160-5166	CAPACITOR-FXD .015µF ±20% 100VDC CER	16299	
C398	0160-5409	CAPACITOR-FXD 3000PF ±5% 50VDC CER	16299	
C399	0160-4787	CAPACITOR-FXD 22PF±5% 100VDC CER 0±30	04222	
C400	0160-4830	CAPACITOR-FXD 2200PF ± 10% 100VDC CER	16299	
C401	0160-4801	CAPACITOR-FXD 100PF ±5% 100VDC CER	16299	
C402	0160-7319	CAPACITOR-FXD OF MET-POLYE	D5243	
C403,04	NOT USED			
C405	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C406	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C407	0160-4801	CAPACITOR-FXD 100PF ±5% 100VDC CER	16299	
C408	0160-5422	CAPACITOR-FXD .047µF ±20% 50VDC CER	16299	
C409,10	NOT USED			
C411,12	0160-5098	CAPACITOR-FXD .22µF ± 10% 50VDC CER	16299	CAC05X7R224J050A
C413	0160-7320	CAPACITOR-FXD .01µF ± 10% 250VDC	D5243	
C414	0160-5410	CAPACITOR-FXD 3300PF ±5% 50VDC CER	16299	
C415	0160-4048	CAPACITOR-FXD .022µF ±20% 250VAC(RMS)	C0633	
C416	0160-7097	CAPACITOR-FXD 4.7µF 100V		
C417	0160-4834	CAPACITOR-FXD .047µF ±10% 100VDC CER	16299	
C418	0160-4832	CAPACITOR-FXD .01µF ±10% 100VDC CER	16299	
C419	0180-0291	CAPACITOR-FXD 1µF ± 10% 35VDC TA	56289	150D105X9035A2
C420	0160-4048	CAPACITOR-FXD .022µF ±20% 250VAC(RMS).	C0633	
C421	0160-4832	CAPACITOR-FXD .01µF ± 10% 100VDC CER	16299	
C422	0160-3969	CAPACITOR-FXD .015µF ±20% 250VAC(RMS)	C0633	
C423	0180-0291	CAPACITOR-FXD 1µF ± 10% 35VDC TA	56289	150D105X9035A2
C424	0160-5422	CAPACITOR-FXD .047µF ±20% 50VDC CER	16299	
C425	0160-4830	CAPACITOR-FXD 2200PF ± 10% 100VDC CER	16299	
C426	0160-4832	CAPACITOR-FXD .01µF ± 10% 100VDC CER	16299	
C427	0160-4966	CAPACITOR-FXD 1µF±10% 100VDC MET-POLYC		

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
C428	0160-5422	CAPACITOR-FXD .047µF ±20% 50VDC CER	16299	
C429	0160-5098	CAPACITOR-FXD .22µF ±10% 50VDC CER	16299	CAC05X7R224J050A
C430,31	NOT USED			
C432	0160-4822	CAPACITOR-FXD 1000PF ±5% 100VDC CER	16299	
C433	0160-4791	CAPACITOR-FXD 10PF ±5% 100VDC CER	16299	
C434	NOT USED			
C435	0160-4807	CAPACITOR-FXD 33PF ±5% 100VDC CER	16299	
C436	0160-6999	CAPACITOR-FXD 2200PF ±5% MET-POLYE	84411	
C437-39	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C440-49	NOT USED			
C450-52	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C453,54	0160-4832	CAPACITOR-FXD .01µF ± 10% 100VDC CER	16299	
C455,56	NOT USED			
C457,58	0160-4835	CAPACITOR-FXD .1µF ±10% 50VDC CER	16299	
C459	0160-4822	CAPACITOR-FXD 1000PF ±5% 100VDC CER	16299	
C460	0160-4835	CAPACITOR-FXD .1µF ± 10% 50VDC CER	16299	
C461	0160-5101	CAPACITOR-FXD 1µF±10% 63VDC MET-POLYE	28480	
CR300-04	1901-0731	DIODE-PWR RECT 400V 1A	04713	IN4004G
CR305-08	NOT USED			
CR309	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR310	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR311,12	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR313-17	NOT USED			
CR318,19	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR320-23	NOT USED			
CR324	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR325	1901-0719	DIODE-PWR RECT 400V 3A 300NS	04713	MR854
CR326	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR327	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR328	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR329	1901-0050	DIODE-SWITCHING 80V 200MA	9N171	1N4150
CR330	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR331-33	1901-1098	DIODE-SWITCHING 50V 200MA	15818	1N4150
CR334,35	1901-0028	DIODE-PWR RECT 400V 750MA	04713	
CR336-39	NOT USED			
CR340	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR341	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR342-44	NOT USED			
CR345	1901-0050	DIODE-SWITCHING 80V 200MA 2NS	9N171	1N4150
CR346	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR347	NOT USED			
CR348	1901-0050	DIODE-SWITCHING 80V 200MA 2NS	9N171	1N4150
CR349	1901-0518	DIODE-SCHOTTKY SM SIG	71785	5082-2800
CR350	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR351	1901-0050	DIODE-SWITCHING 80V 200MA 2NS	9N171	1N4150
CR352,53	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR354	1901-0050	DIODE-SWITCHING 80V 200MA 2NS	S0562	
CR355	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR356-59	1901-0050	DIODE-SWITCHING 80V 200MA 2NS	9N171	1N4150
CR360	1901-1080	DIODE-SCHOTTKY 20V 1A	04713	1N5817(RELAXED)

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
CR361,62	1901-0731	DIODE-PWR RECT 400V 1A	71468	1N4004G
CR363	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
CR364-70	NOT USED			
CR371	1901-0050	DIODE-SWITCHING 80V 200MA 2NS	9N171	1N4150
CR372-79	NOT USED			
CR380,81	1901-0033	DIODE-GEN PRP 180V 200MA	9N171	1N645
F300	2110-0916	FUSE-SUBMINIATURE 7AT 125V	75915	
F302	2110-0716	FUSE-SUBMINIATURE.5A 125V	75915	
F303	2110-0685	FUSE-SUBMINIATURE 7A 125V	75915	
F304	2110-0713	FUSE-SUBMINIATURE 10A 125V	75915	
F305	2110-0916	FUSE-SUBMINIATURE 7AT 125V	75915	
F307	NOT USED			
F308,09	2110-0303	FUSE 2A 250V	16428	
L300	9140-0129	INDUCTOR RF-CH-MLD 220UH ±5%	04072	
L301	NOT USED			
L302	9100-1640	INDUCTOR 160UH	99800	
Q300-317	NOT USED			
Q318	1854-0474	TRANSISTOR NPN SI	04713	2N5551
Q319	1854-0477	TRANSISTOR NPN SI	14433	2N2222A
Q320	1855-0665	TRANSISTOR MOSFET	3L585	RFP2N12L
Q321	1853-0320	TRANSISTOR SI	07263	2N4032
Q322	1854-0087	TRANSISTOR NPN SI	03508	
Q323-34	NOT USED			
Q335	1854-0585	TRANSISTOR NPN SI	04713	MJE182
Q336-38	NOT USED			
Q339	1855-0414	TRANSISTOR J-FET	17856	2N4393
Q340	NOT USED			
Q341	5060-3211	ASSY-REG	28480	
Q342	1855-0549	TRANSISTOR MOSFET	9M011	IRF512
Q343	1854-0474	TRANSISTOR NPN SI	04713	2N5551
Q344-49	NOT USED			
Q350-53	1855-0414	TRANSISTOR J-FET	17856	2N4393
Q354	1853-0423	TRANSISTOR PNP SI	04713	MPS U-60
R300,01	0686-4725	RESISTOR 4.7K 5% .5W CC	01121	EB4725
R302	0811-0610	RESISTOR 56 5% 5W PW	01686	
R303	0698-8911	RESISTOR 1.3K .1% .125W TF	19701	
R304	0757-0403	RESISTOR 121 1 % .125W TF	24546	CT4-1/8-TO-121R-F
R305	0698-8672	RESISTOR 243.4.1% .125W TF	19701	
R306	0698-3700	RESISTOR 715 1% .125W TF	24546	CT4-1 /8-TO-715R-F
R307,08	8159-0005	RESISTOR-ZERO OHMS	72982	
R309	0698-8672	RESISTOR 243.4.1% .125W TF	19701	
R310	0698-0085	RESISTOR 2.61K 1 % .125W TF	24546	CT4-1/8-TO-2611-F
R311	0698-4123	RESISTOR 499 1% .125W TF	24546	CT4-1/8-TO-499R-F
R312	0757-0402	RESISTOR 110 1% .125W TF	24546	CT4-1/8-TO-111-F
R313,14	8159-0005	RESISTOR-ZERO OHMS	72982	
R315	NOT USED			
R316,17	0699-0208	RESISTOR 15% .25W CF	01121	
R318	0757-0284	RESISTOR 150 1% .125W TF	24546	CT4-1/8-TO-151-F
R319-25	NOT USED			
R326,27	0757-0424	RESISTOR 1.1K 1% .125W TF	24546	CT4-1/8-TO-1101-F

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R328	8159-0005	RESISTOR-ZERO OHMS	72982	
R329-32	NOT USED			
R333	0757-0410	RESISTOR 301 1% .125W TF	24546	CT4-1/8-TO-301R-F
R334	NOT USED			
R335,36	0757-0473	RESISTOR 221K 1% .125W TF	28480	CT4-1/8-TO-1003-F
R337,38	0757-0438	RESISTOR 5.11K 1% .125W TF	24546	CT4-1/8-TO-5111-F
R339	8159-0005	RESISTOR ZERO OHMS	28480	
R340	0757-0430	RESISTOR 2.21K 1% .125W TF	24546	CT4-1/8-TO-2211-F
R341-44	NOT USED			
R345	8159-0005	RESISTOR-ZERO OHMS	72982	
R346	0698-5579	RESISTOR 5K .5% .125W TF	91637	
R347	0698-3329	RESISTOR 10K .5% .125W TF	03888	PME55-1/8-TO-1002-D
R348	0698-6533	RESISTOR 12.5K .1% .125W TF	19701	
R349	0698-7929	RESISTOR 9.09K .1% .125W TF	19701	5033R-1/8-TO-9091-B
R350	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R351	0698-4493	RESISTOR 34K 1% .125W TF	24546	CT4-1/8-TO-3402-F
R352	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R353,54	NOT USED			
R355	0698-3328	RESISTOR 8.25K .5% .125W TF	03888	PME55-1/8-TO-8251-D
R356	0698-8913	RESISTOR 1.5M 1% .125W TF	07716	
R357	0699-0489	RESISTOR 16.15K .1% .1W TF	19701	
R358	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-F
R359	0699-1211	RESISTOR 95K .1% .1W TF	19701	
R360	0757-0447	RESISTOR 16.2K 1% .125W TF	24546	CT4-1/8-TO-1622-F
R361	8159-0005	RESISTOR-ZERO OHMS	72982	
R362	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R363,64	NOT USED			
R365	0699-1212	RESISTOR 19K .1% .125W TF	91637	
R366	0699-1722	RESISTOR 9.75K .1% .125W TF	91637	
R367	NOT USED			
R368	8159-0005	RESISTOR-ZERO OHMS	20940	
R369-71	NOT USED			
R372	0683-0335	RESISTOR 3.3 5% .25W CF	01121	CB33G5
R373	0698-4470	RESISTOR 6.98K 1% .125W TF	24546	CT4-1/8-TO-6981-F
R374	0757-0452	RESISTOR 27.4K 1% .125W TF	24546	CT4-1/8-TO-2742-F
R375	0686-2225	RESISTOR 2.2K 5% .5W CC	01121	EB2225
R376	0686-4725	RESISTOR 4.7K 5% .5W CC	01121	EB4725
R377	0698-4446	RESISTOR 267 1 % .125W TF	24546	CT4-1/8-TO-267R-F
R378	0757-0438	RESISTOR 5.11K 1% .125W TF	24546	CT4-1/8-TO-5111-F
R379	0698-5347	RESISTOR 495.5 .1% .125W TF	19701	
R380,81	0698-3510	RESISTOR 453 1% .125W TF	24546	CT4-1/8-TO-453R-F
R382	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R383,84	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R385	0811-1217	RESISTOR 150 5% 5W PW	91637	
R386	0686-8225	RESISTOR 8.2K 5% .5W CC	01121	EB8225
R387	0698-4123	RESISTOR 499 1% .125W TF	24546	CT4-1/8-TO-499R-F
R388	0683-4715	RESISTOR 470 5% .25W CF	01121	CB4715
R389	0698-5088	RESISTOR 12K 1% .125W TF	24546	CT4-1/8-TO-1202-F
R390	NOT USED			

