

Keysight Models 66111A,
66311A/B/D, 66309B/D
Mobile Communications
DC Source

Service Manual

NOTICE: This document contains references to Agilent Technologies. Agilent's former Test and Measurement business has become Keysight Technologies. For more information, go to www.keysight.com.



Warranty Information

CERTIFICATION

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

WARRANTY

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

For warranty service, with the exception of warranty options, this product must be returned to a service facility designated by Keysight Technologies. Customer shall prepay shipping charges by (and shall pay all duty and taxes) for products returned to Keysight Technologies for warranty service. Except for products returned to Customer from another country, Keysight Technologies shall pay for return of products to Customer.

Warranty services outside the country of initial purchase are included in Keysight Technologies' product price, only if Customer pays Keysight Technologies international prices (defined as destination local currency price, or U.S. or Geneva Export price).

If Keysight Technologies is unable, within a reasonable time to repair or replace any product to condition as warranted, the Customer shall be entitled to a refund of the purchase price upon return of the product to Keysight Technologies.

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The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Customer, Customer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation and maintenance. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. KEYSIGHT TECHNOLOGIES SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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THE REMEDIES PROVIDED HEREIN ARE THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. KEYSIGHT TECHNOLOGIES SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

The above statements apply only to the standard product warranty. Warranty options, extended support contacts, product maintenance agreements and customer assistance agreements are also available. Contact your nearest Keysight Technologies Sales and Service office for further information on Keysight Technologies' full line of support programs.

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. Keysight 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 a Keysight 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)

Notice

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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.....	December 1999
Update 1.....	January 2001
Update 1.....	February 2005
Edition 2.....	December 2014

Instrument Identification

The dc source is identified by a unique, two-part serial number, such as, US39450101. The items in this serial number are explained as follows:

US39450101 The first two letters indicate the country of manufacture. US = United States, MY = Malaysia

The next four digits are the year and week of manufacture or last significant design change. Add 1960 to the first two digits to determine the year. For example, 39=1999. The third and fourth digits specify the week of the year (45 = the forty-fifth week).

The last four digits (0101) are a unique sequential number assigned to each unit.

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Introduction

Organization

This manual contains information for troubleshooting and repairing Keysight 66111A, 66311A, 66311B, 66311D, 66309B and 66309D Mobile Communications DC Sources. Hereafter all models will be referred to as the dc source.

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 source chassis.

This dc source 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 source 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 source:

- a User's Guide, part number 5964-8125, containing installation, operating, programming, and calibration information

Revisions

Manual Revisions

This manual was written for dc sources that have the same manufacturing dates (the first four digits) as those listed on the title page and whose unique identification number (the last four digits) are equal to or higher than those listed in the title page.

-
- NOTE:**
- 1) If the first four digits of the serial number of your unit are higher than those shown in the title page, your unit was made after the publication of this manual and may have hardware or firmware differences not covered in this manual. If they are significant to the operation and/or servicing of the dc source, those differences are documented in one or more Manual Change sheets included with this manual.
 - 2) If the first four digits of the serial number of your unit are lower than those shown on the title page, your unit was made before the publication of this manual and may be different from that described here. Such differences, if any, will be covered in a backdating section in chapter 6.
-

Firmware Revisions

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

Electrostatic Discharge

CAUTION: The dc source 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 source, 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 (P/N 9300-0797, or equivalent).
- Using a conductive wrist strap, such as 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 source before removing or installing printed circuit boards.

Verification and Performance Tests

Introduction

This document contains test procedures to verify that the dc source 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 dc source is turned on, check most of the digital circuits and the programming and readback DACs.
- Operation Verification** These tests verify that the dc source 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 User's Guide.

NOTE: The dc source 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 and measurement uncertainties (when test using the recommended test equipment) may be found at the back of this section.

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

Type	Specifications	Recommended Model
Digital Voltmeter	Resolution: 10 nV @ 1V Readout: 8 1/2 digits Accuracy: 20 ppm	Keysight 3458A or equivalent
Current Monitor	15 A (0.1 ohm) 0.04%, TC=5ppm/°C	Guildline 9230/15
Load Resistor (3 W min. TC=20ppm/°C)	400Ω (verification) 800Ω (calibration)	p/n 0811-0942 p/n 0811-0600
Electronic Load	20V, 5A minimum, with transient capability and a slew rate of 833kA/s or better.	Keysight N3300A mainframe, with N3303A module
DC Power Supply	8V @ 5A (for current sink verification/calibration) 25 V source (for DVM verification/calibration)	Keysight 6611C, 6631B 6631C, or 6633B
GPIB Controller	Full GPIB capabilities (only required if you are calibrating the unit over the GPIB)	HP Series 200/300 or equivalent
Oscilloscope	Sensitivity: 1 mV Bandwidth Limit: 20 MHz Probe: 1:1 with RF tip	Keysight 54504A or equivalent

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 dc source may have to be taken into account. "Wait" statements can be used in the test program if the test system is faster than the dc source.

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 turn-on and checkout procedures given in the User's Guide.

Performance Tests

NOTE: The following paragraphs provide test procedures for verifying the supply's compliance with the specifications listed in Table A-1 of the User's Guide. A full Performance Test consists of only those items listed as "Specifications" in Table A-1 of the User's Guide, and that have a procedure in this document.

