

Service Manual
Agilent Model 66332A
Dynamic Measurement DC Source
and Agilent Model 6632B, 6633B, 6634B
System DC Power Supply



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Warranty Information

CERTIFICATION

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Safety Summary

The following general safety precautions must be observed during all phases of operation 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.

WARNING

Servicing instructions are for use by service-trained personnel. To avoid dangerous electrical shock, do not perform any servicing unless you are qualified to do so. Some procedures described in this manual are performed with power supplied to the instrument while its protective covers are removed. If contacted, the energy available at many points may result in personal injury.

BEFORE APPLYING POWER.

Verify that the product is set to match the available line voltage, the correct line fuse is installed, and all safety precautions (see following warnings) are taken. In addition, note the instrument's external markings described under "Safety Symbols"

GROUND THE INSTRUMENT.

Before switching on the instrument, the protective earth terminal of the instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall be inserted only in an outlet socket that is provided with a protective earth contact. This protective action must not be negated by the use of an extension cord (power cable) that is without a protective conductor (grounding). 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.

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.

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. Any adjustment, maintenance, and repair of this instrument while it is opened and under voltage should be avoided as much as possible. When this is unavoidable, such adjustment, maintenance, and repair should be carried out only by a skilled person who is aware of the hazard involved.

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.

SAFETY SYMBOLS

Refer to the table on the following page

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.

| Safety Symbol Definitions | |
|---|---|
| Symbol | Description |
|  | Direct current |
|  | Alternating current |
|  | Both direct and alternating current |
|  | Three-phase alternating current |
|  | Earth (ground) terminal |
|  | Protective earth (ground) terminal |
|  | Frame or chassis terminal |
|  | Terminal is at earth potential (Used for measurement and control circuits designed to be operated with one terminal at earth potential.) |
|  | Terminal for Neutral conductor on permanently installed equipment |
|  | Terminal for Line conductor on permanently installed equipment |
|  | On (supply) |
|  | Off (supply) |
|  | 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. |
|  | In position of a bi-stable push control |
|  | Out position of a bi-stable push control |
|  | Caution, risk of electric shock |
|  | Caution, hot surface |
|  | Caution (refer to accompanying documents) |

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Printing History

The edition and current revision of this manual are indicated below. Reprints of this manual containing minor corrections and updates may have the same printing date. Revised editions are identified by a new printing date. A revised edition incorporates all new or corrected material since the previous printing date.

Changes to the manual occurring between revisions are covered by change sheets shipped with the manual. In some cases, the manual change applies only to specific instruments. Instructions provided on the change sheet will indicate if a particular change applies only to certain instruments.

Edition 1.....June, 1997
Edition 2.....September, 2000
Update 1.....October, 2003

Instrument Identification

Agilent Technologies power supplies are identified by a 10-digit serial number. The format is described as follows: first two letters indicate the country of manufacture. The next four digits are a code that identify either the date of manufacture or of a significant design change. The last four digits are a sequential number assigned to each instrument.

| Item | Description |
|-------------|--|
| US | The first two letters indicates the country of manufacture, where US = USA; MY = Malaysia; SG = Singapore. |
| 3631 | This is a code that identifies either the date of manufacture or the date of a significant design change. |
| 0101 | The last four digits are a unique number assigned to each power supply. |

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Introduction

Organization

This manual contains information for troubleshooting and repairing to the component level the Agilent Model 66332A Dynamic Measurement DC Source and the Agilent Model 6632B, 6633B, 6634B System DC Power Supplies. Hereafter all models will be referred to as the dc power supply.

This manual is organized as follows:

| | |
|------------------|--|
| Chapter 1 | Organization |
| Chapter 2 | Performance tests |
| Chapter 3 | Troubleshooting procedures |
| Chapter 4 | Principles of operation on a block-diagram level |
| Chapter 5 | Replaceable parts |
| Chapter 6 | Diagrams |

Safety Considerations

WARNING: Hazardous voltages exist within the dc power supply chassis.

This dc power supply; is a Safety Class I instrument, which means it has a protective earth terminal. This terminal must be connected to earth ground through a power source equipped with a 3-wire, ground receptacle. Refer to the "Safety Summary" page at the beginning of this manual for general safety information. Before operation or repair, check the dc power supply and review this manual for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places in the manual.

Related Documents

The following documents are shipped with your dc power supply:

- a User's Guide, containing installation, operating, and calibration information
- a Programming Guide, containing detailed GPIB programming information.

Revisions

Manual Revisions

If changes have been made to your power supply since the publication of this manual, a yellow Manual Change sheet may be supplied with the manual. It defines the differences between your power supply and the unit described in this manual. The yellow change sheet may also contain information for correcting errors in the manual. Note that because not all changes to the product require changes to the manual, there may be no update information required for your power supply.

Firmware Revisions

You can obtain the firmware revision number by either reading the integrated circuit label, or query the dc power supply using the GPIB *IDN? query command (See Chapter 3, ROM Upgrade).

Electrostatic Discharge

CAUTION: The dc power supply has components that can be damaged by ESD (electrostatic discharge). Failure to observe standard antistatic practices can result in serious degradation of performance, even when an actual failure does not occur.

When working on the dc power supply, observe all standard, antistatic work practices. These include, but are not limited to:

- Working at a static-free station such as a table covered with static-dissipative laminate or with a conductive table mat (Agilent P/N 9300-0797, or equivalent).
- Using a conductive wrist strap, such as Agilent P/N 9300-0969 or 9300-0970.
- Grounding all metal equipment at the station to a single common ground.
- Connecting low-impedance test equipment to static-sensitive components only when those components have power applied to them.
- Removing power from the dc power supply before removing or installing printed circuit boards.

Verification and Performance Tests

Introduction

This document contains test procedures to verify that the dc power supply is operating normally and is within published specifications. There are three types of tests as follows:

| | |
|-------------------------------|--|
| Built-in Self Tests | These tests, run automatically when the power supply is turned on, check most of the digital circuits and the programming and readback DACs. |
| Operation Verification | These tests verify that the power supply is probably operating normally but do not check all of the specified operating parameters. |
| Performance Tests | These tests check that the supply meets all of the operating specifications as listed in the Operating Manual. |

NOTE: The dc power supply must pass the built-in self-tests before calibration or any of the verification or performance tests can be performed. If the supply fails any of the tests or if abnormal test results are obtained, refer to the troubleshooting procedures in Chapter 3. The troubleshooting procedures will determine if repair and/or calibration is required.

Test Equipment Required

Table 2-1 lists the equipment required to perform the verification and performance tests. A test record sheet with specification limits (when test using the recommended test equipment) may be found at the back of this section.

WARNING: **SHOCK HAZARD.** These tests should only be performed by qualified personnel. During the performance of these tests, hazardous voltages may be present at the output of the supply.

Table 2-1. Test Equipment Required for Verification and Performance Tests

| Type | Specifications | Recommended Model |
|--------------------------|---|-----------------------------|
| Current Monitor Resistor | 15 A (0.1 ohm) 0.04%, for power supplies up to 15 A output | Guildline 9230/15 |
| DC Power Supply | 5 V, 10 A | Agilent 6642A, 6653A |
| Digital Voltmeter | Resolution: 10 nV @ 1V Readout: 8 1/2 digits Accuracy: 20 ppm | Agilent 3458A or equivalent |
| Electronic Load | 20 V, 5 A minimum, with transient capability | Agilent 6060B or equivalent |
| GPIB Controller | HP Series 300 or other controller with full GPIB capabilities | |

2 - Verification and Performance Tests

| | | |
|--|---|---|
| Resistor (substitute for electronic load if load is too noisy for CC PARD test) | 1 ohm, 50 W 3 ohm, 100 W (Agilent 66332A/6632B) 24 ohm, 100 W (Agilent 6633B) 99 ohm, 100 W (Agilent 6634B) 1k ohm, 5%, 3W (all models) | Ohmite L50J1R0 Ohmite RLS5R0 (adjustable) Ohmite RLS25R (adjustable) Ohmite RLS100 (adjustable) Agilent 0813-0001 |
| Oscilloscope | Sensitivity: 1 mV Bandwidth Limit: 20 MHz Probe: 1:1 with RF tip | Agilent 54504A or equivalent |
| RMS Voltmeter | True RMS Bandwidth: 20 MHz Sensitivity: 100 μ V | Agilent 3400B or equivalent |
| Variable-Voltage Transformer | Adjustable to highest rated input voltage range. Power: 500 VA | |

Measurement Techniques

Test Setup

Most tests are performed at the rear terminals of the supply as shown in Figure 2-1a. Measure the dc voltage directly at the +S and -S terminals.

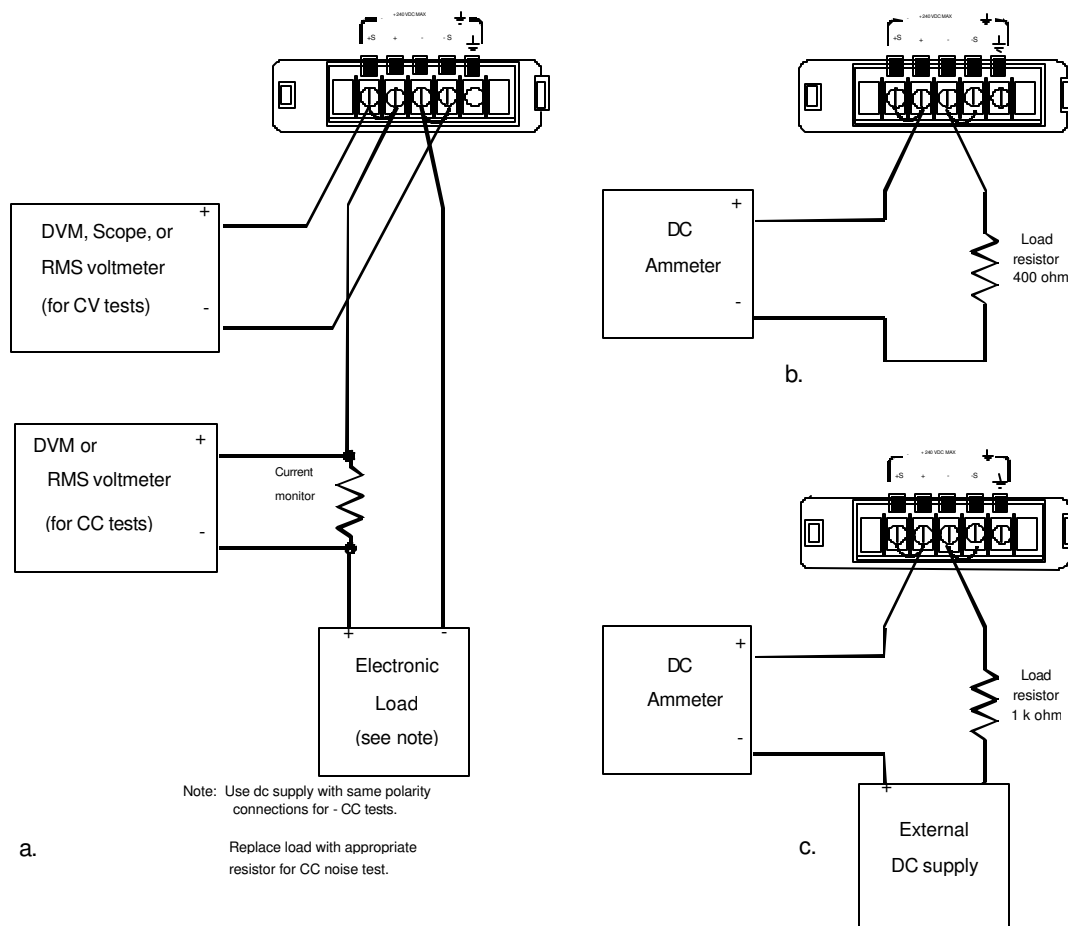


Figure 2-1. Test Setup

Electronic Load

Many of the test procedures require the use of a variable load capable of dissipating the required power. If a variable resistor is used, switches should be used to either; connect, disconnect, or short the load resistor. For most tests, an electronic load can be used. The electronic load is considerably easier to use than load resistors, but it may not be fast enough to test transient recovery time and may be too noisy for the noise (PARD) tests.

Fixed load resistors may be used in place of a variable load, with minor changes to the test procedures. Also, if computer controlled test setups are used, the relatively slow (compared to computers and system voltmeters) settling times and slew rates of the power supply may have to be taken into account. "Wait" statements can be used in the test program if the test system is faster than the supply.

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 -OUT and the load as a four-terminal device. Connect the current-monitoring leads inside the load-lead connections directly at the monitoring points on the resistor element.

Operation Verification Tests

To assure that the supply is operating properly, without testing all specified parameters, perform the following test procedures:

- a. Perform the turn-on and checkout procedures given in the Operating Manual.
- b. Perform the Voltage Programming and Readback Accuracy test, and the Current Programming and Readback Accuracy tests from this procedure.

Performance Tests

NOTE: A full Performance Test consists of only those items listed as "Specifications" in Table A-1 of the Operating Manual, and that have a procedure in this document.

The following paragraphs provide test procedures for verifying the supply's compliance with the specifications listed in Table A-1 of the Operating Manual. All of the performance test specifications are entered in the appropriate Performance Test Record Card for your specific model. You can record the actual measured values in the column provided in this card.

Programming

You can program the supply from the front panel keyboard or from a GPIB controller when performing the tests. The test procedures are written assuming that you know how to program the supply either; remotely from a 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 User's Guide and in the Programming Guide. Programming ratings are as follows:

2 - Verification and Performance Tests

Table 2-2. Programming Ratings

| Model | Voltage Rating | Full Scale Rating | Current Rating | Full Scale Rating |
|-------------------------|----------------|-------------------|----------------|-------------------|
| Agilent 66332A/6632B | 20 V | 20.020 V | 5 A | 5.0045 A |
| Agilent 6633B | 50 V | 50.045 V | 2 A | 2.002 A |
| Agilent 6634B | 100 V | 100.1 V | 1 A | 1.001 A |

Constant Voltage (CV) Tests

CV Setup

If more than one meter or if a meter and an oscilloscope are used, connect each to the terminals by a separate pair of leads to avoid mutual coupling effects. For constant voltage dc tests, connect only to +S and -S, since the unit regulates the output voltage that appears between +S and -S, and not between the (+) and (-) output terminals. Use coaxial cable or shielded two-wire cable to avoid noise pickup on the test leads.

Voltage Programming and Readback Accuracy

This test verifies that the voltage programming, GPIB readback and front panel display functions are within specifications. Note that the values read back over the GPIB should be identical to those displayed on the front panel.

- Turn off the supply and connect a digital voltmeter between the +S and the -S terminals as shown in Figure 2-1a.
- Turn on the supply and program the supply to zero volts and the maximum programmable current with the load off.
- Record the output voltage readings on the digital voltmeter (DVM) and the front panel display. The readings should be within the limits specified in the performance test record chart for the appropriate model under CV PROGRAMMING @ 0 VOLTS. Also, note that the CV annunciator is on. The output current reading should be approximately zero.
- Program the output voltage to full-scale.
- Record the output voltage readings on the DVM and the front panel display. The readings should be within the limits specified in the performance test record chart for the appropriate model under CV PROGRAMMING @ FULL SCALE.

CV Load Effect

This test measures the change in output voltage resulting from a change in output current from full load to no load.

- Turn off the supply and connect the output as shown in Figure 2-1a with the DVM connected between the +S and -S terminals.
- Turn on the supply and program the current to the maximum programmable value and the voltage to the full-scale value.
- Adjust the load for the full-scale current as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load so that the output current drops slightly.
- Record the output voltage reading on the DVM connected to +S and -S.

- e. Open the load and again record the DVM voltage reading. The difference between the DVM readings in steps (d) and (e) is the load effect voltage, and should not exceed the value listed in the performance test record chart for the appropriate model under CV LOAD EFFECT.

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 as shown in Figure 2-1a with the DVM connected between the +S and the -S terminals. Set the transformer to nominal line voltage.
- c. Turn on the supply and program the current to the maximum programmable value and the output voltage to the full-scale value .
- d. Adjust the load for the full-scale current value as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load so that the output current drops slightly.
- e. Adjust the transformer to the lowest rated line voltage (e.g., 104 Vac for a 115 Vac nominal line voltage input).
- f. Record the output voltage reading on the DVM.
- g. Adjust the transformer to the highest rated line voltage (e.g., 127 Vac for 115 Vac nominal line voltage input).
- h. Record the output voltage reading on the DVM. The difference between the DVM reading is steps (f) and (h) is the source effect voltage and should not exceed the value listed in the performance test record chart for the appropriate model under CV SOURCE EFFECT.

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 the frequency range specified in the User's Guide.

- a. Turn off the supply and connect the output as shown in Figure 2-1a to an oscilloscope (ac coupled) between the (+) and the (-) terminals. Set the oscilloscope's bandwidth limit to 20 MHz and use an RF tip on the oscilloscope probe.
- b. Turn on the supply and program the current to the maximum programmable value and the output voltage to the full-scale value.
- c. Adjust the load for the full-scale current value as indicated on the front panel display.
- d. Note that the waveform on the oscilloscope should not exceed the peak-to-peak limits in the performance test record chart for the appropriate model under CV NOISE (PARD).
- e. Disconnect the oscilloscope and connect an ac rms voltmeter in its place. The rms voltage reading should not exceed the RMS limits in the performance test record chart for the appropriate model under CV NOISE (PARD).

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Transient Recovery Time

This test measures the time for the output voltage to recover to within the specified value following a 50% change in the load current.

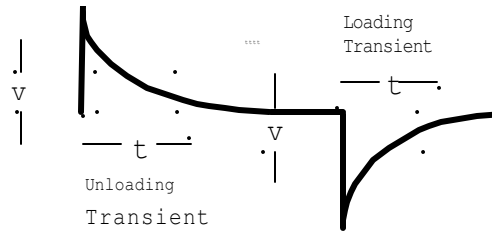


Figure 2-2. Transient Waveform

- Turn off the supply and connect the output as in Figure 2-1a with the oscilloscope across the +S and the -S terminals.
- Turn on the supply and program the output voltage to the full-scale value and the current to the maximum programmable value.
- Set the load to the Constant Current mode and program the load current to 1/2 the power supply full-scale rated current.
- Set the electronic load's transient generator frequency to 100 Hz and its duty cycle to 50%.
- Program the load's transient current level to the supply's full-scale current value and turn the transient generator on.
- Adjust the oscilloscope for a waveform similar to that in Figure 2-2.
- The output voltage should return to within the specified voltage (v) in less than the specified time (t). Check both loading and unloading transients by triggering on the positive and negative slope.

Constant Current (CC) Tests

CC Setup

Follow the general setup instructions in the Measurement Techniques paragraph and the specific instructions given in the following paragraphs.

Current Programming and Readback Accuracy

This test verifies that the current programming and readback are within specification.

- Turn off the supply and connect the current monitoring resistor across the power supply output and the DVM across the resistor as shown in Figure 2-1a. See "Current Monitoring Resistor" for connection information.
- Turn on the supply and program the output voltage to 5 V and the current to zero.
- Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (I_{out}). The reading should be within the limits specified in the performance test record card for the appropriate model under CC PROGRAMMING @ 0 AMPS.
- Set the current readback range to High and program the output current to 20mA. For model 66332A, set the current detect mode to "DC". Repeat step C to get the I_{out} . Record the current reading on the front panel display. The reading should be within the limits specified in the performance test record card for the appropriate model under Current Readback Accuracy @ 20mA (High Range).

- e. Program the output current to full-scale .
- f. Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (Iout). Also, record the current reading that appears on the front panel display. The readings should be within the limits specified in the performance test record card for the appropriate model under CC PROGRAMMING @ FULL-SCALE.

Current Sink (-CC) Operation

This test verifies current sink operation and readback.

- a. Turn off the supply and connect the output as shown in Figure 2-1a, except connect a dc power supply in place of the electronic load as indicated. Connect the DMM across the current shunt.
- b. Set the external power supply to 5 V and the current limit approximately 20% above the full scale current rating of the supply under test.
- c. Turn on the supply under test and program the output voltage to zero and full scale output current. The current on the UUT display should be approximately full scale current negative.
- d. Divide the voltage drop across the current monitoring resistor by its resistance to obtain the current sink value in amps and subtract this from the current reading on the display. The difference between the readings should be within the limits specified in the performance test record chart under CURRENT SINK READBACK.

Low Range Current Readback Accuracy

This test verifies the readback accuracy of the 20 milliamper current range.

- a. Turn off the supply and connect the output as shown in Figure 2-1b. Set the DMM to operate in current mode.
- b. Turn on the supply under test and program the output voltage to zero and full scale output current. The current on the UUT display should be approximately 0 mA.
- c. Record the current reading on the DMM and the reading on the front panel display. The difference between the two readings should be within the limits specified in the performance test record chart under 20mA RANGE CURRENT READBACK ACCURACY @ 0A.
- d. Program the output voltage to 20V and record the current reading on the DMM and the reading on the front panel display. The difference between the readings should be within the limits specified in the performance test record chart for the appropriate model under 20mA RANGE CURRENT READBACK ACCURACY @ 20mA
- e. Turn off the supply and connect the output and an external supply as shown in Figure 2-1c. Set the DMM to operate in current mode.
- f. Turn on the external supply and program it to 20 V and 1 amp. Then program the supply under test to zero volts and 1 amp. The UUT display should read approximately -20 mA.
- c. Record the current reading on the DMM and the reading on the front panel display. The difference between the two readings should be within the limits specified in the performance test record chart under 20mA RANGE CURRENT READBACK ACCURACY @ -20 mA.

CC Load and Line Regulation

These tests (CC Load Effect and CC Source Effect given below) are tests of the dc regulation of the power supply's output current. To insure that the values read are not the instantaneous measurement of the ac peaks of the output current ripple, several dc measurements should be made and the average of these readings calculated. An example of how to do this is given below using an Agilent 3458A System Voltmeter programmed from the front panel. Set up the voltmeter and execute the "Average Reading" program follows:

- a. Program 10 power line cycles per sample by pressing NPLC 1 0 ENTER .
- b. Program 100 samples per trigger by pressing (N Rdgs/Trig) 1 0 0 ENTER .

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- c. Set up voltmeter to take measurements in the statistical mode as follows:
Press Shift key, f0, Shift key, N
Press ^ (up arrow) until MATH function is selected, then press >.
Press ^ (up arrow) until STAT function is selected then press (ENTER).
 - d. Set up voltmeter to read the average of the measurements as follows:
Press Shift key, f1, Shift key, N.
Press down arrow until RMATH function is selected, then press >.
Press ^ (up arrow) until MEAN function is selected, then press ENTER.
 - e. Execute the program by pressing f0, ENTER, TRIG, ENTER
 - f. Wait for 100 readings and then read the average measurement by pressing f1, ENTER.
- To repeat the measurement, perform steps (e) and (f).

CC Load Effect

This test measures the change in output current for a change in load from full scale output voltage to short circuit.

- a. Turn off the supply and connect the output as shown in Figure 2-1a with the DVM connected across the current monitoring resistor.
- b. Turn on the supply and program the current to the full scale current value and the output voltage to the maximum programmable voltage value.
- c. Adjust the load in the CV mode for full scale voltage as indicated on the front panel display. Check that the CC annunciator of the UUT is on. If it is not, adjust the load so that the output voltage drops slightly.
- d. Record the output current reading (DVM reading/current monitor resistance value in ohms). You may want to use the average reading program described under “CC Load and Line Regulation”.
- e. Short the load switch and record the output current reading. The difference in the current readings in steps (d) and (e) is the load effect and should not exceed the limit specified in the performance test record chart for the appropriate model under CC LOAD EFFECT.

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 terminals as shown in Figure 2-1a with the DVM connected across the current monitoring resistor. Set the transformer to the nominal line voltage.
- c. Turn on the supply and program the current to the full scale value and the output voltage to the maximum programmable value.
- d. Adjust the load in the CV mode for full scale voltage as indicated on the front panel display. Check that the CC annunciator of the UUT is on. If it is not, adjust the load so that the output voltage drops slightly.
- e. Adjust the transformer to the lowest rated line voltage.
- f. Record the output current reading (DVM reading/current monitoring resistor in ohms). You may want to use the average reading program described under “CC Load and Line Regulation”.
- g. Adjust the transformer to the highest rated line voltage.
- h. Record the output current reading again. The difference in the current readings in steps (f) and (h) is the CC source effect and should not exceed the values listed in the performance test record card under CC SOURCE EFFECT.

CC Noise (PARD)

Periodic and random deviations (PARD) in the output combine to produce a residual ac current, as well, as an ac voltage superimposed on the dc output. Constant current (CC) PARD is specified as the rms output current in a frequency range 20 Hz to 20 Mhz with the supply in CC operation.

- a. Turn off the supply and connect the load, monitoring resistor, and rms voltmeter across the monitoring resistor as shown in Figure 2-1a. The Current Monitoring resistor may have to be substituted by one with a higher resistance and power rating, such as a 1 ohm 50 W current shunt in series with the appropriate 3, 24, or 99 ohm resistor, to get the RMS voltage drop high enough to measure with the RMS voltmeter. Leads should be as short as possible to reduce noise pick-up. An electronic load may contribute ripple to the measurement so if the RMS noise is above the specification a resistive load may have to be substituted for this test.
- b. Check the test setup for noise with the supply turned off. Other equipment (e.g. computers, DVMs, etc.) may affect the reading.
- c. Turn on the supply and program the current to full scale and the output voltage to the maximum programmable value.
- d. The output current should be at the full scale rating with the CC annunciator on.
- e. Divide the reading on the rms voltmeter by the monitor resistor to obtain rms current. It should not exceed the values listed in the performance test record card under CC NOISE (RMS).

Performance Test Equipment Form

Test Facility: _____

 Model _____
 Serial No. _____
 Options _____
 Firmware Revision _____

Report Number _____
 Date _____
 Customer _____
 Tested By _____
 Ambient Temperature (C) _____
 Relative Humidity (%) _____
 Nominal Line Frequency _____

Special Notes:

Test Equipment Used:

| Description | Model No. | Trace No. | Cal. Due Date |
|-----------------|-----------|-----------|---------------|
| AC Source | _____ | _____ | _____ |
| DC Voltmeter | _____ | _____ | _____ |
| RMS Voltmeter | _____ | _____ | _____ |
| Oscilloscope | _____ | _____ | _____ |
| Electronic Load | _____ | _____ | _____ |
| Current Shunt | _____ | _____ | _____ |

Performance Test Record Forms

| Model Agilent 66332A OR Agilent6632B | Report No _____ | Date _____ | |
|---|--------------------------------------|------------|--------------------------------------|
| Test Description | Minimum Specs. | Results* | Maximum Specs. |
| Constant Voltage Tests | | | |
| Voltage Programming and Readback | | | |
| Low Voltage (0V) Vout | - 10 mV | _____ | + 10 mV |
| Front Panel Display Readback | Vout - 3 mV | _____ | Vout + 3 mV |
| High Voltage (Full Scale) Vout | 19.980 V | _____ | 20.020 V |
| Front Panel Display Readback | Vout - 9 mV | _____ | Vout + 9 mV |
| Load Effect | - 2 mV | _____ | + 2 mV |
| Source Effect | - 0.5 mV | _____ | + 0.5 mV |
| PARD (Ripple and Noise) | | | |
| Peak-to-Peak | N/A | _____ | + 3 mV |
| RMS | N/A | _____ | + 0.3 mV |
| Transient Response | | | |
| Voltage in 100 μ s | Vout - 20 mV | _____ | Vout + 20 mV |
| Constant Current Tests | | | |
| Current Programming and Readback(High Range) | | | |
| CC Programming Accuracy @ 0A | - 3.32mA | _____ | + 3.32 mA |
| Current Readback Accuracy @ 20mA (High Range) | Iout - 0.54 mA | _____ | Iout + 0.54 mA |
| CC Programming @ Full Scale | 4.9955 A | _____ | 5.0045 A |
| Current Readback Accuracy @ Full Scale | Iout - 10.5 mA | _____ | Iout + 10.5 mA |
| Current Sink Readback | Isink - 11.1mA | _____ | Isink + 11.1mA |
| 20 mA Range Current Readback | | | |
| Readback Accuracy @ 0 A | - 2.5 μ A | _____ | + 2.5 μ A |
| Readback Accuracy @ + 20 mA | Iout - 22.5 μA | _____ | Iout + 22.5 μA |
| Readback Accuracy @ - 20 mA | Iout - 22.5 μA | _____ | Iout + 22.5 μA |
| PARD (Current Ripple and Noise) | | | |
| RMS | N/A | _____ | + 2.0 mA |
| Load Effect | - 1.0 mA | _____ | + 1.0 mA |
| Source Effect | - 0.5 mA | _____ | + 0.5 mA |

* Enter your test results in this column

| Model Agilent 6633B | Report No _____ | Date _____ | |
|---|----------------------------|------------|----------------------------|
| Test Description | Minimum Specs. | Results* | Maximum Specs. |
| Constant Voltage Tests | | | |
| Voltage Programming and Readback | | | |
| Low Voltage (0V) Vout | - 20 mV | _____ | + 20 mV |
| Front Panel Display Readback | Vout - 6 mV | _____ | Vout + 6 mV |
| High Voltage (Full Scale) Vout | 49.955 V | _____ | 50.045 V |
| Front Panel Display Readback | Vout - 21 mV | _____ | Vout + 21 mV |
| Load Effect | - 4 mV | _____ | + 4 mV |
| Source Effect | - 1.0 mV | _____ | + 1.0 mV |
| PARD (Ripple and Noise) | | | |
| Peak-to-Peak | N/A | _____ | + 3 mV |
| RMS | N/A | _____ | + 0.5 mV |
| Transient Response | | | |
| Voltage in 100 μ s | Vout - 50 mV | _____ | Vout + 50 mV |
| Constant Current Tests | | | |
| Current Programming and Readback(High Range) | | | |
| CC Programming Accuracy @ 0A | - 1.53 mA | _____ | + 1.53 mA |
| Current Readback Accuracy @ 20mA (High Range) | Iout - 0.29 mA | _____ | Iout + 0.29 mA |
| CC Programming @ Full Scale | 1.998 A | _____ | 2.002 A |
| Current Readback Accuracy @ Full Scale | Iout - 4.25 mA | _____ | Iout + 4.25 mA |
| Current Sink Readback | Isink - 4.85mA | _____ | Isink + 4.85mA |
| 20 mA Range Current Readback | | | |
| Readback Accuracy @ 0 A | - 2.5 μ A | _____ | + 2.5 μ A |
| Readback Accuracy @ + 20 mA | Iout - 22.5 μ A | _____ | Iout + 22.5 μ A |
| Readback Accuracy @ - 20 mA | Iout - 22.5 μ A | _____ | Iout + 22.5 μ A |
| PARD (Current Ripple and Noise) | | | |
| RMS | N/A | _____ | + 2.0 mA |
| Load Effect | - 1.0 mA | _____ | + 1.0 mA |
| Source Effect | - 0.25 mA | _____ | + 0.25 mA |

* Enter your test results in this column

2 - Verification and Performance Tests

| Model Agilent 6634B | Report No _____ | Date _____ | |
|---|----------------------------|------------|----------------------------|
| Test Description | Minimum Specs. | Results* | Maximum Specs. |
| Constant Voltage Tests | | | |
| Voltage Programming and Readback | | | |
| Low Voltage (0V) Vout | - 50 mV | _____ | + 50 mV |
| Front Panel Display Readback | Vout - 12 mV | _____ | Vout + 12 mV |
| High Voltage (Full Scale) Vout | 99.9 V | _____ | 100.1 V |
| Front Panel Display Readback | Vout - 42 mV | _____ | Vout + 42 mV |
| Load Effect | - 5 mV | _____ | + 5 mV |
| Source Effect | - 1 mV | _____ | + 1 mV |
| PARD (Ripple and Noise) | | | |
| Peak-to-Peak | N/A | _____ | + 5 mV |
| RMS | N/A | _____ | + 0.6 mV |
| Transient Response | | | |
| Voltage in 100 μ s | Vout - 100 mV | _____ | Vout + 100 mV |
| Constant Current Tests | | | |
| Current Programming and Readback(High Range) | | | |
| CC Programming Accuracy @ 0A | - 0.76 mA | _____ | + 0.76 mA |
| Current Readback Accuracy @ 20mA (High Range) | Iout - 0.29 mA | _____ | Iout + 0.29 mA |
| CC Programming @ Full Scale | 0.999 A | _____ | 1.001 A |
| Current Readback Accuracy @ Full Scale | Iout - 2.25 mA | _____ | Iout + 2.25 mA |
| Current Sink Readback | Isink - 2.85 mA | _____ | Isink + 2.85 mA |
| 20 mA Range Current Readback | | | |
| Readback Accuracy @ 0 A | - 2.5 μ A | _____ | + 2.5 μ A |
| Readback Accuracy @ + 20 mA | Iout - 22.5 μ A | _____ | Iout + 22.5 μ A |
| Readback Accuracy @ - 20 mA | Iout - 22.5 μ A | _____ | Iout + 22.5 μ A |
| PARD (Current Ripple and Noise) | | | |
| RMS | N/A | _____ | + 2.0 mA |
| Load Effect | - 1.0 mA | _____ | + 1.0 mA |
| Source Effect | - 0.25 mA | _____ | + 0.25 mA |

* Enter your test results in this column

Troubleshooting

Introduction

WARNING: **SHOCK HAZARD.** Most of the troubleshooting procedures given in this chapter 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 (for example, fire and electrical shock).