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R391	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R392	0757-0282	RESISTOR 221 1% .125W TF	24546	CT4-1/8-TO-221R-F
R393	0698-0435	RESISTOR 2.49K 1% .125W TF	24546	CT4-1/8-TO-2491F
R394	0757-0473	RESISTOR 221K 1% .125W TF	24546	CT4-1/8-TO-2213-F
R395	0757-0431	RESISTOR 2.43K 1% .125W TF	24546	CT4-1/8-TO-2431-F
R396	0757-0200	RESISTOR 5.62K 1% .125W TF	24546	CT4-1/8-TO-5621-F
R397	0757-0481	RESISTOR 475K 1% .125W TF	19701	5033R-1/8-TO-4753-F
R398	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R399	0757-0464	RESISTOR 90.9K 1% .125W TF	24546	CT4-1/8-TO-9092-F
R400	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R401	0698-4099	RESISTOR 139 1% .125W TF	03888	PME55-1/8-TO-139R-F
R402	8159-0005	RESISTOR-ZERO OHMS	72982	
R403	NOT USED			
R404	0757-0429	RESISTOR 1.82K 1% .125W TF	24546	CT4-1/8-TO-1821-F
R405	0698-5089	RESISTOR 33K 1% .125W TF	24546	CT4-1/8-TO-3302-F
R406	0683-4715	RESISTOR 470 5% .25W CF	19701	(CR-25) 1-4-5P-47OE
R407	0811-3752	RESISTOR .18 5% 2W		
R408	NOT USED			
R409,10	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R411	0812-0010	RESISTOR 3K 5% 3W PW	91637	
R412	0698-4536	RESISTOR 340K 1% .125W TF	07716	
R413	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R414	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-F
R415	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R416-18	NOT USED			
R419	0698-4435	RESISTOR 2.49K 1% .125W TF	24546	CT4-1/8-TO-2491-F
R420	0683-3305	RESISTOR 33 5% .25W CF	19701	(CR-25) 1-4-5P-33E
R421	0698-3449	RESISTOR 28.7K 1% .125W TF	24546	CT4-1/8-TO-2872-F
R422	0698-8827	RESISTOR 1M 1% .125W TF	19701	
R423	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R424	NOT USED			
R425	0757-0413	RESISTOR 392 1% .125W TF	24546	CT4-1/8-TO-392R-F
R426	0757-0427	RESISTOR 1.5K 1% .125W TF	24546	CT4-1/8-TO-1501-F
R427	0698-3444	RESISTOR 316 1% .125W TF	24546	CT4-1/8-TO-316R-F
R428	0757-0405	RESISTOR 162 1% .125W TF	24546	CT4-1/8-TO-162R-F
R429,30	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R431	NOT USED			
R432	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R433	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R434	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R435	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R436	0683-4735	RESISTOR 47K 5% .25W CF	19701	(CR-25) 1-4-5P-47K
R437	NOT USED			
R438	0698-3156	RESISTOR 14.7K 1% .125W TF	24546	CT4-1/8-TO-1472-F
R439	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R440,41	NOT USED			
R442	0698-8913	RESISTOR 1.5M 1% .125W TF	07716	
R443	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R444	0757-0447	RESISTOR 16.2K 1% .125W TF	24546	
R445	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R446	0698-4480	RESISTOR 15.8K 1% .125W TF	24546	CT4-1/8-TO-1582-F
R447	0757-0440	RESISTOR 7.5K 1% .125W TF	24546	CT4-1/8-TO-7501-F
R448	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-f
R449	0698-3447	RESISTOR 422 1% .125W TF	24546	CT4-1/8-TO-422R-F
R450	0698-8827	RESISTOR 1M 1% .125W TF	19701	
R451	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R452	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R453	0698-4480	RESISTOR 15.8K 1% .125W TF	24546	CT4-1/8-TO-1582-F
R454	0698-7880	RESISTOR 28.7K 1% .125W TF	19701	5033R-1/8-T9-2872-F
R455	0698-8827	RESISTOR 1M 1% .125W TF	19701	
R456	0698-0087	RESISTOR 316 1% .25W TF	24546	NA5-1/4-TO-3160-F
R457	0811-2553	RESISTOR 7.5 5% 2W PW	75042	BWH2-7R5-J
R458	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R459	0757-0446	RESISTOR 15K 1% .125W TF	24546	CT4-1/8-TO-1502-F
R460	0698-8913	RESISTOR 1.5M 1%	28480	
R461	0683-4735	RESISTOR 47K 5% .25W CF	01121	CB4735
R462	0757-0288	RESISTOR 9.09K 1% .125W TF	19701	5033R-1/8-TO-9091-F
R463	0698-0084	RESISTOR 2.15K 1% .125W TF	24546	CT4-1/8-TO-2151
R464	0757-0124	RESISTOR 39.2K 1% .125W TF	07716	
R465	0698-4484	RESISTOR 19.1K 1% .125W TF	24546	
R466-70	NOT USED			
R471	0699-0070	RESISTOR 3.16M 1% .125W TF	07716	
R472	0698-6363	RESISTOR 40K .1% .125W TF	07716	
R473	0757-0439	RESISTOR 6.81K 1% .125W TF	24546	CT4-1/8-TO-3652-F
R474	0757-0124	RESISTOR 39.2K 1% .125W TF	0716	
R475	0683-8235	RESISTOR 82K 5% .25W CF	01121	CB835
R476	0699-0088	RESISTOR 1.21M 1% .125W TF	19701	
R477	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R478-82	NOT USED			
R483	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R484-86	NOT USED			
R487	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R488	0757-0460	RESISTOR 61.9K 1% .125W TF	24546	CT4-1/8-TO-6192-F
R489,90	0686-1065	RESISTOR 10M 5% .5W CC	01121	EB 1065
R491	0683-0475	RESISTOR 4.7 5% .25W CF	01121	CB47G5
R492	0683-2225	RESISTOR 2.2K 5% .25W CF	19701	CB2225
R493	0757-0430	RESISTOR 2.21K 1% .125W TF	24546	CT4-1/8-TO-2211-F
R494	0698-3430	RESISTOR 21.5 1% .125W TF	03888	PME55-1/8-TO-21 R5-F
R495	0757-0447	RESISTOR 16.2K 1% .125W TF	24546	CT4-1/8-TO-1622-F
R496	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R497	0683-3915	RESISTOR 390 5% .25W CF	19701	(CR-25) 1-4-5P-39OE
R498	0683-1015	RESISTOR 100 5% .25W CF	01121	CB1015
R499	0698-4493	RESISTOR 34K 1% .125W TF	24546	CT4-1/8-TO-3402-F
R500,01	0757-0404	RESISTOR 130 1% .125W TF	24546	CT4-1/8-TO-131-F
R502	0757-0283	RESISTOR 2K 1% .125W TF	24546	CT4-1/8-TO-2001-F
R503	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	
R504	0683-1035	RESISTOR 10K 5% .25W CF	01121	CB1035
R505	NOT USED			
R506	0757-0280	RESISTOR 1K 1% .125W TF	24546	CT4-1/8-TO-1001-F
R507	0683-0475	RESISTOR 4.7 5% .25W CF	01121	CB47G5

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
R508,09	0686-1065	RESISTOR 10M 5% .5W CC	01121	EB1065
R510,11	NOT USED			
R512	0683-1065	RESISTOR 10M 5% .25W CC	01121	CB1065
R513	NOT USED			
R514	0698-4435	RESISTOR 2.49K 1% .125W TF	24546	CT4-1/8-TO-6811-F
R515	0757-0452	RESISTOR 27.4K 1% .125W TF	24546	CT4-1/8-TO-2742-F
R516-604	NOT USED			
R605	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R606-09	NOT USED			
R610,11	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R612-19	NOT USED			
R620	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R621	0683-1825	RESISTOR 1.8K 5% .25W CF	01121	CB1825
R622,23	NOT USED			
R624	0698-0087	RESISTOR 316 1% .25W TF	24546	NA5-1/8-TO-3160-F
R625	NOT USED			
R626	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R627	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R628	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R629	0757-0442	RESISTOR 10K 1% .125W TF	24546	CT4-1/8-TO-1002-F
R630	0757-0199	RESISTOR 21.5K 1% .125W TF	24546	CT4-1/8-TO-2152-F
R631	0698-4435	RESISTOR 2.49K 1% .125W TF	24546	CT4-1/8-TO-2491-F
R632,33	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R634	0757-0200	RESISTOR 5.62K 1% .125W TF	24546	CT4-1/8-TO-5621-F
R635	0757-0465	RESISTOR 100K 1% .125W TF	24546	CT4-1/8-TO-1003-F
R636-46	NOT USED			
R647	0683-6855	RESISTOR 6.8M 5% .25W CC	01121	CB6855
R648-59	NOT USED			
R660	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R661,62	0757-0469	RESISTOR 150K 1% .125W TF	24546	CT4-1/8-TO-1503-F
R663	0757-0401	RESISTOR 100 1% .125W TF	24546	CT4-1/8-TO-101-F
R664	0757-0438	RESISTOR 5.11K 1% .125W TF	24546	CT4-1/8-TO-5111-F
R665-69	NOT USED			
R670	0683-1065	RESISTOR 10M 5 .25W CC	01121	CB1065
T301	06624-80091	XFMR-PULSE	28480	
U300	5060-3212	ASSY RGLTR & HS	28480	
U301	5060-3260	IC V RGLTR-A	28480	
U302	5060-2942	ASSY-HS	28480	
U303	1826-0527	ASSY-HS		
U304-09	NOT USED			
U310,11	1990-0996	IC OPTO-ISOLATOR	28480	HCPL-2200
U312	NOT USED			
U313,14	1826-1917	IC D/A 14-BIT	24355	AD7534KN
U315	1826-1590	IC OP AMP PRON QUAD	10858	LT1014CN
U316,17	NOT USED			
U318	1826-1514	IC V RGLTR-V-REF-FXD 9.95/10.05V	10858	LT1021BCN8-10
U319	1826-1590	IC OP AMP PRON QUAD	10858	LT1014CN
U320	1820-1216	IC DCDR TTL LS 3-TO-8-LINZE 14INP	01295	SN74LS138N
U321	1826-1917	IC D/A 14-BIT	24355	AD7534KN
U322	NOT USED			
U323	1826-1021	IC ANALOG MULTIPLEXER CHNL	17856	DC508ACJ

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Table 5-8. 50W/2A BOARD Replacement Parts List (Continued)