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 an GPIB controller when performing the tests. The test procedures are written assuming that you know how to program the supply either; remotely from an GPIB controller or locally using the control keys and indicators on the supply's front panel. Also, when performing the verification tests from an GPIB controller, you may have to consider the relatively slow settling times and slew rates of the dc source as compared to computer and system voltmeters. Suitable WAIT statements can be inserted into the test program to give the dc source time to respond to the test commands.

Table 2-2. Programming and Output Values

Keysight Model	Full scale Voltage	Vmax	Full Scale Current	I _{max}	I _{sink}	OV Max
66111A	15	15.356	3	3.0712	- 2A	22.0
66311A/B/D	15	15.356	3	3.0712	- 2A	22.0
66309B/D output 1	15	15.356	3	3.0712	- 2A	22.0
66309B/D output 2	12	12.25	1.5	1.52	N.A.	N.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 values read back over the GPIB should be identical to those displayed on the front panel.

- a. Turn off the supply and connect a digital voltmeter (DVM) directly across the +S and -S terminals as shown in Figure 2-1a.
- b. Turn on the dc source and program the output to zero volts and the maximum programmable current (I_{max} in Table 2-2) with the load off.
- c. 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 card for the appropriate model under Voltage Programming and Readback @ 0 Volts. Also, note that the CV annunciator is on. The output current reading should be approximately zero.
- d. Program the output voltage to full-scale (see Table 2-2) .
- e. 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 card for the appropriate model under Voltage Programming and Readback @ 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.

- a. Turn off the dc source and connect a DVM directly across the +S and -S terminals as shown in Figure 2-1a.
- b. Turn on the dc source and program the current to the maximum programmable value (I_{max}) and the voltage to the full-scale value in Table 2-2.
- c. Adjust the load for the full-scale current in Table 2-2 as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load so that the output current drops slightly.
- d. 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 card 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 dc source 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 dc source and program the current to the maximum programmable value (I_{max}) and the output voltage to the full-scale value in Table 2-2.
- d. Adjust the load for the full-scale current value in Table 2-2 as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load so that the output current drops slightly.
- e. Adjust the transformer to the lowest rated line voltage (refer Table A-2 in Appendix A of the User's Guide, under "Mains Input Ratings").
- f. Record the output voltage reading on the DVM.
- g. Adjust the transformer to the highest rated line voltage (refer Table A-2 in Appendix A of the User's Guide, under "Mains Input Ratings").
- h. Record the output voltage reading on the DVM. The difference between the DVM reading in steps (f) and (h) is the source effect voltage and should not exceed the value listed in the performance test record card for the appropriate model under CV Source Effect.

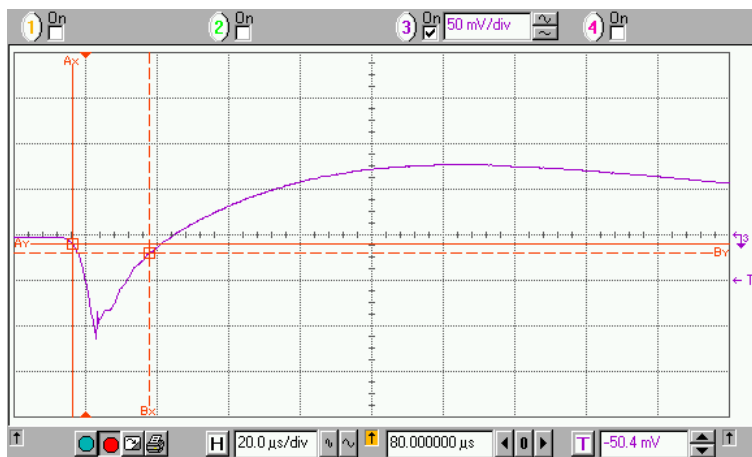
CV Noise (PARD)

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 Appendix A of the User's Guide.

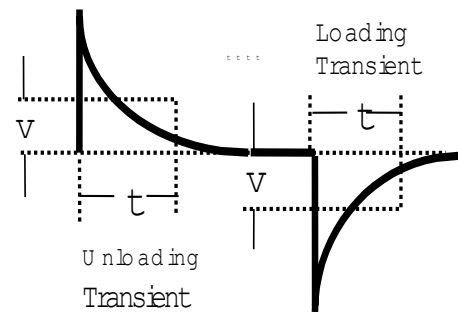
- a. Turn off the dc source and connect the output as shown in Figure 2-1a to an oscilloscope (ac coupled) between the (+) and the (-) terminals. Set the scope's bandwidth limit to 20 MHz and use an RF tip on the scope probe.
- b. Turn on the dc source and program the current to the maximum programmable value (I_{max}) and the output voltage to the full-scale value in Table 2-2.
- c. Adjust the load for the full-scale current value in Table 2-2 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 card 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 card for the appropriate model under CV Noise (PARD).

Transient Recovery Time

This test measures the time for the output voltage to recover to within the specified value following the specified load change in High capacitance mode. The focus of the output 1 transient is on the initial dip below zero.