CAUTION: This instrument uses components which can either be damaged or suffer serious performance degradation as a result of ESD (electrostatic discharge). Observe the standard antistatic precautions to avoid damage to the components. An ESD summary is given in Chapter 1.

This chapter provides troubleshooting and repair information for the dc power supply. Before attempting to troubleshoot the dc power supply, first check that the problem is with the supply itself and not with an associated circuit. The verification tests in Chapter 2 enable you to isolate a problem to the dc power supply. Troubleshooting procedures are provided to isolate a problem to one of the circuit boards or a particular circuit. Figure 3-2 shows the location of the circuit boards and other major components of the unit. If a problem has been isolated to the A1 Control circuit board, additional troubleshooting procedures are available to isolate the problem to the defective component(s). Disassembly procedures are provided at the end of this chapter and should be referred to, as required, in order to gain access to and/or replace defective components.

If a component is defective, replace it and then conduct the verification test given in Chapter 2.

NOTE: Note that when certain components are replaced, the supply must be calibrated (See "Post Repair Calibration" later in this chapter). If the A2 Interface Board is replaced, the supply must be initialized before it is calibrated. See "Initialization" later in this chapter.

Chapter 5 lists all of the replaceable parts for the power supplies. Chapter 6 contains schematics, test point measurements, and component location diagrams to aid you in troubleshooting the supply.

Test Equipment Required

Table 3-1 lists the test equipment required to troubleshoot the power supply. Recommended models are listed.

Table 3-1. Test Equipment Required for Troubleshooting

| Type | Purpose | Recommended Model |
|-----------------------|---|-----------------------|
| GPIB Controller | To communicate with the supply via the GPIB interface | HP Series 300 |
| Digital Voltmeter | To check various voltage levels | Agilent 3458A |
| Oscilloscope | To check waveforms and signal levels | Agilent 54504A/54111A |
| Electronic Load | To test operation of current circuit | Agilent 6060B |
| IC Test Clips | To access IC pins | AP Products No. LTC |
| Ammeter/Current Shunt | To measure output current | Guildline 9230/15 |

Overall Troubleshooting

Overall troubleshooting procedures for the power supply are given in the Figure 3-1. The procedures first check that neither an AC input, nor a bias supply failure is causing the problem and that the supply passes the turn-on self test (error annunciator stays off). The normal turn-on, self-test indications are described in the "Checkout Procedure" in Chapter 3 of the User's Guide.

If the supply passes the self test and there are no obvious faults, you should perform the verification procedures in Chapter 2 from the front panel to determine if any functions are not calibrated or are not operating properly. Then program and read back a voltage via the GPIB to see if the supply responds properly to bus commands. If the supply fails any of the tests, you will be directed to the applicable flow chart or troubleshooting procedure.

Flow Charts

Troubleshooting flow charts are given in Figure 3-1 sheets 1-10. Several flow charts make reference to the test points listed in Chapter 6. The circuit locations of the test points are shown on the schematics and on the component location diagrams in Chapter 6.

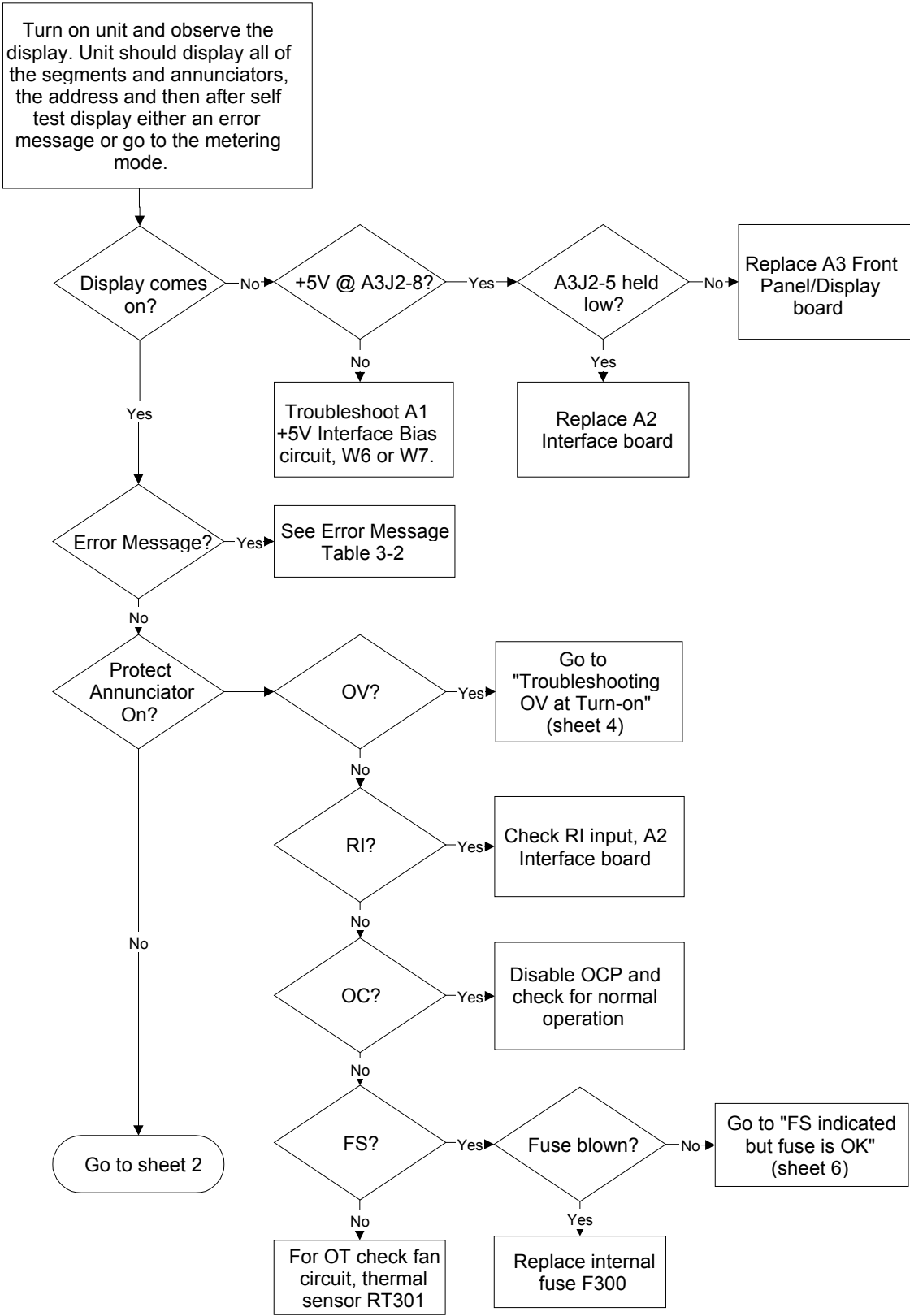


Figure 3-1 Sheet 1. Main Flowchart

3 - Troubleshooting

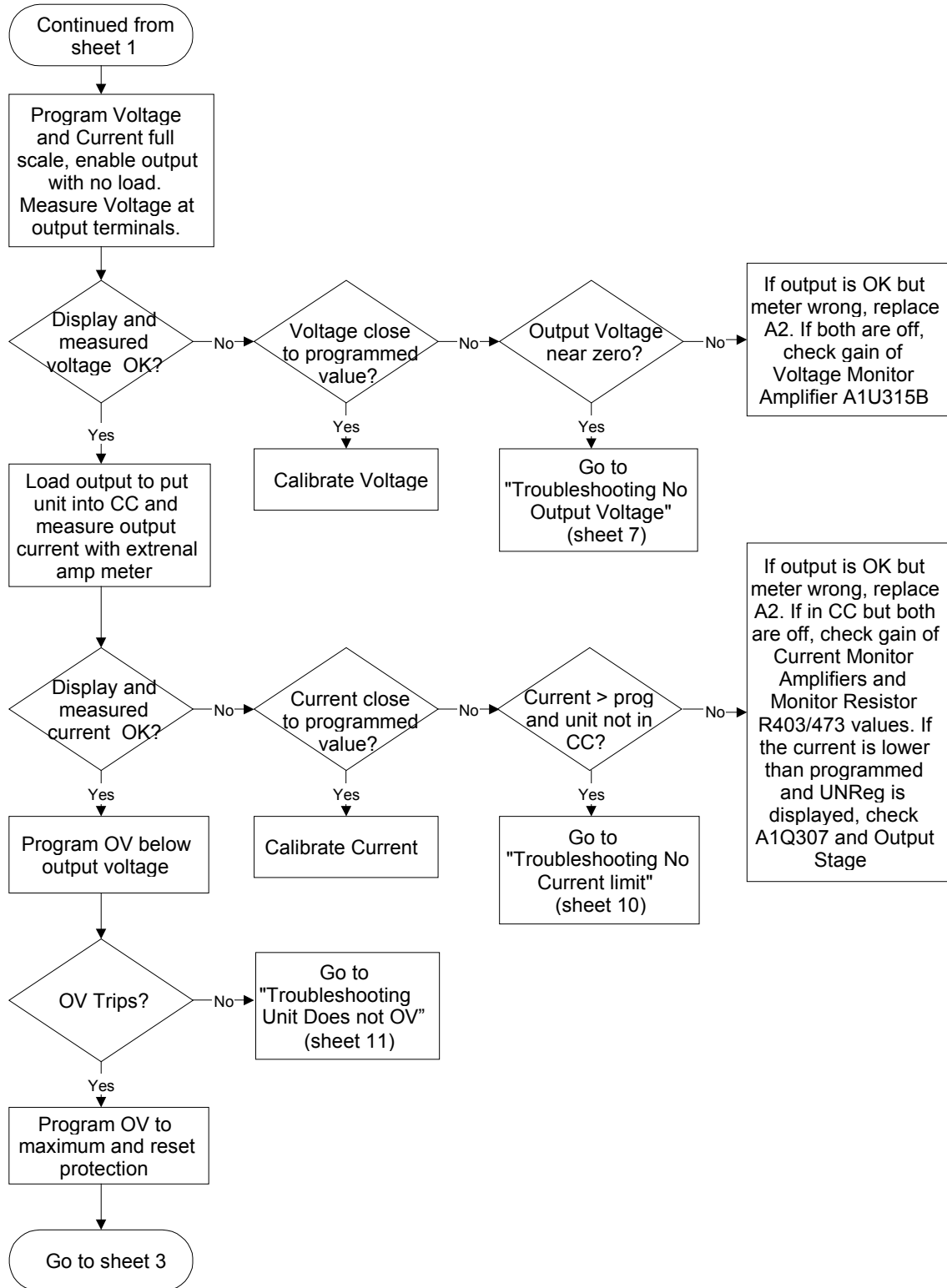


Figure 3-1 Sheet 2. Main Flowchart (continued)

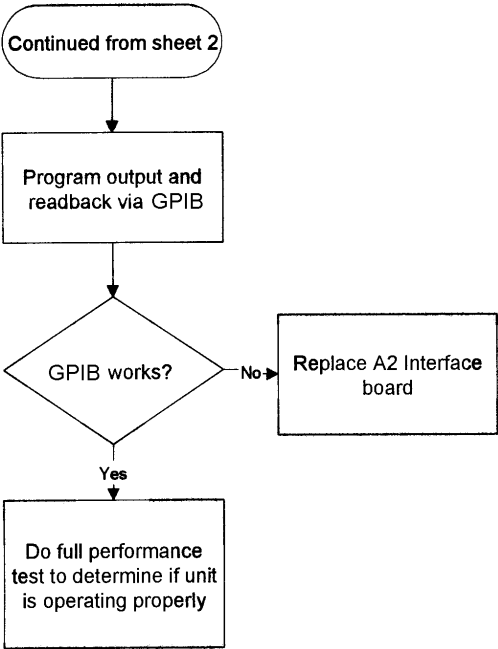


Figure 3-1 Sheet 3. Main Flowchart (continued)

3 - Troubleshooting

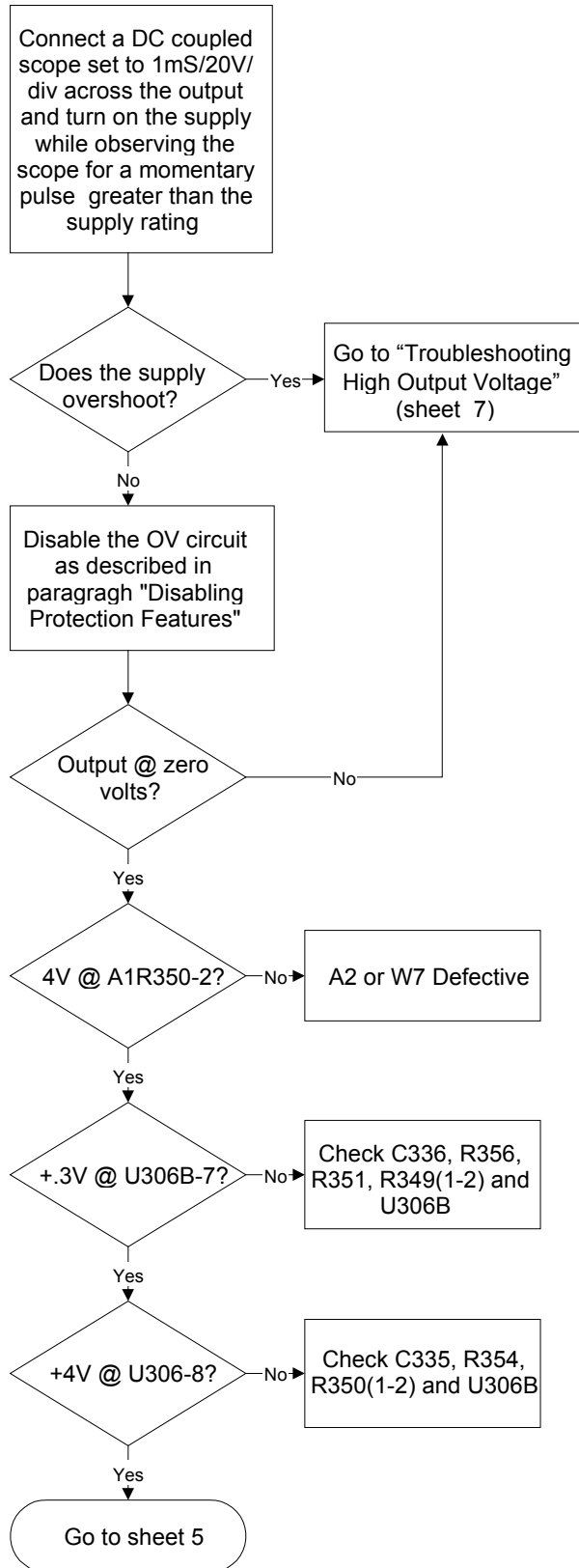


Figure 3-1 Sheet 4. OV at Turn-On

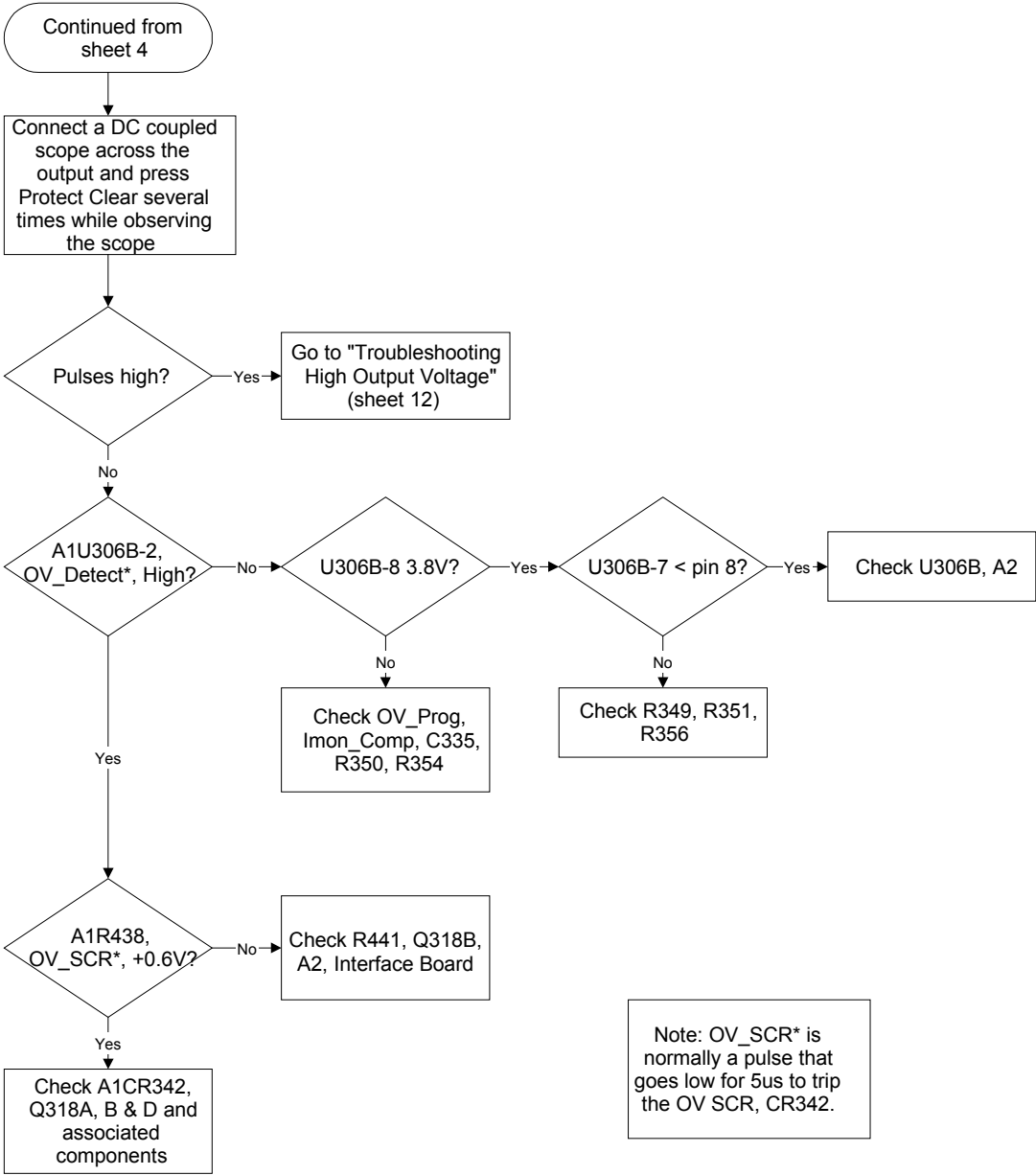


Figure 3-1 Sheet 5. OV at Turn-On (continued)

3 - Troubleshooting

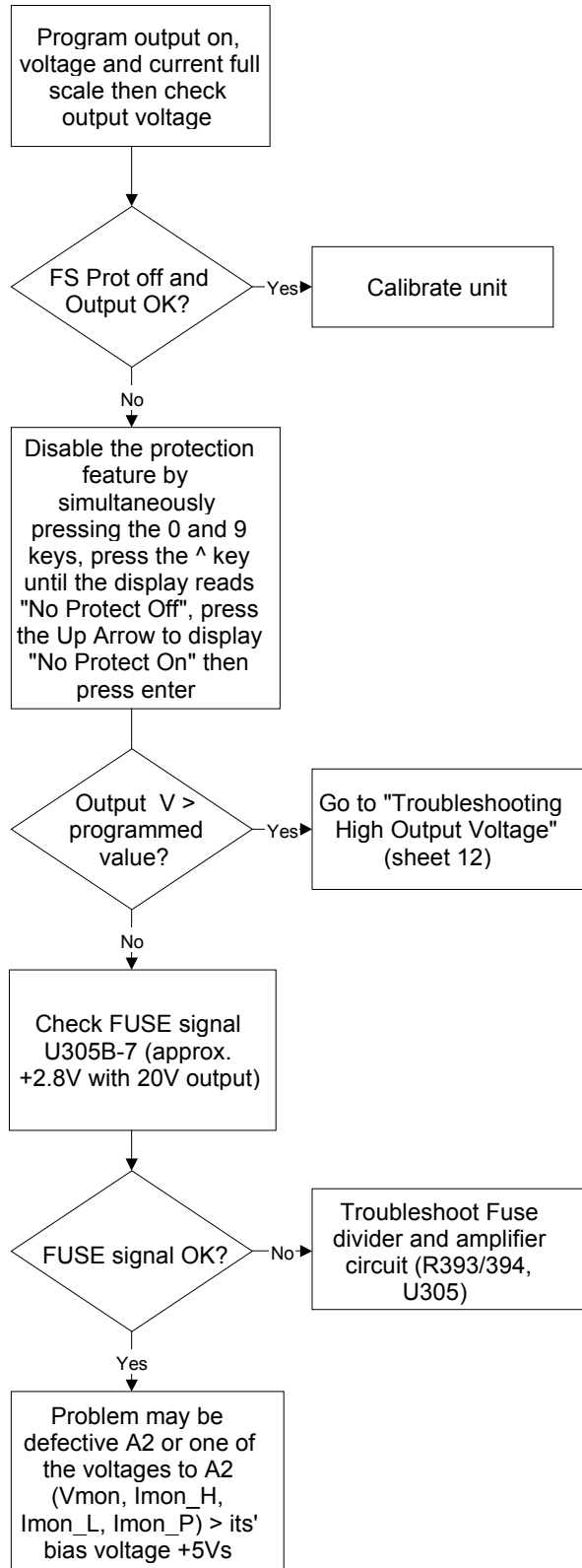


Figure 3-1 Sheet 6. FS Indicated but Fuse OK

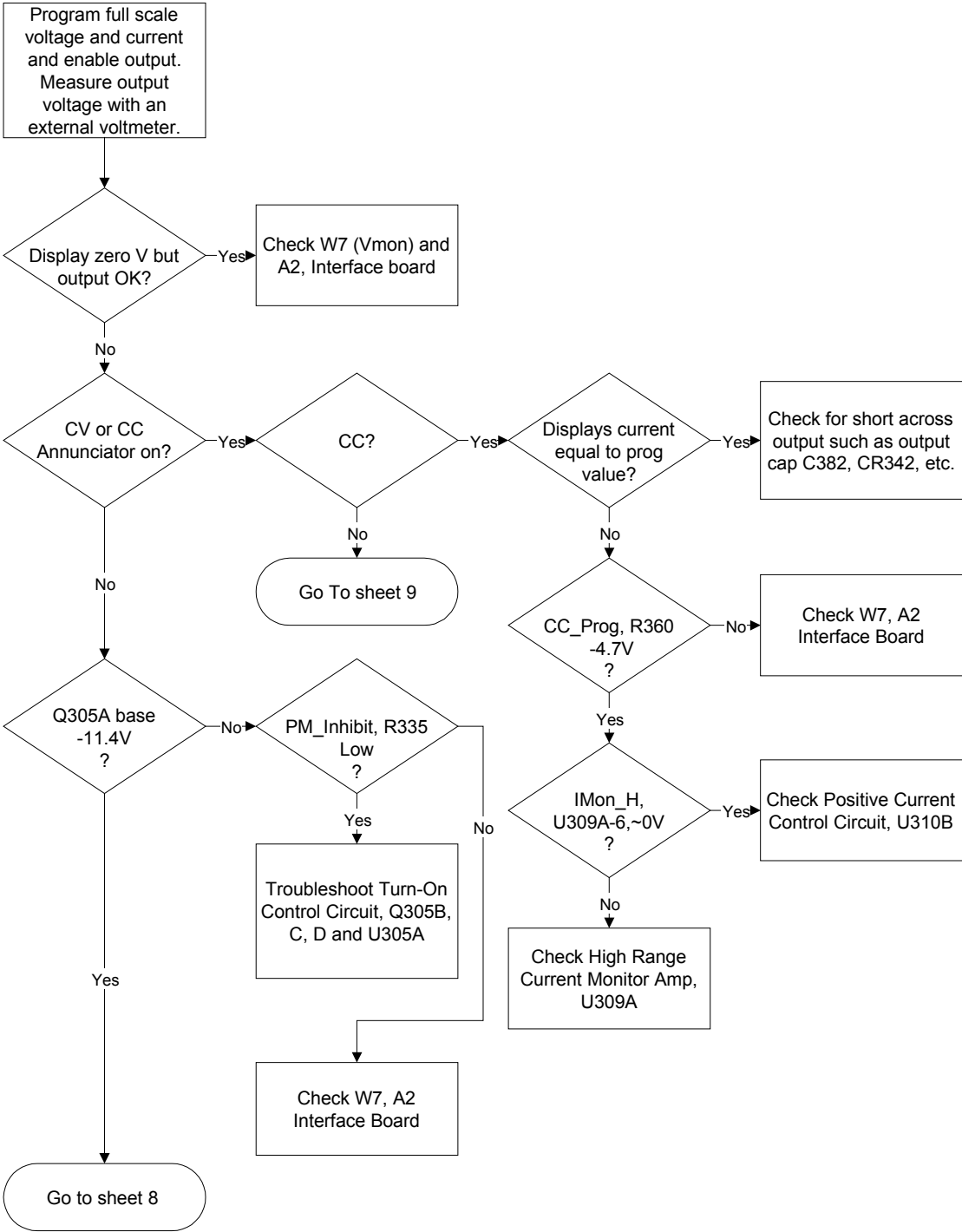


Figure 3-1 Sheet 7. No Output Voltage

3 - Troubleshooting

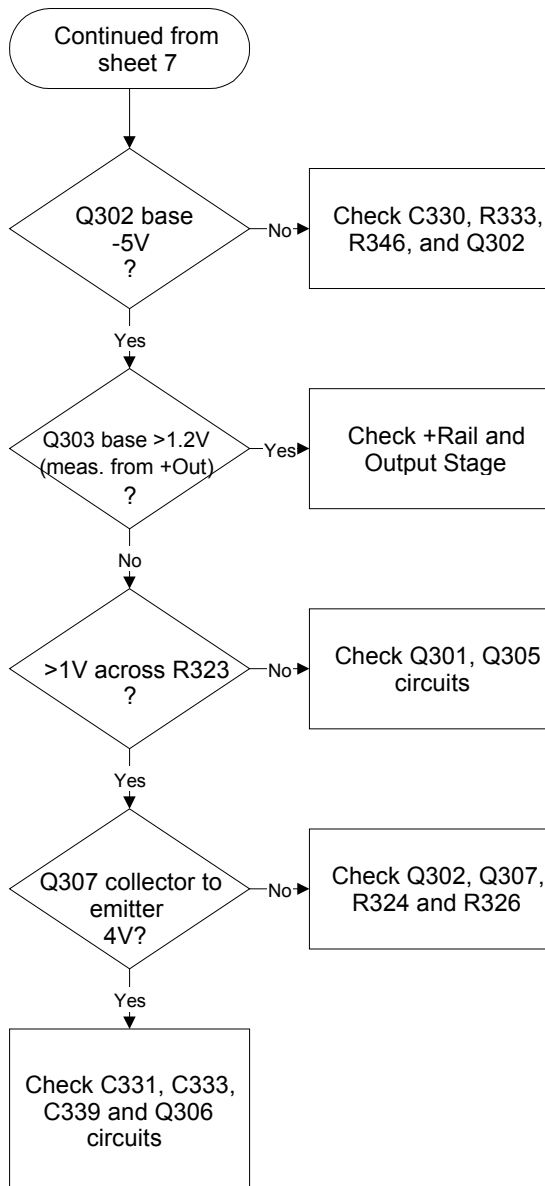


Figure 3-1 Sheet 8. No Output Voltage (continued)