Design	Agilent Part No.	Description	Mfg. Code	Mfg. Part No.
U324	1826-1475	IC COMPARATOR CP	10858	LT1011CN8
U325	1826-0412	IC COMPARATOR PRON DUAL	27014	LM393N
U326	1810-039	NETWORK-RES	01121	
U327	1826-1842	IC ANALOG SPECIAL		
U328-33	NOT USED			
U334,35	1906-0349	DIODE-FW BRDG 200V 6A	71744	KBP0602
U336	1858-0088	TRANSISTOR ARRAY	04713	MPQ7091
U337	1826-1843		04713	TL431IP
U338	5060-3567	IC POWER - HYBRED	28480	
U339	NOT USED			
U340	1858-0127	TRANSISTOR ARRAY	56289	TPQA56
U341-45	NOT USED			
U346,47	1826-1895		10858	LT1001ACN8
U348	1858-0083	TRANSISTOR ARRAY	56289	TPQ6002
U349	NOT USED			
U350	1826-0493	IC OP AMP LOW-BIAS-H-IMPD	27014	LM308AN
U351	1826-0138	IC COMPARATOR GP QUAD	27014	LM339N
U352	1826-1896		10858	LT1001CN8
U353	NOT USED			
U354	1826-0468	IC V RGLTR-OV-V-SEN	04713	MC34062P1
U355-59	NOT USED			
U360-62	1826-1895		10858	LT1001ACN8
U363	1826-1068	IC D/A 8-BIT	27014	DAC0832LCN
U364-66	1826-2191		17856	DGP201ADJ
U367,68	1820-3344	IC SHF-RGTR CMOS/74HC ASYNCHRO SERIAL-IN	04713	MC74HC595N
U369	1820-2102	IC LCH TTL LS D-TYPE OCTL	01295	SN74LS373N
U370	1820-1201	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
U371,72	1826-1895		10858	LT1001ACN8
U373,74	1826-1896		10858	LT1001CN8
U375	1826-1302	IC OP AMP LP QUAD	27014	LF444ACN
U376,77	1826-0493	IC OP AMP LOW-BIAS-H-IMPD	27014	LM308AN
U378	1826-1895		10858	LT1001ACN8
U379	1810-1266	RESISTOR NETWORK	28480	
U380	1810-1267	RESISTOR NETWORK	28480	
U381	1810-1263	RESISTOR NETWORK	28480	
U382	1810-1262	RESISTOR NETWORK	28480	
VR300-04	NOT USED			
VR305	1902-1377	DIODE-ZNR 6.19V 2%	04713	
VR306	1902-0182	DIODE-ZNR 20.5V 5%	15818	
VR307-14	NOT USED			
VR315	1902-0057	DIODE-ZNR 6.49V 5%	15818	
VR316	1902-0244	DIODE-ZNR 30V 5%	07263	
VR317-89	NOT USED			
VR390	1902-3323	DIODE-ZNR 42.2V 5%,	15818	
VR391-99	NOT USED			
VR400,01	1902-0783	DIODE-ZNR 16V 5%	04713	
VR402	1902-0064	DIODE-ZNR 7.5V 5%	04713	
Y300	0410-1627	RESONATOR-CERAMIC 4.0MHZ	28480	

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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 6-4. 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 models. 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 models.

Figures 6-3 and 6-4 illustrate the circuits on the 25W and 50W output boards. The configuration for each model is as follows.

MODEL	OUTPUT 1	OUTPUT 2	OUTPUT 3	OUTPUT 4
6625A	25W/0.5A	50W/2A	NU	NU
6626A	25W/0.5A	25W/0.5A	50W/2A	50W/2A
6628A	50W/2A	50W/2A	NU	NU
6629A	50W/2A	50W/2A	50W/2A	50W/2A

Figure 6-3 (Sheets 1 through 5) show the following circuits and cover all 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.
Sheet 5 - Ranging and Readback amplifiers.

Figure 6-4 (Sheets 1 through 5) are similar to Figure 6-3 and cover all 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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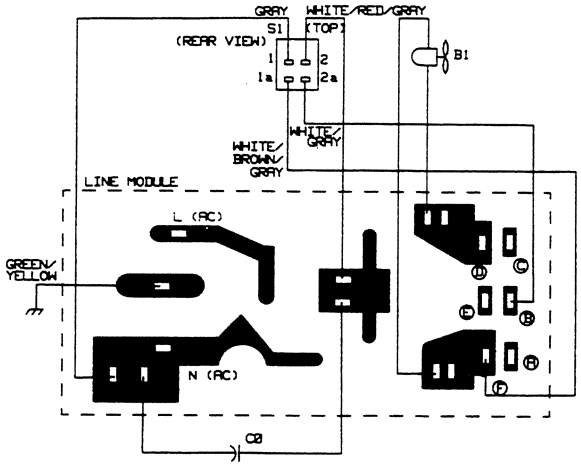
Schematic Notes For Figure 6-1

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 voltage line voltage source (100, 120, 220, or 240 Vac). See Section II in the Operating Manual (Agilent P/N 06626-90001) for details.

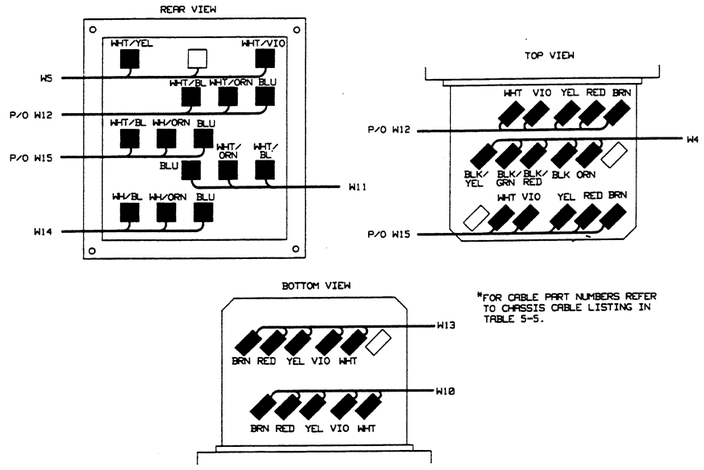
3. The reference designators (W1, W2, etc.) for the cable assemblies are for schematic reference only. Use the Agilent part number to physically identify cables in the supply. Each cable is marked cable is marked with the appropriate Agilent Part No. The illustration below shows the transformer T1 terminal 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.



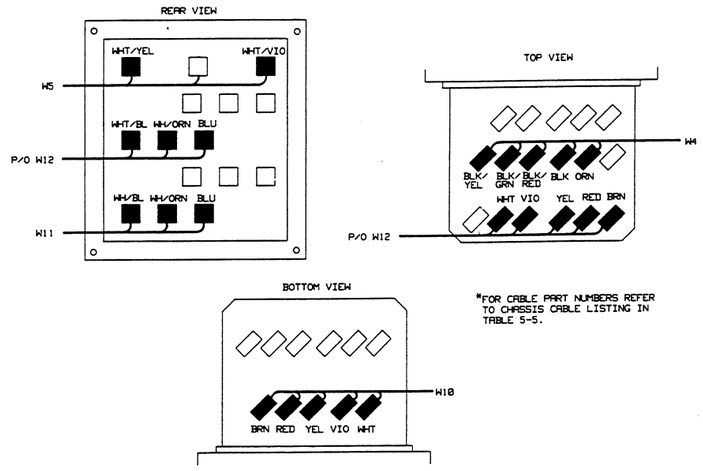
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MODEL Agilent 6626A AND Agilent 6629A
TRANSFORMER T1 CONNECTIONS*



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

MODEL Agilent 6625A AND Agilent 6628A
TRANSFORMER T1 CONNECTIONS*



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

FOR AGILENT 6625A, 6626A, 6628A, 6629A

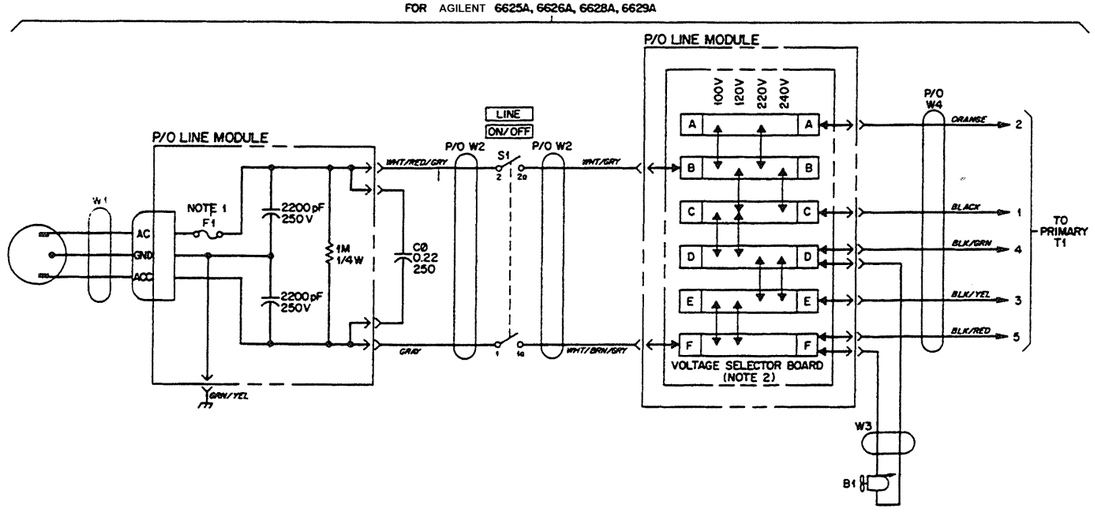
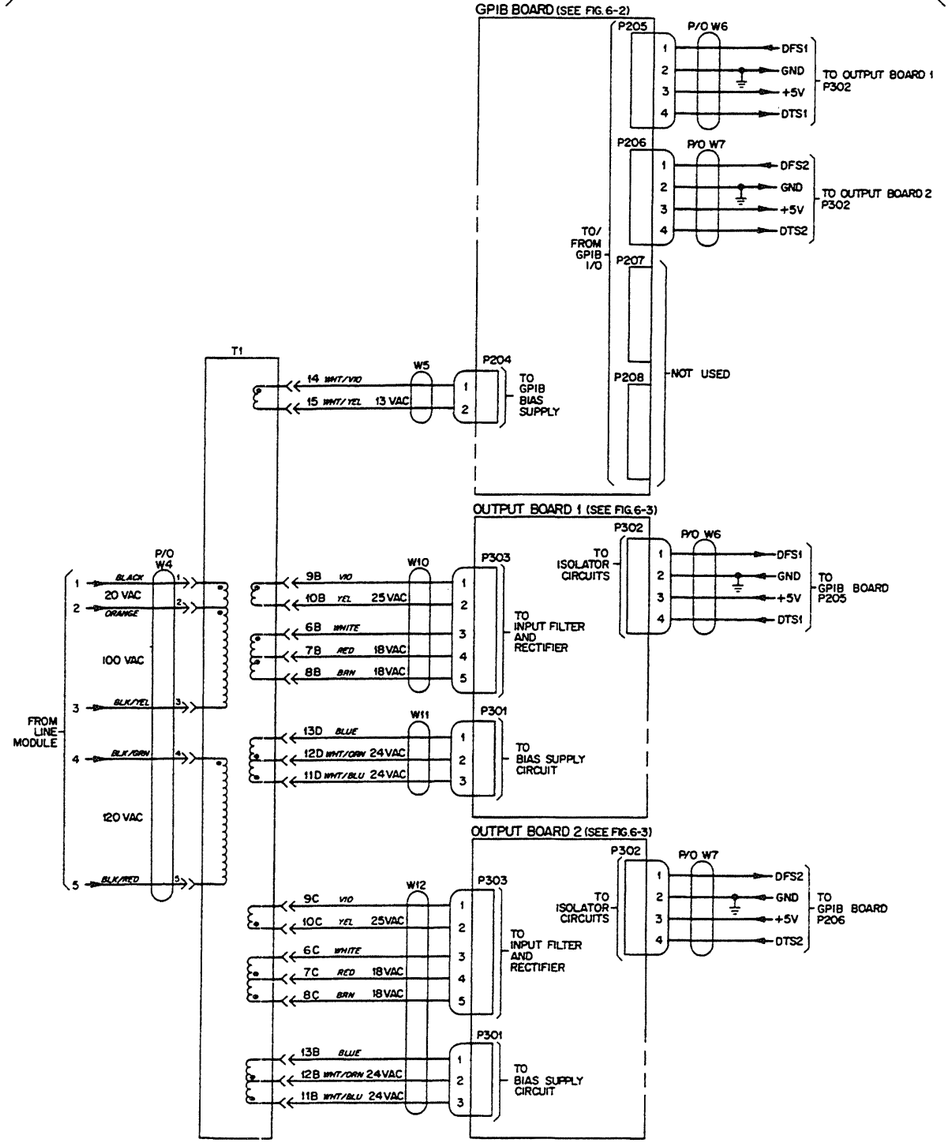