Waveform A (output 1)



Waveform B (output 2)

Figure 2-2. Transient Waveforms

2 - Verification and Performance Tests

- a. Turn off the dc source and connect the output as in Figure 2-1d with the oscilloscope and the RC network across the + and - load terminals. Connect everything at the load and keep the load leads as short as possible. To reduce noise, twist the sense lead pair together. Also twist the load lead pair together. Set the compensation to High capacitance mode.
- b. Turn on the dc source and program the output current to the maximum programmable value (I_{max}) and the voltage to the full-scale value in Table 2-2.
- c. Set the load to the Constant Current mode. For output 1, program the load current to 0.1A. For output 2, program the load current to 0.75A.
- d. Set the electronic load's transient generator frequency to 100 Hz and its duty cycle to 50%.
- e. For output 1, program the load's transient current level to 1.5A. For output 2, program the load's transient current level to 1.5A. Turn the transient generator on.
- f. Set the oscilloscope for negative edge triggering and adjust it for a waveform similar to that in Figure 2-2.
- g. The output voltage should return to within the specified voltage in less than 35 microseconds for output 1, and less than 400 microseconds for output 2 following the specified load change. Record the voltage at time "t" in the performance test record card under CV Transient Response.

Constant Current (CC) Tests

CC Setup

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

Current Programming and Readback Accuracy

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

- a. Turn off the dc source and connect the current monitoring resistor across the dc source output and the DVM across the resistor as shown in Figure 2-1a. See "Current Monitoring Resistor" for connection information.
- b. Turn on the dc source and program the output voltage to 5 V and the current to 0 A. The dc source's current detector must be set to DC.
- c. Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (I_{out}). Also, record the current reading on the front panel display. The readings should be within the limits specified in the performance test record card for the appropriate model under Current Programming and Readback @ 0A.
- d. Program the output current to the full-scale value in Table 2-2.
- e. Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amps and record this value (I_{out}). 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 Current Programming and Readback @ Full Scale.

Low Current Range Readback Accuracy

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

- a. Turn off the dc source and connect the output as shown in Figure 2-1b using the 400 ohm load resistor. Set the DMM to operate in current mode.
- b. Turn on the dc source and set the current range readback to Low (0.02A). Program the output voltage to 0V and the current to the full scale value in Table 2-2. The current on the UUT display should be approximately 0mA.

- 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 card under Low Range Current Readback @ 0A.
- d. Program the output voltage to 8V and record the current reading on the DMM and the reading on the front panel display. If the meter indicates overrange, lower the 8 volts slightly. The difference between the readings should be within the limits specified in the performance test record card for the appropriate model under Low Range Current Readback @ +20mA

Low Current Sink Operation

This test verifies current sink operation and readback of the $-0.02A$ range.

- a. Turn off the dc source and connect the output and an external supply as shown in Figure 2-1c using the 400 ohm load resistor. Set the DMM to operate in current mode.
- b. Turn on the dc source and set the current range readback to 0.02A.
- c. Turn on the external power supply and program it to 8V and 5A. Then program the dc source to 0V and 1A. If the meter indicates overrange, lower the voltage of the external supply slightly. The UUT display should read approximately -20 mA.
- d. 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 card under Current Sink Readback @ -20 mA.

High Current Sink Operation

This test verifies current sink operation and readback of the $-3A$ range.

- a. Turn off the dc source and connect the current monitoring resistor across the output and the DMM across the resistor as shown in Figure 2-1a. Connect an external power supply in place of the electronic load. Set the DMM to operate in voltage mode.
- b. Turn on the dc source and set the current range readback to 3A.
- c. Turn on the external power supply and program it to 1.5V and 3A. Then program the dc source to 0V and the current to the full scale value in Table B-2. The UUT display should read approximately $-3A$.
- d. Divide the voltage drop (DVM reading) across the current monitoring resistor by its resistance to convert to amperes and record this value. 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 Current Sink Readback @ $-3A$.

CC Load and Line Regulation

The following CC Load Effect and CC Source Effect tests verify the regulation of the 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 a Keysight 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 Rds/Trig) 1 0 0 ENTER .
- 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).

2 - Verification and Performance Tests

- 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 dc source and connect the output as shown in Figure 2-1a with the DVM connected across the current monitoring resistor.
- b. Turn on the dc source and if it was set to low range readback in the previous test, set it back to high or auto. Program the current to full scale and the output voltage to the maximum programmable voltage value (V_{max}) in Table 2-2.
- c. Adjust the load in the CV mode for the UUT full scale voltage in Table 2-2 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 card 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 dc source 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 dc source and program the current to the full scale value and the output voltage to the maximum programmable value (V_{max}) in Table 2-2.
- 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 (refer Table A-2 in Appendix A of the User’s Guide, under “Mains Input Ratings”).
- 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 (refer Table A-2 in Appendix A of the User’s Guide, under “Mains Input Ratings”).
- 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 dc source in CC operation.

- a. Turn off the dc source and connect the load, monitoring resistor, and rms voltmeter 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 50W, 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 dc source turned off. Other equipment (e.g. computers, DVMs, etc.) may affect the reading.
- c. Turn on the dc source and program the current to full scale and the output voltage to the maximum programmable value (V_{max}) in Table 2-2.
- 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 current monitor resistance to obtain rms current. It should not exceed the values listed in the performance test record card under CC Noise (RMS).

DVM Tests

DVM Measurement Accuracy

This test verifies the DVM measurement accuracy.