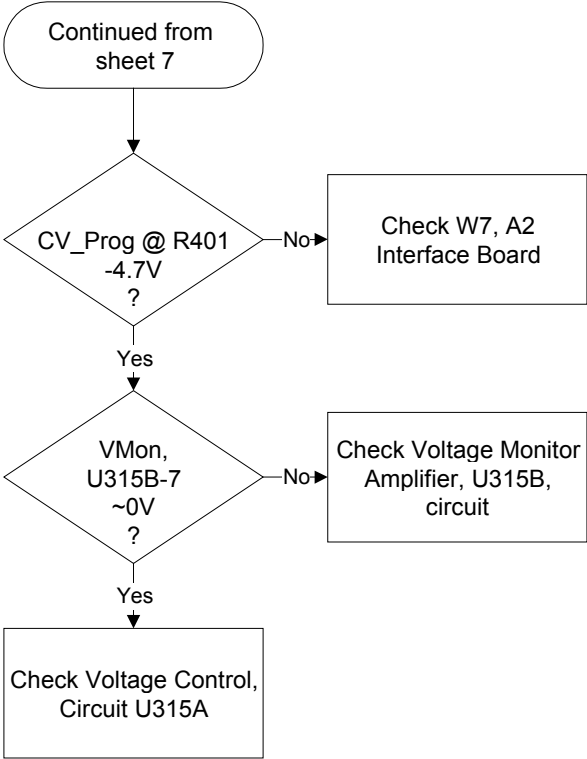


Figure 3-1 Sheet 9 No Output Voltage (continued)

3 - Troubleshooting

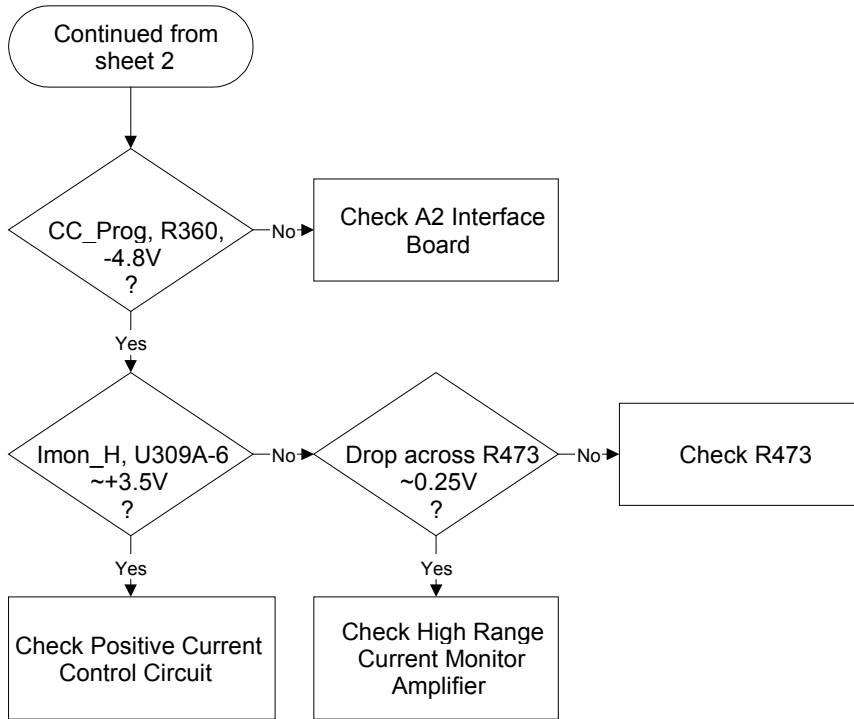


Figure 3-1 Sheet 10. No Current Limit

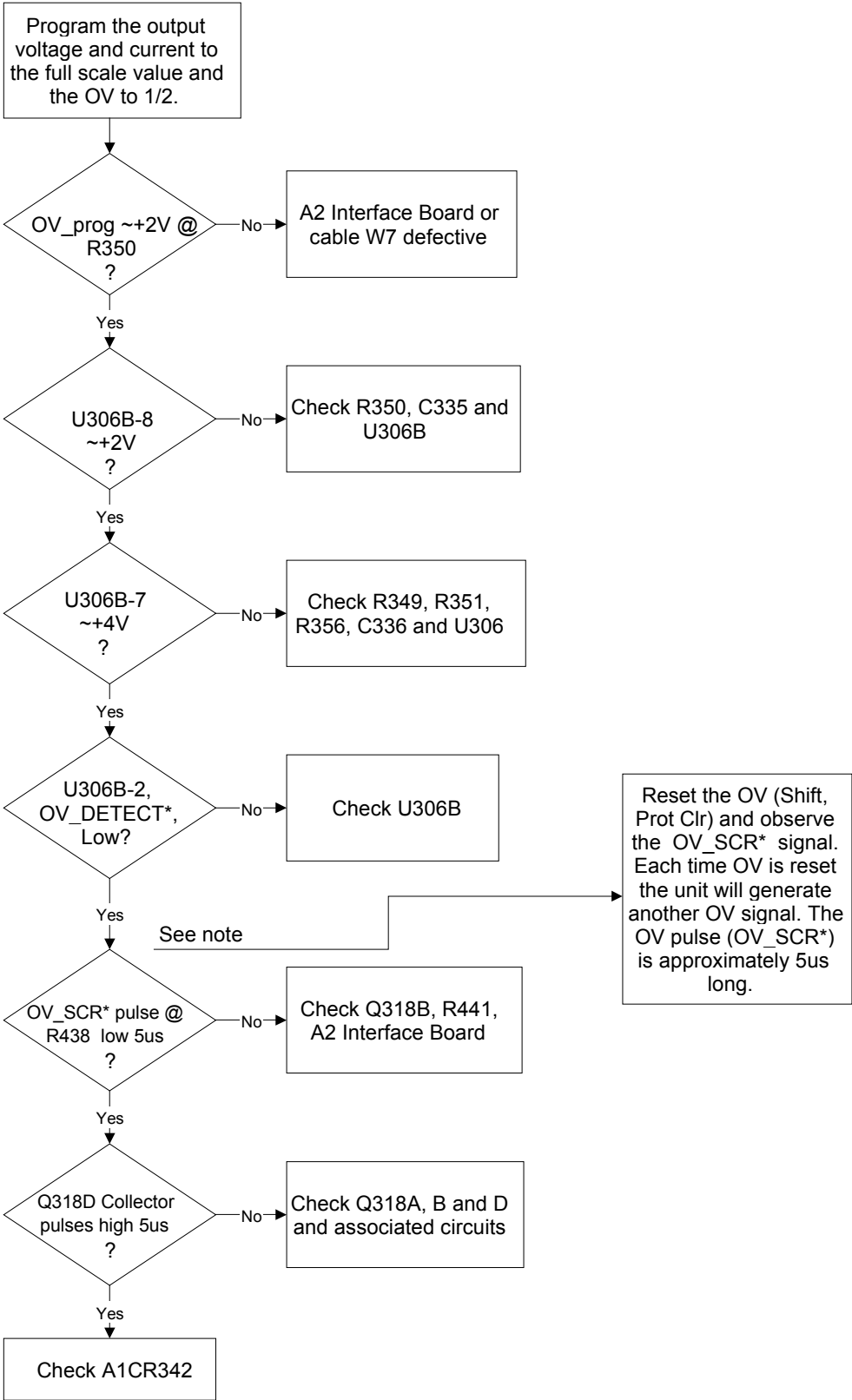


Figure 3-1 Sheet 11. Unit Does Not OV

3 - Troubleshooting

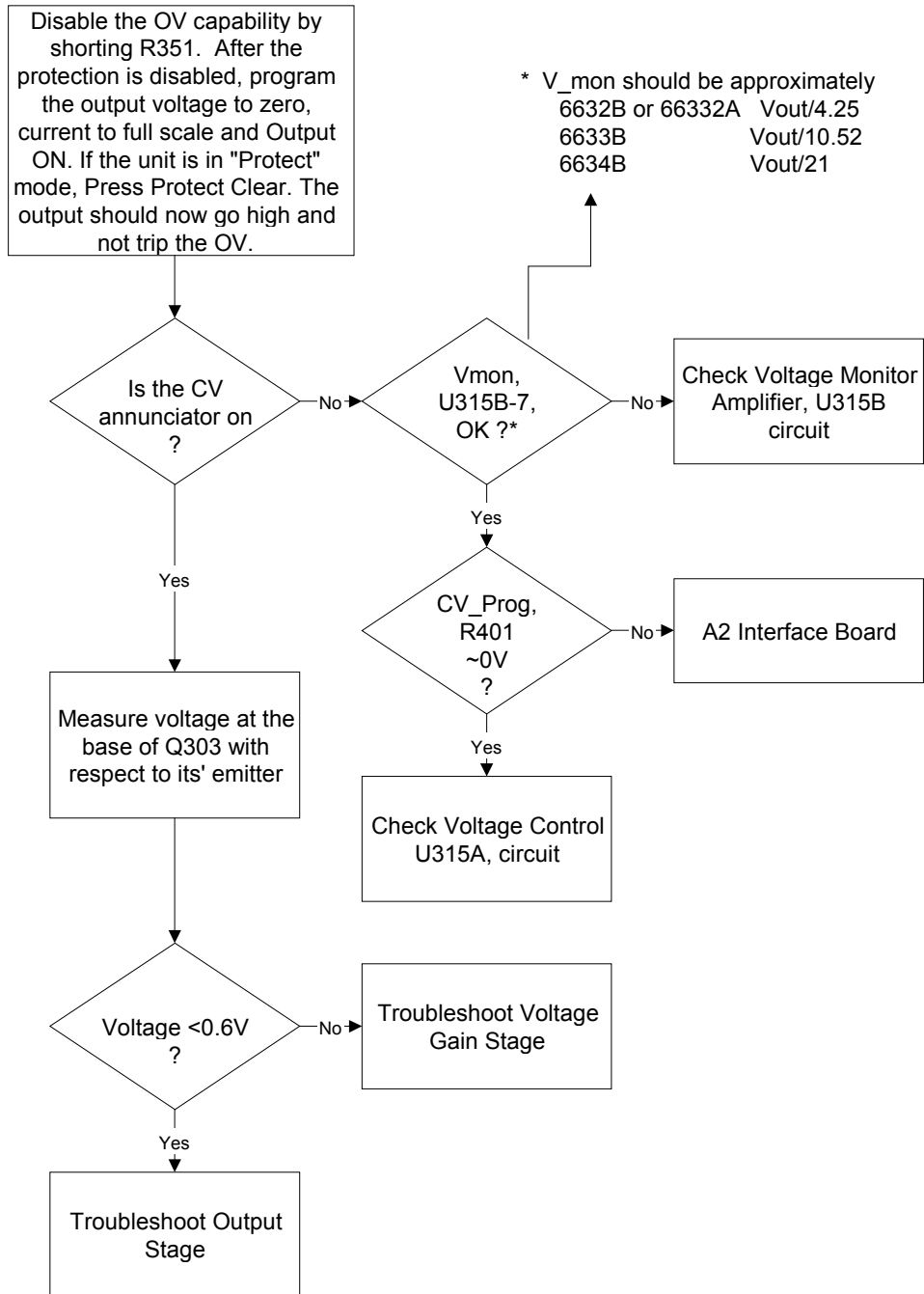


Figure 3-1 Sheet 12. High Output Voltage

Specific Troubleshooting Procedures

Power-on Self-test Failures

The power-on self-test sequence tests most of the digital and DAC circuits. If the supply fails self-test, the display "ERR" annunciator will come on. You can then query the unit to find out what the error(s) are. When an error is detected, the output is not disabled so you can still attempt to program the supply to help troubleshoot the unit. Table 3-2 lists the self test errors and gives the probable cause for each error.

NOTE: A partial self test is performed when the *TST? query is executed. Those tests that interfere with normal interface operation or cause the output to change are not performed by *TST?. The return value of *TST? will be zero if all tests pass, or the error code of the first test that failed. The power supply will continue normal operation if *TST? returns a non-zero value.

Table 3-2. Self-Test Error Codes/Messages

| Error Code | Description | Probable Cause |
|------------|--|---------------------------|
| E1 | Checksum in Read-only Non-volatile ROM | A2 Interface Bd |
| E2 | Checksum in Config Non-volatile ROM | A2 Interface Bd |
| E3 | Checksum in Cal Non-volatile ROM | A2 Interface Bd |
| E4 | Checksum in State Non-volatile ROM | A2 Interface Bd |
| E5 | Checksum in RST Non-volatile ROM | A2 Interface Bd |
| E10 | RAM test failed | A2 Interface Bd |
| E11 | 12 bit DAC test failed, 0 is written to DAC U241A and B, ADC U242 is checked for 133 +/- 7 counts | A2 Interface Bd |
| E12 | 12 bit DAC test failed, 4095 is written to DAC U241A and 0 to B, ADC U242 is checked for 71 +/- 7 counts | A2 Interface Bd |
| E13 | 12 bit DAC test failed, 0 is written to DAC U241A and 4095 to B, ADC U242 is checked for 71 +/- 7 counts | A2 Interface Bd |
| E14 | 12 bit DAC test failed, 4095 is written to DAC U241A and B, ADC U242 is checked for 10 +/- 7 counts | A2 Interface Bd |
| E15 | 8 bit DAC test failed, 10 and 240 are written to DAC U244, ADC U242 is checked for 10 and 240 +/- 7 counts | A2 Interface Bd |
| E80 | Dig I/O test failed, SEC_PCLR written low and high, read back through Xilinx | A2 Interface Bd |
| E213 | RS-232 input buffer overrun | A2 Interface Bd |
| E216 | RS-232 framing error | A2 Interface Bd |
| E217 | RS-232 parity error | A2 Interface Bd |
| E218 | RS-232 UART input overrun | A2 Interface Bd |
| E220 | Front Panel comm UART input overrun | A3 Front Panel/Display Bd |
| E221 | Front Panel comm UART framing error | A3 Front Panel/Display Bd |
| E222 | Front Panel comm UART parity error | A3 Front Panel/Display Bd |
| E223 | Front Panel firmware input buffer overrun | A3 Front Panel/Display Bd |

3 - Troubleshooting

CV/CC Status Annunciators Troubleshooting

The CV/CC annunciators are particularly helpful when troubleshooting a unit with no output. If the unit has no output voltage or current and one of the annunciators is on then the problem is in the control circuit associated with that annunciator. An example of how this might be useful would be in a case where the voltage and current are programmed to some positive value, there is no output voltage and the CV annunciator is on. This indicates that the problem is probably in the Voltage Amplifier circuit. If the CC annunciator were on then the problem would likely be in the Current Amplifier. If UNR is indicated then neither the voltage nor the current circuits are in control and the problem would be in circuits after the gating diodes such as the driver or output regulator stages.

When troubleshooting the CV/CC status annunciators or the status readback circuits, first measure the voltage drop across the gating diodes; A1 D328 (CV) and D325 (CC). A conducting diode indicates an active (ON) control circuit. This forward drop is applied to the input of the associated status comparator (U306A and D respectively) and drives the output (CV_DETECT* or CC_DETECT*) low. The low signal indicates an active status which is sent to the A2 board microprocessor. The front panel CV annunciator indicates when the CV mode is active (CV_DETECT* is low). The front panel CC annunciator indicates when the CC mode is active (CC_DETECT* is low). The UNREGULATED (UNR) annunciator comes on when neither the CV nor CC is active.

Bias and Rail Voltages

Before troubleshooting any circuit check the bias and/or rail voltages to make sure that they are not the cause. Table 3-3 lists the bias and rail voltage test points for the A1 Main Control, A2 Interface, and the A3 Front Panel/Display boards. Unless otherwise noted, all voltages are measured with respect to secondary common (R473-3) with no load on the supply.

Table 3-3. Bias and Reference Voltages

| Bias | Test Point (See Figure 6-1) | Common | Measurement |
|---|--------------------------------|--------------------|------------------------|
| +Rail ¹ (Agilent 6632B/66332B) | A1 TP 310 | - Output | +38V 10% (800mV P/P) |
| +Rail ¹ (Agilent 6633B) | A1 TP 310 | - Output | +73V 10% (2.5V P/P) |
| +Rail ¹ (Agilent 6634B) | A1 TP 310 | - Output | +130V 10% (2.2V P/P) |
| -Rail ¹ (Agilent 6632B/66332B) | A1 TP 311 | - Output | -9.8V 10% (400mV P/P) |
| -Rail ¹ (Agilent 6633B) | A1 TP 311 | - Output | -10.2V 10% (300mV P/P) |
| -Rail ¹ (Agilent 6634B) | A1 TP 311 | - Output | -10.5V 10% (300mV P/P) |
| +5V secondary | A1 R317 | Secondary Common | +5V 4% |
| +12V secondary | A1 D470 cathode | Secondary Common | +12V 5% |
| +15V secondary | A1 R318 | Secondary Common | +15V 4% |
| -12V secondary | A1 D471 anode | Secondary Common | -12V 5% |
| -15V secondary | A1 R315 | Secondary Common | -15V 4% |
| V Ref | A1 R475 | Secondary Common | +2.5V 6% |
| +5V Interface ² | E306 (red wire) | E 306 (black wire) | +5V 3% |

¹ Measured with respect to - Output at nominal ac input line voltage

² Measured with reference to Interface Ground (E306 black wire)

J307 Voltage Measurements

J307 connects the A1 Main Board Assembly to the A2 Interface Assembly. Table 3-4 provides a quick method of determining if the voltages between these assemblies are within the normal range. If any of these voltages is outside the normal range, refer to the flowcharts to further troubleshoot the circuit associated with the abnormal voltage.

Table 3-4. Voltage Measurements at J307 (A2 Interface to A1 Main board)

| A1J307 Pin # | Signal Name | CV Mode Full Scale Voltage No Load | CC Mode Full Scale Voltage Full Load |
|--------------|----------------------|------------------------------------|--------------------------------------|
| 1 | PM_INHIBIT (Enabled) | 0 | 0 |
| 2 | OV_SCR* | +5 | +5 |
| 3 | OV_PROG | +3.9 | +3.9 |
| 4 | FAN_PROG | +2.8 | +3.8 |
| 5 | OV_DETECT* | +5 | +5 |
| 6 | SW_POS (Norm) | +5 | +5 |
| 7 | RANGE_SELECT (High) | 0 | 0 |
| 8 | OS_TRIM_NEG (COMP) | +1.7 | +1.7 |
| | OS_TRIM_NEG (SCPI) | +4.0 | +4.0 |
| 9 | +5Vs | +5 | +5 |
| 10 | COMMON | 0 | 0 |
| 11 | COMMON | 0 | 0 |
| 12 | +15Vs | +15 | +15 |
| 13 | -15Vs | -15 | -15 |
| 14 | HS_THERM (@25C) | +2.5 | +2.5 |
| 15 | FUSE | +2.4 | +2.6 |
| 16 | IMON_H | 0 | +3.5 |
| 17 | IMON_L | 0 | +14.7 |
| | IMON_L (@20mA Out) | +4.8 | +4.8 |
| 18 | IMON_P | 0 | 0 |
| 19 | VMON | +4.8 | +4.8 |
| 20 | COMMON | 0 | 0 |
| 21 | COMMON | 0 | 0 |
| 22 | COMMON | 0 | 0 |
| 23 | COMMON | 0 | 0 |
| 24 | CV_PROG | -4.8 | -4.8 |
| 25 | CC_PROG | -4.8 | -4.8 |
| 26 | CC_DETECT* | +5 | 0 |
| 27 | CCN_DETECT* | +5 | +5 |
| 28 | CV_DETECT* | 0 | +5 |

3 - Troubleshooting

Manual Fan Speed Control

Under some circumstances such as testing acoustical devices where the fan noise would interfere with the test, it would be advantageous to reduce the fan speed. If the test requires a very light load, the ambient temperature is low and the duration of the test is short, the fan speed may be temporarily reduced. The turn-on default is "Automatic" so this procedure must be performed, as needed, every time the line voltage is turned on. To manually control the fan speed:

- a. Simultaneously depress the "0" and "9" keys. EEINIT <model> will be displayed.
- b. Using the Up/Down annunciator keys select FAN:MODE<AUTO.>.
- c. Using the Up/Down arrows select FAN:MODE <MAN>
- d. Press "Enter"
- e. Simultaneously depress the "0" and "9" keys. EEINIT <model> will be displayed.
- f. Using the Up/Down annunciator keys select FAN:SPEED <data>
- g. Press "Enter Number".
- h. Enter the desired speed (numeric entry range is 0 to 100%)
- i. Press "Enter"

Disabling Protection Features

Except for overvoltage protection, the power supply's protection features may be disabled. This is not recommended as a normal operating condition but is helpful under some circumstances such as troubleshooting. The turn-on default is "NO-PROTECT OFF" (protection enabled) so this procedure must be performed, as needed, every time the line voltage is turned on. To disable the protection:

- a. Simultaneously depress the "0" and "9" keys. EEINIT <model> will be displayed.
- b. Using the Up/Down annunciator keys select NO-PROTECT <OFF>.
- c. Using the Up/Down arrows select NO-PROTECT <ON>.
- d. Press "Enter"

Post-repair Calibration

Calibration is required annually and whenever certain components are replaced. If components in any of the circuits listed below are replaced, the supply must be re-calibrated as described in Appendix B of the User's Guide.

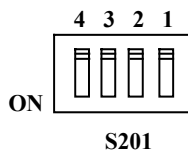
- a. A1 Control Board: Voltage or Current Monitor Amplifier circuits, High Bandwidth Current Amplifier, or Current Monitor resistors R403/R473
- b. A2 Interface Board

If the Interface board A2 is replaced, the supply must be initialized first (see "Initialization" later in this chapter) and then be calibrated.

Inhibit Calibration Switch

If "CAL DENIED" appears on the display when calibration is attempted, or if error code 401 occurs when calibrating over the GPIB, the internal INHIBIT CAL switch has been set. This switch setting prevents unauthorized or inadvertent power supply calibration. You must reset this switch in order to calibrate the supply.

This four-section switch, S201, is located on the A2 Interface board near the GPIB connector. The switch has 2 functions related to calibration. One is Inhibit Calibration. With this switch set the supply will not respond to calibration commands, thus providing security against unauthorized calibration. The other switch allows you to bypass the password in case it is forgotten.



| | Switch 3 | Switch 4 |
|----------------------------|----------|----------|
| Normal | Off | Off |
| Clear Password | Off | On |
| Inhibit Calibration | On | Off |

Calibration Password

In order to enter the calibration mode, you must use the correct password as described in Appendix B of the Operating Manual. As shipped from the factory, the number 0 (zero) is the password. If you use an incorrect password, "OUT OF RANGE" will appear on the display for front panel calibration (or error code 402 occurs for GPIB calibration) and the calibration mode will not be enabled.

If you have changed the password and have forgotten it, you can set the configuration switch on A2 Interface board to bypass the password. See "Calibration Switch" paragraph above.

Initialization

The dc power supply's GPIB address and model number as well as other constants which are required to program and calibrate the supply are stored in a EEPROM on the A2 Interface board. The Interface board also contains references and other components that will affect the alignment of the supply. If the Interface board is replaced, the supply must be reinitialized and calibrated. To initialize the power supply:

- a. Enable the Calibration mode
- b. Simultaneously depress the "0" and "9" keys.
- c. Using the Up/Down arrows select the appropriate model number
- d. Press "Enter"

The dc power supply will go through the turn-on self test sequence. It is now re-initialized and must be calibrated. See Appendix A of the User's Guide for the calibration procedure.

ROM Upgrade

Identifying the Firmware

You can use the *IDN? query to identify the revision of the supply's firmware. The query will readback the revisions of the Primary Interface ROM located on the A2 Interface board. The manufacturer and model number of the supply are also returned. The following is a sample program:

```
10 ALLOCATE L$ [52]
20 OUTPUT 705; "*IDN?"
30 ENTER 705; L$
40 DISP L$
50 END
```

The computer will display the manufacturer's name, the model number, a "0," and then the firmware revision. Example: "AGILENT TECHNOLOGIES,66332A,0,A.00.01". The revision level of the ROM can also be found on the label affixed to the physical IC chip itself.

Upgrade Procedure

If the Interface board ROM is upgraded you can re-initialize the supply without affecting the calibration.

- a. Enable the Calibration mode.
- b. Simultaneously depress the "0" and "9" keys. EEINIT <model> will be displayed.
- c. Using the Up/Down annunciator keys select ROMUPD <model>.
- d. Using the Up/Down arrows select the appropriate model number.
- e. Press "Enter".

The supply will go through the turn-on self test sequence and return to the power supply metering mode.

Disassembly Procedures

The following paragraphs provide instructions on how to disassemble various components of the dc power supply. Once disassembled, the components can be reassembled by performing the disassembly instructions in reverse order. Figure 3-2 shows the location of the major components of the unit.

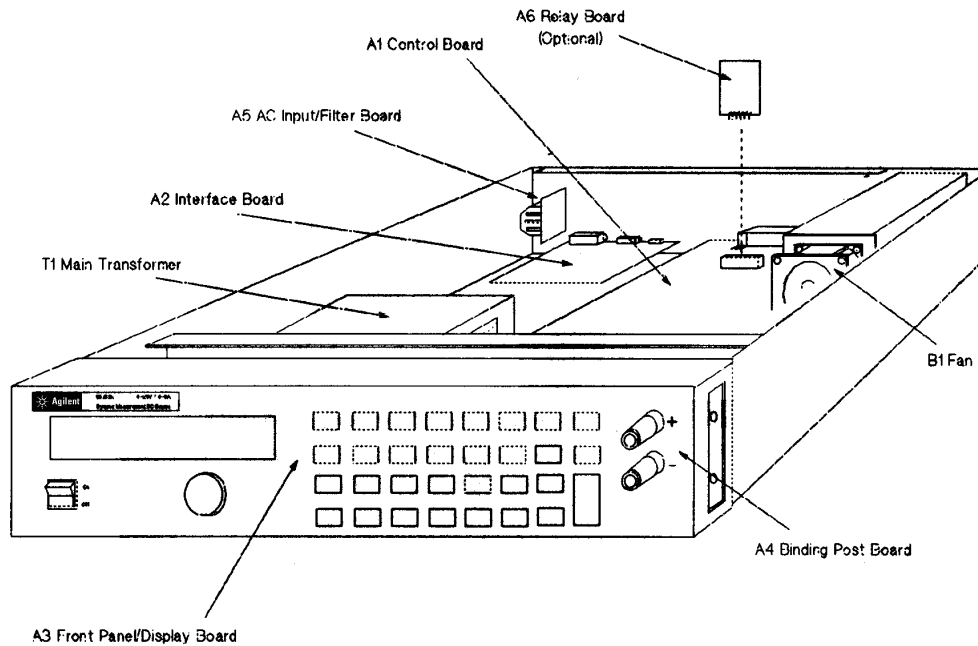


Figure 3-2. Component Location

WARNING: **SHOCK HAZARD.** To avoid the possibility of personal injury, turn off AC power and disconnect the line cord before removing the top cover. Disconnect the GPIB cable and any loads, and remote sense leads before attempting disassembly.

CAUTION: Most of the attaching hardware is metric. Use of other types of fasteners will damage threaded inserts. Refer to the list of required tools when performing disassembly and replacement.

List of Required Tools

- a. 2PT Pozidriv screwdrivers.
- b. T10 and T15 Torx screwdrivers.
- c. Hex drivers: 7 mm for GPIB connector,
3/16" for RS-232 connector,
1/4" for front panel binding posts
- d. Long nose pliers.
- e. Antistatic wrist discharge strap.

3 - Troubleshooting

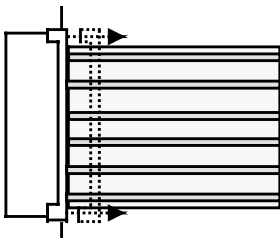
Cover, Removal and Replacement

- a. Using a 2TP Pozi screwdriver, unscrew the two screws that hold the carrying straps to the power supply, and then remove the two screws from the opposite side of the case.
- b. To remove the cover, first spread the bottom rear of the cover slightly and push from the front panel
- c. Slide the cover backward until it clears the rear of the power supply.

A2 Interface Board, Removal and Replacement

To remove the Interface Board, proceed as follows:

- a. Remove the cover of the power supply as described under, "Cover Removal and Replacement."
- b. Remove the two 7 mm and 3/16 inch hex screws that hold the GPIB and RS-232 connectors in place.
- c. Unplug the cable from J206. Depress the release button located at the end of the connector where the wires enter the housing.
- d. Unplug the flat cables. Note the position of the conductive side for reinstallation. Connectors release the cable by pulling out end tabs as shown by the arrows in the following figure.



- e. Lift the board off of the snap-in standoffs.
- f. To reinstall the Interface board, perform the above steps in reverse order.

Front Panel Assembly, Removal and Replacement

This procedure removes the front panel assembly from the dc power supply.

- a. Remove the Power Supply Cover as described earlier in, "Top Cover Removal and Replacement."
- b. Disconnect the cable between the Front Panel board and the Interface board at the Interface board.
- c. Carefully peel off the vinyl trim strips on each side of the front panel that cover the front panel screws.
- d. Using a Torx T10 driver remove the two screws (one on each side) that hold the front panel assembly to the chassis.
- e. Slide the Front Panel assembly forward and away from the chassis to access the S1 power switch.
- f. Disconnect the wires going to the S1 switch assembly. For reassembly, make a note of the color coding of the wires and the pins to which they are connected.
- g. If the supply has front panel binding posts, unplug the cable from the binding post connector and use a Torx T15 driver to remove the screw connecting the ground wire to the chassis.
- f. You can now remove the front panel assembly from the supply.
- g. To reinstall the Front Panel Assembly, perform the above steps in reverse order.

S1 Line Switch, Removal and Replacement

- a. First remove the front panel assembly as described under “Front Panel Assembly, Removal and Replacement.”
- b. Release the switch from the front panel by pressing the locking tabs inward against the body of the switch and pushing the switch out of its opening.

NOTE: When reinstalling the switch, make sure that the letter “O” is facing up when the switch is installed in its opening.

A3 Front Panel Board, Removal and Replacement

First remove the front panel assembly as described under, "Front Panel Assembly, Removal and Replacement." Once you have access to the front panel board perform these steps:

- a. Remove the RPG knob by pulling it away from the front panel.
- b. Use a Torx T10 driver to remove the screw that secures the board to the front panel assembly.
- c. Slide the board to the left to disengage the holding clips, then lift it out.
- d. To reinstall the Front Panel board, perform the above steps in reverse order.

A1 Main Control Board

- a. Remove the top cover and the A2 Interface board as previously described.
- b. Disconnect all cables going to connectors on the main control board.

NOTE: Be sure to note the position and orientation of all cables prior to removal so that no mistake is made later when reinstalling these cables.