Figure 6-1. Power Distribution Schematic (sheet 1 of 2) 6-3

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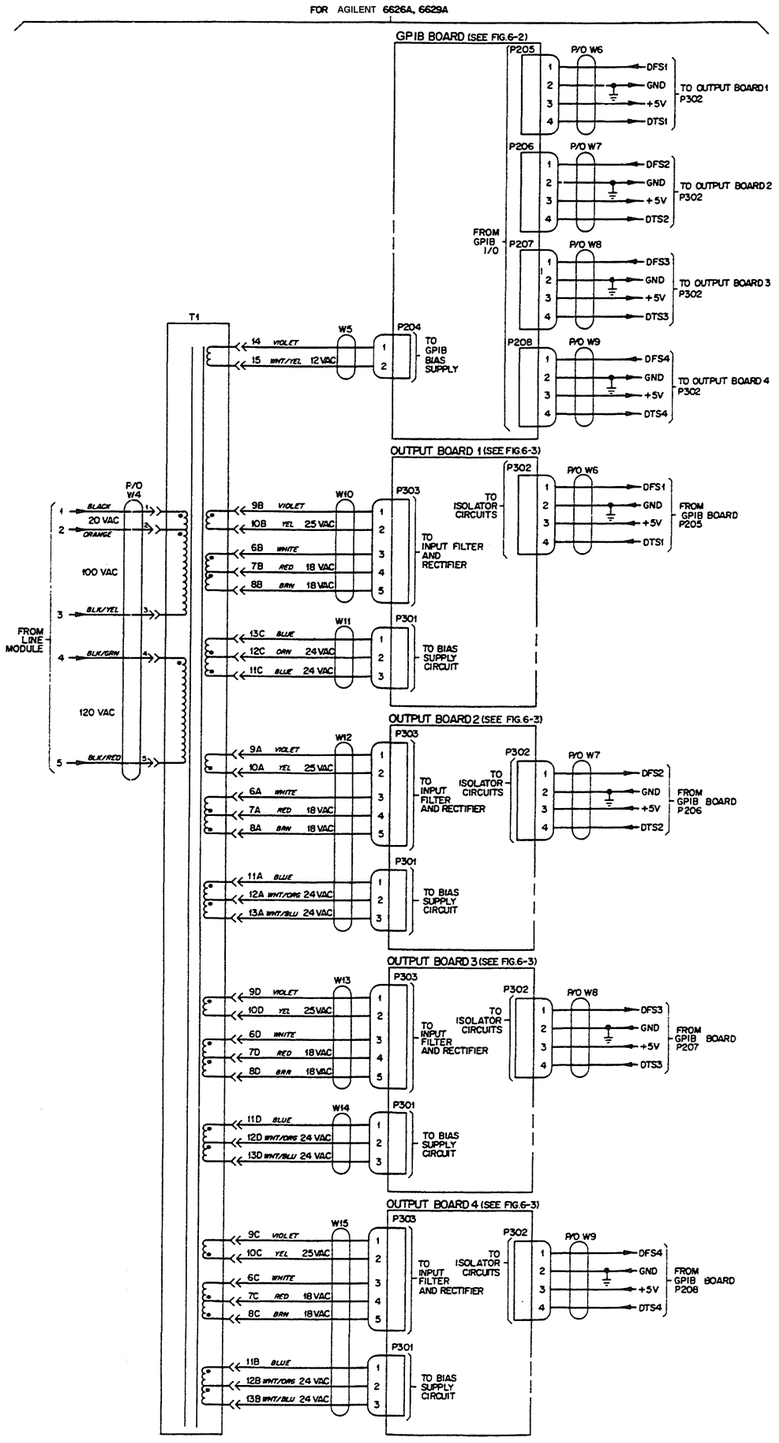
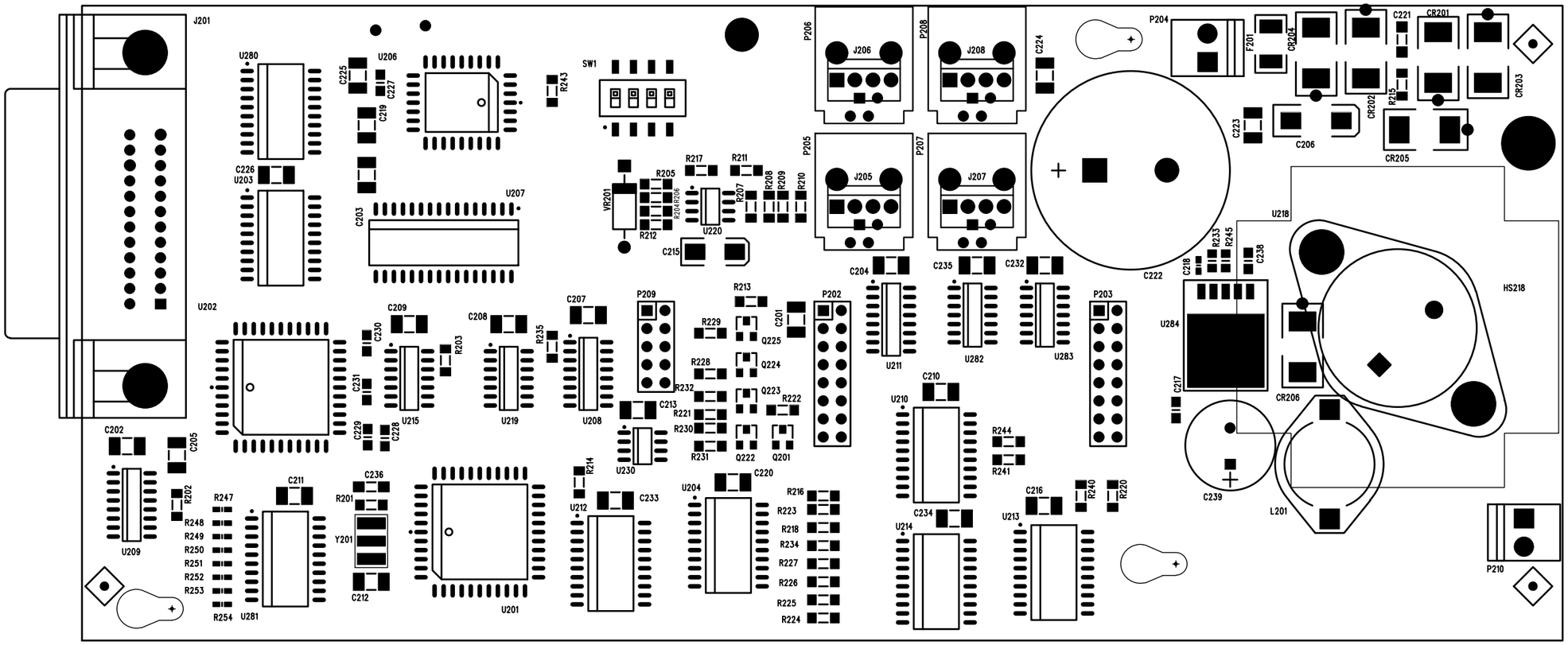


Figure 6-1. Power Distribution Schematic (sheet 2 of 2) 6-4

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NOTES:
This surface-mount GPIB assembly applies to models starting with the following serial numbers and up:
6625A 3738A01389-up
6626A 3737A02259-up
6628A 3738A00727-up
6629A 3738A00968-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 = OFF

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 6-5

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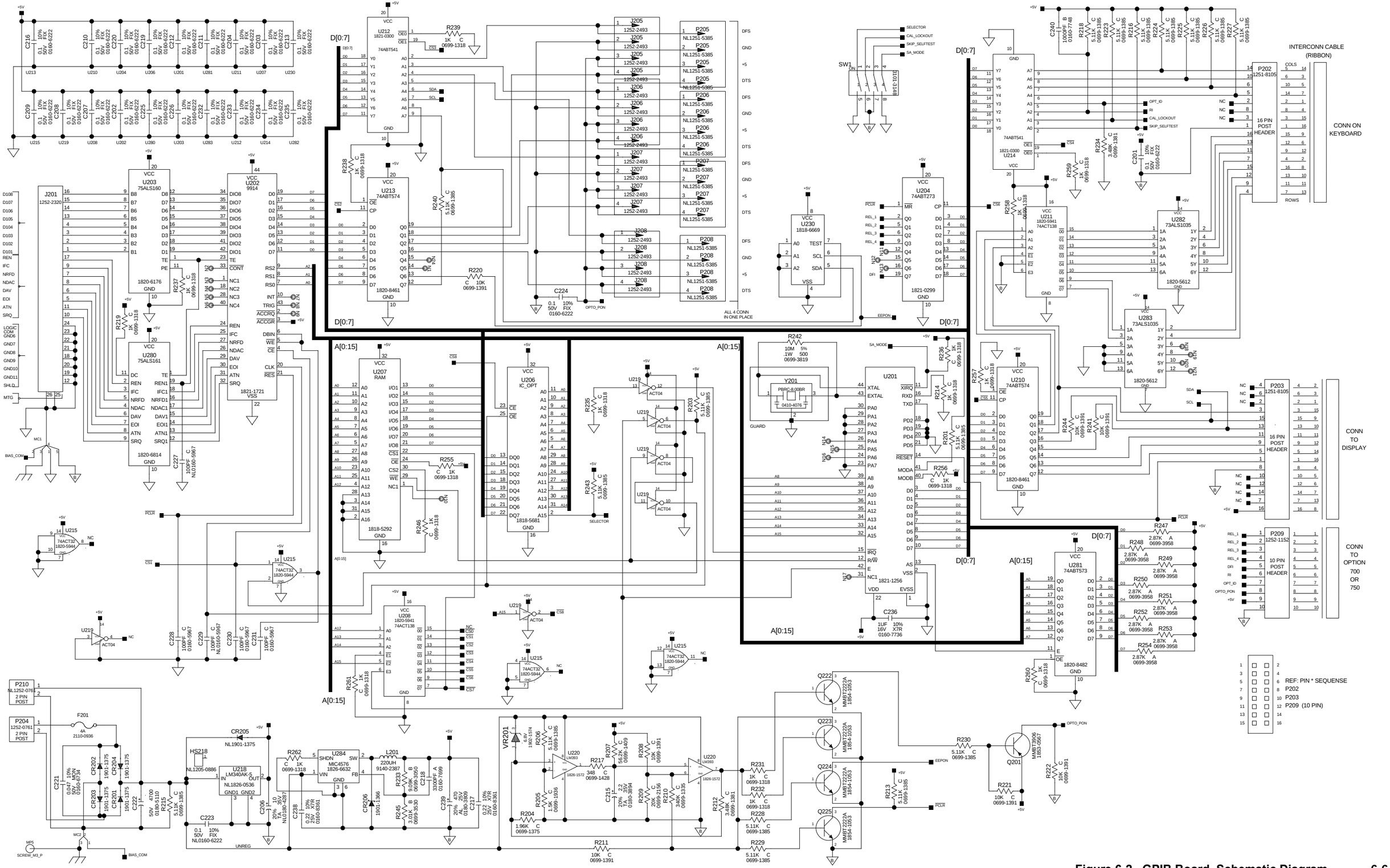