- a. Turn off the dc source and connect the external DMM and the external power supply to the DVM inputs as shown in figure B-1e. Connect only the negative output lead of output 1 to the DVM inputs. Then turn on the dc source and select output 1.
- b. Set output 1 to zero volts and the external power supply to 25 volts.
- c. Record the external (3458) DMM reading and the internal DVM reading. The difference should be within the positive limits specified for the DVM in Table A-3.
- d. Set output 1 to 15 V and repeat step c.
- e. Reverse the leads of the external power supply to the DVM inputs. Keep other connections the same.
- f. With output 1 set to 15 V, lower the voltage on the external power supply until the external (3458) DMM reads -4.5 V.
- g. Record the external (3458) DMM reading and the internal DVM reading. The difference should be within the negative limits specified for the DVM in Table A-3.
- h. Set output 1 to zero volts and repeat step g.

Performance Test Record Form

Model Keysight 66111A	Report No _____	Date _____	
Test Description	Minimum Specifications	Results*	Maximum Specifications
Constant Voltage Tests			
Voltage Programming and Readback			
Low Voltage (0V) Vout	- 10 mV	_____	+ 10 mV
Front Panel Display Readback	Vout - 5 mV	_____	Vout + 5 mV
High Voltage (Full Scale) Vout	14.9825 V	_____	15.0175 V
Front Panel Display Readback	Vout - 9.5mV	_____	Vout + 9.5 mV
Load Effect	- 2.0mV	_____	+ 2.0mV
Source Effect	- 0.5mV	_____	+ 0.5 mV
PARD (Ripple and Noise)			
RMS	N.A.	_____	+ 1 mV
peak-to-peak	N.A.	_____	+ 6 mV
Transient Response			
Voltage in 35 μ s	- 20 mV	_____	+ 20 mV
Constant Current Tests			
High Range Current Programming and Readback			
Low current (0A) Iout	- 2.3 mA	_____	+ 2.3 mA
High Current (Full Scale)	2.99717 A	_____	3.00283 A
Front Panel Display Readback @ Iout	Iout - 15mA	_____	Iout + 15mA
Current Sink			
High Current (-2A @ 7.5V) Readback	Isink - 13 mA	_____	Isink + 13 mA
Load Effect	- 0.75mA	_____	+ 0.75mA
Source Effect	- 0.75mA	_____	+ 0.75mA
PARD (Current Ripple and Noise)			
RMS	- 2.0 mA	_____	+ 2.0 mA

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Model Keysight 66311B/D	Report No _____	Date _____	
Model Keysight 66309B/D output 1			
Test Description	Minimum Specification	Results	Maximum Specification
CONSTANT VOLTAGE TESTS			
Voltage Programming and Readback			
Low Voltage (@ 0 V) Vout	- 10 mV	_____	+ 10 mV
Front Panel Display Readback	Vout - 5 mV	_____	Vout + 5 mV
High Voltage (@ Full Scale) Vout	14.9825 V	_____	15.0175 V
Front Panel Display Readback	Vout - 9.5mV	_____	Vout + 9.5 mV
CV Load Effect	- 2.0mV	_____	+ 2.0mV
CV Source Effect	- 0.5mV	_____	+ 0.5 mV
PARD (Ripple and Noise)			
peak-to-peak	N.A.	_____	+ 6 mV
RMS	N.A.	_____	+ 1 mV
Transient Response			
Voltage in 35 μ s	- 20 mV	_____	+ 20 mV
CONSTANT CURRENT TESTS			
Current Programming and Readback			
Low current (@ 0 A) Iout	- 2.3 mA	_____	+ 2.3 mA
Front Panel Display Readback	Iout - 0.5mA	_____	Iout + 0.5mA
High Current (@ Full Scale) Iout	2.99717 A	_____	3.00283 A
Front Panel Display Readback	Iout - 6.5mA	_____	Iout + 6.5mA
Low Range Current Readback			
Front Panel Display Readback @ 0 A	Iout - 2.5 μ A	_____	Iout + 2.5 μ A
Front Panel Display Readback @ + 20 mA	Iout - 22.5 μ A	_____	Iout + 22.5 μ A
Current Sink			
Front Panel Display Readback @ - 20 mA	Isink - 22.5 μ A	_____	Isink + 22.5 μ A
Front Panel Display Readback @ - 3 A	Isink - 5.1 mA	_____	Isink + 5.1 mA
CC Load Effect	- 0.75mA	_____	+ 0.75mA
CC Source Effect	- 0.75mA	_____	+ 0.75mA
PARD (Current Ripple and Noise)			
RMS	N.A.	_____	+ 2.0 mA

Model 66309B/D Output 2	Report No _____	Date _____	
Test Description	Minimum Specification	Results	Maximum Specification
CONSTANT VOLTAGE TESTS			
Voltage Programming and Readback			
Output 2 Low Voltage @ 0 V	- 40 mV	_____	+ 40 mV
Output 2 Front Panel Display Readback	Vout2 - 15 mV	_____	Vout2 + 15 mV
Output 2 High Voltage @ Full Scale	11.936 V	_____	12.064 V
Output 2 Front Panel Display Readback	Vout2 - 39 mV	_____	Vout2 + 39 mV
Load Effect	- 1.6 mV	_____	+ 1.6mV
Source Effect	- 0.4 mV	_____	+ 0.4 mV
PARD (Ripple and Noise)			
Peak-to-Peak	N.A.	_____	+ 6 mV
RMS (with phone capacitance <6μF)	N.A.	_____	+ 1 mV
Transient Response¹			
Time in <400 μs	- 20 mV	_____	+ 20 mV
CONSTANT CURRENT TESTS			
Current Programming and Readback			
Output 2 Low Current @ 0 A	- 4.5 mA	_____	+ 4.5 mA
Output 2 High Current @ Full Scale	1.4925 A	_____	1.5075 A
Output 2 Front Panel Display Readback	Iout2 - 6 mA	_____	Iout2 + 6 mA
Current Sink (-0.032A @ 7.5V) Readback	Isink - 25 mA	_____	Isink + 39 mA
PARD (Current Ripple and Noise)			
RMS	N.A.	_____	+ 2.0 mA
Load Effect	- 0.375 mA	_____	+ 0.375 mA
Source Effect	- 0.25 mA	_____	+ 0.25 mA