- c. If your power supply is equipped with a relay option board, remove the Torx T10 screw that holds the relay board bracket.
- d. Remove four Torx T15 screws that secure the main control board to the chassis.
- e. Slide the main board towards the front panel to release it from chassis mounted standoffs and then lift the board out of the chassis.

T1 Power Transformer, Removal and Replacement

To remove the power transformer, the front panel assembly must first be removed to gain access to the bracket screws that hold the transformer in place.

- a. Remove the three Torx T10 screws securing the rear of the transformer bracket to the bottom of the chassis and the two Torx T10 screws securing the front of the transformer to the chassis.
- b. Use long nose pliers to disconnect all wires going to the transformer terminals.
- c. Lift the transformer out of the chassis.

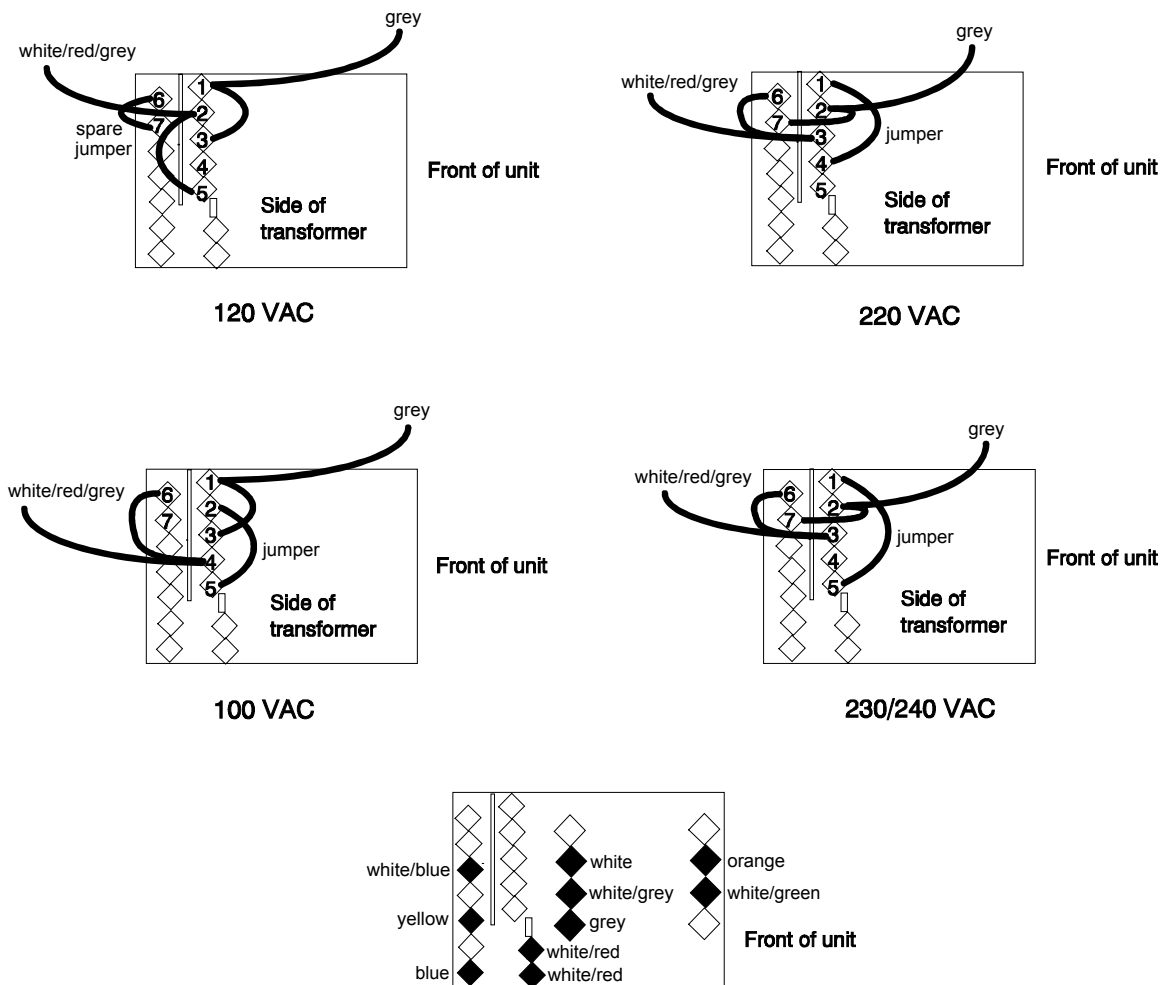
NOTE: The AC power connections at the transformer primary are line voltage dependent. Refer to Figure 3-3 subsequent reconnection.

3 - Troubleshooting

Line Voltage Wiring

Figure 3-3 illustrates the primary wiring configuration of the power transformer for various ac line voltages. Use long nose pliers to disconnect the wires going to the transformer terminals.

NOTE: Install the correct fuse when changing the ac line voltage from a previous setting:
 for 110/120 Vac: 4 AM, Agilent p/n 2110-0055;
 for 220/230 Vac: 2 AM, Agilent p/n 2110-0002



BIAS WIRING (for all voltages)

Figure 3-3. Transformer Wiring

Principles of Operation

Introduction

This section describes the different functional circuits used in the dc power supply models covered in this manual. First, the I/O external signals that connect to the Agilent power supply are described. Next, the overall block diagrams for the dc power supply are described in detail.

The simplified block diagrams in this section show the major circuits on the dc power supply as well as the signals between circuits. They also show the reference designations of some of the components in the functional circuit. These same reference designators are shown in the schematic diagrams in Section 6.

I/O Interface Signals

Table 4-1 describes the interface signals between the power supply and the end user (or other external circuits and devices).

Table 4-1. Power Supply Interface signals

| Connector | Signal | Description | | | | | | | | | | |
|---|--|--|----------------------------------|-------------------------|------------|-------|------------|-------|-----------|------------|------------|--------|
| Front panel outputs | +OUT -OUT | Positive DC output voltage Negative DC voltage (or return) | | | | | | | | | | |
| Rear panel output/sense screw terminals | +OUT -OUT + sense - sense common | Positive DC output voltage Negative DC voltage (or return) +OUT sensing terminal -OUT sensing terminal connected to ground conductor | | | | | | | | | | |
| INH/FLT connector | pin 1 pin 2 pin 3 pin 4 | <table border="0"> <tr> <td><u>FLT/INH mode</u>¹</td> <td><u>Digital I/O mode</u></td> </tr> <tr> <td>FLT output</td> <td>OUT 0</td> </tr> <tr> <td>FLT Common</td> <td>OUT 1</td> </tr> <tr> <td>INH Input</td> <td>IN 2/OUT 2</td> </tr> <tr> <td>INH Common</td> <td>Common</td> </tr> </table> ¹ as-shipped configuration | <u>FLT/INH mode</u> ¹ | <u>Digital I/O mode</u> | FLT output | OUT 0 | FLT Common | OUT 1 | INH Input | IN 2/OUT 2 | INH Common | Common |
| <u>FLT/INH mode</u> ¹ | <u>Digital I/O mode</u> | | | | | | | | | | | |
| FLT output | OUT 0 | | | | | | | | | | | |
| FLT Common | OUT 1 | | | | | | | | | | | |
| INH Input | IN 2/OUT 2 | | | | | | | | | | | |
| INH Common | Common | | | | | | | | | | | |
| RS-232 connector | XON-XOFF RTS-CTS DTR-DSR NONE | uses ASCII control codes DC# and DC1 uses Request-To-Send and Clear-To-Send lines uses Data-Terminal-Ready and Data-Set-Ready lines there is no flow control | | | | | | | | | | |
| GPIB connector | GPIB/IEEE 488 | Provides the interface to an external GPIB controller | | | | | | | | | | |
| Ac input connector | ac mains | Can be 100 Vac, 120 Vac, 220 Vac or 240 Vac Input | | | | | | | | | | |

A3 Front Panel Circuits

As shown in Figure 4-1, the supply's front panel assembly contains a circuit board, a keypad, a liquid crystal display (LCD), and a rotary control (RPG) for the output voltage and current. With the exception of the RPG (A3G1), the A3 Front Panel board is an assembly-level replaceable part. A separate front panel binding post board is also included on the unit. It is also available as an assembly-level replaceable part.

The A3 front panel board contains microprocessor circuits, which decode and execute all keypad and RPG commands that are transferred to the power supply output via the serial I/O port to the primary interface circuits on the A2 interface board. The front panel microprocessor circuits also process power supply measurement and status data received on the serial I/O port. This data is displayed on the LCD.

A2 Interface Circuits

The circuits on the A2 interface board provide the interface between the GPIB interface, RS-232 interface, and front panel interface and the dc power supply. Communication between the power supply and a GPIB controller is processed by the GPIB interface and the primary microprocessor circuits on the A2 board. The A2 Interface board is assembly-level replaceable; it contains no user-replaceable parts.

With the exception of the front panel microprocessor, all digital circuits, analog-to-digital converters (ADC) and digital-to-analog converters (DAC) in the dc power supply are located on the A2 Interface board. All control signals between the A2 interface board and the A1 main board are either analog or level signals.

Primary Interface

The primary microprocessor circuits (DSP, ROM, and RAM chips) decode and execute all instructions and control all data transfers between the controller and the secondary interface. The primary microprocessor circuits also process measurement and status data received from the secondary interface.

A Dual Asynchronous Control chip on the A2 board converts the RS-232, RI/DFI, and front panel data into the primary microprocessor's 8-bit data format. The serial data is transferred between the primary interface and the secondary interface via a serial bus and optical isolator chips. These chips isolate the primary interface circuits (referenced to earth ground) from the secondary interface circuits.

Secondary Interface

The secondary interface circuits include a programmed logic array, EEPROM, boot-ROM, 8 and 12-bit DAC circuits, and 8 and 16-bit ADC circuits. The programmed logic array translates the serial data received from the primary interface into a corresponding digital signal for the appropriate DAC/ADC circuits. The logic array is also connected directly to four DAC/ADC circuits. Under control of the logic array, the selected DAC converts the data on the bus into an analog signal. Conversely, the selected ADC converts the analog signals from the A1 board into a digital signal.

The logic array also directly receives status information from the A1 main board via three level-sensitive signal lines, which inform the array of the following operating conditions: constant voltage mode (CV_Detect*), constant current mode (CC_Detect*), negative current mode (CCN_Detect*), and overvoltage (OV_Detect*). The PM_Inhibit control signal is used to shut down the bias voltage to the output stages and keep the power supply output off. The OV_SCR* control signal is used to fire the SCR and keep the power supply output off when an overvoltage condition has occurred.

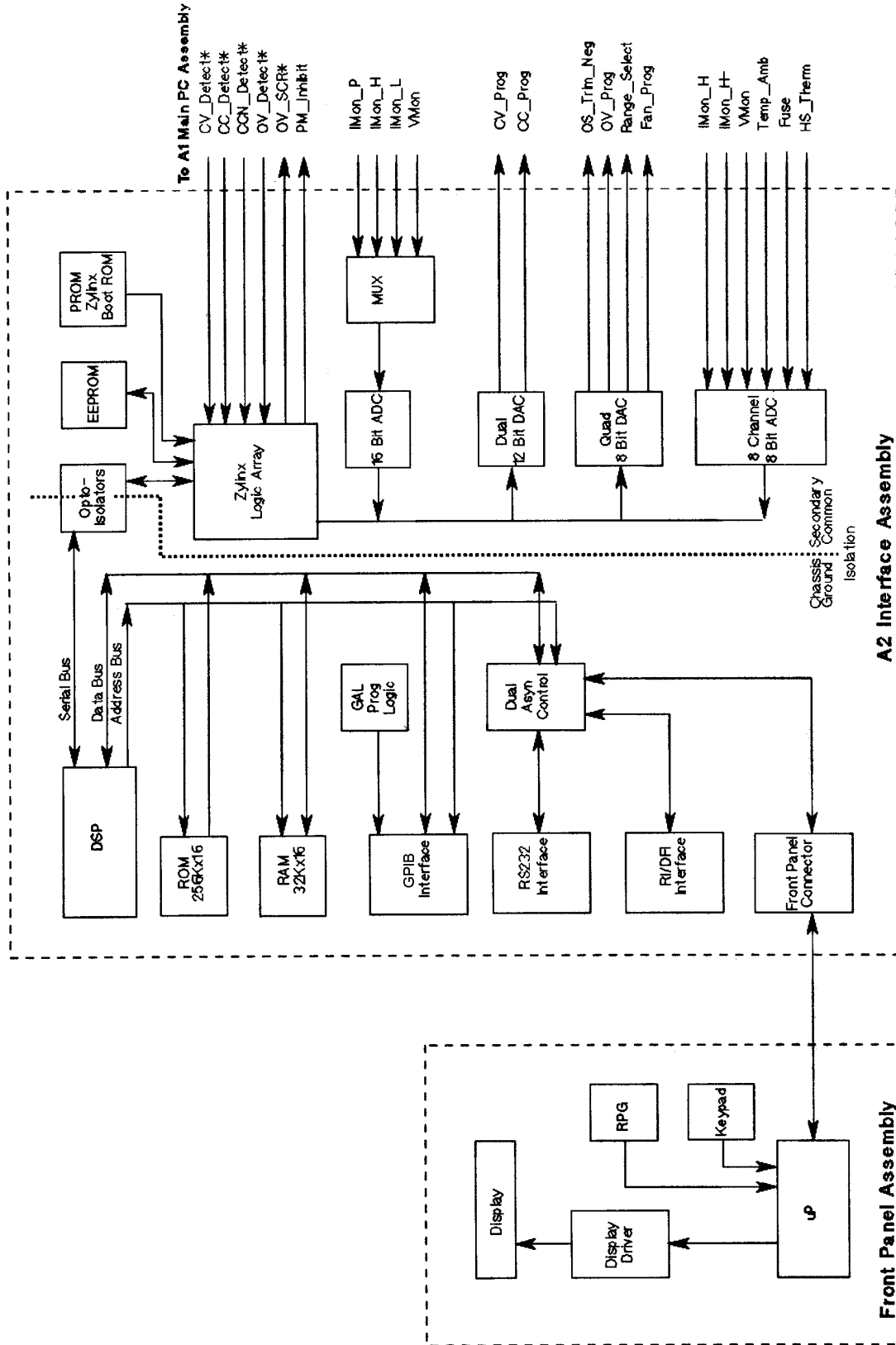


Figure 4-1. A2/A3 Block Diagram

4 - Principles of Operation

The EEPROM (electrically erasable programmable read-only memory) chip on the A2 interface board stores a variety of data and configuration information. This information includes calibration constants, GPIB address, present programming language, and model-dependent data, such as the minimum and maximum values of voltage and current. One of the EEPROM storage locations holds a checksum value which is used to verify the integrity of the EEPROM data. Access to the calibration data in the EEPROM is controlled by the combination of a password and switch settings on A2S201, located on A2 interface board (See Chapter 3 "Inhibit Calibration Switch").

The Dual 12-bit DAC converts the programmed value of voltage and current on the bus into the CV_Prog and CC_Prog signals, which are sent to the CV control circuits in order to control the magnitude of the output voltage in the CV mode and output current in CC mode. The CV_Prog and CC_Prog signals are in the 0 to -5 V range, which corresponds to the zero to full-scale output ratings of the dc power supply.

The Quad 8-bit DAC converts programmed information for the following circuits into analog format: negative offset trim (OS_Trim_Neg), overvoltage setting (OV_Prog), current measurement range select (Range_Select), and fan speed programming (Fan_Prog). The OS_Trim_Neg signal allows the negative current control circuit to be calibrated at zero. The OV_Prog signal is applied to the OV detect circuit, which compares the programmed overvoltage setting with the actual output voltage. The Range_Select signal selects either the high or the low (20mA) measurement range. The Fan_Prog signal is applied to the fan speed control circuit in order to speed up the fan as temperature increases, and to slow the fan speed down as temperature decreases.

The 16-bit ADC in conjunction with a 4x1 multiplexer returns data from the following measurement signals to the logic array: monitored output voltage (VMon), monitored high-range current (Imon_H), monitored low-range current (Imon_L), and monitored peak current (Imon_P). All measurement signals are in the range of 0 to +5V, which corresponds to the zero to full-scale readback capability of the dc power supply.

The 8-channel, 8-bit ADC returns the following signals to the logic array: high-range output current (Imon_H), high range negative current (Imon_H-), overvoltage (V_Mon), ambient temperature (Temp_Amb), heatsink temperature (HS_Therm), and output fuse state (Fuse). Five of these signals are for fan control. The logic array varies the Fan_Prog signal depending upon the ambient temperature, the heatsink temperature, and the present output voltage and current. The Fuse signal informs the logic array if the output fuse (F300) is open.

A1 Main Board Circuits

Power Circuits

As shown in Figure 4-2, the power circuits consist of: input power rectifiers and filter, current-monitoring resistors, an output stage, a voltage gain stage, an overvoltage SCR, and an output filter.

The ac input rectifier and filter converts ac input to a dc level. The output stage regulates this dc level at the output of the power supply. The output stage has up to four parallel NPN transistors mounted on a heatsink and connected between the +Rail and the +Output. These transistors are driven to conduct by a positive-going signal from driver Q303 (located in the voltage gain stage). The output stage also has up to four parallel PNP transistors mounted on a heatsink and connected between the +Rail and the -Rail. These transistors are driven to conduct by a negative-going signal from driver Q304 (located in the voltage gain stage).

The voltage gain stage is controlled by a signal from the control circuits. A positive-going signal to the voltage gain stage makes the output more positive. A negative-going signal to the voltage gain stage makes the output more negative. The Turn-on control signal to the voltage gain stage simply keeps the output of the unit turned off for about 100 milliseconds at power turn-on while the microprocessor is initializing the unit.

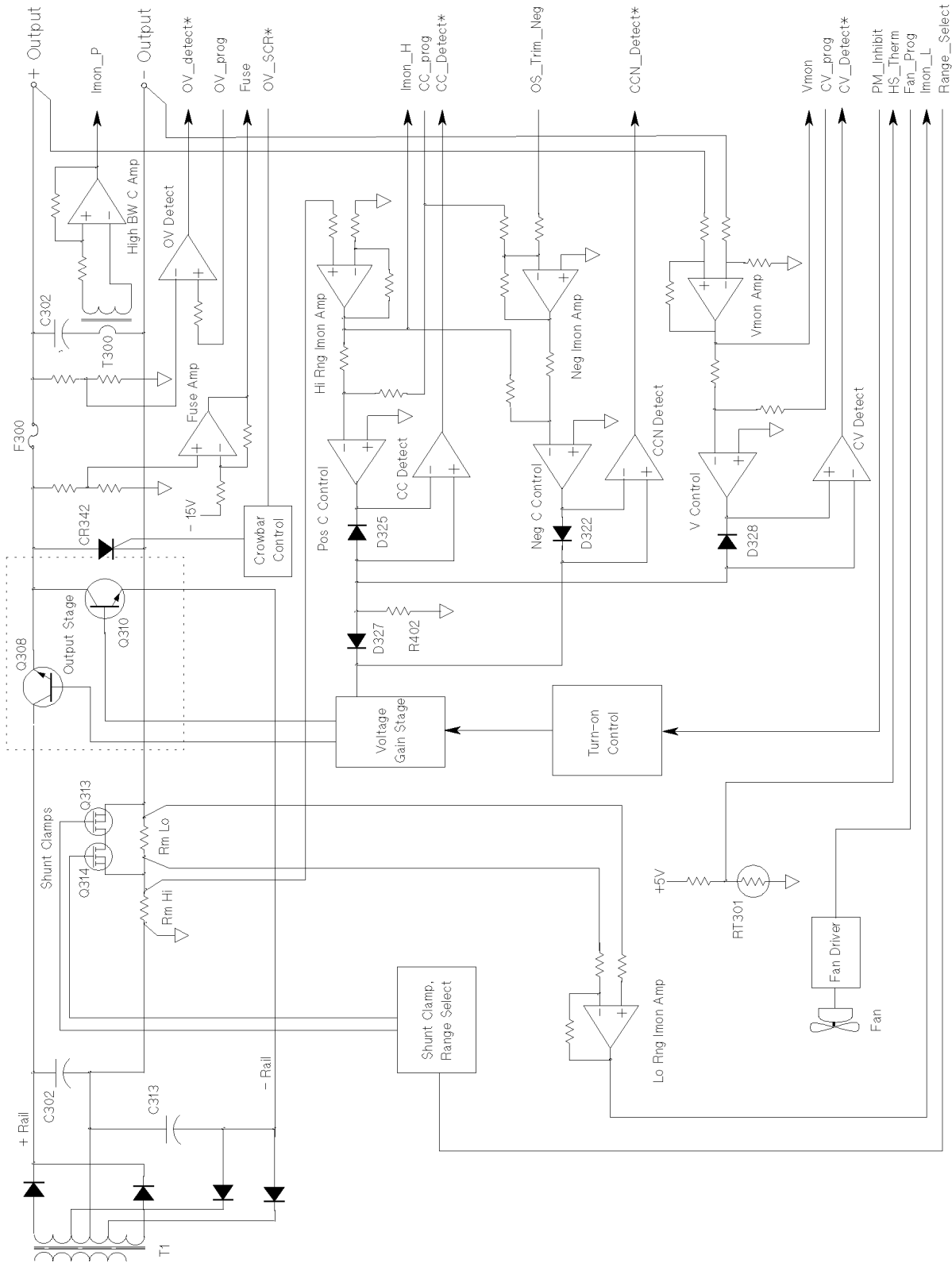


Figure 4-2. A1 Block Diagram

4 - Principles of Operation

Two current shunt resistors monitor the output current. RmHi (R473) monitors the high current range; RmLo (R403) monitors the low current range. Shunt clamps, connected in parallel across RmLo, turn on at approximately 25 mA to limit the voltage drop at high currents. The Range_Select signal sets the level at which switching occurs. The output of the current monitor drives the level.

The SCR, connected across the output, will fire and short the output when an overvoltage condition is detected. The SCR is controlled by the OV_SCR* signal from the crowbar control circuit (described in the next section).

The output filter capacitor provides additional filtering of the dc output.

Control Circuits

As shown in Figure 4-2, the control circuits consist of the CV/CC controls, output voltage/current monitor, bias supplies, and SCR control.

The CV/CC control circuits provide a CV control loop, a positive CC control loop, and a negative CC control loop. For any value of load resistance, the supply must act either as a constant voltage (CV) or as a constant current (CC) supply. Transfer between these modes is accomplished automatically by the CV/CC control circuit at a value of load resistance equal to the ratio of the programmed voltage value to the programmed current value. The negative CC control circuit is activated when a current source such as another power supply is connected across the output terminals and its voltage is greater than the programmed voltage. A low level CV_Detect*, CC_Detect*, or CCN_Detect* signal is returned to the secondary interface to indicate that the corresponding mode is in effect.

When the CV loop is in control, diode D328 is conducting current. Voltage regulation is accomplished by comparing the programmed voltage signal CV_Prog with the output voltage monitor signal Vmon. The Vmon signal is in the 0 to +5 V range, which corresponds to the zero to full-scale output voltage range of the supply. If the output voltage exceeds the programmed voltage, Vmon goes high and produces a more negative-going CV signal, which reduces the input to the voltage gain stage and lowers the output voltage. Conversely, if the output voltage is less than the programmed voltage, Vmon goes low and produces a more positive-going CV signal, which increases the input to the voltage gain stage and raises the output voltage. Depending upon the position of the sense switch, the output voltage is either monitored at the supply's output terminals (local), or at the load (remote) using the +S and -S terminals with remote sense leads connected to the load. If the output voltage goes higher than the programmed value, the unit starts sinking current to reduce the output voltage.

When the CC loop is in control, diode D325 is conducting current. Current regulation is accomplished by comparing the programmed current signal CC_Prog with the output current monitor signal Imon_H. The Imon_H signal is produced by measuring the voltage drop across the current monitoring resistor and is in the 0 to +5 V range, which corresponds to the zero to full-scale output current range of the supply. If the output current exceeds the programmed current, Imon_H goes high and produces a more negative going CC signal, which reduces the input to the voltage gain stage and lowers the output current. Conversely, if the output current is less than the programmed current, Imon_H goes low and produces a more positive-going CC signal, which increases the input to the voltage gain stage and raises the output current.

When the supply is sinking current, only the CV control circuit or the CCN control circuit can be active. In this case, the supply is acting as a load instead of a power source and will attempt to pull the output voltage down by drawing off current from the externally applied source. The current that will be drawn from the externally supplied source is determined by the CC_Prog signal. When the current required to reduce the voltage is less than the programmed current value, the CV control circuit is active and regulates the output voltage. When the current required to reduce the voltage exceeds the programmed current value, the CCN control circuit is active. It regulates the output current by comparing the negative Imon_H signal to the inverted CC_Prog signal.

During operation, a PM_Inhibit signal will cause the turn-on control to turn off the bias to the voltage gain stage and shut down the output if any of the following occur:

The output is programmed off.

An overvoltage condition is detected (OV_Detect* signal is received).

The line voltage falls below 90 volts (approximately).

Current readback is provided by three separate circuits. The previously discussed high range current signal (Imon_H) returns the high range current measurement. When the unit is operating in the low current readback mode, a separate low range current shunt and amplifier provides low-current readback via the Imon_L signal. The Range_Select signal drives shunt clamps Q304 and Q305, which clamp the voltage across RmLo to approximately 1.8 V. A third current readback circuit is available on the Agilent 66332A unit. It consists of a high bandwidth current amplifier that returns dynamic current measurements from the output filter capacitor via the Imon_P signal. Note that the Imon_H and the Imon_P signal are combined to return the actual output current measurement.

An overvoltage detect circuit compares the output voltage to the programmed overvoltage setting. When the output exceeds the programmed setting, the OV_Detect* signal goes low, which informs the logic array that an OV condition has occurred. The crowbar control circuit is enabled when the OV_SCR* signal is received. When an overvoltage condition occurs, the SCR control circuit generates the OV signal, which causes the following actions to occur:

1. The SCR fires, shorting the supply's output.
2. The microprocessor circuits are notified of the OV condition (OV_Detect* is low) in order to program the output off, turn off the gain stage bias, and update the status of the unit.
3. When a output protection clear command is executed, the microprocessor circuits resets the OV circuits, turns on the gain stage bias, and programs the output to its previous level.

The fan driver control circuit provides the DC voltage to operate the cooling fan. The Fan_Prog signal from the secondary interface circuit varies this voltage according to the ambient and heatsink temperature as well as the output voltage and current of the supply.

Replaceable Parts List

Introduction

This section lists the replaceable parts for Agilent Models 66332A, 6632B, 6633B, and 6634B power supplies. Refer to Figures 5-1 for the location of mechanical parts with the reference designators MP. Refer to the board location diagrams in Chapter 6 for the location of electrical parts.