Figure 6-2. GPIB Board, Schematic Diagram 6-6

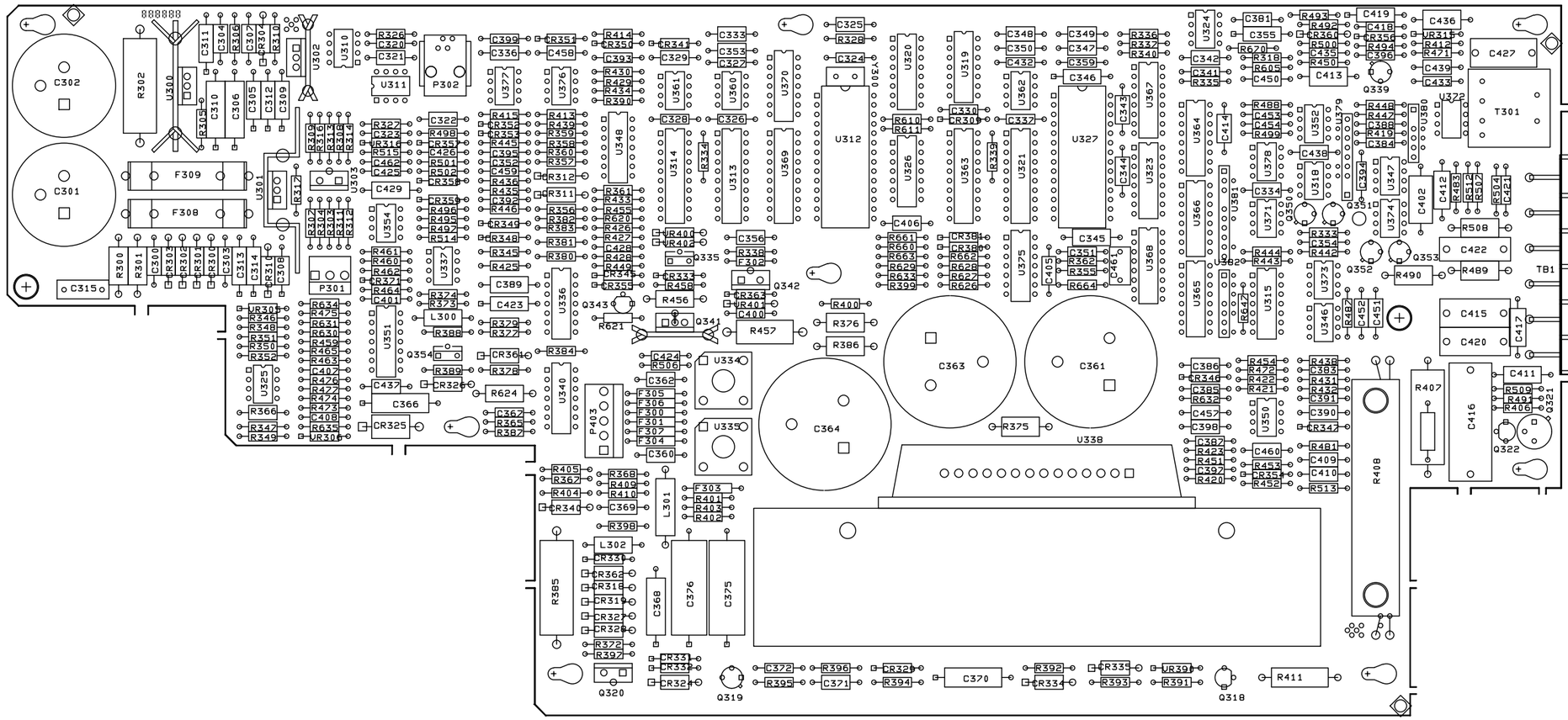


Figure 6-3. Output 1 & 2 Board, Component Location 6-7

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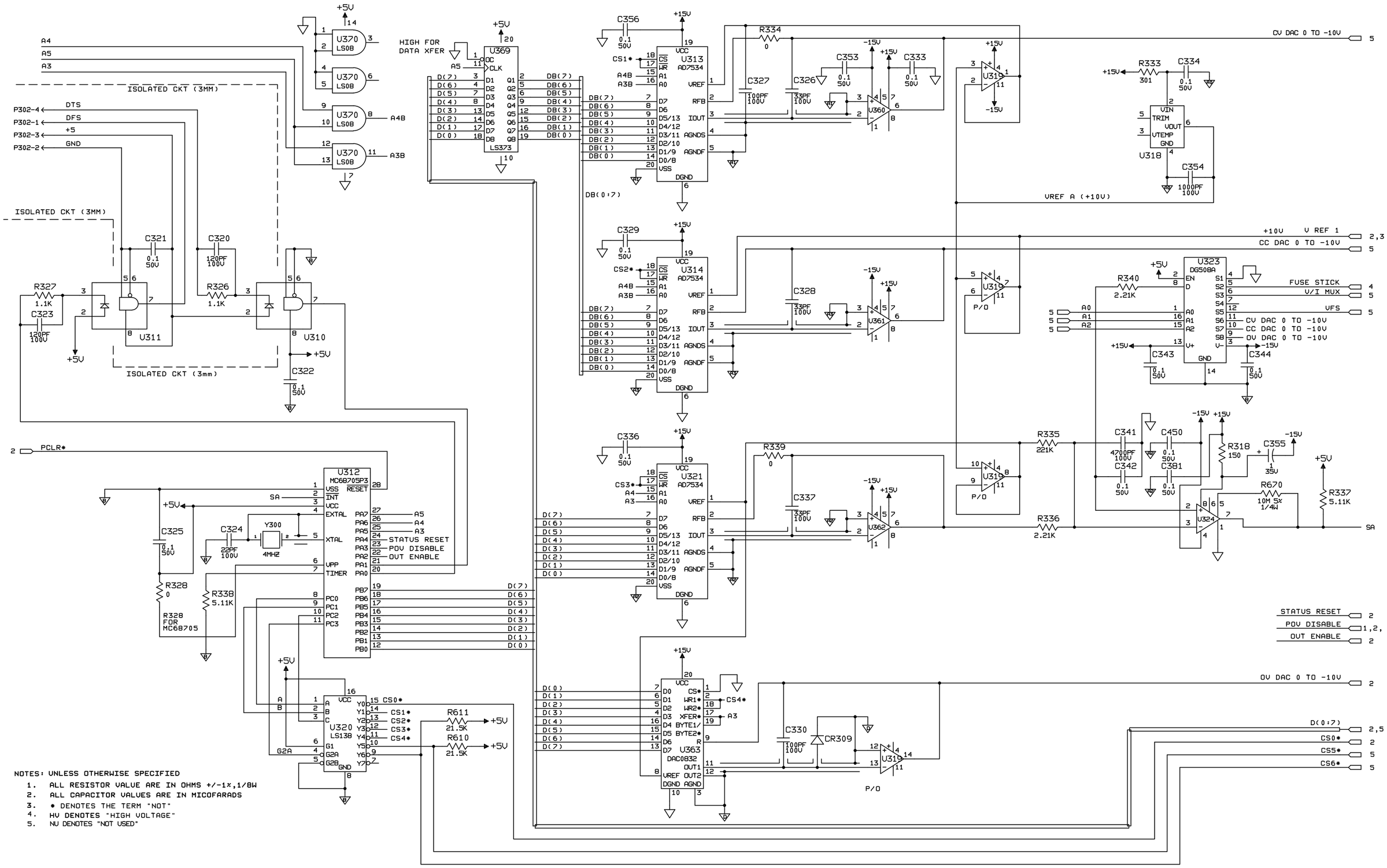