¹Following a 0.75A to 1.5A load change

Model 66311D/66309D DVM Input	Report No _____	Date _____	
Test Description	Minimum Specification	Results	Maximum Specification
DVM VOLTAGE CALIBRATION VERIFICATION			
Positive Voltage Measurement	-15mV	_____	+15mV
Negative Voltage Measurement	-6.8mV	_____	+6.8mV

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 source. Before attempting to troubleshoot the dc source, 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 source. Troubleshooting procedures are provided to isolate a problem to one of the circuit boards. Figure 3-2 shows the location of the circuit boards and other major components of the unit. 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 an assembly is defective, replace it and then conduct the verification test given in Chapter 2.

NOTE: When either the A1 Control Board or the A2 Interface Board is 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 board level replaceable parts for the dc source. Chapter 6 contains block diagrams, 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 dc source. 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 200/300
Digital Voltmeter	To check various voltage levels	Keysight 3458A
Oscilloscope	To check waveforms and signal levels	Keysight 54504A/54111A
Electronic Load	To test operation of current circuit	Keysight 6060B (60V) or 6063B (240V)
Ammeter/Current Shunt	To measure output current	Guildline 9230/15

Overall Troubleshooting

Overall troubleshooting procedures for the dc source 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 1-4. The flow charts make reference to the test points listed in Chapter 6. The circuit locations of the test points are shown on the component location diagrams in Chapter 6.