Table 5-1. Chassis, Electrical

| Designator | Model | Part Number | Qty | Description |
|------------|-------------------|-------------|-----|----------------------------------|
| A1 | 66332A/6632B | 5063-3431 | 1 | Control PCA, Tested |
| A1 | 6633B | 06633-61023 | 1 | Control PCA, Tested |
| A1 | 6634B | 06634-61023 | 1 | Control PCA, Tested |
| A2 | 66332A | 5063-3439 | 1 | Interface PCA, Tested |
| A2 | 6632B/6633B/6634B | 5063-3429 | 1 | Interface PCA, Tested |
| A3 | All | 5063-3432 | 1 | Front Panel PCA, Tested |
| A4 | 6633B/6634B | 5063-3406 | 1 | Binding Post PCA |
| A4 | 66332A/6632B | 06611-60022 | 1 | Binding Post PCA |
| A5 | All | 5063-3433 | 1 | AC Input/RFI PCA |
| A6 | All | 5063-3434 | 1 | Relay PCA, Tested |
| B1 | All | 06632-60002 | 1 | Fan Assembly |
| T1 | 66332A/6632B | 9100-5501 | 1 | Main Transformer |
| T1 | 6633B | 9100-5567 | 1 | Main Transformer |
| T1 | 6634B | 9100-5568 | 1 | Main Transformer |
| S1 | All | 3101-2862 | 1 | Rocker Switch (AC Line) |
| W1 | All | 06612-80001 | 1 | Cable (A5 to S1) |
| W2 | All | 06612-80002 | 1 | Cable (S1 to T1) |
| W3 | All | 06632-80004 | 1 | Cable (T1 to A1J303) |
| W4 | All | 06612-80008 | 1 | Cable (T1 to A1 J304/J305) |
| W5 | All | 06612-80003 | 1 | T1 Jumper |
| W6 | All | 5080-2452 | 1 | Cable (A1 to A2 J206) |
| W7 | All | 5080-2448 | 1 | Cable (A1 to A2 J207) |
| W10 | All | 5080-2457 | 1 | Cable (A2 J210 to A6 J610) |
| W11 | All | 5080-2457 | 1 | Cable (A2 J211 to A3 J111) |
| W15 | All | 06612-80010 | 1 | Cable (A1 J314 to A4 J615) |
| | All | 8120-4383 | 1 | Line Cord, Standard (Option 903) |
| | All | 8120-1350 | 1 | Line Cord, Option 900 |
| | All | 8120-1369 | 1 | Line Cord, Option 901 |
| | All | 8120-1689 | 1 | Line Cord, Option 902 |
| | All | 8120-0698 | 1 | Line Cord, Option 904 |
| | All | 8120-2104 | 1 | Line Cord, Option 906 |
| | All | 8120-2956 | 1 | Line Cord, Option 912 |
| | All | 8120-4211 | 1 | Line Cord, Option 917 |
| | All | 8120-4753 | 1 | Line Cord, Option 918 |

5 - Replaceable Parts

Table 5-2. Chassis, Mechanical

| Designator | Model | Part Number | Qty | Description |
|------------|--------|-------------|-----|--|
| MP1 | All | 06612-00002 | 1 | Chassis |
| MP2 | All | 5063-3426 | 1 | Front Panel Assy, Std unit |
| MP2 | All | 5063-3443 | 1 | Front Panel Assy, Option 020 |
| MP3 | All | 0370-3238 | 1 | Knob, 6mm |
| MP4 | All | 06612-40001 | 1 | Keypad |
| MP5 | All | 1510-0091 | 2 | Binding Post, Single, Red |
| MP6 | 66332A | 66332-80001 | 1 | Nameplate (66332A) |
| MP6 | 6632B | 06632-80019 | 1 | Nameplate (6632B) |
| MP6 | 6633B | 06633-80002 | 1 | Nameplate (6633B) |
| MP6 | 6634B | 06634-80002 | 1 | Nameplate (6634B) |
| MP7 | All | 5001-9847 | 1 | Top Cover |
| MP8 | All | 5041-8819 | 1 | Strap Handle Cap, front |
| MP9 | All | 5041-8820 | 1 | Strap Handle Cap, rear |
| MP10 | All | 5062-3702 | 1 | Strap Handle |
| MP11 | All | 06624-20007 | 1 | Barrier Block Cover |
| MP12 | All | 1252-1488 | 1 | Terminal Block, 4 Position, RI/DFI |
| MP13 | All | 06611-40006 | 1 | Fan Spacer (G10) |
| MP14 | All | 5020-2859 | 1 | Main Heat Sink |
| MP15 | All | 06612-20002 | 1 | Thermal Insulator |
| MP16 | All | 0515-0433 | 15 | Screw M4x0.7x8mm, Torx T15, Pan, Conical washer |
| MP17 | All | 1400-1826 | 8 | Spring Clip |
| MP18 | All | 06612-20001 | 4 | Insulator |
| MP19 | All | 06612-80004 | 1 | Rear Label |
| MP20 | All | 5041-8801 | 4 | Foot |
| MP21 | All | 0515-1117 | 2 | Screw M5x0.8x10mm, Pozi, Flat, Patch Lock |
| MP22 | All | 0515-1132 | 2 | Screw M5x0.8x10mm Pozi, Pan, Patch Lock |
| MP23 | All | 06612-00005 | 1 | Relay Option Bracket |
| MP24 | All | 06612-00004 | 1 | Binding Post Plate |
| MP25 | All | 2950-0144 | 2 | Nut, Hex 3/8-32 Nylon |
| MP26 | All | 0590-0305 | 2 | Nut, Hex w/Lockwasher 6-32 |
| MP27 | All | 5001-0538 | 2 | Side Trim |
| MP28 | All | 0380-0644 | 2 | Stud Mounted Standoff |
| MP29 | All | 2190-0034 | 2 | Washer, Helical Lock #10 |
| MP30 | All | 3050-0849 | 2 | Washer, Flat #10 |
| MP31 | All | 5001-6788 | 1 | Transformer Bracket |
| MP32 | All | 5001-6787 | 1 | Transformer Shim |
| MP33 | All | 1400-1281 | 2 | Cable Clip |
| MP34 | All | 0515-0380 | 10 | Screw M4x0.7x10mm, Torx T15, Pan, conical washer |
| MP35 | All | 0515-1946 | 1 | Screw M3x0.5x6mm, Torx T10, Flat, Patch Lock |
| MP36 | All | 0515-2535 | 4 | Screw, M3x0.5x8mm, Torx T10, Thread Rolling |
| MP37 | All | 0515-0374 | 6 | Screw M3x0.5x10mm, Torx T10, Pan, conical washer |
| MP38 | All | 0535-0031 | 2 | Nut, Hex w/lockwasher, M3x0.5 |
| MP39 | All | 0460-2362 | 1 | Foam Pad |
| MP40 | All | 0380-2086 | 2 | Standoff, snap-in |
| MP41 | All | 8160-0916 | 2 | RFI Clip |
| MP42 | All | 1252-3056 | 2 | Screw Lock Kit (ref RS232 Connector) |
| | All | 5962-0872 | 1 | Operating Guide |
| | All | 5962-8108 | 1 | Programming Guide |

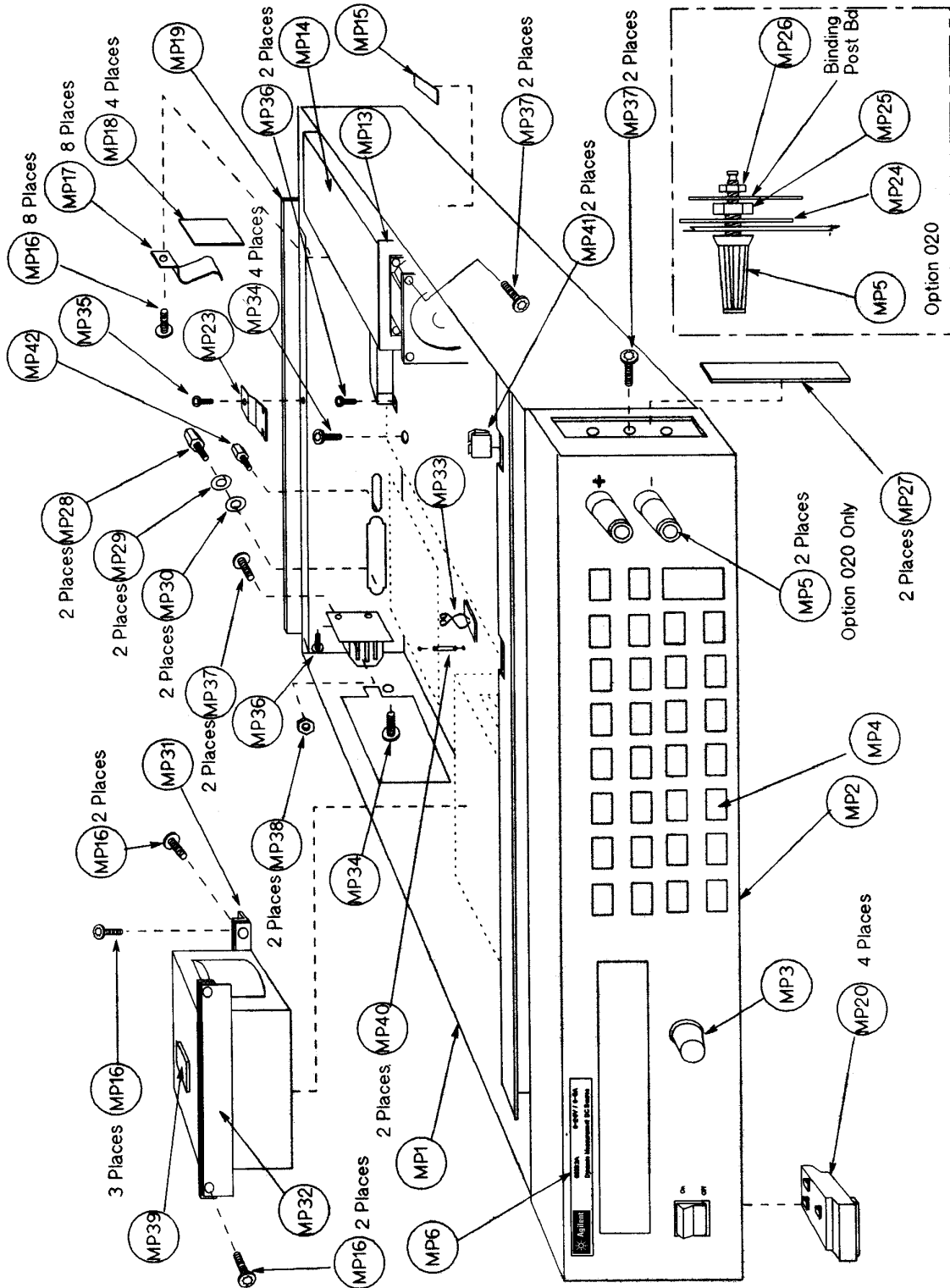


Figure 5-1. Mechanical Parts Identification

5 - Replaceable Parts

Table 5-3. A1 Control Board PC Board Assembly

| Designator | Model | Part Number | Qty | Description |
|------------|--------------|-------------|-----|---------------------|
| A1 | 66332A/6632B | 5063-3431 | 1 | Control PCA, Tested |
| A1 | 6633B | 06633-61023 | 1 | Control PCA, Tested |
| A1 | 6634B | 06634-61023 | 1 | Control PCA, Tested |
| C300 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C301 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C303 | 66332A/6632B | 0180-4756 | 1 | Cap 18,000 uF 50V |
| C303 | 6633B | 0180-4815 | 1 | Cap 2200 uF 160V |
| C303 | 6634B | 0180-4816 | 1 | Cap 1200 uF 250V |
| C304 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C305 | All | 0180-2980 | 1 | Cap 1000 uF 50V |
| C306 | All | 0180-4033 | 1 | Cap 2200 uF 35 V |
| C307 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C308, 309 | All | 0160-5422 | 2 | Cap 0.047 uF 20% |
| C310 | All | 0180-4818 | 1 | Cap 8200 uF 16V |
| C311, 312 | All | 0160-5422 | 2 | Cap 0.047 uF 20% |
| C313 | 66332A/6632B | 0180-4819 | 1 | Cap 33,000 uF 25V |
| C313 | 6633B | 0180-4817 | 1 | Cap 18,000 uF 16V |
| C313 | 6634B | 0180-4818 | 1 | Cap 8200 uF 16V |
| C314 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C315, 316 | 66332A/6632B | 0160-5422 | 2 | Cap 0.047 uF 20% |
| C317 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C318, 319 | All | 0180-4129 | 2 | Cap 1 uF 35V |
| C320 | All | 0180-4136 | 1 | Cap 10 uF 20V |
| C321 | All | 0180-4129 | 1 | Cap 1 uF 35V |
| C322 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C323 | All | 0160-4831 | 1 | Cap 4700 pF 10% |
| C324 | All | 0180-4129 | 1 | Cap 1 uF 35V |
| C325 - 327 | All | 0160-5422 | 3 | Cap 0.047 uF 20% |
| C328 | All | 0160-5098 | 1 | Cap 0.22 uF 10% |
| C330 | All | 0160-4832 | 1 | Cap 0.01 uF 10% |
| C331, 332 | 66332A/6632B | 0160-4830 | 2 | Cap 2200 pF 10% |
| C333 | 66332A/6632B | 0160-5644 | 1 | Cap 0.033 uF 10% |
| C334 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C334 | 6633B/6634B | 0160-4835 | 1 | Cap 0.1 uF 10% 50V |
| C335 | 66332A/6632B | 0160-7001 | 1 | Cap 3300 pF 100V |
| C335 | 6633B | 0160-5410 | 1 | Cap 3300 pF |
| C335 | 6634B | 0160-4834 | 1 | Cap 0.047 uF 10% |
| C336 | All | 0160-4812 | 1 | Cap 220 pF 5% |
| C337 - 339 | All | 0160-5422 | 3 | Cap 0.047 uF 20% |
| C340 | 6634B | 0160-6836 | 1 | Cap 0.01 uF 250V |
| C341 - 343 | All | 0160-5422 | 3 | Cap 0.047 uF 20% |
| C344 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C344 | 6633B/6634B | 0160-4833 | 1 | Cap 0.022 uF |
| C345 | All | | | Not loaded |
| C346 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C346 | 6633B/6634B | 0160-4833 | 1 | Cap 0.022 uF |
| C347 | All | 0160-6827 | 1 | Cap 0.022 uF 400V |
| C348 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |

| Designator | Model | Part Number | Qty | Description |
|------------|--------------------|-------------|-----|--------------------|
| C349 | 66332A/6632B | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C349 | 6633B/6634B | 0160-4807 | 1 | Cap 0.033 uF |
| C350 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C351 | All | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C352 | 66332A/6632B | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C352 | 6633B/6634B | 0160-4807 | 1 | Cap 0.033 uF |
| C353, 354 | All | 0160-5422 | 2 | Cap 0.047 uF 20% |
| C355 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C355 | 6633B/6634B | 0160-4835 | 1 | Cap 0.1 uF 10% 50V |
| C356 | All | | | Not loaded |
| C357 | All | 0160-4801 | 1 | Cap 100 pF 5% |
| C358 | All | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C359 | 66332A/6632B | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C359 | 6633B/6634B | 0160-4787 | 1 | Cap 22 pF 5% 100V |
| C360 | 66332A/6632B | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C360 | 6633B | 0160-4789 | 1 | Cap 15 pF 5% 100V |
| C360 | 6634B | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C361 | 66332A/6632B | 0160-4807 | 1 | Cap 33 pF 5% 100V |
| C362 | 66332A/6632B | 0160-4813 | 1 | Cap 180 pF 5% |
| C362 | 6633B | 0160-4812 | 1 | Cap 220 pF 5% 100V |
| C362 | 6634B | 0160-4800 | 1 | Cap 120 pF 5% |
| C363 | All | 0160-4807 | 1 | Cap 33 pF 5% 100V |
| C364 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C365 | All | 0160-5471 | 1 | Cap 0.1 uF 5% 50V |
| C366, 367 | All | 0160-4791 | 2 | Cap 10 pF 5% 100V |
| C368 | All | 0160-4789 | 1 | Cap 15 pF 5% 100V |
| C369 | All | 0160-6827 | 1 | Cap 0.022 uF 400V |
| C370 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C371 | All | 0160-4812 | 1 | Cap 220 pF 5% |
| C372, 373 | 66332A/6632B | 0160-5422 | 2 | Cap 0.047 uF 20% |
| C374 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C375 | 66332A/6632B/6633B | 0160-5410 | 1 | Cap 3300 pF 5% |
| C375 | 6634B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C376 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C376 | 6633B | 0160-4918 | 1 | Cap 0.022 uF 20% |
| C376 | 6634B | 0160-6616 | 1 | Cap 6800 pF 20% |
| C377 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C377 | 6633B | 0160-4918 | 1 | Cap 0.022 uF 20% |
| C377 | 6634B | 0160-6616 | 1 | Cap 6800 pF 20% |
| C378 | 66332A/6632B | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C379 | All | 0160-8153 | 1 | Cap 4700 pF |
| C380 | All | 0180-4129 | 1 | Cap 1 uF 35V |
| C381 | All | 0160-8153 | 1 | Cap 4700 pF |
| C382 | 66332A/6632B | 0160-8231 | 1 | Cap-MET 100 uF |
| C382 | 6633B | 0160-8299 | 1 | Cap 50 uF 70V |
| C382 | 6634B | 0160-8230 | 1 | Cap 22 uF 150V |
| C383 | 66332A/6632B | 0160-5469 | 1 | Cap 1 uF 10% 50V |
| C384 | All | 0160-4789 | 1 | Cap 15 pF 5% 100V |
| C386 | All | 0160-4787 | 1 | Cap 22 pF 5% 100V |

5 - Replaceable Parts

| Designator | Model | Part Number | Qty | Description |
|------------|--------------|-------------|-----|-------------------------------------|
| C403 | 66332A/6632B | 0160-4791 | 1 | Cap 10 pF 5% 100V |
| C405 | All | 0160-3454 | 1 | Cap 220 pF 1KV |
| C411 | 6633B/6634B | 0160-7277 | 1 | Cap 2.2 uF |
| C420 | 6633B/6634B | 0160-6800 | 1 | Cap 0.022 uF 20% |
| C421 | 6633B/6634B | 0160-6800 | 1 | Cap 0.022 uF 20% |
| C422 | 6633B | 0160-6180 | 1 | Cap 1000 pF 20% |
| C422 | 6634B | 0160-7336 | 1 | Cap 220 pF 20% |
| C423 | 6633B | 0160-6804 | 1 | Cap 0.047 uF 20% |
| C423 | 6634B | 0160-7568 | 1 | Cap 0.0047 uF 10% |
| C424 | 6633B | 0160-6180 | 1 | Cap 1000 pF 20% |
| C424 | 6634B | 0160-7336 | 1 | Cap 220 pF 20% |
| C425 | 6633B/6634B | 0160-4822 | 1 | Cap 1000 pF |
| C426 | 6634B | 0160-6806 | 1 | Cap 0.1 uF |
| C427 | 6634B | 0160-0157 | 1 | Cap 4700 pF |
| C428 - 430 | 6633B/6634B | 0160-6803 | 3 | Cap 0.047 uF 250v 20% |
| C431, 432 | 6633B | 0160-5847 | 2 | Cap 0.22 uF |
| C480, 481 | All | 0160-5422 | 2 | Cap 0.047 uF 20% |
| C482 | 6633B/6634B | 0160-6800 | 1 | Cap 0.022 uF 20% |
| C496, 497 | All | 0180-4129 | 2 | Cap 1 uF 35V |
| C498 | All | 0160-4801 | 1 | Cap 100 pF 5% |
| C499 | 66332A/6632B | 0160-7562 | 1 | Cap 6.8 uF 63 V |
| CR342 | 66332A/6632B | 5060-3234 | 1 | SCR/Rectifier Assembly (CR342/D330) |
| | | 1205-0571 | 1 | ref CR342 Heat Sink |
| | | 1884-0310 | 1 | ref CR342 SCR MCR69-3 |
| | | 1901-0987 | 1 | ref CR342 Power Diode D330 |
| CR342 | 6633B | 5060-3234 | 1 | SCR/Rectifier Assembly (CR342/D330) |
| | | 1205-0571 | 1 | ref CR342 Heat Sink |
| | | 1884-0310 | 1 | ref CR342 SCR MCR69-3 |
| | | 1901-0987 | 1 | ref CR342 Power Diode D330 |
| CR342 | 6634B | 5060-3251 | 1 | SCR/Heatsink Assembly |
| | | 1884-0316 | 1 | ref CR342 SCR 2N6402 |
| | | 1205-0571 | 1 | ref CR342 Heat Sink |
| D300 - 303 | All | 1901-0731 | 4 | Diode |
| D304 | All | 1901-1098 | 1 | Diode |
| D305, 306 | All | 1901-0731 | 2 | Diode |
| D307 | All | 1901-1098 | 1 | Diode |
| D308 | 66332A/6632B | 5060-3378 | 1 | Rectifier Assembly |
| | | 1901-1383 | 1 | ref D308 Power Diode |
| | | 1205-0282 | 1 | ref D308 Heat Sink |
| D308 | 6633B/6634B | 1901-1130 | 1 | Diode |
| D309 | 66332A/6632B | 5060-3228 | 1 | Rectifier Assembly |
| | | 1901-0987 | 1 | ref D309 Rectifier |
| | | 1205-0282 | 1 | ref D309 Heat Sink |
| D309 | 6633B/6634B | 1901-1130 | 1 | Diode |
| D310 | 66332A/6632B | 5060-3228 | 1 | Rectifier Assembly |
| | | 1901-0987 | 1 | ref D310 Rectifier |
| | | 1205-0282 | 1 | ref D310 Heat Sink |

| Designator | Model | Part Number | Qty | Description |
|---------------|--------------------|-------------|-----|---------------------------------|
| D310 | 6633B/6634B | 1901-1130 | 1 | Diode |
| D311 | 66332A/6632B | 5060-3378 | 2 | Rectifier Assembly |
| | | 1205-0282 | 1 | ref D311 Heat Sink |
| | | 1901-1383 | 1 | ref D311 Power Diode |
| D311 | 6633B/6634B | 1901-1130 | 1 | Diode |
| D312 | All | 1901-1098 | 1 | Diode |
| D313, 314 | All | 1901-0731 | 2 | Diode |
| D315 | All | 1901-0050 | 1 | Diode |
| D316 | All | 1901-0719 | 1 | Power Diode |
| D317 | 66332A/6632B | 1901-1080 | 1 | Diode |
| D317 | 6633B/6634B | 1901-1098 | 1 | Diode |
| D318 | 66332A/6632B | 1901-1080 | 1 | Diode |
| D318 | 6633B/6634B | 1901-1098 | 1 | Diode |
| D319 - 321 | 6633B/6634B | 1901-1098 | 3 | Diode |
| D322 | All | 1901-0050 | 1 | Diode |
| D323, 324 | All | 1901-0033 | 2 | Diode |
| D325 | All | 1901-0050 | 1 | Diode |
| D326 | All | 1901-0033 | 1 | Diode |
| D327, 328 | All | 1901-0050 | 2 | Diode |
| D329 | All | 1901-0033 | 1 | Diode |
| D330 | 66332A/6632B/6633B | 1901-0987 | 1 | Power Diode (See CR342) |
| D335 | 66332A/6632B | 1902-0953 | 1 | Zener Diode 6.2V 5% |
| D336, 337 | All | 1901-0880 | 2 | Diode |
| D400 | 6634B | 1901-0719 | 1 | Diode, Power |
| D470, 471 | All | 1902-0960 | 2 | Zener Diode 12V 5% |
| D499 | 66332A/6632B/6633B | 1901-0987 | 1 | Power Diode (See Q314) |
| F300, 301 | All | 2110-0712 | 2 | Fuse, Submin 4AM, 125V |
| F302 | 66332A/6632B/6633B | 2110-0697 | 1 | Fuse, Submin 15AM, 32V |
| F302 | 6634B | 2110-0685 | 1 | Fuse, Submin 7AM, 125V |
| F303 | 66332A/6632B/6633B | 2110-0697 | 1 | Fuse, Submin 15AM, 32V |
| F303 | 6634B | 2110-0685 | 1 | Fuse, Submin 7AM, 125V |
| F304 | All | 2110-0699 | 1 | Fuse, Submin 5AM, 125V |
| F305 | 66332A/6632B/6633B | 2110-0777 | 1 | Fuse 8AM 32V |
| F305 | 6634B | 0811-3776 | 1 | Res Fusible 0.5 Ohm 5W |
| | All | 2110-1107 | 2 | ref F305 Fuseholder Clips |
| F400, 406 | 66332A/6632B | Not Used | 2 | Replaced by track on all models |
| F401-405, 407 | All | Not Used | 6 | Replaced by track on all models |
| J303 | All | 1252-0063 | 1 | Connector |
| J304 | All | 1251-6832 | 1 | Connector |
| J305 | All | 1252-0063 | 1 | Connector |
| J307 | All | 1252-5977 | 1 | Connector |
| J309 | All | 0360-2609 | 1 | Barrier Block |
| J314 | All | 1252-0056 | 1 | Connector |
| J414 | All | 1252-0063 | 1 | Connector |
| J508 | All | 1252-3771 | 1 | AC Line Module |
| L300, 301 | 66332A/6632B | 9140-0115 | 2 | Coil 22 uH 10% |

5 - Replaceable Parts

| Designator | Model | Part Number | Qty | Description |
|------------|--------------------|-------------|-----|--------------------------------|
| Q300 | All | 5060-3245 | 1 | Darlington Fan Driver Assembly |
| | All | 1854-0828 | 1 | ref Q300 Transistor,NPN SI |
| | All | 1205-0282 | 1 | ref Q300 Heat Sink |
| Q301 | 66332A/6632B/6633B | 1854-0474 | 1 | Transistor, NPN |
| Q301 | 6634B | 1854-0575 | 1 | Transistor, NPN |
| Q302 | 66332A/6632B/6633B | 1854-0474 | 1 | Transistor, NPN |
| Q302 | 6634B | 1854-0575 | 1 | Transistor, NPN |
| Q303 | 66332A/6632B | 06612-60008 | 1 | Transistor Driver Assembly |
| | | 1854-0872 | 1 | ref Q303 Transistor, NPN |
| | | 1205-0350 | 1 | ref Q303 Heat Sink |
| Q303 | 6633B | 06633-60009 | 1 | Assembly, Transistor/Heat Sink |
| | | 1854-0920 | 1 | ref Q303 Transistor, NPN |
| | | 1205-0571 | 1 | ref Q303 Heat Sink |
| Q303 | 6634B | 06634-60009 | 1 | Transistor/HS Assembly |
| | | 1205-0571 | 1 | ref Q303 Heat Sink |
| | | 1854-0838 | 1 | ref Q303 Transistor, NPN |
| Q304 | 66332A/6632B | 06612-60009 | 1 | Transistor Driver Assembly |
| | | 1205-0350 | 1 | ref Q304 Heat Sink |
| | | 1853-0497 | 1 | ref Q304 Transistor, PNP |
| Q304 | 6633B | 5063-3451 | 1 | Assembly, Transistor/Heat Sink |
| | | 1853-0652 | 1 | ref Q304 Transistor PNP Q304 |
| | | 1205-0571 | 1 | ref Q304 Heat Sink |
| Q304 | 6634B | 5063-3451 | 1 | Transistor/HS Assembly |
| | | 1853-0652 | 1 | ref Q304 Transistor PNP Q304 |
| | | 1205-0571 | 1 | ref Q304 Heat Sink |
| Q305 | All | 1858-0054 | 1 | Transistor Array |
| Q306 | All | 1853-0336 | 1 | Transistor, PNP |
| Q307 | All | 1853-0086 | 1 | Transistor, PNP |
| Q308 | 66332A/6632B | 1854-1174 | 1 | Transistor, NPN |
| Q308 | 6633B/6634B | 1854-1362 | 1 | Transistor, NPN |
| Q309 | 66332A/6632B | 1854-1174 | 1 | Transistor, NPN |
| Q309 | 6633B/6634B | 1854-1362 | 1 | Transistor, NPN |
| Q310 | 66332A/6632B | 1853-0656 | 1 | Transistor, PNP |
| Q310 | 6633B/6634B | 1853-0772 | 1 | Transistor, PNP |
| Q311 | 66332A/6632B | 1853-0656 | 1 | Transistor, PNP |
| Q311 | 6633B/6634B | 1853-0772 | 1 | Transistor, PNP |
| Q312 | 66332A/6632B | 1854-1174 | 1 | Transistor, NPN |
| Q313 | All | 06612-60006 | 1 | FET Assembly |
| | All | 1855-0831 | 1 | ref Q313 MOSFET N-Chan |
| | All | 1205-0350 | 1 | ref Q313 Heat Sink |
| Q314 | All | 06612-60005 | 1 | FET/Diode Assembly |
| | All | 0590-0199 | 1 | ref Q314 Hex Nut w/ Lockwasher |
| | All | 1855-0726 | 1 | ref Q314 MOSFET P-Chan |
| | All | 1205-0350 | 1 | ref Q314 Heat Sink |
| | All | 0340-0950 | 1 | ref Q314 Insulator |
| | All | 2200-0143 | 1 | ref Q314 Mach Screw 4-40 |
| | All | 1901-0987 | 1 | ref Q314 Diode (D499) |

| Designator | Model | Part Number | Qty | Description |
|------------|--------------------|-------------|-----|-----------------------|
| Q315 | 66332A/6632B | 1854-1174 | 1 | Transistor, NPN |
| Q315 | 6633B/6634B | 1854-1362 | 1 | Transistor, NPN |
| Q316 | All | 1855-1016 | 1 | Transistor, FET |
| Q317 | 66332A/6632B | 1853-0656 | 1 | Transistor, PNP |
| Q317 | 6633B/6634B | 1853-0772 | 1 | Transistor, PNP |
| Q318 | All | 1858-0074 | 1 | Transistor Array |
| Q319 | 66332A/6632B | 1853-0656 | 1 | Transistor, PNP |
| R300 | 66332A/6632B/6633B | 0698-3642 | 1 | Res 3K 5% 2W MO |
| R300 | 6634B | 0764-0046 | 1 | Res 33K 5% 2W MO |
| R301 | 66332A/6632B | 0757-0403 | 1 | Res 121 Ohm 1% 0.125W |
| R301 | 6633B | 0757-0416 | 1 | Res 511 1% 0.125W |
| R301 | 6634B | 0757-0283 | 1 | Res 2k 1% 0.125W |
| R302 | 66332A/6632B | 0757-0403 | 1 | Res 121 Ohm 1% 0.125W |
| R302 | 6633B | 0757-0416 | 1 | Res 511 1% 0.125W |
| R302 | 6634B | 0757-0283 | 1 | Res 2k 1% 0.125W |
| R303 | All | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R304 | All | 0698-3279 | 1 | Res 4.99K 1% |
| R305 | All | 0698-4202 | 1 | Res 8.87K 1% |
| R306 | All | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R307 - 309 | All | 0757-0442 | 3 | Res 10K 1% 0.125W |
| R310 | All | 0698-3156 | 1 | Res 14.7K 1% |
| R311 | All | 0686-2225 | 1 | Res 2.2K 5% 0.5W |
| R312 | All | 0698-0092 | 1 | Res 2.61K 1% |
| R313 | 66332A/6632B | 0683-0475 | 1 | Res 4.7 Ohm 5% 0.25W |
| R313 | 6633B/6634B | 0757-0346 | 1 | Res 10 1% |
| R314 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R315 | All | 8159-0005 | 1 | Jumper |
| R316 | All | 0757-0401 | 1 | Res 100 Ohm 1% 0.125W |
| R317, 318 | All | 8159-0005 | 2 | Jumper |
| R319 | 66332A/6632B | 0698-3444 | 1 | Res 316 Ohm 1% 0.125W |
| R319 | 6633B | 0757-0416 | 1 | Res 511 1% |
| R319 | 6634B | 0757-0420 | 1 | Res 750 1% |
| R320 | 66332A/6632B | 0757-0427 | 1 | Res 1.5K 1% 0.125W |
| R320 | 6633B | 0698-0085 | 1 | Res 2.61k 1% |
| R320 | 6634B | 0757-0280 | 1 | Res 1k 1% |
| R321 | 66332A/6632B | 0698-4509 | 1 | Res 80.6K 1% |
| R321 | 6633B | 0698-3454 | 1 | Res 215k 1% |
| R321 | 6634B | 0698-4536 | 1 | Res 340k 1% |
| R322 | All | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R323 | 66332A/6632B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R323 | 6633B | 0757-0438 | 1 | Res 5.11K 1% |
| R323 | 6634B | 0698-3156 | 1 | Res 14.7K 1% |
| R324 | 66332A/6632B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R324 | 6633B/6634B | 0757-0438 | 1 | Res 5.11K 1% |
| R325 | 66332A/6632B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R325 | 6633B | 0698-3156 | 1 | Res 14.7K 1% |
| R325 | 6634B | 0757-0438 | 1 | Res 5.11K 1% |