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 1 of 5) 6-8

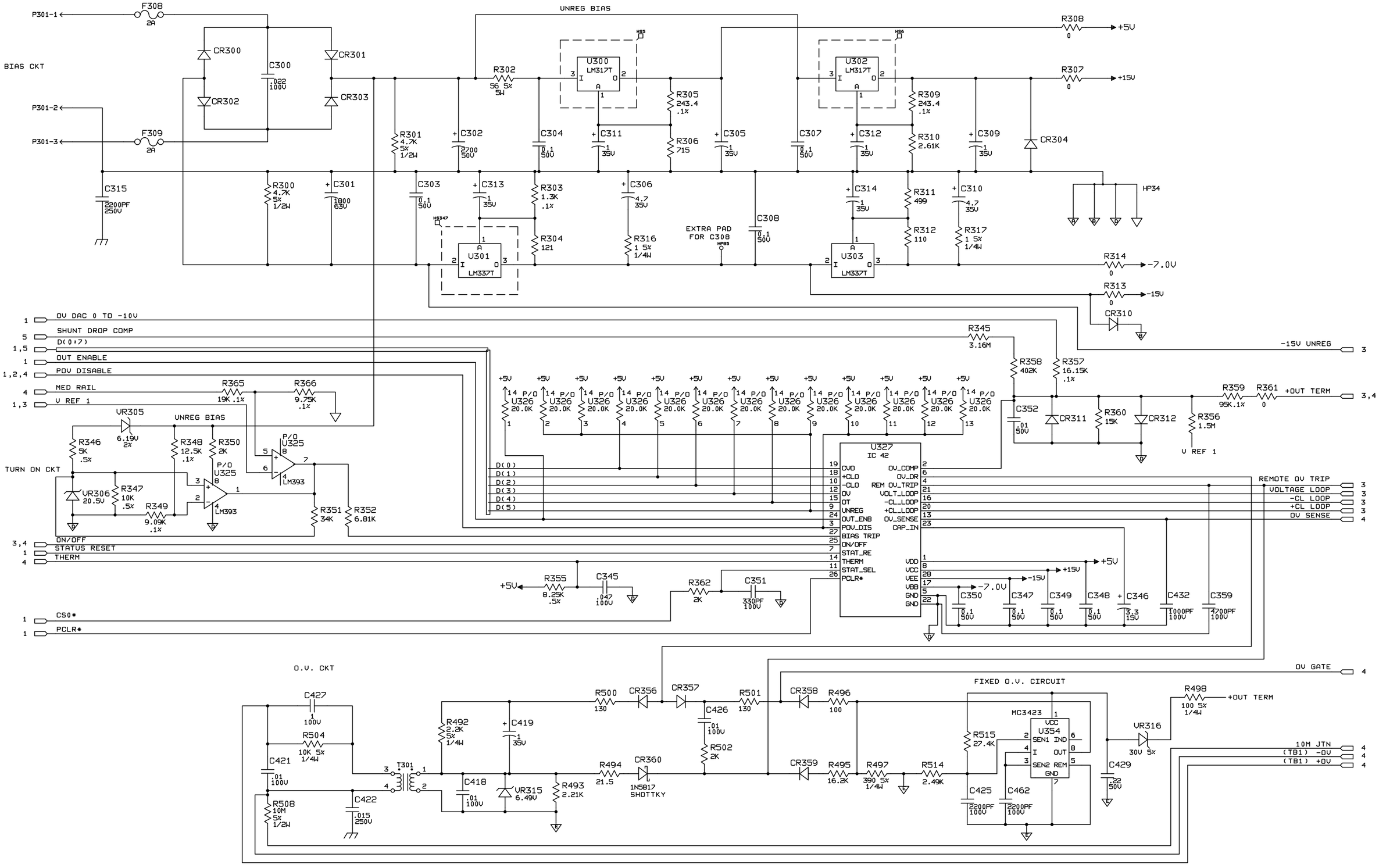


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 2 of 5) 6-9

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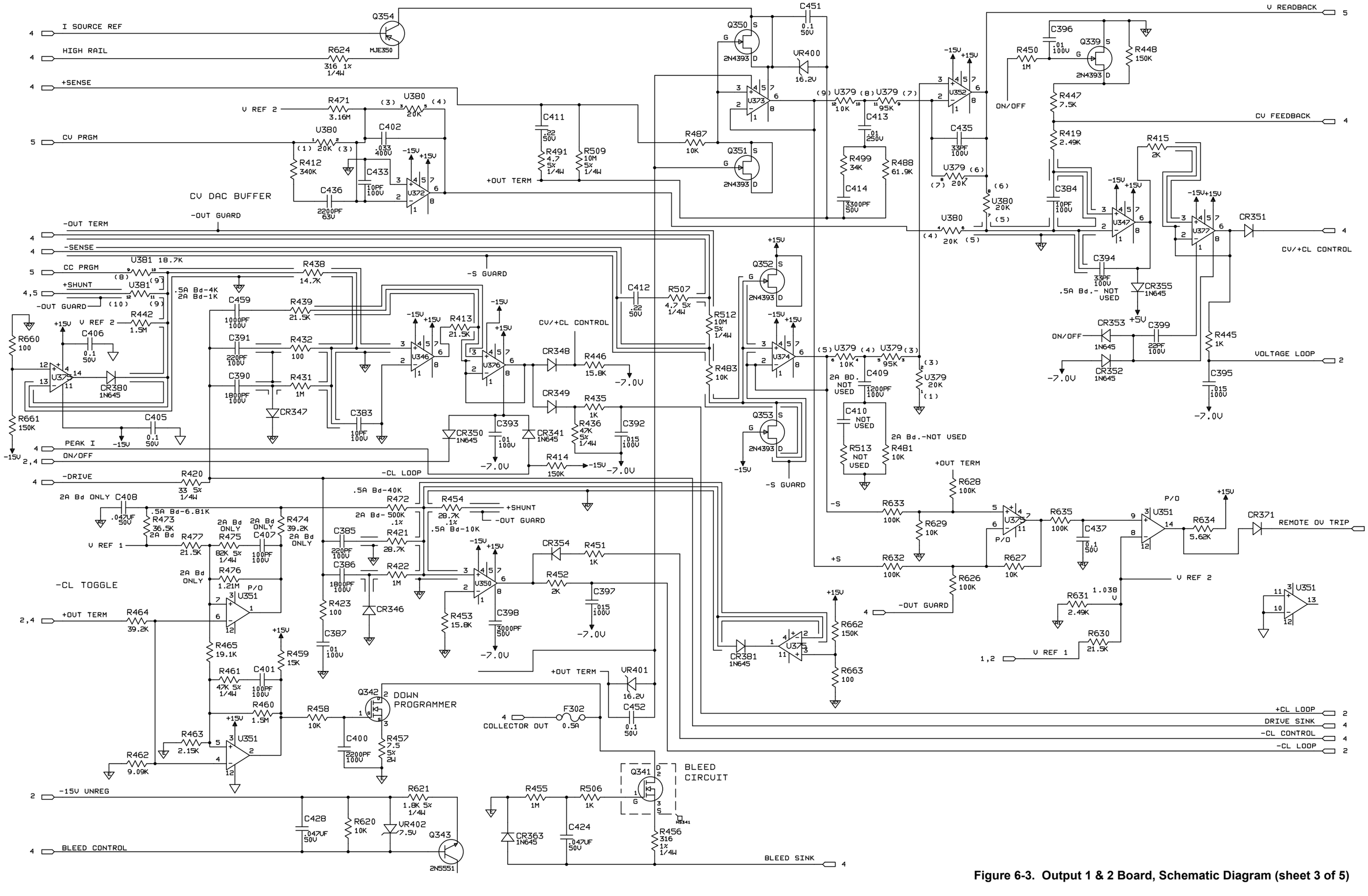