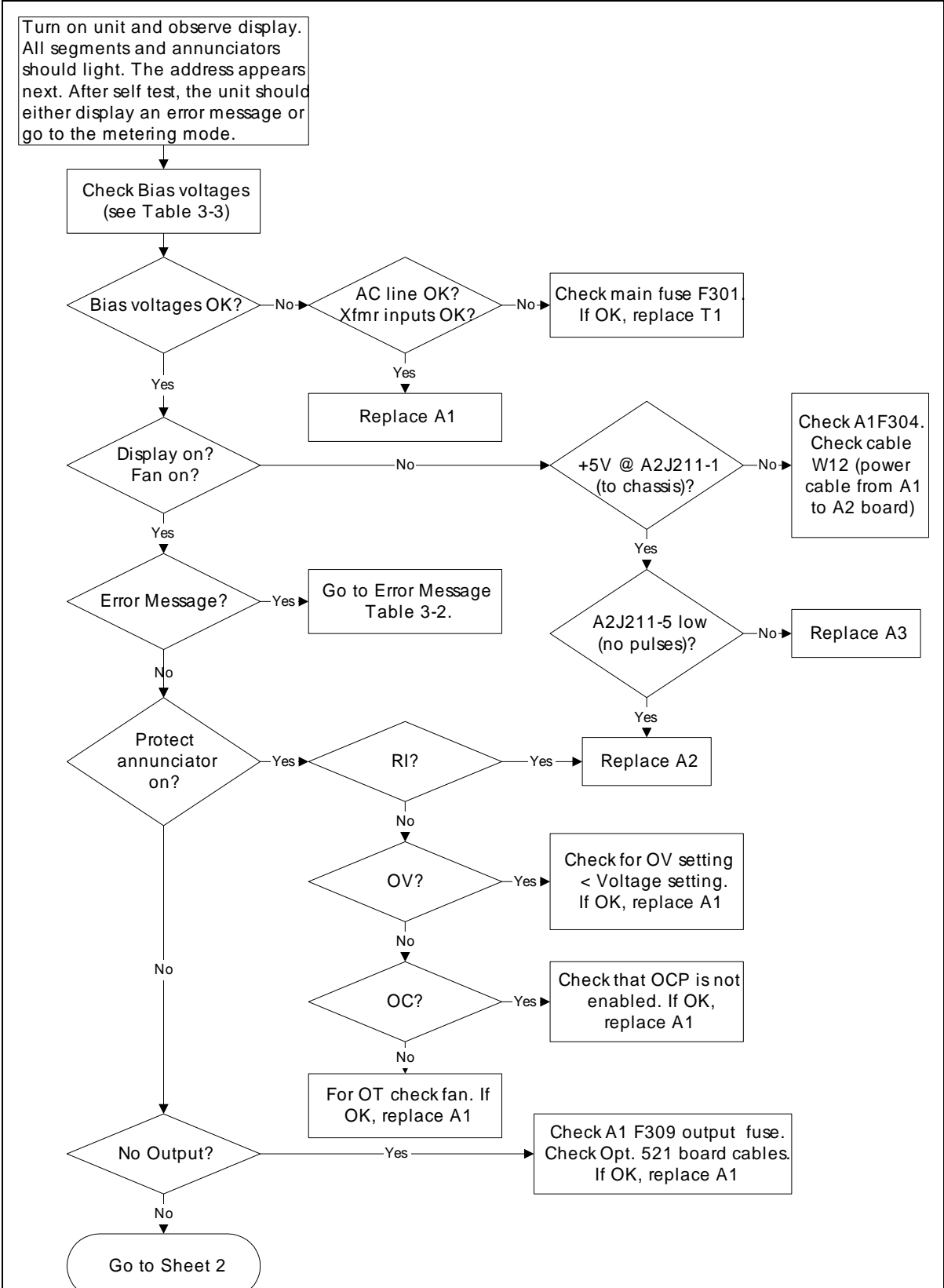


Figure 3-1 Sheet 1. Troubleshooting Flowchart

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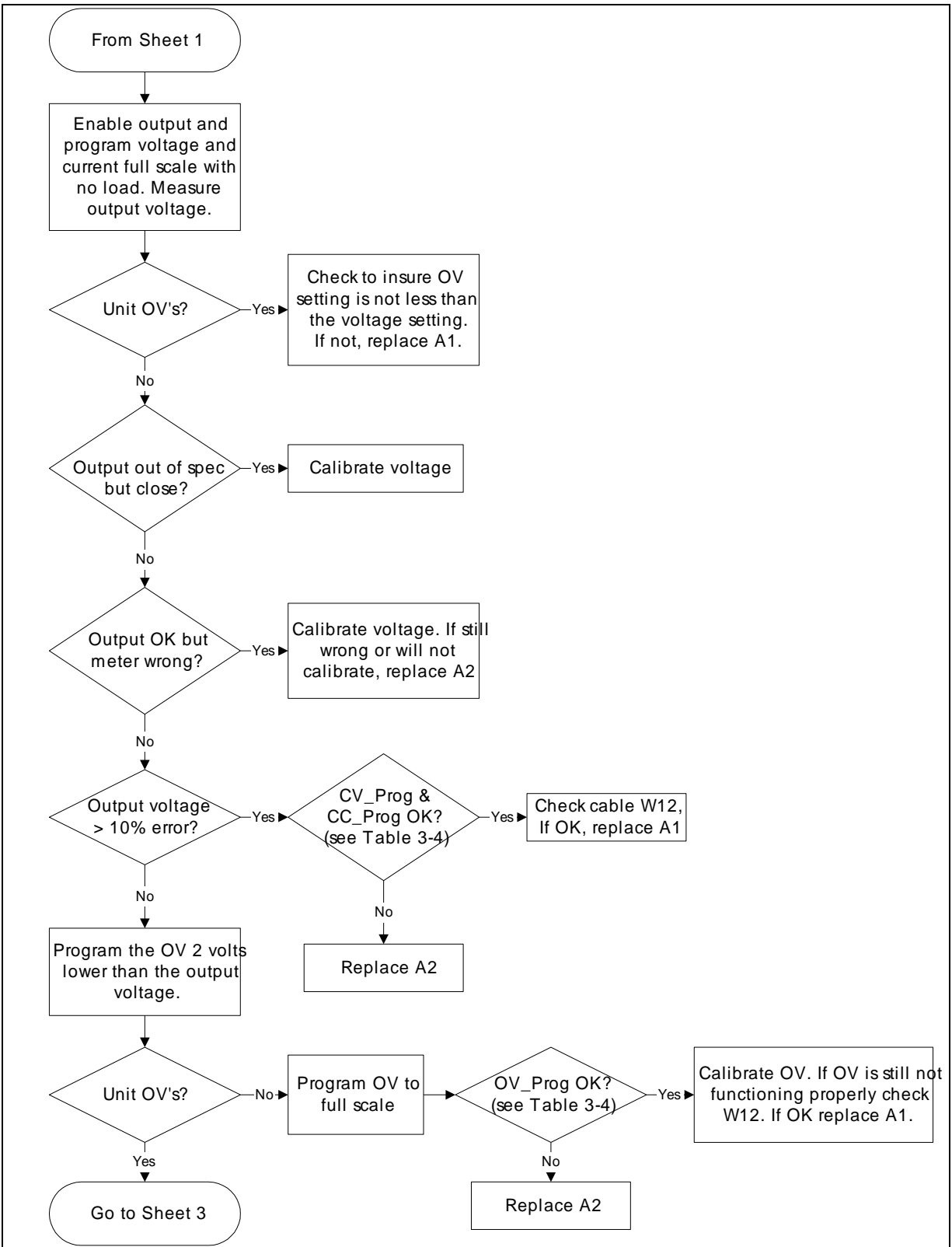