5 - Replaceable Parts

| Designator | Model | Part Number | Qty | Description |
|------------|--------------------|-------------|-----|-----------------------|
| R326 | 66332A/6632B | 0757-0200 | 1 | Res 5.62K 1% |
| R326 | 6633B/6634B | 0698-3159 | 1 | Res 26.1K 1% |
| R327 | All | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R328 | 66332A/6632B | 0683-0475 | 1 | Res 20K 1% 0.125W |
| R328 | 6633B/6634B | 0757-0346 | 1 | Res 10 1% |
| R329 | 66332A/6632B | 0757-0449 | 1 | Res 4.7 Ohm 5% 0.25W |
| R329 | 6633B | 0757-0453 | 1 | Res 30.1K 1% |
| R329 | 6634B | 0757-0458 | 1 | Res 51.1K 1% |
| R330 | 66332A/6632B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R330 | 6633B/6634B | 0698-3156 | 1 | Res 14.7K 1% |
| R331 | All | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R332 | All | 0757-0199 | 1 | Res 21.5K 1% |
| R333 | 66332A/6632B | 0757-0438 | 1 | Res 5.11K 1% |
| R333 | 6633B/6634B | 0757-0441 | 1 | Res 8.25K 1% |
| R334 | 66332A/6632B | 8159-0005 | 1 | Jumper |
| R335 | All | 0757-0438 | 1 | Res 5.11K 1% |
| R336 | All | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R337 | 66332A/6632B/6633B | 0698-3444 | 1 | Res 316 Ohm 1% 0.125W |
| R337 | 6634B | 0757-0420 | 1 | Res 750 1% 0.125W |
| R339 | 66332A/6632B | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R339 | 6633B | 0757-0458 | 1 | Res 51.1k 1% 0.125W |
| R339 | 6634B | 0698-3454 | 1 | Res 215K 1% 0.125W |
| R340 | 66332A/6632B | 0757-0407 | 1 | Res 200 Ohm 1% 0.125W |
| R340 | 6633B | 0757-0414 | 1 | Res 432 1% 0.125W |
| R340 | 6634B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R341 | 66332A/6632B | 0698-3441 | 1 | Res 215 Ohm 1% |
| R341 | 6633B | 0757-0414 | 1 | Res 432 1% 0.125W |
| R341 | 6634B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R342 | 66332A/6632B | 0698-4509 | 1 | Res 80.6K 1% |
| R342 | 6633B | 0698-3456 | 1 | Res 287K 1% 0.125W |
| R342 | 6634B | 0698-3260 | 1 | Res 464K 1% 0.125W |
| R343 | 66332A/6632B | 0698-3441 | 1 | Res 215 Ohm 1% |
| R343 | 6633B | 0757-0414 | 1 | Res 432 1% 0.125W |
| R343 | 6634B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R344 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R345 | All | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R346 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R347 | All | 0757-0458 | 1 | Res 51.1K 1% |
| R348 | 66332A/6632B | 0698-3444 | 1 | Res 316 Ohm 1% 0.125W |
| R348 | 6633B | 0698-4187 | 1 | Res 632 1% |
| R348 | 6634B | 0757-0427 | 1 | Res 1.5K 1% |
| R349 | 66332A/6632B | 0698-3159 | 1 | Res 26.1K 1% |
| R349 | 6633B | 0698-4509 | 1 | Res 80.6K 1% |
| R349 | 6634B | 0757-0468 | 1 | Res 130K 1% |
| R350 | 66332A/6632B | 0757-0279 | 1 | Res 3.16K 1% |
| R350 | 6633B | 0757-0435 | 1 | Res 3.92K 1% |
| R350 | 6634B | 0757-0279 | 1 | Res 3.16K 1% |

| Designator | Model | Part Number | Qty | Description |
|------------|--------------|-------------|-----|-----------------------|
| R351 | 66332A/6632B | 0698-6320 | 1 | Res 5K 0.1% |
| R351 | 6633B | 0698-5087 | 1 | Res 6.2K 1% |
| R351 | 6634B | 0698-6320 | 1 | Res 5K 1% |
| R352 | 66332A/6632B | 8159-0005 | 1 | Jumper |
| R353 | All | 0698-8959 | 1 | Res 619K 1% |
| R354 | 66332A/6632B | 0757-0447 | 1 | Res 16.2K 1% |
| R354 | 6633B | 0757-0458 | 1 | Res 51.1K 1% |
| R354 | 6634B | 0698-4509 | 1 | Res 80.6K 1% |
| R355 | All | 0698-0084 | 1 | Res 2.15K 1% |
| R356 | 66332A/6632B | 0757-0472 | 1 | Res 200K 1% |
| R356 | 6633B | 0757-0270 | 1 | Res 249K 1% |
| R356 | 6634B | 0757-0472 | 1 | Res 200K 1% |
| R357 | 66332A/6632B | 0699-2246 | 1 | Res 25K 0.05% |
| R357 | 6633B/6634B | 0699-1510 | 1 | Res 22.22K 0.05% |
| R358 | All | | | Not loaded |
| R359 | 66332A/6632B | 8159-0005 | 1 | Jumper |
| R360, 361 | All | 0699-2246 | 2 | Res 25K 0.05% |
| R362 | 66332A/6632B | 0698-8807 | 1 | Res 39K 0.1% |
| R362 | 6633B/6634B | 0699-1513 | 1 | Res 40K 0.05% |
| R363 | All | 0757-0473 | 1 | Res 221K 1% |
| R364 | 66332A/6632B | 0699-2246 | 1 | Res 25K 0.05% |
| R364 | 6633B/6634B | 0699-1510 | 1 | Res 22.22K 0.05% |
| R365, 366 | All | 0698-6392 | 2 | Res 22K 0.1% 0.125W |
| R367 | All | 0757-0436 | 1 | Res 4.32K 1% |
| R370 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R371 | 66332A/6632B | 0699-0934 | 1 | Res 35.65K 0.1% |
| R371 | 6633B/6634B | 0699-2246 | 1 | Res 25K 0.05% |
| R372 | 66332A/6632B | 0699-0236 | 1 | Res 2.5K 0.1% 0.1W |
| R372 | 6633B/6634B | 0699-1867 | 1 | Res 3.2K 0.1% 0.1W |
| R373 | 66332A/6632B | 0757-0401 | 1 | Res 100 Ohm 1% 0.125W |
| R374 | All | 0757-0458 | 1 | Res 51.1K 1% |
| R375 | All | | | Not loaded |
| R376 | 66332A/6632B | 0699-0934 | 1 | Res 35.65K 0.1% |
| R376 | 6633B/6634B | 0699-2246 | 1 | Res 25K 0.05% |
| R377 | 66332A/6632B | 0698-8807 | 1 | Res 39K 0.1% |
| R377 | 6633B/6634B | 0699-1513 | 1 | Res 40K 0.05% |
| R378 | 66332A/6632B | 0698-3634 | 1 | Res 470 Ohm 5% 2W |
| R378 | 6633B/6634B | 0698-3642 | 1 | Res 3K 5% 2W MO |
| R379 | All | 0757-0436 | 1 | Res 4.32K 1% |
| R380 | All | 0757-0401 | 1 | Res 100 Ohm 1% 0.125W |
| R381 | All | 0698-8959 | 1 | Res 619K 1% 0.125W |
| R382 | All | 0757-0401 | 1 | Res 100 Ohm 1% 0.125W |
| R383 | All | 0698-3460 | 1 | Res 422K 1% |
| R384 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R384 | 6633B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R385 | 66332A/6632B | 0699-0236 | 1 | Res 2.5K 0.1% 0.1W |
| R385 | 6633B/6634B | 0699-1867 | 1 | Res 3.2K 1% 0.125W |

5 - Replaceable Parts

| Designator | Model | Part Number | Qty | Description |
|------------|--------------------|-------------|-----|-----------------------|
| R386 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R386 | 6633B/6634B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R387 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R387 | 6633B/6634B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R388 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R389 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R389 | 6633B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R390, 391 | All | 0698-8834 | 2 | Res 9K 0.1% 0.125W |
| R392 | 66332A/6632B | 0698-6320 | 1 | Res 5K 0.1% |
| R392 | 6633B/6634B | 0698-6348 | 1 | Res 3K 0.1% 0.125W |
| R393 | 66332A/6632B/6633B | 0698-6360 | 1 | Res 10K 0.1% |
| R393 | 6634B | 0698-8865 | 1 | Res 4.45K 0.1% 0.1W |
| R394 | 66332A/6632B | 0698-6358 | 1 | Res 100K 0.1% |
| R394 | 6633B | 0698-6376 | 1 | Res 200K 0.1% 0.1W |
| R394 | 6634B | 0698-7841 | 1 | Res 164K 0.1% 0.1W |
| R395, 396 | All | 0699-1866 | 2 | Res 2.7K 0.1% |
| R397 | 6634B | 0698-3642 | 1 | Res 3K 2W |
| R398 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R399 | All | 0698-6533 | 1 | Res 12.5K 0.1% |
| R400, 401 | All | 0757-0442 | 2 | Res 10K 1% 0.125W |
| R402 | All | 0757-0438 | 1 | Res 5.11K 1% |
| R403 | All | 0699-4484 | 1 | Res 72 Ohm |
| R404 | 66332A/6632B | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R405 | All | 0698-8827 | 1 | Res 1M 1% 0.125W |
| R406 | All | 0698-3456 | 1 | Res 287K 1% |
| R407 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R407 | 6633B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R408 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R408 | 6633B/6634B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R409 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R409 | 6633B/6634B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R410 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R410 | 6633B | 0811-2553 | 1 | Res 7.5 5% 2W PW |
| R411 | 66332A/6632B/6633B | 8159-0005 | 1 | Jumper |
| R412 | 66332A/6632B/6633B | 0698-3454 | 1 | Res 215K 1% |
| R412 | 6634B | 0698-3459 | 1 | Res 383K 1% |
| R413 | 66332A/6632B | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R414 | All | 0699-0088 | 1 | Res 1.2M 1% |
| R415 | 66332A/6632B | 0698-6392 | 1 | Res 22K 0.1% 0.125W |
| R415 | 6633B/6634B | 0699-1510 | 1 | Res 22.22K 0.1%.125W |
| R416 | All | 0686-7515 | 1 | Res 750 Ohm 5% 0.5W |
| R417 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R418 | 66332A/6632B | 0757-0458 | 1 | Res 51.1K 1% |
| R418 | 6633B | 0698-3201 | 1 | Res 80K 1% |
| R418 | 6634B | 0698-5092 | 1 | Res 160K 1% |
| R419 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R420 | All | 0699-1972 | 1 | Res 1.74M 0.1% 0.125W |

| Designator | Model | Part Number | Qty | Description |
|------------|--------------------|-------------|-----|-----------------------|
| R421 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R421 | 6633B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R422 | 66332A/6632B | 0698-6351 | 1 | Res 133K 0.1% |
| R423 | 66332A/6632B/6633B | 0699-0267 | 1 | Res 10K 0.05% |
| R423 | 6634B | 0699-0278 | 1 | Res 15K 0.05% 0.1W |
| R425 | 66332A/6632B | 0698-4539 | 1 | Res 402K 1% |
| R427 | 66332A/6632B | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R427 | 6633B/6634B | 8159-0005 | 1 | Jumper |
| R428 | 6634B | 0698-3642 | 1 | Res 3K |
| R429 | 66332A/6632B/6633B | 0699-0267 | 1 | Res 10K 0.05% |
| R429 | 6634B | 0699-0278 | 1 | Res 15K 0.05% 0.1W |
| R430 | 66332A/6632B | 0757-0272 | 1 | Res 52.3K 1% |
| R431 | All | 0757-0438 | 1 | Res 5.11K 1% |
| R432 | 66332A/6632B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R432 | 6633B | 0698-0084 | 1 | Res 2.15K 1% |
| R432 | 6634B | 0757-0438 | 1 | Res 5.11K 1% |
| R433 | 66332A/6632B | 0698-4099 | 1 | Res 139 Ohm 1% 0.125W |
| R434 | 66332A/6632B | 8159-0005 | 1 | Jumper |
| R435 | All | 8159-0005 | 1 | Jumper |
| R436, 437 | 66332A/6632B | 0811-1672 | 2 | Res 3.3 Ohm 5% 2W |
| R438 | All | 8159-0005 | 1 | Jumper |
| R439 | 66332A/6632B | 0698-6317 | 1 | Res 500 Ohm 0.1% |
| R440 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R440 | 6633B/6634B | 0811-2553 | 1 | Res 7.5 5% 2W PW |
| R441 | All | 0698-4486 | 1 | Res 24.9K 1% |
| R442 | 66332A/6632B | 0699-1513 | 1 | Res 40K 0.05% |
| R442 | 6633B | 0699-3416 | 1 | Res 100K 0.05% 0.1W |
| R442 | 6634B | 0699-3448 | 1 | Res 300K 0.05% 0.1W |
| R443 | 66332A/6632B | 0699-1513 | 1 | Res 40K 0.05% |
| R443 | 6633B | 0699-3416 | 1 | Res 100K 0.05% 0.1W |
| R443 | 6634B | 0699-3448 | 1 | Res 300K 0.05% 0.1W |
| R444 | All | 0757-0438 | 1 | Res 5.11K 1% |
| R445 | 66332A/6632B | 0811-0929 | 1 | Res 0.51 Ohm 5% 2W |
| R445 | 6633B | 0812-0019 | 1 | Res 0.33 5% 2W PW |
| R445 | 6634B | 0811-1220 | 1 | Res 1.5 5% 2W PW |
| R446 | 66332A/6632B | 0698-6631 | 1 | Res 2.5K 0.1% |
| R446 | 6633B | 0698-8863 | 1 | Res 5.2K 0.1% |
| R446 | 6634B | 0699-0489 | 1 | Res 16.1K 0.1% |
| R447 | 66332A/6632B | 0698-4123 | 1 | Res 499 Ohm 1% 0.125W |
| R448 | All | 8159-0005 | 1 | Jumper |
| R449 | 66332A/6632B | 8159-0005 | 1 | Jumper |
| R450 | 66332A/6632B | 0698-8812 | 1 | Res 1 Ohm 1% 0.125W |
| R451 | All | 8159-0005 | 1 | Jumper |
| R452 | 66332A/6632B | 0757-0280 | 1 | Res 1K 1% 0.125W |
| R452 | 6633B | 0698-0084 | 1 | Res 2.15K 1% |
| R452 | 6634B | 0757-0438 | 1 | Res 5.11K 1% |
| R453 | 66332A/6632B | 0698-6360 | 1 | Res 10K 0.1% |
| R454 | All | 8159-0005 | 1 | Jumper |

5 - Replaceable Parts

| Designator | Model | Part Number | Qty | Description |
|------------|--------------------|-------------|-----|------------------------|
| R455 | 66332A/6632B | 0698-6631 | 1 | Res 2.5K 0.1% |
| R455 | 6633B | 0698-8863 | 1 | Res 5.2K 0.1% |
| R455 | 6634B | 0699-0489 | 1 | Res 16.1K 0.1% |
| R456 | All | 8159-0005 | 1 | Jumper |
| R457 | 66332A/6632B | 8159-0005 | 1 | Jumper |
| R458 | All | 8159-0005 | 1 | Jumper |
| R459 | 66332A/6632B | 8159-0005 | 1 | Jumper |
| R460 | All | 0698-6620 | 1 | Res 150K 0.1% |
| R461 | All | 0757-0395 | 1 | Res 56.2 Ohm 1% |
| R462 | 66332A/6632B/6633B | 0757-0416 | 1 | Res 511 Ohm 1% 0.125W |
| R462 | 6634B | 0757-0394 | 1 | Res 51.1 Ohm 1% 0.125W |
| R463 | 6634B | 0698-3642 | 1 | Res 3K 2W |
| R464, 465 | All | 0698-0084 | 2 | Res 2.15K 1% |
| R466 | 66332A/6632B | 0698-8812 | 1 | Res 1 Ohm 1% 0.125W |
| R466 | 6633B | 0683-0475 | 1 | Res 4.7 Ohm |
| R466 | 6634B | 0757-0379 | 1 | Res 12.1 Ohm |
| R467, 468 | 66332A/6632B | 0811-1672 | 2 | Res 3.3 Ohm 5% 2W |
| R469 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R469 | 6633B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R470 | 66332A/6632B | 0811-1672 | 1 | Res 3.3 Ohm 5% 2W |
| R470 | 6633B/6634B | 0811-2553 | 1 | Res 7.5 Ohm 5% 2W PW |
| R471 | 66332A/6632B | 0699-1797 | 1 | Res 10M 5% 0.25W |
| R471 | 6633B/6634B | 0683-1065 | 1 | Res 10M |
| R472 | All | 0757-0442 | 1 | Res 10K 1% 0.125W |
| R473 | 66332A/6632B | 0811-3770 | 1 | Res 0.05 Ohm 1% |
| R473 | 6633B | 0811-3771 | 1 | Res 0.25 Ohm 1% |
| R473 | 6634B | 0811-3772 | 1 | Res 0.5 Ohm 1% |
| R474 | All | 8159-0005 | 1 | Jumper |
| R476 | All | 0757-0281 | 1 | Res 2.74K 1% |
| R477 | All | 0757-0199 | 1 | Res 21.5K 1% |
| R478, 479 | All | 0698-4444 | 2 | Res 4.87K 1% |
| R480, 481 | All | 0757-0269 | 2 | Res 270 Ohm 1% 0.125W |
| R482 | All | 0698-3226 | 1 | Res 6.49K 1% |
| R483 | All | 0698-5089 | 1 | Res 33K 1% 0.125W |
| R488 | 66332A/6632B | 0698-3922 | 1 | Res 487K 0.1% |
| R488 | 6633B | 0699-1744 | 1 | Res 280K 0.1% |
| R488 | 6634B | 0699-0070 | 1 | Res 3.16M 1% |
| R489 | 66332A/6632B | 0698-3922 | 1 | Res 487K 0.1% |
| R489 | 6633B | 0698-6950 | 1 | Res 1.25M 0.1% 0.5W |
| R489 | 6634B | 0699-0070 | 1 | Res 3.16M 1% |
| R490 | 66332A/6632B | 0699-0730 | 1 | Res 1M 0.1% |
| R490 | 6633B | 0699-0070 | 1 | Res 3.16M 1% |
| R490 | 6634B | 0683-6855 | 1 | Res 6.8M 5% |
| R493 | All | 0757-0438 | 1 | Res 5.11K 1% |
| R494, 495 | All | 0698-8812 | 2 | Res 1 Ohm 1% 0.125W |
| R496 | 66332A/6632B | 0757-0289 | 1 | Res 13.3K 1% |
| R496 | 6633B/6634B | 0757-0433 | 1 | Res 3.32K 0.125W |

Replaceable Parts - 5

| Designator | Model | Part Number | Qty | Description |
|-------------------|--------------|--------------------|------------|---|
| R497 | 66332A/6632B | 0757-0289 | 1 | Res 13.3K 1% |
| R497 | 6633B/6634B | 0757-0433 | 1 | Res 3.32K 0.125W |
| R498 - 500 | All | 0757-0407 | 2 | Res 200 Ohm 1% 0.125W |
| R505 | 6633B | Not Used | 1 | |
| R510 - 517 | 66332A/6632B | 0811-1672 | 8 | Res 3.3 Ohm 5% 2W |
| R520 | 6633B/6634B | Not Used | 1 | |
| R521 | All | Not Used | 1 | Replaced by wire in 6633B/6634B units |
| R522 | All | Not Used | 1 | |
| RT301 | All | 0837-0397 | 1 | Thermistor |
| S300 | All | 3101-2927 | 1 | Switch, Right Angle Slide |
| T300 | 66332A/6632B | 9100-4350 | 1 | Current Transformer |
| T300 | 6633B/6634B | 8159-0005 | 1 | Jumper |
| U300 | All | 5060-3229 | 1 | -15V Regulator Assembly |
| | All | 1826-0214 | 1 | ref U300 Integrated Circuit |
| | All | 1205-0282 | 1 | ref U300 Heat Sink |
| U301 | All | 5063-2389 | 1 | +5V Regulator Assembly (Interface Bias) |
| | All | 1826-1597 | 1 | ref U301 Integrated Circuit |
| | All | 1205-0402 | 1 | ref U301 Heat Sink |
| U302 | All | 5060-2948 | 1 | +5V Regulator Assembly (Secondary Bias) |
| | All | 1205-0282 | 1 | ref U302 Heat Sink |
| | All | 1826-0122 | 1 | ref U302 Integrated Circuit |
| U303 | All | 1826-1533 | 1 | Integrated Circuit |
| U304 | All | 5060-3232 | 1 | +15V Regulator Assembly |
| | All | 1826-0106 | 1 | ref U304 Integrated Circuit |
| | All | 1205-0282 | 1 | ref U304 Heat Sink |
| U305 | All | 1826-0346 | 1 | Integrated Circuit |
| U306 | All | 1826-1370 | 1 | Integrated Circuit |
| U308 | All | 1826-1534 | 1 | Integrated Circuit |
| U309 | All | 1826-3521 | 1 | Integrated Circuit |
| U310 | All | 1826-2252 | 1 | Integrated Circuit |
| U311 | All | 1826-3521 | 1 | Integrated Circuit |
| U313 | All | 1826-1878 | 1 | Integrated Circuit |
| U314 | 66332A/6632B | 1826-3521 | 1 | Integrated Circuit |
| U315 | All | 1826-1878 | 1 | Integrated Circuit |
| U400 | All | 1826-0643 | 1 | Integrated Circuit |
| VR300 | All | 1902-0955 | 1 | Integrated Circuit |
| VR301 | All | 1902-0957 | 1 | Zener Diode 9.1V 5% |
| VR302 | 6634B | 1902-3092 | 1 | Zener Diode 4.99V 5% |
| VR303 | 66332A/6632B | 1902-0953 | 1 | Zener Diode 6.2V 5% |
| VR303 | 6633B/6634B | 1902-0958 | 1 | Zener Diode 10V 5% |
| VR304 | 66332A/6632B | 1902-0943 | 1 | Zener Diode 2.4V 5% |
| VR304 | 6633B/6634B | 1902-0947 | 1 | Zener Diode 3.6V 5% |
| VR305 | 66332A/6632B | 1902-0943 | 1 | Zener Diode 2.4V 5% |
| VR305 | 6633B/6634B | 1902-0947 | 1 | Zener Diode 3.6V 5% |
| VR335 | 66332A/6632B | 1902-0953 | 1 | Zener Diode 6.2V 5% |
| VR335 | 6633B/6634B | 1902-0957 | 1 | Zener Diode 9.1V 5% |
| W300, 301 | All | 8159-0005 | 2 | Jumper |

5 - Replaceable Parts

| | | |
|---|------------------|----------------------------------|
| A2 Interface PCA, Tested for 66332A | 5063-3439 | No user replaceable parts |
| A2 Interface PCA, Tested for 6632B/6633B/6634B | 5063-3429 | No user replaceable parts |
| A3 Front Panel PCA Tested for all models | 5063-3432 | No user replaceable parts |

Table 5-4. Binding Post Option #020

| Designator | Model | Part Number | Qty | Description |
|-------------------|--------------|--------------------|------------|----------------------------|
| A4 | 6633B/6634B | 5063-3406 | 1 | Binding Post PCA |
| A4 | 66332A/6632B | 06611-60022 | 1 | Binding Post PCA |
| C603, 604 | All | 0160-8153 | 2 | Cap 4700 pF |
| J615 | All | 1252-0056 | 1 | 4 Pin Connector |
| MP5 | All | 1510-0091 | 2 | Binding Post, Single, Red |
| MP26 | All | 0590-0305 | 2 | Nut, Hex 6-32 w/Lockwasher |
| MP25 | All | 2950-0144 | 2 | Nut, Hex 3/8-32 Nylon |
| MP24 | All | 06612-00004 | 1 | Binding Post Plate |
| W15 | All | 06612-80010 | 1 | Cable (A1 J314 to A4 J615) |

Table 5-5. A5 AC input/RFI Board

| Designator | Model | Part Number | Qty | Description |
|-------------------|--------------|--------------------|------------|--|
| A5 | All | 5063-3433 | 1 | AC Input/RFI PCA |
| C500 | All | 0160-4259 | 1 | Cap 0.22 uF 10% |
| C501, 502 | All | 0160-8181 | 2 | Cap 0.0022 uF |
| F500 | All | 2110-0055 | 1 | Fuse 4AM, 250V (100Vac and 120Vac input) |
| F500 | All | 2110-0002 | 1 | Fuse 2AM, 250V (220Vac and 230Vac input) |
| J508 | All | 1252-3771 | 1 | AC Line Module |
| XF500 | All | 2110-0927 | 1 | Fuseholder, with cap |

Table 5-6. Relay Option #760

| Designator | Model | Part Number | Qty | Description |
|-------------------|--------------|--------------------|------------|----------------------------|
| A6 | All | 5063-3434 | 1 | Relay PCA, Tested |
| C600 | All | 0160-5422 | 1 | Cap 0.047 uF 20% |
| C601, 602 | All | 0150-0081 | 2 | Cap 0.01 uF |
| F601, 602 | All | 2110-0671 | 2 | Fuse 0.125AM, 125V |
| J610 | All | 1252-7643 | 1 | Connector |
| K601 - 603 | All | 0490-1405 | 3 | Relay, 2C 12VDC |
| K604, 605 | All | 0490-1670 | 2 | Power Relay |
| R601, 602 | All | 0686-2215 | 2 | Res 220 Ohm 5% 0.5W |
| R603 | All | 0698-3439 | 1 | Res 178 Ohm 1% 0.125W |
| R604 | All | 0757-0284 | 1 | Res 150 Ohm 1% 0.125W |
| R605 | All | 0698-3439 | 1 | Res 178 Ohm 1% 0.125W |
| R606 | All | 0757-0284 | 1 | Res 150 Ohm 1% 0.125W |
| R607 | All | 0698-3439 | 1 | Res 178 Ohm 1% 0.125W |
| U601 | All | 1858-0047 | 1 | Transistor Array |
| W10 | All | 5080-2457 | 1 | Cable (A2 J210 to A6 J610) |

Diagrams

Introduction

This chapter contains drawings and diagrams for troubleshooting and maintaining the Agilent Model 66332A Dynamic Measurement DC Source and the Agilent Model 66332A/6632B/6633B/6634B System DC Power Supplies. Unless otherwise specified in the drawings, a drawing or diagram applies to all models and input voltage options.

General Schematic Notes

- Components marked with an asterisk are model dependent (See Table 6-1).
- All resistors are in ohms 1%, 1/8 W, unless otherwise specified.
- All resistors are in ohms 1%, 1/8 W, unless otherwise specified.
- All capacitors are in microfarads unless otherwise specified.
- Unless otherwise noted, bias connections to integrated-circuit packages are as follows:

| | <u>Common</u> | <u>5 V</u> |
|-----------------|---------------|------------|
| 14-pin packages | pin 7 | pin 14 |
| 16-pin packages | pin 8 | pin 16 |
| 20-pin packages | pin 10 | pin 20 |

Table 6-1. Model-dependent Components

| Designator | 66332A/ 6632B | 6633B | 6634B | Designator | 66332A/ 6632B | 6633B | 6634B |
|----------------|------------------|----------|----------|----------------|------------------|----------|-----------|
| C300, 304, 307 | 0.047 uF | | | C411 | | 2.2 uF | 2.2 uF |
| C302 | 18000 uF | 2200 uF | 1200 uF | C420, 421 | | 0.022 uF | 0.022 uF |
| C313 | 33,000 uF | 18000 uF | 8200 uF | C422, 424, 425 | | 1000 pF | 220 pF |
| C314-316 | 0.047 uF | | | C423 | | 0.047 uF | 0.0047 uF |
| C331, 332 | 2200 pF | | | C425 | | 1000 pF | 1000 pF |
| C333 | 0.033 uF | | | C426 | | | 0.1 uF |
| C335 | 3300 pF | 3300 pF | 0.047 pF | C427 | | | 4700 pF |
| C340 | | | 0.01 uF | C428-430 | | 0.047 uF | 0.047 uF |
| C344, 346 | 0.047 uF | 0.022 uF | 0.022 uF | C431, 432 | | 0.22 uF | |
| C349, 352 | 10 pF | 0.033 uF | 0.033 uF | C482 | | 0.022 uF | 0.022 uF |
| C359 | 10 pF | 22 pF | 22 pF | C499 | 6.8 uF | | |
| C360 | 10 pF | 15 pF | 10 pF | D319, 320, 321 | | Diode | Diode |
| C361 | 33 pF | | | D330 | Diode | Diode | |
| C362 | 180 pF | 220 pF | 120 pF | D400 | | | Diode |
| C372, 373 | 0.047 uF | | | D499 | Diode | Diode | |
| C375 | | | 0.047 uF | F400, 406 | 0 Ohm | | |
| C376, 377 | 0.047 uF | 0.022 uF | 6800 pF | L300, 301 | 22 uH | | |
| C378 | 0.047 uF | | | Q312, 319 | Transistor | | |
| C382 | 100 uF | 50 uF | 22 uF | R300 | 3K | 12K | 33K |
| C383 | 1 uF | | | R301, 302 | 121 Ohm | 511 Ohm | 2k |
| C403 | 10 pF | | | R313 | 4.7 Ohm | 10 Ohm | 10 Ohm |

6 - Diagrams

Table 6-1. Model-dependent Components (continued)

| Designator | 66332A/ 6632B | 6633B | 6634B | Designator | 66332A/ 6632B | 6633B | 6634B |
|------------|------------------|---------|---------|------------|------------------|----------|----------|
| R319 | 316 Ohm | 511 Ohm | 750 Ohm | R413 | 10K | | |
| R320 | 1.5K | 2.61k | 1k | R415 | 22K | 22.22K | 22.22K |
| R321 | 80.6K | 215k | 340k | R418 | 51.1K | 80K | 160K |
| R323 | 1K | 5.11K | 14.7K | R421 | 3.3 Ohm | 7.5 Ohm | |
| R324 | 1K | 5.11K | 5.11K | R422 | 133K | | |
| R325 | 1K | 14.7K | 5.11K | R423, 429 | 10K | 10K | 15K |
| R326 | 5.62K | 26.1K | 26.1K | R425 | 402K | | |
| R328 | 20K | 10 Ohm | 10 Ohm | R427 | 10K | 0 Ohm | 0 Ohm |
| R329 | 4.7 Ohm | 30.1K | 51.1K | R428 | | | 3K |
| R330 | 1K | 14.7K | 14.7K | R430 | 52.3K | | |
| R333 | 5.11K | 8.25K | 8.25K | R432 | 1K | 2.15K | 5.11K |
| R334 | 0 Ohm | | | R433 | 139 Ohm | | |
| R337 | 316 Ohm | 316 Ohm | 750 Ohm | R434 | 0 Ohms | | |
| R339 | 10K | 51.1k | 215K | R436, 437 | 0 Ohms | | |
| R340 | 200 Ohm | 432 Ohm | 1K | R439 | 500 Ohm | | |
| R341, 343 | 215 Ohm | 432 Ohm | 1K | R440 | 3.3 Ohm | 7.5 Ohm | 7.5 Ohm |
| R342 | 80.6K | 287K | 464K | R442, 443 | 40K | 100K | 300K |
| R348 | 316 Ohm | 632 Ohm | 1.5K | R445 | 0.51 Ohm | 0.33 | 1.5 |
| R349 | 26.1K | 80.6K | 130K | R446 | 2.5K | 5.2K | 16.1K |
| R350 | 3.16K | 3.92K | 3.16K | R447 | 499 Ohm | | |
| R351 | 5K | 6.2K | 5K | R449 | 0 Ohm | | |
| R352 | 0 Ohm | | | R450 | 1 Ohm | | |
| R354 | 16.2K | 51.1K | 80.6K | R452 | 1K | 2.15K | 5.11K |
| R356 | 200K | 249K | 200K | R453 | 10K | | |
| R357 | 25K | 22.22K | 22.22K | R455 | 2.5K | 5.2K | 16.1K |
| R359 | 0 Ohm | | | R457, 459 | 0 Ohm | | |
| R362 | 39K | 40K | 40K | R462 | 511 Ohm | 511 Ohm | 51.1 Ohm |
| R364 | 25K | 22.22K | 22.22K | R463 | | | 3K |
| R371 | 35.65K | 25K | 25K | R466 | 1 Ohm | 4.7 Ohm | 12.1 Ohm |
| R372 | 2.5K | 3.2K | 3.2K | R467, 468 | 0 Ohm | | |
| R373 | 100 Ohm | | | R469 | | 7.5 Ohm | |
| R376 | 35.65K | 25K | 25K | R470 | | 7.5 Ohm | 7.5 Ohm |
| R377 | 39K | 40K | 40K | R473 | 0.05 Ohm | 0.25 Ohm | 0.5 Ohm |
| R378 | 470 Ohm | 3K | 3K | R488 | 487K | 280K | 3.16M |
| R384, 389 | 3.3 Ohm | 7.5 Ohm | | R489 | 487K | 1.25M | 3.16M |
| R385 | 2.5K | 3.2K | 3.2K | R490 | 1M | 3.16M | 6.8M |
| R386, 387 | 3.3 Ohm | 7.5 Ohm | 7.5 Ohm | R496, 497 | 13.3K | 3.32K | 3.32K |
| R392 | 5K | 3K | 3K | R505 | 1.25M | | |
| R393 | 10K | 10K | 4.45K | R513, 515 | 0 Ohm | | |
| R394 | 100K | 200K | 164K | R520 | | 0 Ohm | 0 Ohm |
| R397 | | | 3K | T300 | Xfmr | | |
| R404 | 10K | | | U314 | IC | | |
| R407, 410 | 3.3 Ohm | 7.5 Ohm | | VR302 | | | 4.99V |
| R408, 409 | 3.3 Ohm | 7.5 Ohm | 7.5 Ohm | VR303 | 6.2V | 10V | 10V |
| R411 | 0 Ohm | 0 Ohm | | VR304, 305 | 2.4V | 3.6V | 3.6V |
| R412 | 215K | 215K | 383K | VR335 | 6.2V | 9.1V | 9.1V |