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 3 of 5) 6-10

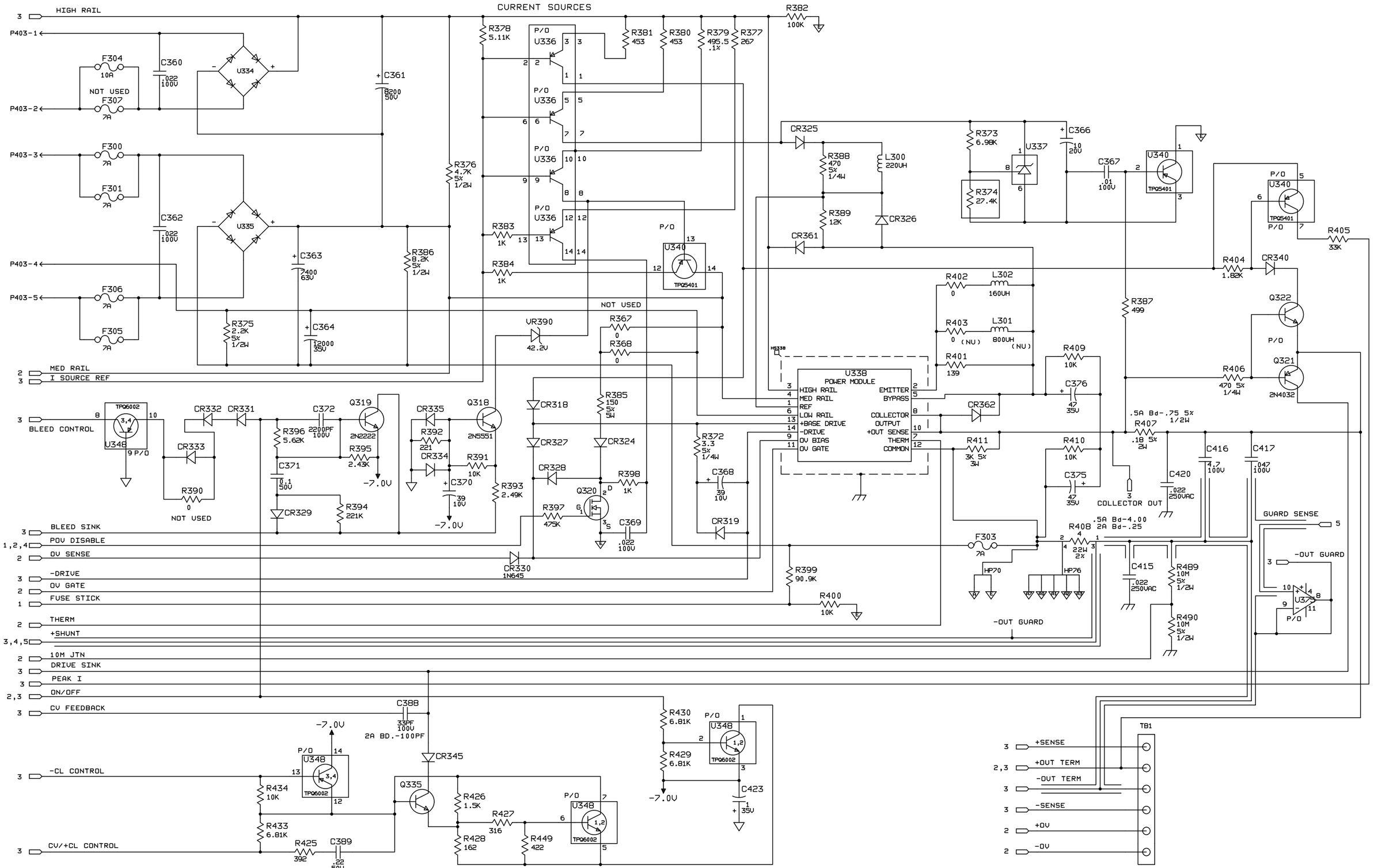


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 4 of 5) 6-11

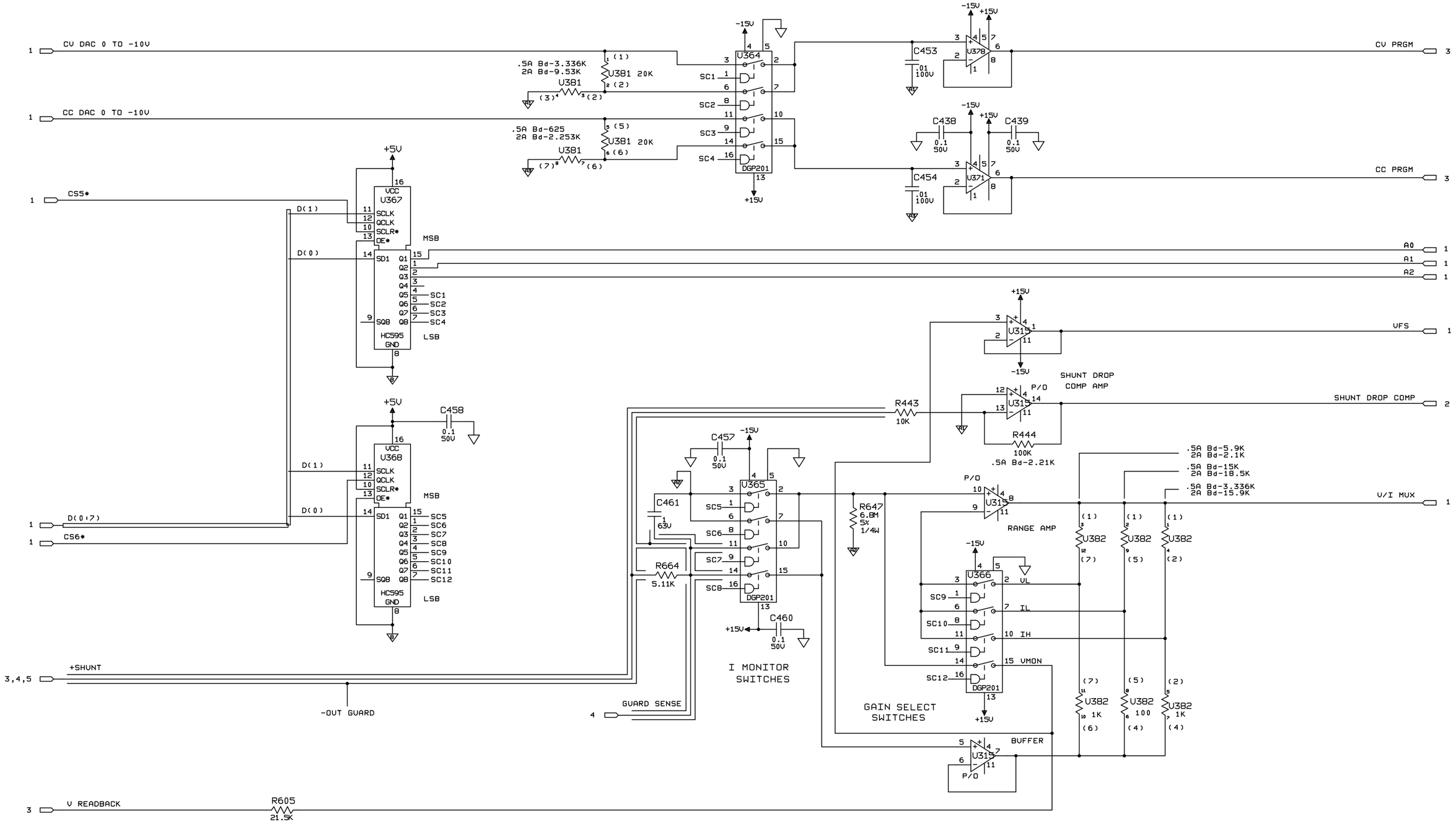


Figure 6-3. Output 1 & 2 Board, Schematic Diagram (sheet 5 of 5) **6-12**

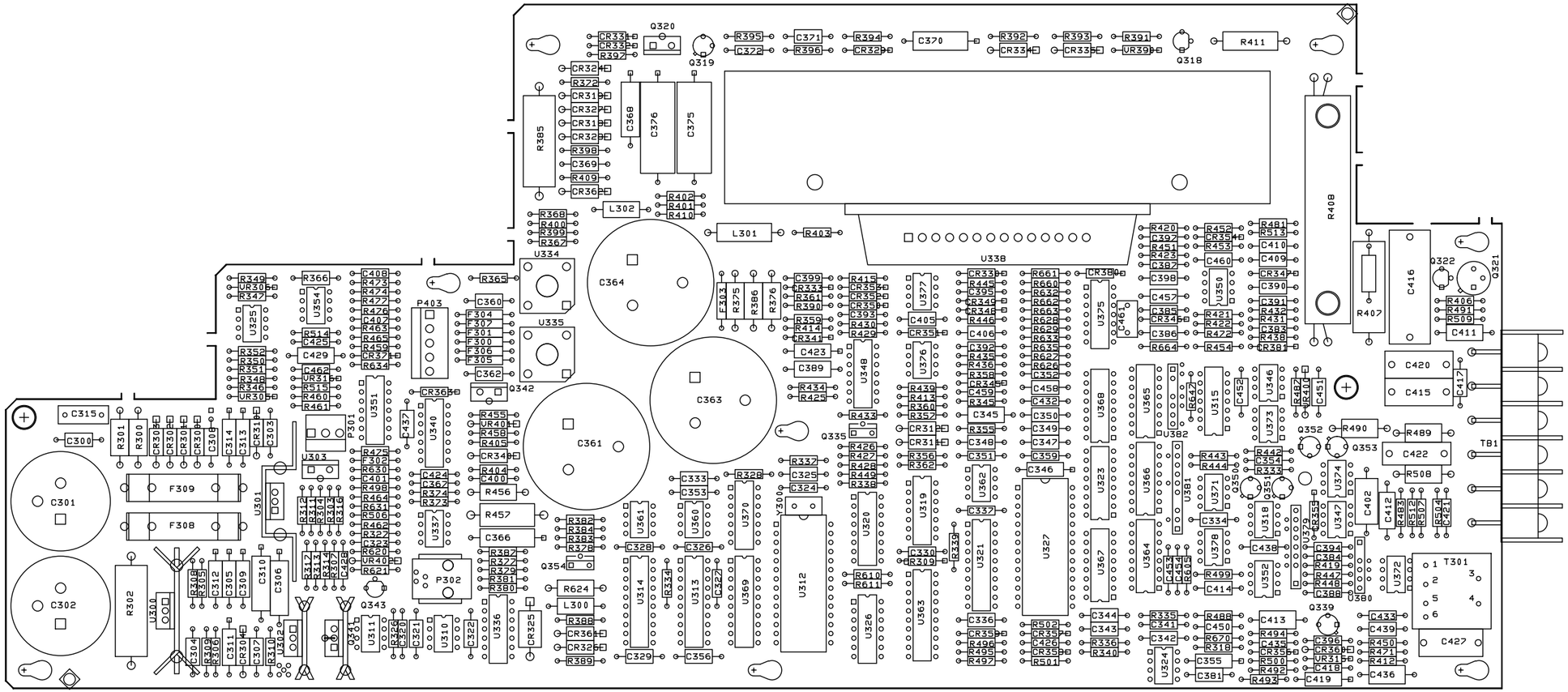
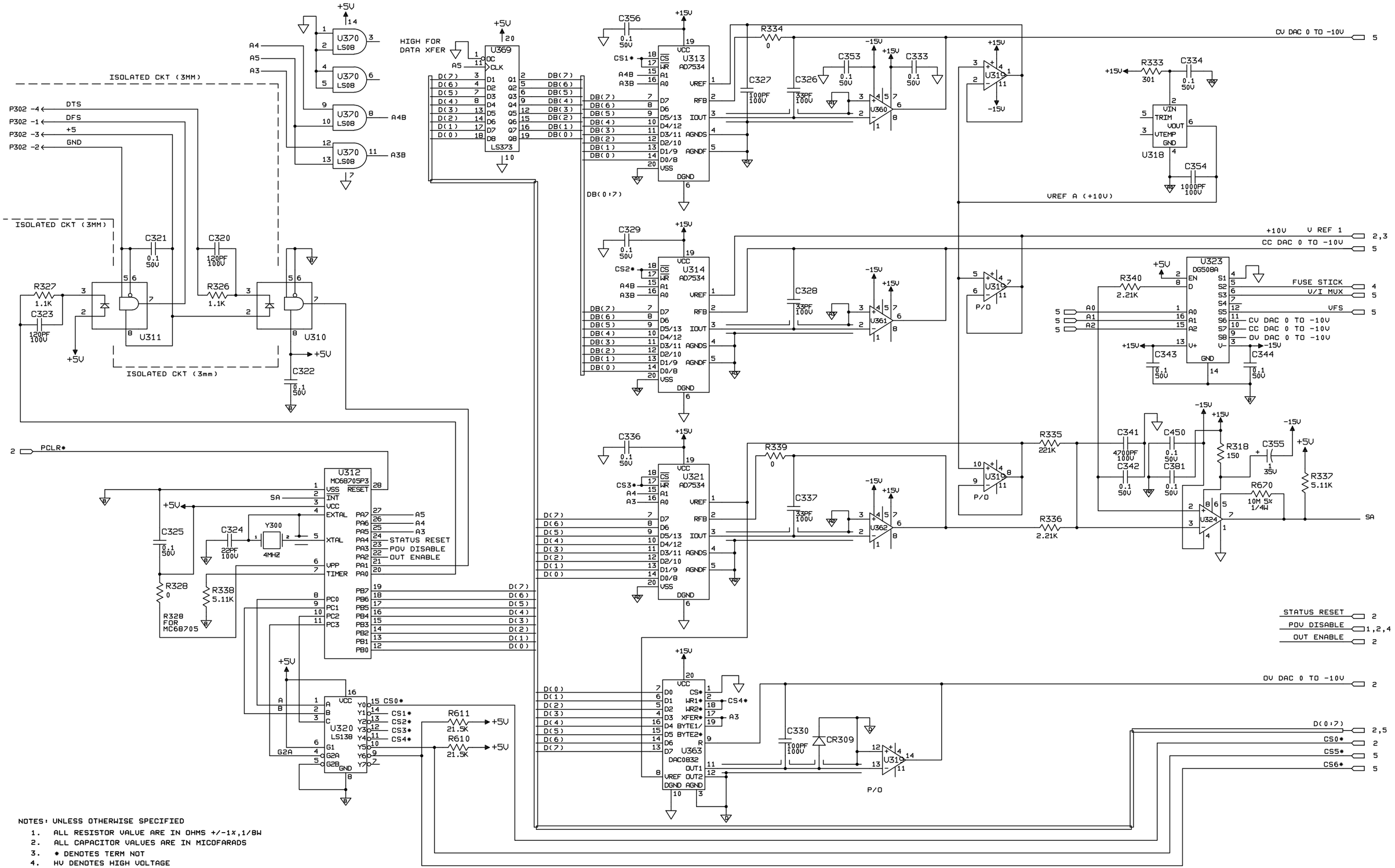


Figure 6-4. Output 3 & 4 Board, Component Location 6-13

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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 5) 6-14