Figure 3-1 Sheet 2. Troubleshooting Flowchart

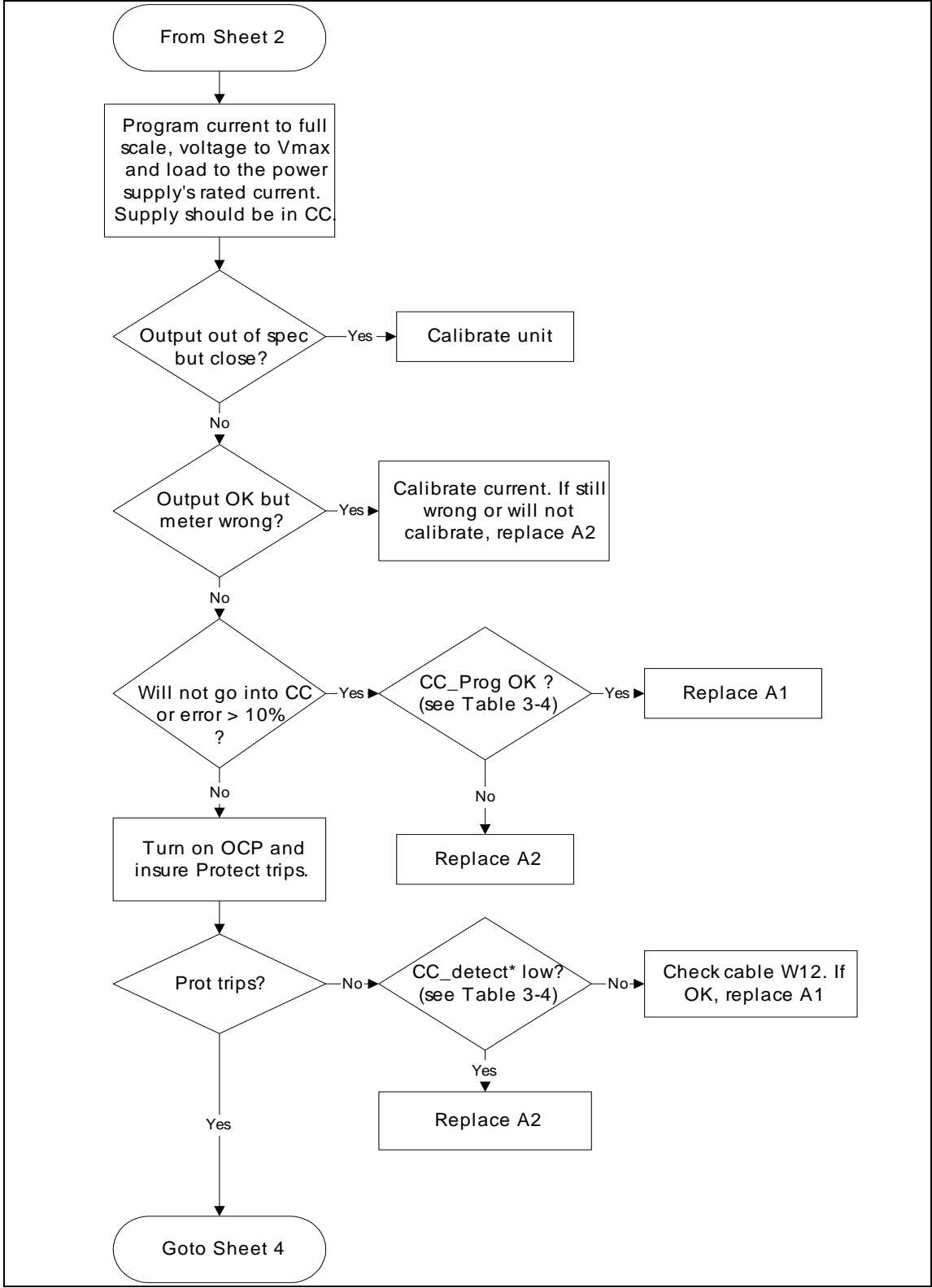


Figure 3-1 Sheet 3. Troubleshooting Flowchart

3 - Troubleshooting

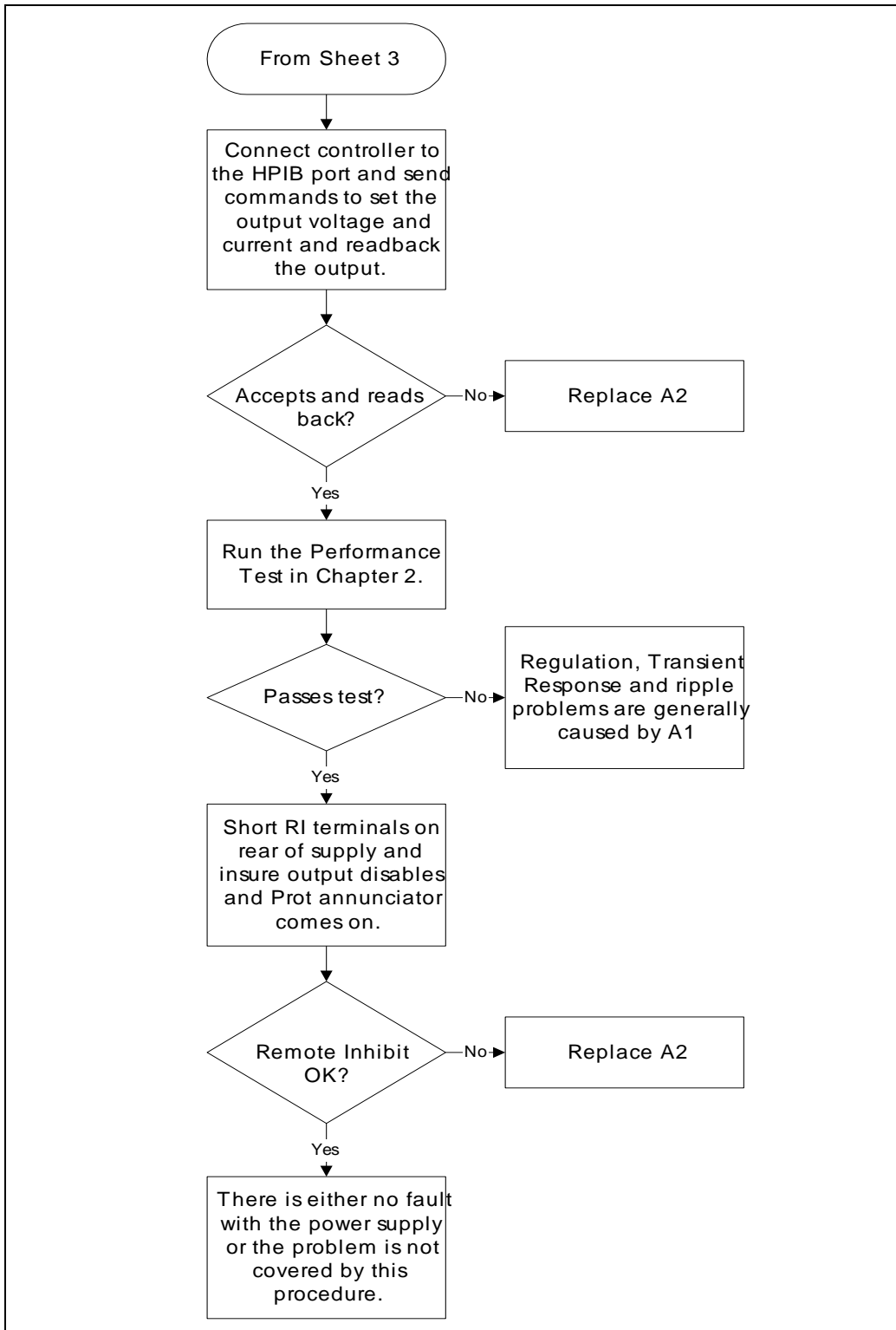


Figure 3-1 Sheet 4. Troubleshooting Flowchart

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 dc source 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

Bias and Reference Supplies

Before troubleshooting any circuit check the bias and/or reference voltages to make sure that they are not the cause. Table 3-3 lists the bias and reference 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 (R899 on surface-mount units; R431-4 on through-hole units) with no load on the supply.

Table 3-3. Bias and Reference Voltages

Bias	Test Point	Common	Measurement
+5V primary	A1 J206-1(Red)	Chassis (J206-2 black)	+5V +/- 0.15V
+5V secondary	A1 R423	A1 R431-4 (through-hole) A1 R899 (surface-mount)	+5V +/- 0.2V
+15V secondary	A1 R419	A1 R431-4 (through-hole) A1 R899 (surface-mount)	+15V +/- 0.6V
-15V secondary	A1 R422	A1 R431-4 (through-hole) A1 R899 (surface-mount)	-15V +/- 0.6V
+15V secondary gated	A1 F304	A1 R431-4 (through-hole) A1 R899 (surface-mount)	+14.2V +/- 5%
-15V secondary gated	A1 F302	A1 R431-4 (through-hole) A1 R899 (surface-mount)	-14.2V +/- 5%
+Rail Output 1 ^{Note1}	Heat Sink	- Output	~25V with no load +/-10%
+Rail Output 2 ^{Note1}	Drain/Case Q762	- Output 2	~20V with no load +/-10%
+2.5V reference	A1 J307-6 (through-hole) A1 +C753 (surface-mount)	A1 R431-4 (through-hole) A1 R899 (surface-mount)	+2.5V +/- 5%