Table 6-2. A1 Board Component Locations

| Ref. | X | Y | Ref. | X | Y | Ref. | X | Y | Ref. | X | Y | Ref. | X | Y |
|------|-------|-------|-------|-------|-------|------|-------|-------|------|-------|-------|------|-------|-------|
| C300 | 8.125 | 3.25 | C371 | 5.05 | 7.65 | D323 | 1.025 | 4.9 | R301 | 5.45 | 1.0 | R366 | 1.3 | 3.925 |
| C301 | 2.075 | 0.525 | C372 | 1.875 | 7.9 | D324 | 0.1 | 4.375 | R302 | 6.275 | 0.1 | R367 | 0.675 | 4.225 |
| C302 | 7.5 | 1.925 | C373 | 1.875 | 7.8 | D325 | 0.15 | 7.125 | R303 | 7.925 | 2.8 | R368 | 1.125 | 5.0 |
| C304 | 6.025 | 0.45 | C374 | 0.3 | 8.325 | D326 | 0.775 | 8.525 | R304 | 5.85 | 2.1 | R370 | 3.65 | 5.875 |
| C307 | 5.45 | 0.45 | C375 | 3.575 | 8.4 | D327 | 1.0 | 8.025 | R305 | 4.85 | 2.075 | R371 | 2.075 | 5.8 |
| C308 | 4.05 | 3.45 | C376 | 1.2 | 9.875 | D328 | 1.0 | 7.825 | R306 | 5.3 | 1.975 | R372 | 2.375 | 6.25 |
| C309 | 8.025 | 2.8 | C377 | 0.525 | 9.85 | D329 | 0.425 | 8.425 | R307 | 0.7 | 2.7 | R373 | 3.175 | 9.275 |
| C311 | 4.775 | 0.975 | C378 | 1.775 | 10.42 | D330 | 4.2 | 8.7 | R308 | 1.15 | 2.8 | R374 | 0.1 | 5.325 |
| C312 | 4.875 | 1.425 | C379 | 0.525 | 10.17 | D331 | 5.15 | 0.8 | R309 | 1.6 | 3.0 | R375 | 0.675 | 4.125 |
| C314 | 3.5 | 4.925 | C380 | 4.675 | 6.975 | D332 | 4.575 | 0.8 | R310 | 1.7 | 3.5 | R376 | 1.975 | 5.8 |
| C315 | 3.825 | 4.7 | C381 | 0.925 | 10.4 | D333 | 5.775 | 0.8 | R311 | 3.45 | 2.3 | R377 | 0.55 | 4.475 |
| C316 | 3.625 | 3.175 | C382 | 3.0 | 10.45 | D334 | 6.25 | 0.8 | R312 | 1.4 | 1.75 | R378 | 8.025 | 8.55 |
| C317 | 1.15 | 2.5 | C383 | 3.8 | 10.25 | D336 | 4.65 | 6.4 | R313 | 4.025 | 4.25 | R379 | 0.1 | 4.125 |
| C318 | 0.95 | 1.35 | C384 | 0.3 | 9.35 | D337 | 4.825 | 6.25 | R314 | 0.6 | 3.1 | R380 | 1.75 | 6.25 |
| C319 | 3.525 | 1.475 | C386 | 2.45 | 6.875 | D400 | 3.375 | 7.7 | R315 | 3.05 | 2.0 | R381 | 0.55 | 5.625 |
| C320 | 4.8 | 2.25 | C403 | 1.775 | 8.475 | D470 | 3.3 | 6.525 | R316 | 4.825 | 7.025 | R382 | 1.75 | 5.875 |
| C321 | 3.975 | 1.925 | C405 | 0.525 | 9.975 | D471 | 3.65 | 6.175 | R317 | 2.85 | 2.0 | R383 | 1.125 | 5.425 |
| C322 | 5.4 | 2.2 | C411 | 2.825 | 8.3 | D499 | 3.65 | 6.825 | R318 | 2.95 | 2.0 | R384 | 6.8 | 5.45 |
| C323 | 5.4 | 2.0 | C420 | 3.475 | 4.825 | F300 | 1.875 | 0.075 | R319 | 2.25 | 3.5 | R385 | 2.275 | 6.25 |
| C324 | 2.45 | 1.5 | C421 | 3.3 | 4.825 | F301 | 1.975 | 0.075 | R320 | 2.15 | 3.4 | R386 | 7.05 | 5.45 |
| C326 | 0.175 | 2.05 | C422 | 2.175 | 2.25 | F302 | 4.725 | 0.425 | R321 | 2.15 | 2.9 | R387 | 5.7 | 5.1 |
| C327 | 1.15 | 2.0 | C423 | 1.7 | 3.2 | F303 | 4.825 | 0.425 | R322 | 1.7 | 3.6 | R388 | 1.75 | 4.225 |
| C328 | 0.475 | 2.7 | C424 | 1.775 | 2.75 | F304 | 0.275 | 2.05 | R323 | 1.6 | 2.2 | R389 | 5.95 | 5.1 |
| C329 | 0.35 | 2.425 | C425 | 0.525 | 6.7 | F400 | 7.95 | 7.375 | R324 | 4.75 | 4.85 | R390 | 1.875 | 7.6 |
| C330 | 1.25 | 2.9 | C426 | 4.6 | 10.57 | F401 | 8.05 | 5.425 | R325 | 3.35 | 3.225 | R391 | 1.875 | 7.3 |
| C331 | 2.3 | 2.425 | C427 | 2.1 | 10.47 | F402 | 5.6 | 7.1 | R326 | 4.65 | 5.3 | R392 | 0.5 | 2.1 |
| C332 | 1.925 | 2.7 | C428 | 6.25 | 0.525 | F403 | 5.55 | 4.8 | R327 | 0.6 | 3.0 | R393 | 2.225 | 2.0 |
| C333 | 1.7 | 3.3 | C429 | 5.375 | 0.425 | F404 | 7.75 | 8.85 | R328 | 3.475 | 5.025 | R394 | 2.05 | 2.0 |
| C334 | 1.125 | 4.625 | C430 | 8.225 | 3.35 | F405 | 7.95 | 6.275 | R329 | 2.25 | 3.2 | R395 | 2.425 | 7.4 |
| C335 | 1.15 | 7.225 | C431 | 1.75 | 10.47 | F406 | 5.725 | 8.85 | R330 | 4.15 | 3.175 | R396 | 2.325 | 7.7 |
| C336 | 1.05 | 7.65 | C432 | 4.6 | 10.45 | F407 | 5.65 | 5.925 | R331 | 1.6 | 3.1 | R397 | 8.275 | 8.55 |
| C337 | 0.1 | 5.525 | C480 | 3.75 | 6.2 | F500 | 4.871 | 3.147 | R332 | 2.25 | 3.0 | R398 | 4.95 | 8.875 |
| C338 | 0.7 | 7.35 | C481 | 3.75 | 6.3 | J303 | 0.15 | 2.75 | R333 | 2.25 | 3.3 | R399 | 0.875 | 8.225 |
| C339 | 1.15 | 7.45 | C482 | 3.2 | 3.75 | J304 | 5.8 | 0.2 | R334 | 4.125 | 4.25 | R400 | 1.45 | 8.425 |
| C340 | 1.5 | 2.35 | C496 | 2.5 | 1.85 | J305 | 1.575 | 0.15 | R335 | 0.6 | 2.9 | R401 | 1.45 | 8.225 |
| C341 | 2.7 | 4.025 | C497 | 3.05 | 1.825 | J307 | 0.147 | 5.878 | R336 | 1.6 | 3.2 | R402 | 1.4 | 7.925 |
| C342 | 1.05 | 5.875 | C498 | 1.8 | 3.7 | J309 | 2.075 | 10.63 | R337 | 3.925 | 4.25 | R403 | 2.6 | 8.3 |
| C343 | 1.75 | 4.025 | C499 | 2.875 | 7.95 | J314 | 1.375 | 10.17 | R338 | 1.7 | 2.8 | R404 | 2.7 | 3.825 |
| C344 | 3.75 | 6.4 | C500 | 5.725 | 2.725 | J320 | 2.25 | 9.55 | R339 | 2.7 | 2.525 | R405 | 0.425 | 8.325 |
| C345 | 0.95 | 4.75 | C501 | 6.35 | 3.1 | J414 | 4.7 | 2.225 | R340 | 2.675 | 2.1 | R406 | 1.45 | 8.625 |
| C346 | 3.65 | 6.075 | C502 | 5.1 | 3.1 | J508 | 6.35 | 3.45 | R341 | 2.7 | 3.1 | R407 | 5.95 | 6.9 |
| C347 | 0.6 | 3.325 | Cr342 | 3.9 | 8.9 | L300 | 3.625 | 4.85 | R342 | 1.7 | 3.0 | R408 | 5.7 | 6.9 |
| C348 | 1.95 | 5.15 | D300 | 1.875 | 1.025 | L301 | 3.5 | 5.2 | R343 | 1.7 | 3.1 | R409 | 7.05 | 7.325 |
| C349 | 2.175 | 5.8 | D301 | 1.975 | 1.025 | P300 | 0.125 | 3.55 | R344 | 1.75 | 4.125 | R410 | 6.8 | 7.325 |
| C350 | 0.1 | 5.425 | D302 | 1.65 | 0.325 | Q300 | 3.85 | 2.55 | R345 | 0.6 | 3.2 | R411 | 7.75 | 10.17 |
| C351 | 2.4 | 5.65 | D303 | 1.75 | 0.325 | Q301 | 2.725 | 2.75 | R346 | 2.25 | 3.4 | R412 | 1.45 | 9.025 |
| C352 | 1.95 | 5.65 | D304 | 4.7 | 1.95 | Q302 | 1.5 | 2.6 | R347 | 0.675 | 5.2 | R413 | 2.25 | 3.925 |
| C353 | 1.875 | 6.25 | D305 | 0.2 | 0.6 | Q303 | 3.575 | 3.35 | R348 | 2.05 | 2.1 | R414 | 1.45 | 8.925 |
| C354 | 2.375 | 6.35 | D306 | 0.325 | 0.6 | Q304 | 4.375 | 3.35 | R349 | 2.4 | 9.7 | R415 | 0.175 | 8.325 |
| C355 | 0.55 | 4.575 | D307 | 2.675 | 1.4 | Q305 | 1.55 | 3.6 | R350 | 1.15 | 7.0 | R416 | 4.275 | 6.75 |
| C356 | 0.3 | 4.25 | D308 | 6.25 | 1.0 | Q306 | 1.4 | 2.275 | R351 | 1.65 | 8.3 | R417 | 1.45 | 8.525 |
| C357 | 1.925 | 7.05 | D309 | 4.575 | 1.0 | Q307 | 4.925 | 5.8 | R352 | 1.675 | 2.6 | R418 | 1.275 | 9.125 |
| C358 | 2.25 | 6.775 | D310 | 5.15 | 1.0 | Q308 | 7.768 | 5.007 | R353 | 0.1 | 4.775 | R419 | 0.425 | 8.725 |
| C359 | 0.775 | 8.125 | D311 | 5.775 | 1.0 | Q309 | 4.972 | 5.433 | R354 | 1.15 | 7.1 | R420 | 1.45 | 8.325 |
| C360 | 1.35 | 8.125 | D312 | 4.275 | 2.55 | Q310 | 7.768 | 6.109 | R355 | 2.25 | 3.6 | R421 | 5.95 | 7.2 |
| C361 | 0.65 | 9.95 | D313 | 0.225 | 1.5 | Q311 | 4.972 | 6.535 | R356 | 0.7 | 7.55 | R422 | 0.425 | 8.625 |
| C362 | 0.775 | 8.025 | D314 | 0.35 | 1.5 | Q312 | 7.768 | 7.211 | R357 | 0.55 | 4.675 | R423 | 0.1 | 8.425 |
| C363 | 1.975 | 7.5 | D315 | 1.1 | 2.6 | Q313 | 3.9 | 7.4 | R358 | 0.675 | 4.325 | R425 | 1.875 | 4.4 |
| C364 | 1.875 | 6.9 | D316 | 7.975 | 4.3 | Q314 | 3.35 | 7.025 | R359 | 3.625 | 4.25 | R427 | 2.7 | 3.725 |
| C365 | 0.7 | 8.9 | D317 | 3.725 | 4.25 | Q315 | 4.972 | 8.248 | R360 | 1.125 | 4.425 | R428 | 8.025 | 9.425 |
| C366 | 2.275 | 8.0 | D318 | 4.25 | 4.25 | Q316 | 0.65 | 7.85 | R361 | 1.25 | 3.725 | R429 | 0.2 | 9.45 |
| C367 | 0.175 | 9.0 | D319 | 3.625 | 4.5 | Q317 | 7.768 | 8.313 | R362 | 1.125 | 4.525 | R430 | 1.975 | 4.4 |
| C368 | 0.2 | 8.425 | D320 | 4.125 | 4.5 | Q318 | 4.8 | 7.625 | R363 | 1.275 | 4.425 | R431 | 4.95 | 7.1 |
| C369 | 1.35 | 7.65 | D321 | 1.75 | 2.5 | Q319 | 4.972 | 10.05 | R364 | 1.125 | 5.1 | R432 | 1.65 | 9.15 |
| C370 | 0.075 | 9.55 | D322 | 1.65 | 4.325 | R300 | 8.225 | 0.725 | R365 | 1.75 | 3.825 | R433 | 1.925 | 8.75 |

6 - Diagrams

Table 6-2 continued

| Ref. | X | Y | Ref. | X | Y |
|------|-------|-------|-------|-------|-------|
| R434 | 2.5 | 9.825 | R500 | 2.175 | 4.325 |
| R435 | 2.4 | 9.825 | R505 | 0.525 | 6.8 |
| R436 | 7.05 | 7.75 | R510 | 6.2 | 5.1 |
| R437 | 6.8 | 7.75 | R511 | 6.2 | 7.2 |
| R438 | 4.675 | 6.875 | R512 | 6.55 | 5.45 |
| R439 | 1.925 | 8.65 | R513 | 6.55 | 7.75 |
| R440 | 5.7 | 7.2 | R514 | 6.2 | 6.9 |
| R441 | 5.05 | 7.125 | R515 | 6.2 | 9.9 |
| R442 | 0.35 | 9.65 | R516 | 6.55 | 7.325 |
| R443 | 0.2 | 9.55 | R517 | 6.55 | 9.75 |
| R444 | 4.375 | 7.9 | R520 | 4.15 | 9.75 |
| R445 | 3.425 | 9.275 | R521 | 2.5 | 6.05 |
| R446 | 0.9 | 9.65 | R522 | 4.25 | 1.75 |
| R447 | 2.4 | 8.45 | Rt301 | 7.4 | 10.43 |
| R448 | 1.95 | 9.675 | S300 | 4.291 | 10.63 |
| R449 | 1.95 | 9.775 | T300 | 4.35 | 9.925 |
| R450 | 1.925 | 8.85 | Tp318 | 4.825 | 6.05 |
| R451 | 0.825 | 9.25 | Tp319 | 4.975 | 7.63 |
| R452 | 1.95 | 9.25 | Tp320 | 4.975 | 9.475 |
| R453 | 2.375 | 8.55 | Tp321 | 4.825 | 5.15 |
| R454 | 1.35 | 9.75 | Tp323 | 3.825 | 8.825 |
| R455 | 0.075 | 9.75 | U300 | 3.85 | 1.725 |
| R456 | 1.225 | 10.02 | U301 | 1.275 | 1.625 |
| R457 | 1.125 | 10.02 | U302 | 3.85 | 2.15 |
| R458 | 2.2 | 9.825 | U303 | 6.275 | 2.3 |
| R459 | 2.1 | 9.825 | U304 | 2.775 | 1.725 |
| R460 | 0.6 | 2.55 | U305 | 1.05 | 2.4 |
| R461 | 4.675 | 7.375 | U306 | 0.575 | 7.05 |
| R462 | 4.675 | 7.275 | U308 | 4.6 | 5.675 |
| R463 | 8.275 | 9.425 | U309 | 2.375 | 5.55 |
| R464 | 4.225 | 7.075 | U310 | 0.475 | 4.9 |
| R465 | 4.675 | 7.175 | U311 | 2.25 | 6.675 |
| R466 | 3.6 | 9.8 | U313 | 2.15 | 3.825 |
| R467 | 5.7 | 9.9 | U314 | 2.175 | 8.025 |
| R468 | 5.95 | 9.9 | U315 | 0.575 | 8.875 |
| R469 | 6.8 | 9.75 | U400 | 0.825 | 5.6 |
| R470 | 7.05 | 9.75 | U498 | 3.925 | 3.45 |
| R471 | 4.925 | 10.82 | U499 | 3.925 | 3.15 |
| R472 | 4.725 | 6.6 | Vr300 | 4.7 | 1.85 |
| R473 | 2.7 | 5.4 | Vr301 | 4.7 | 2.05 |
| R474 | 7.85 | 9.125 | Vr302 | 4.0 | 5.025 |
| R476 | 0.525 | 6.6 | Vr303 | 1.45 | 8.825 |
| R477 | 3.75 | 5.7 | Vr304 | 0.45 | 4.025 |
| R478 | 3.2 | 5.775 | Vr305 | 1.45 | 8.725 |
| R479 | 3.2 | 5.675 | Vr335 | 1.175 | 4.025 |
| R480 | 3.75 | 6.1 | W300 | 3.625 | 9.45 |
| R481 | 3.75 | 6.0 | W301 | 4.65 | 7.475 |
| R482 | 4.2 | 5.8 | | | |
| R483 | 4.2 | 5.9 | | | |
| R484 | 4.025 | 3.6 | | | |
| R485 | 3.925 | 3.675 | | | |
| R486 | 3.725 | 4.125 | | | |
| R487 | 3.825 | 3.675 | | | |
| R488 | 0.525 | 6.9 | | | |
| R489 | 0.525 | 6.8 | | | |
| R490 | 1.35 | 6.775 | | | |
| R493 | 1.2 | 6.675 | | | |
| R494 | 3.1 | 8.85 | | | |
| R495 | 3.2 | 8.85 | | | |
| R496 | 3.65 | 5.975 | | | |
| R497 | 4.275 | 6.5 | | | |
| R498 | 3.75 | 6.55 | | | |
| R499 | 3.2 | 6.775 | | | |

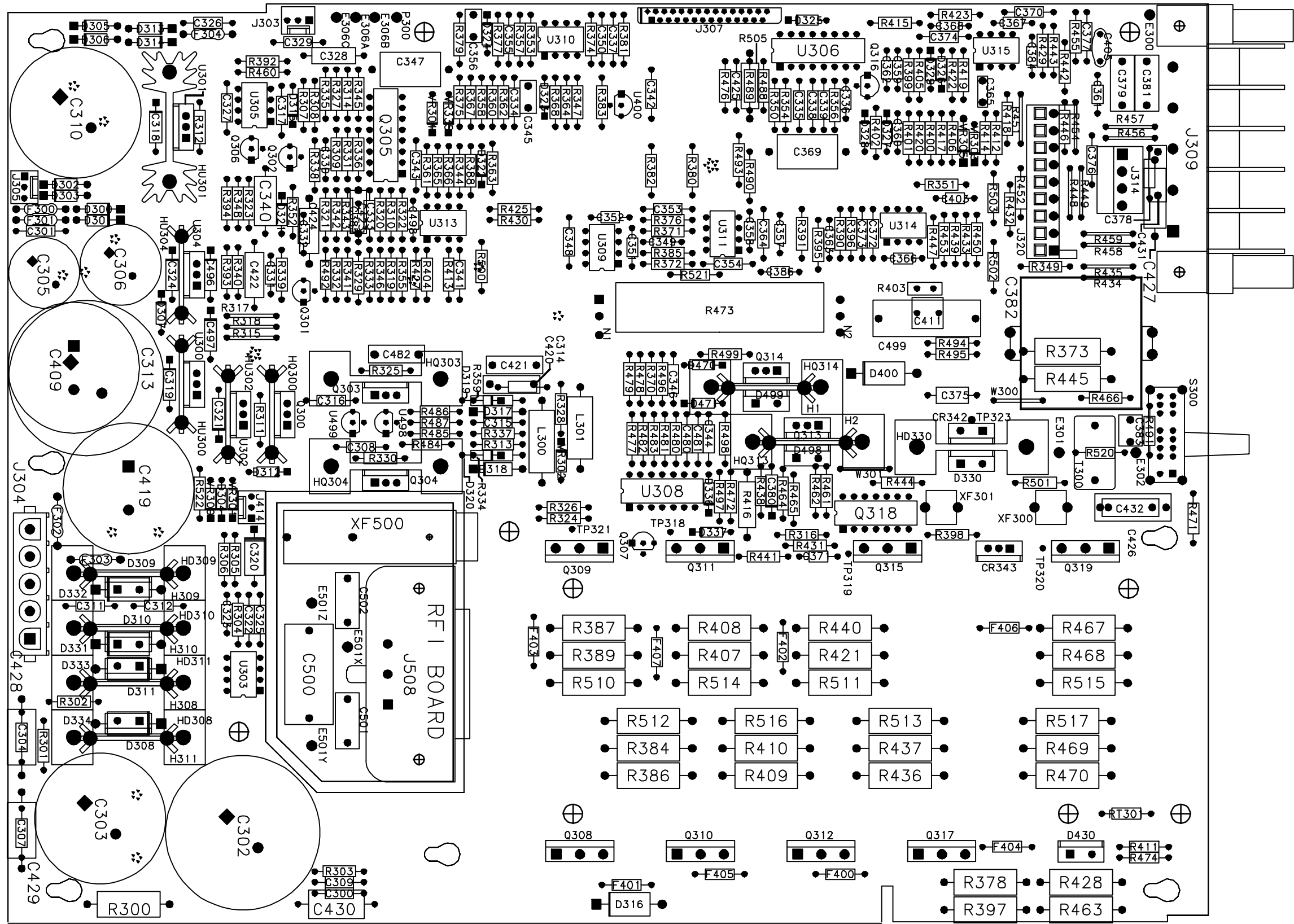


Figure 6-1. A1 Board Component Locations

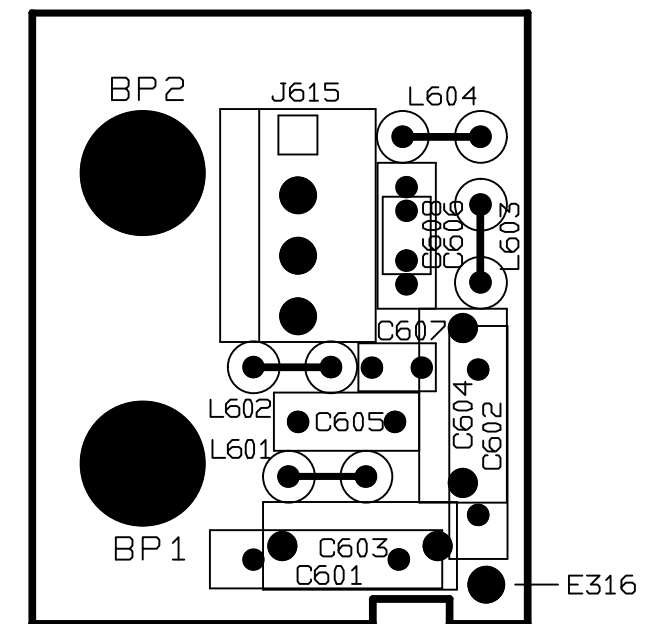
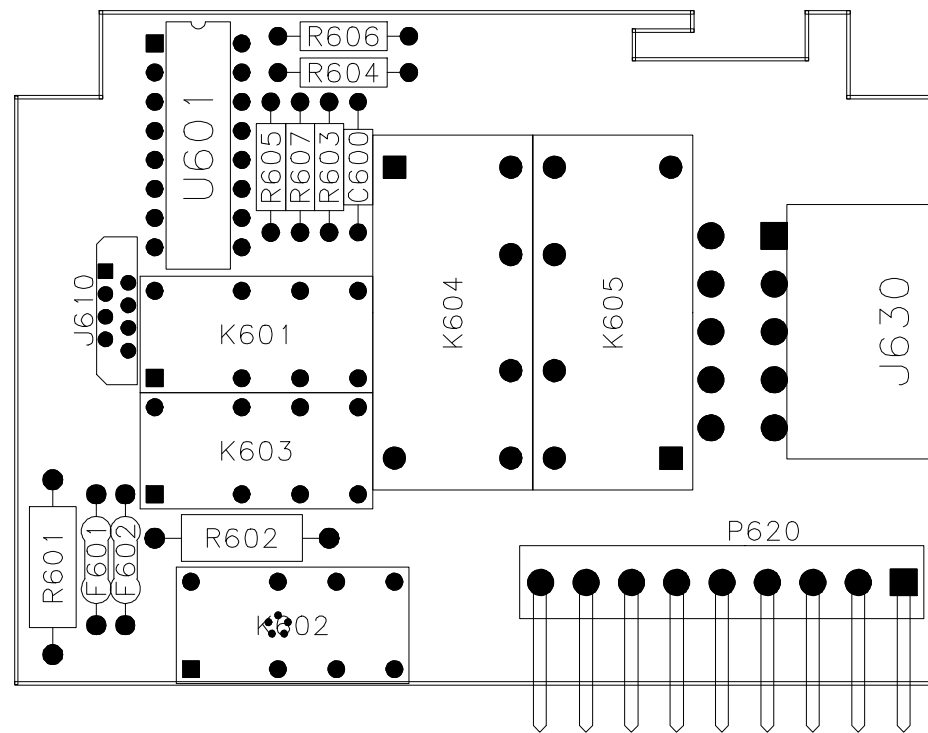
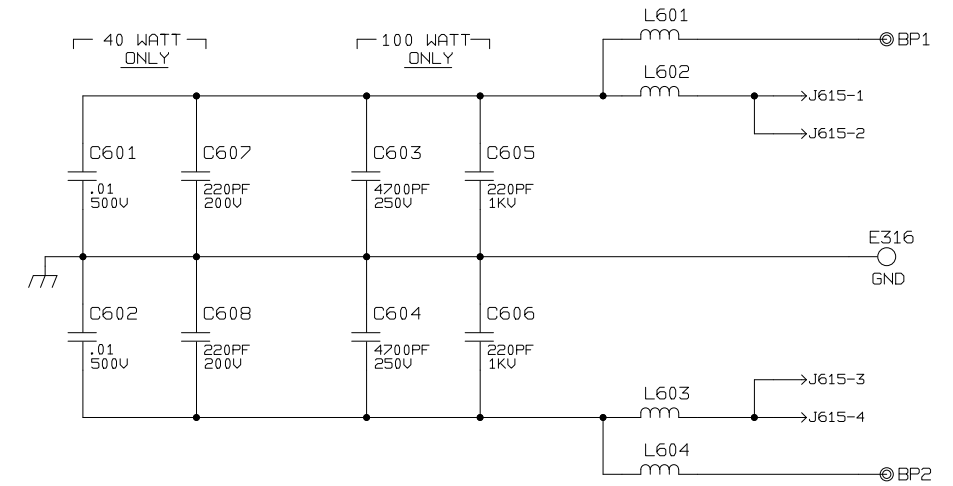
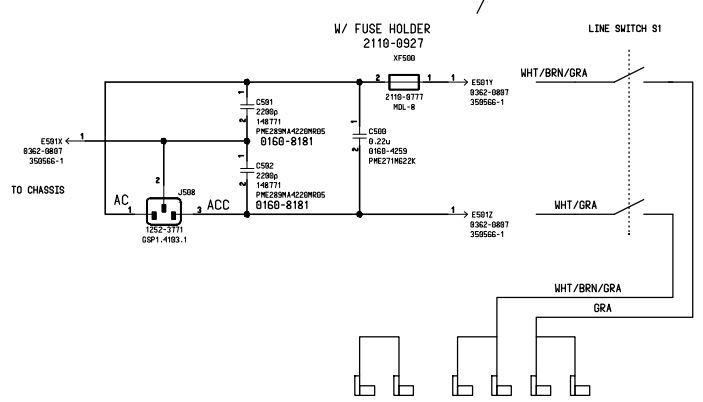