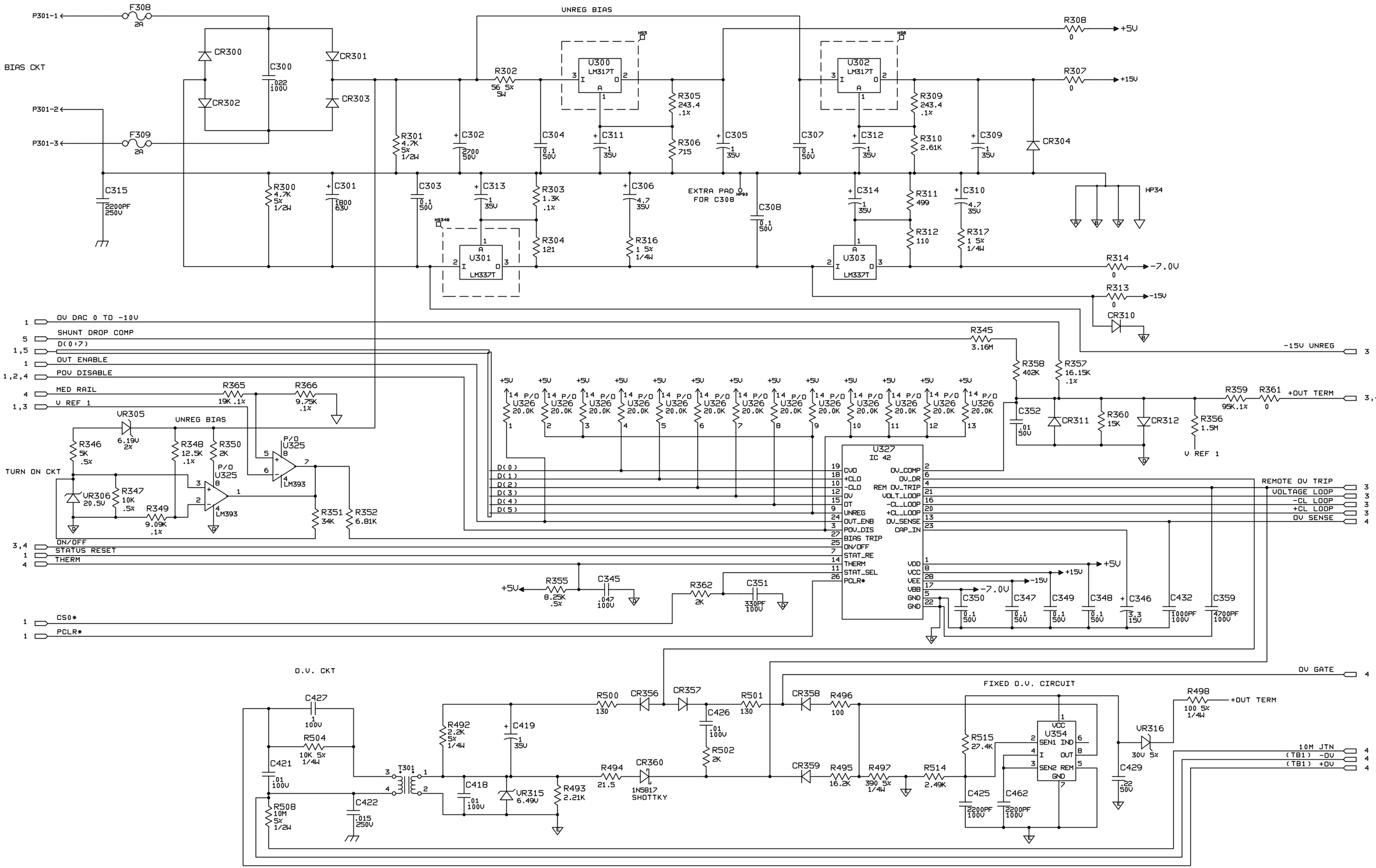


Figure 6-4. Output 3 & 4 Board, Schematic Diagram (sheet 2 of 5) 6-15

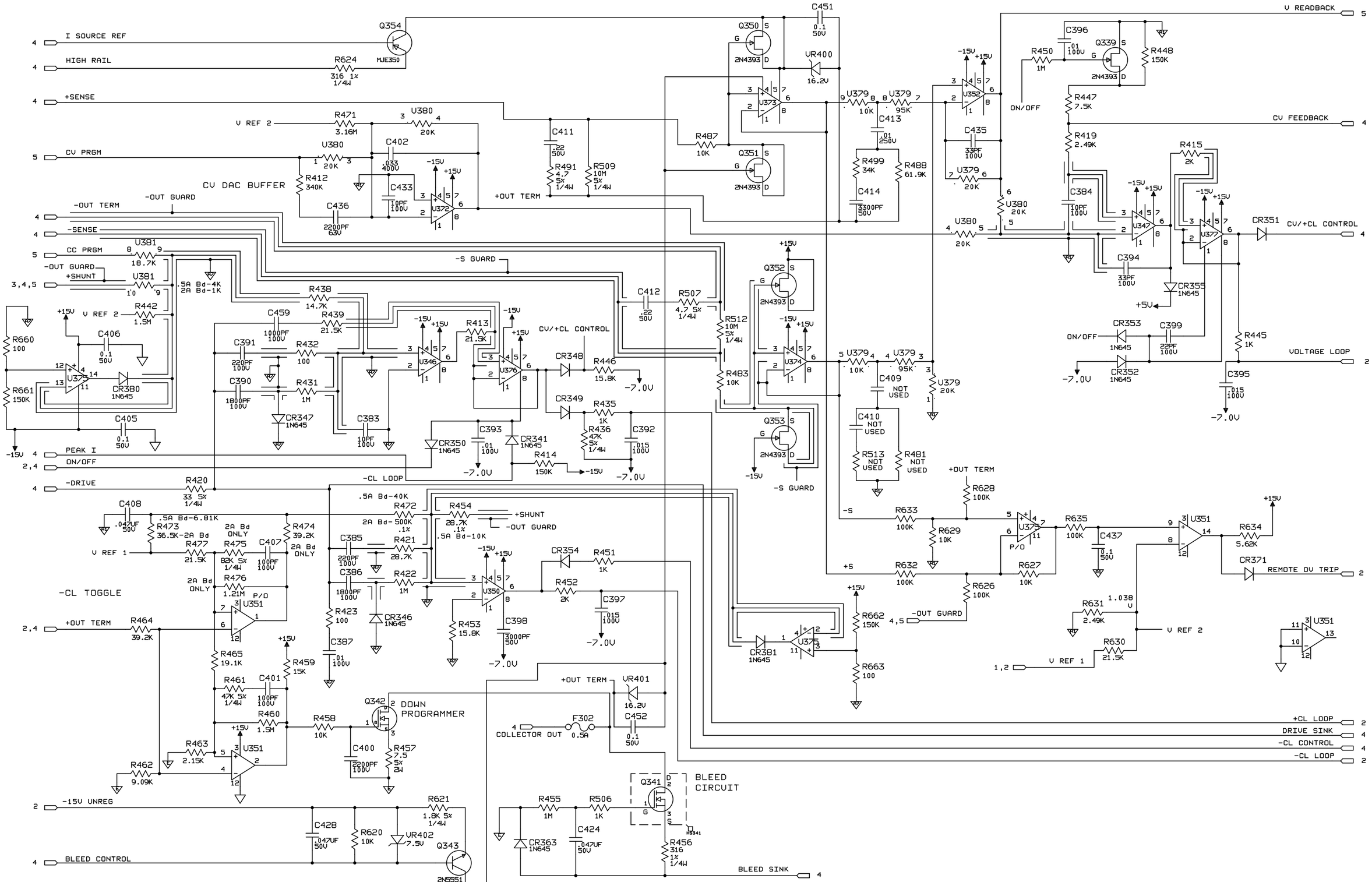


Figure 6-4. Output 3 & 4 Board, Schematic Diagram (sheet 3 of 5) 6-16

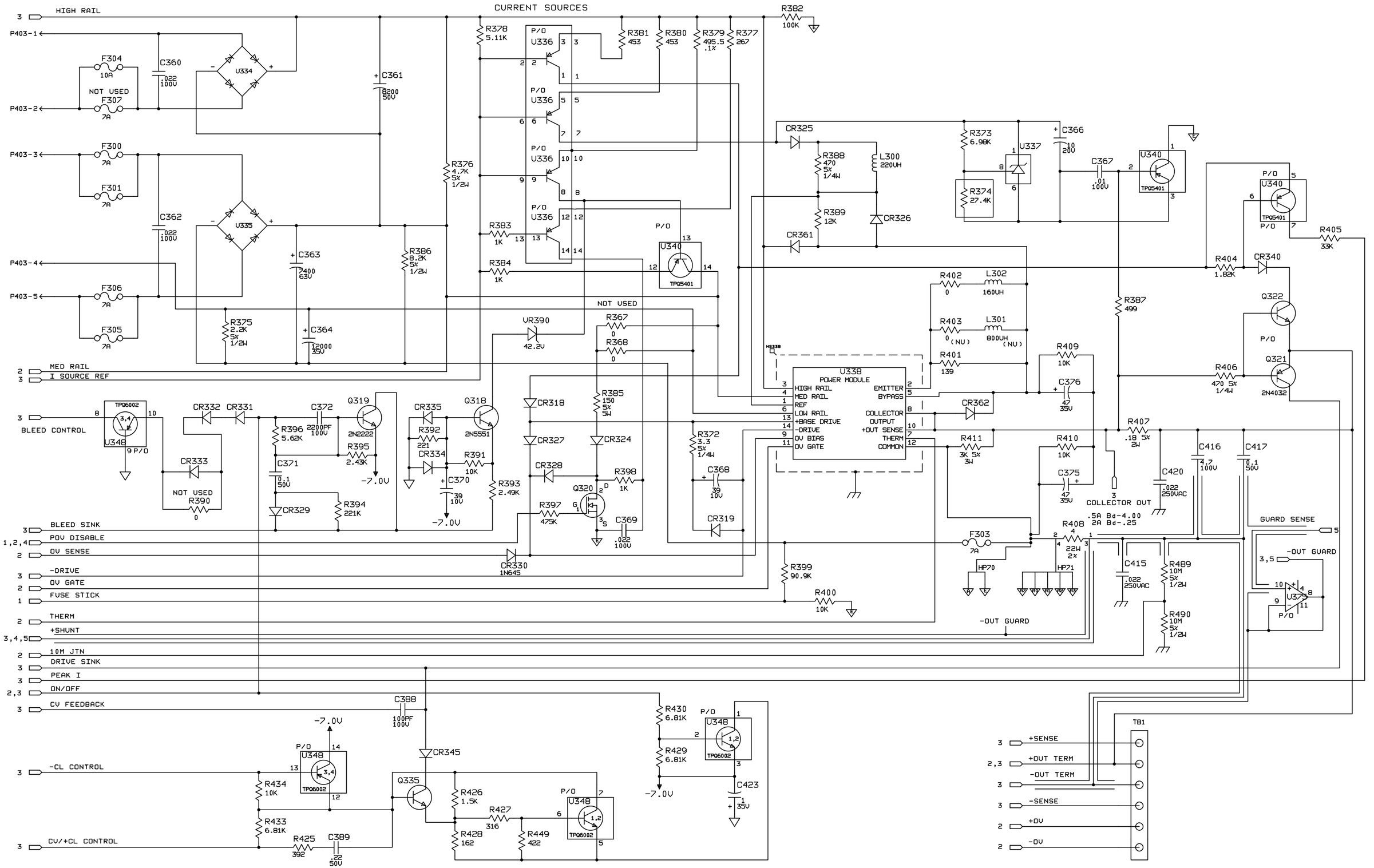


Figure 6-4. Output 3 & 4 Board, Schematic Diagram (sheet 4 of 5) 6-17

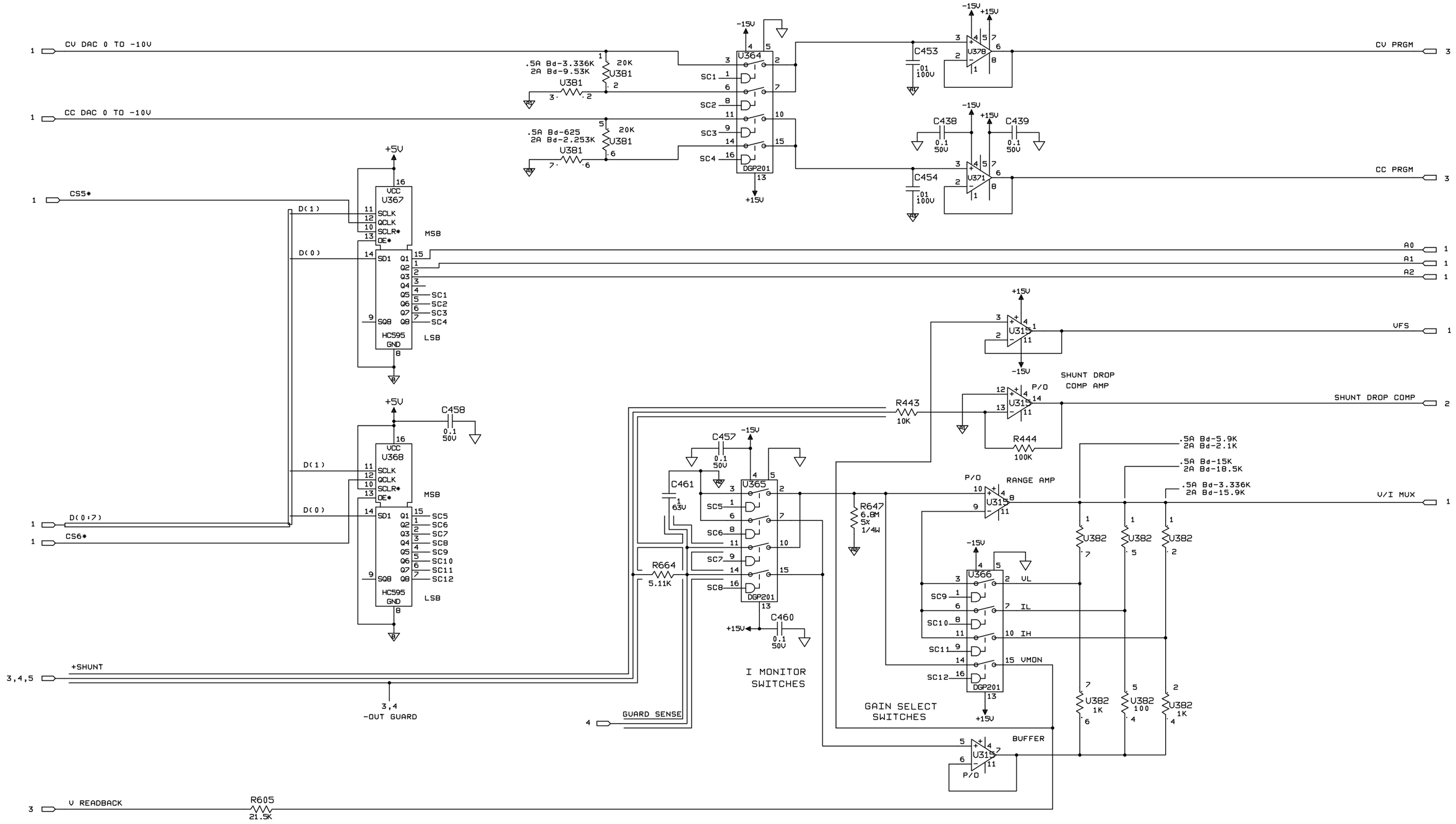


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