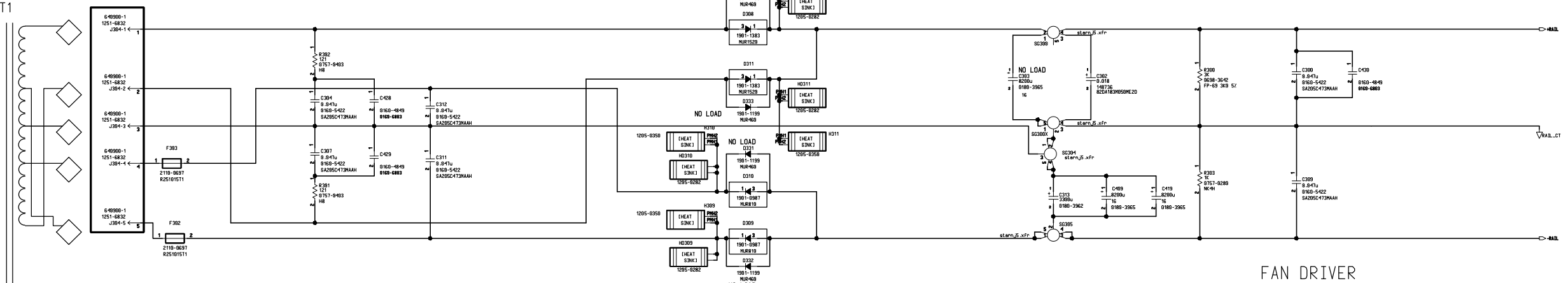
Figure 6-2. A4 and A6 Board Component Locations

| LINE VOLTAGE | FUSE RATING | PART NUMBER |
|--------------|-------------|-------------|
| 100V / 120V | 4A 250V | 2110-0055 |
| 220V / 240V | 2A 250V | 2110-0002 |

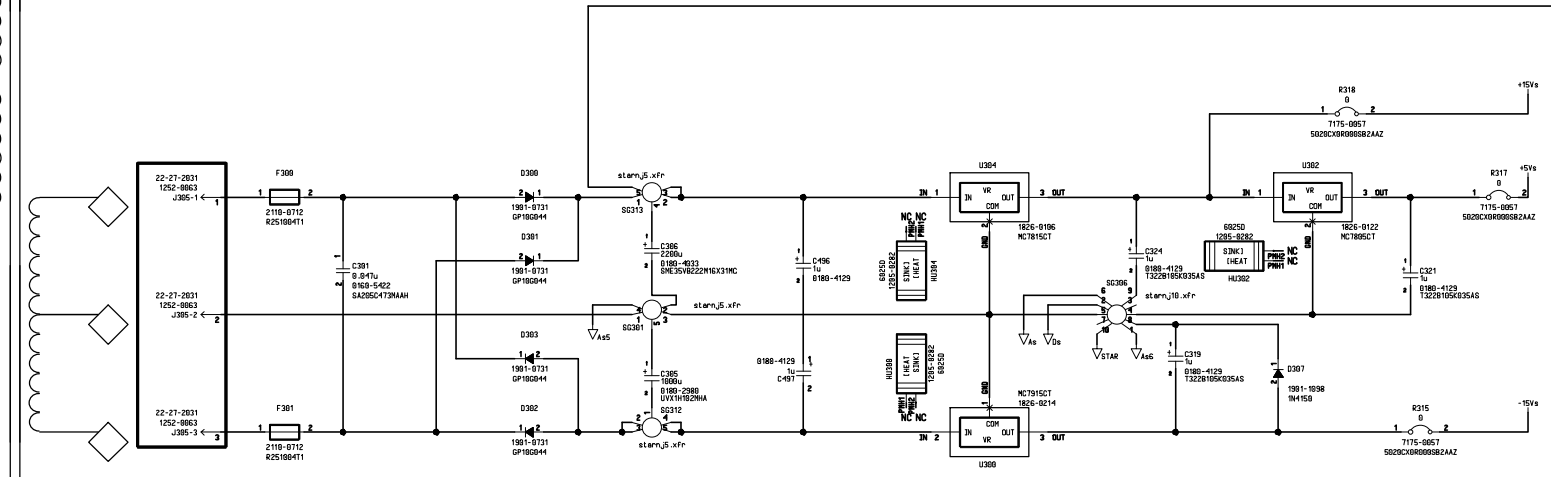
AC LINE FILTER



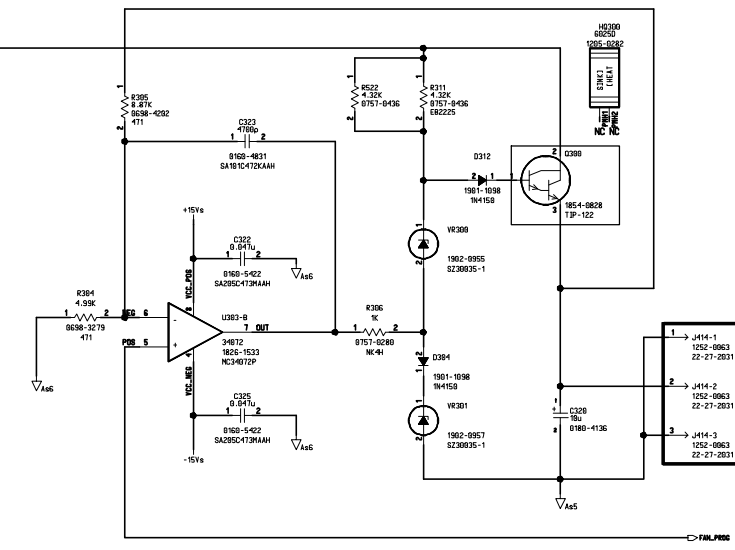
POWER RECTIFIER/FILTER



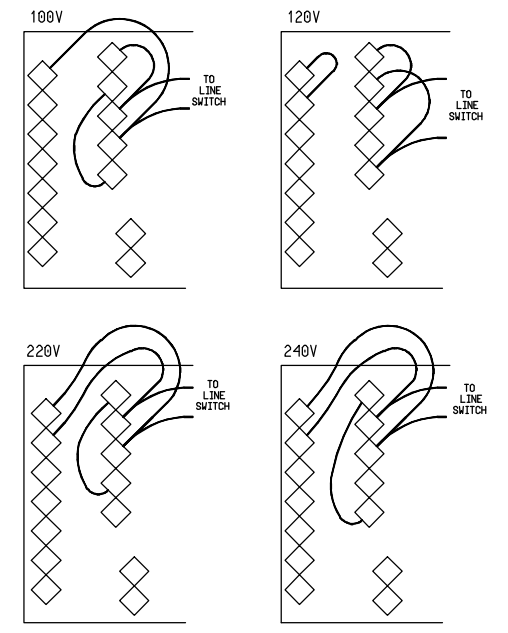
+/-15V AND +5V SECONDARY BIAS SUPPLIES



FAN DRIVER

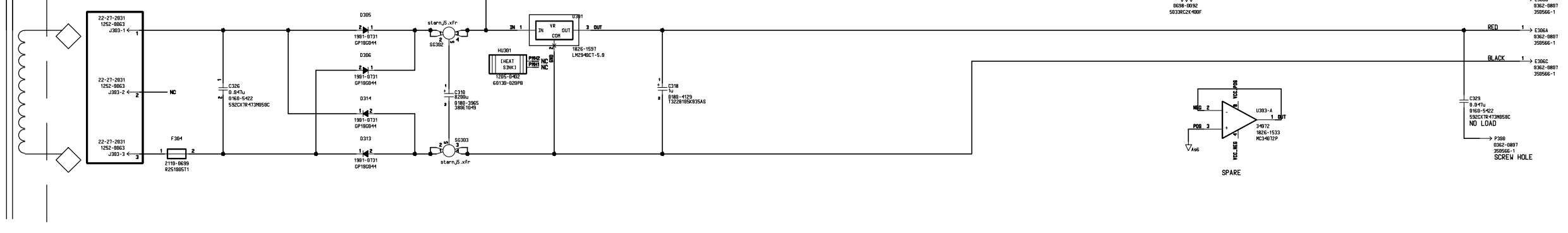


PRIMARY AC LINE CONFIGURATION (VIEW FROM SIDE OPENING OF UNIT)



SECONDARY TO INTERFACE

+5V INTERFACE BIAS SUPPLY



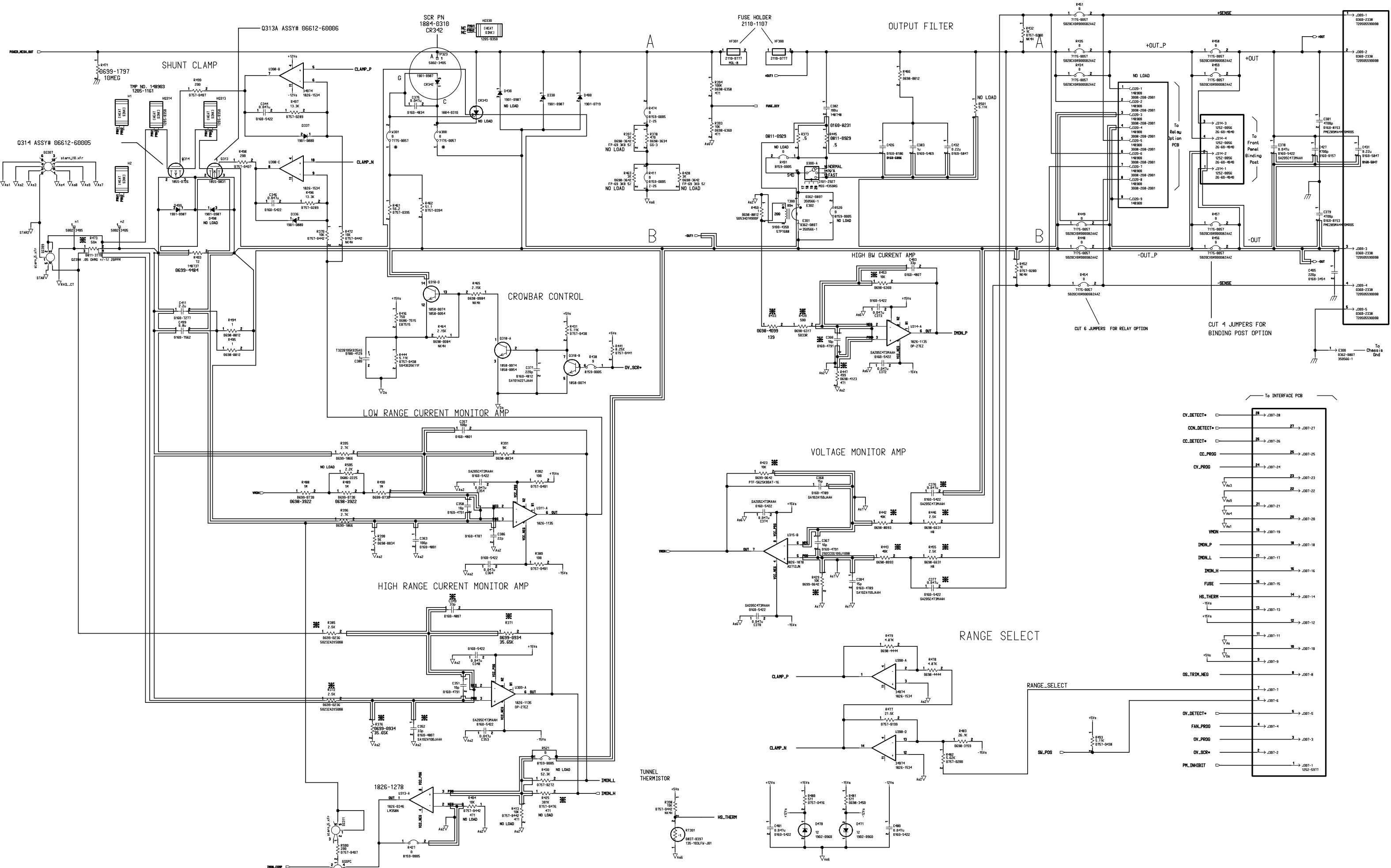
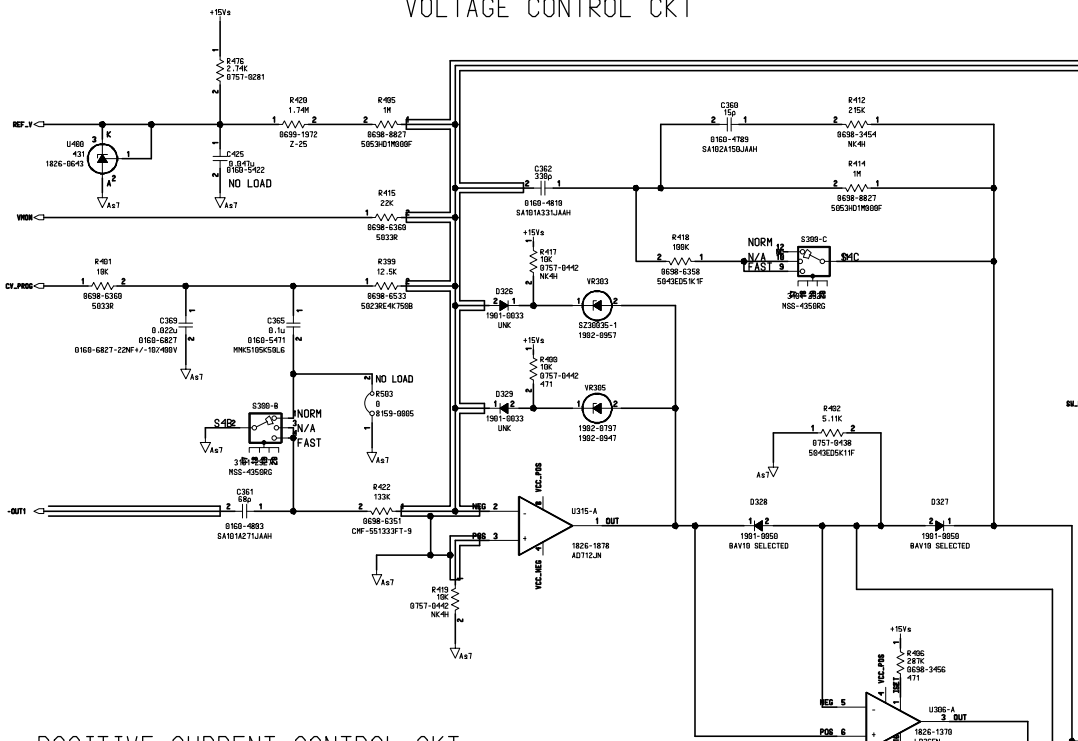
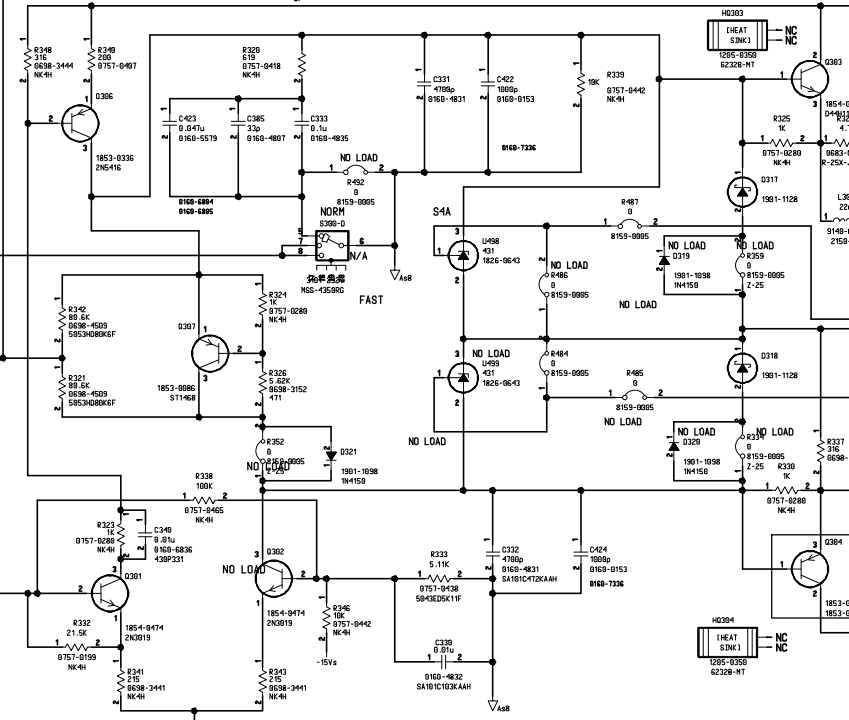


Figure 6-3. A1 Board schematic (sheet 2)

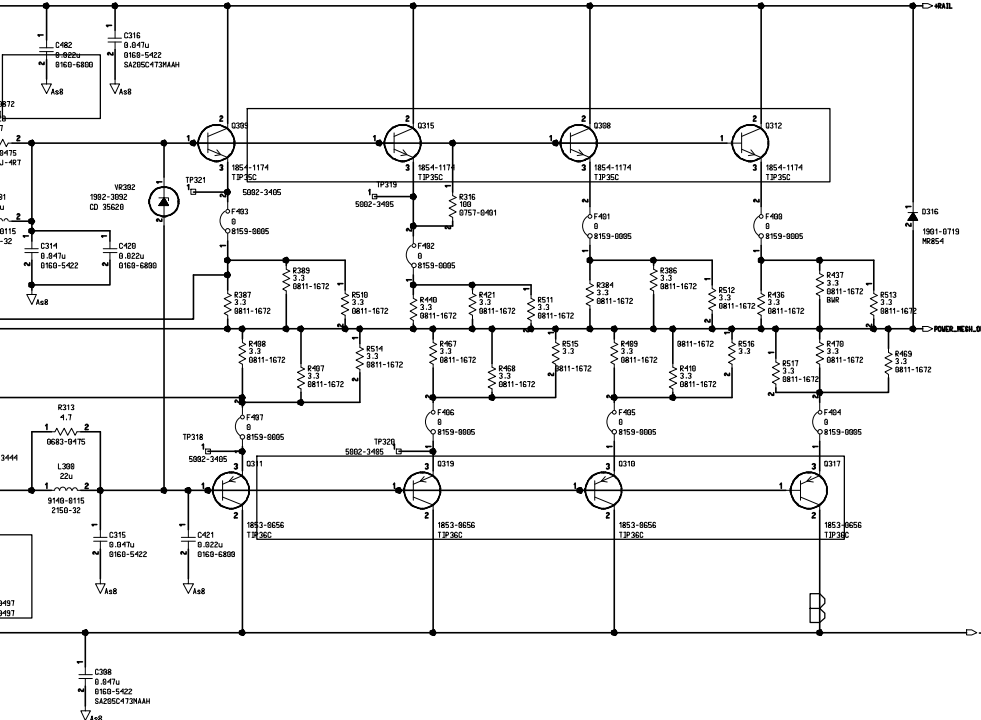
VOLTAGE CONTROL CKT



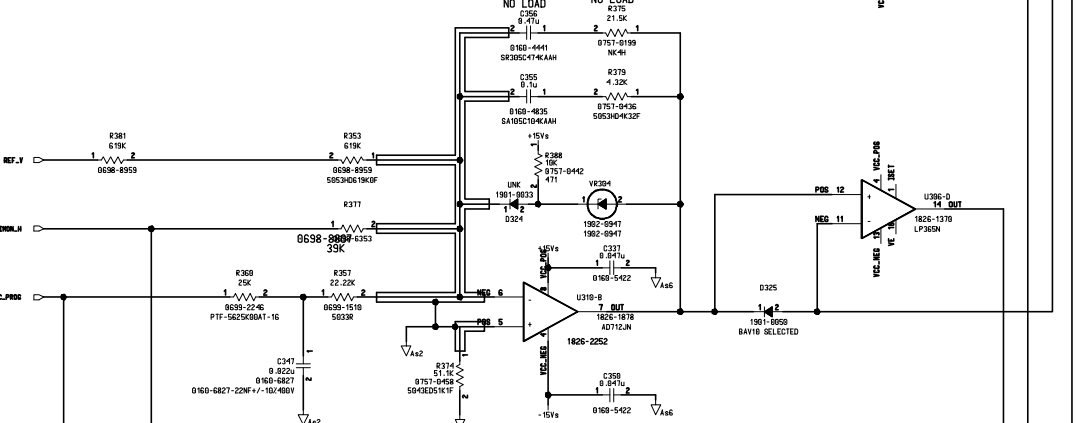
VOLTAGE GAIN STAGE



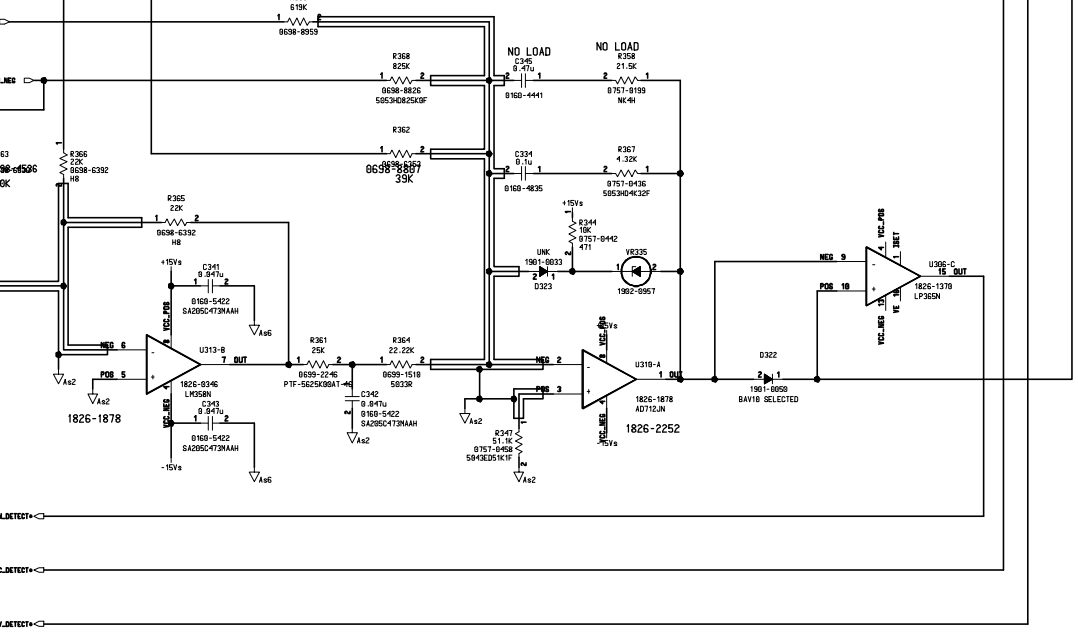
OUTPUT STAGE



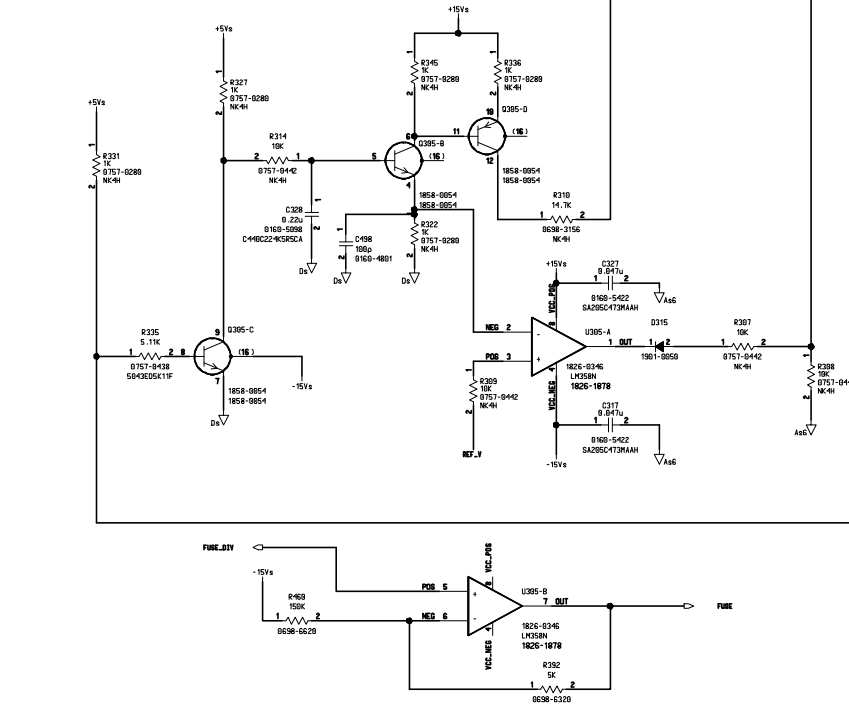
POSITIVE CURRENT CONTROL CKT



NEGATIVE CURRENT CONTROL CKT



TURN ON CONTROL



OVERVOLTAGE DETECTION AND CONTROL

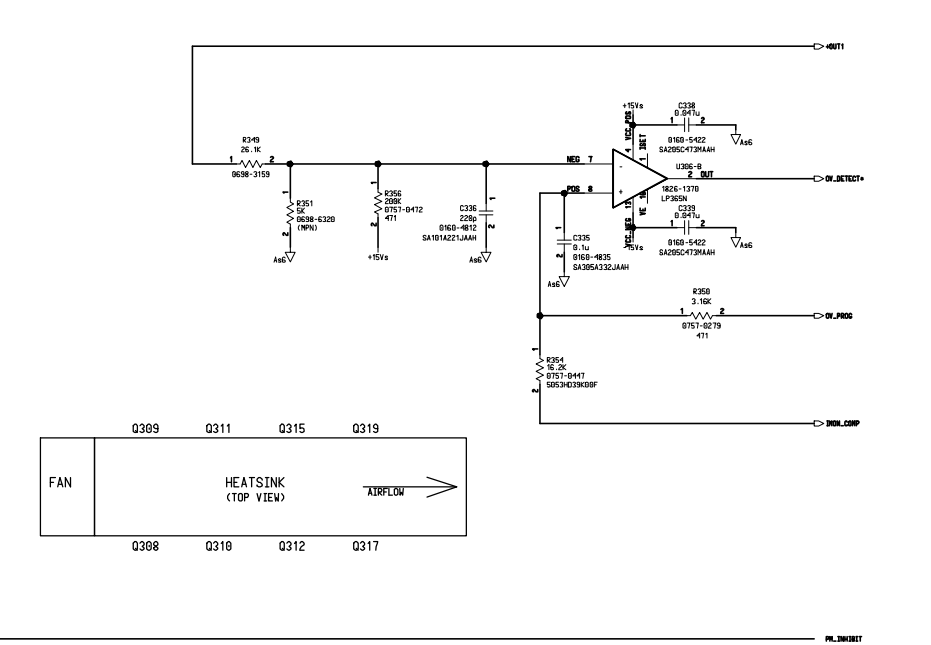


Figure 6-3. A1 Board schematic (sheet 3)

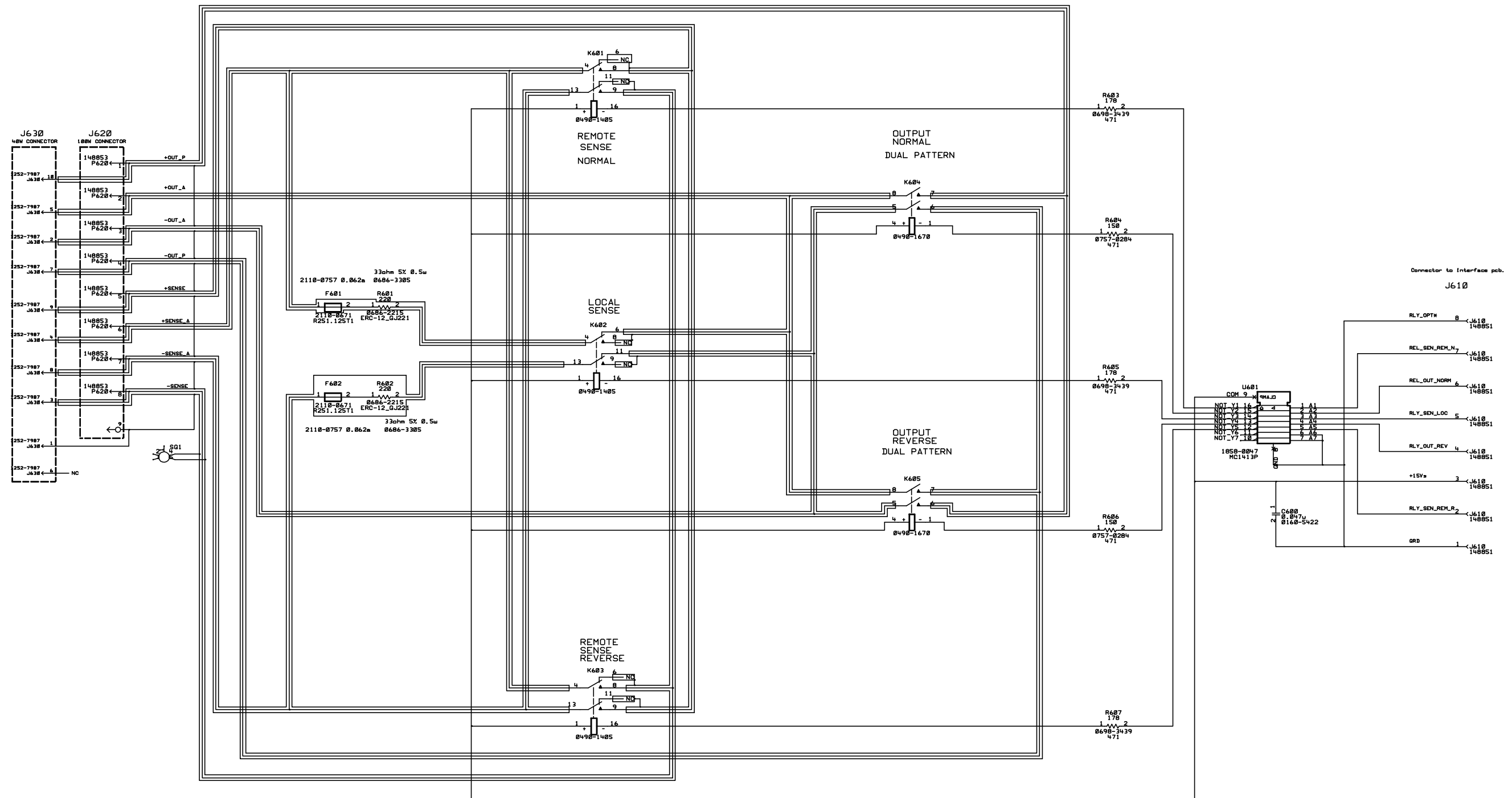


Figure 6-4. A6 Relay Option Board schematic

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Manual Updates

The following updates have been made to this manual since the original print date.

4/25/03

Information about serial numbers and manual revisions has been updated on pages 5 and 10.

Information has been corrected on page 16 and pages 20-22 to comply with ISO 17025.

8/15/03

Information has been corrected on page 16 and pages 20-22 to comply with ISO 17025.

10/2/03

The ripple and noise specification limits have changed for Model 6634B on page 22.