+5V bias Output 2	A1 UB771-1	R885	+5V +/- 0.2V
-5V bias Output 2	A1 UB760-16	R885	-5V +/- 0.2V
+12V bias Output 2	A1 UB760-15	R885	+12V +/- 0.5V

¹ Measured at nominal ac input line voltage

CV/CC Status Annunciators Troubleshooting

The CV/CC annunciators are particularly helpful when troubleshooting a unit with no output voltage or current. If the unit has passed self test the programming DAC circuits on the A2 circuit board are probably working properly. If either the CV or CC annunciators is on then the problem is in either the CV or CC control circuits located on the A1 Main board. If UNR is indicated then neither the voltage nor the current circuits are in control and the problem would be in the main power transformer or the driver or output regulator stages circuits, also on A1 but after the gating diodes.

J307 Voltage Measurements

Cable W8 connects J307 of the A1 Main Board Assembly to J207 of 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. Note that Keysight 66311B units with through-hole boards (these are the units that have the external remote sense switch on the rear panel) have a 28-pin connector. All other units with surface-mount boards use the 30-pin connector.

Table 3-4. Voltage Measurements at J207 (A2 Interface to A1 Main board)

A1J207 (30-pin)	A1J207 (28-pin)	Signal Name	CV Mode Full Scale Voltage No Load	CC Mode Full Scale Current Full Load
1		Status_Ctrl_1 (30-pin only)		
2	1	PM_Inhibit	0 (Enabled)	0 (Enabled)
3	2	OV_SCR	+5	+5
4	3	OV_Prog	+3.9	+3.9
5	4	Fan_Prog	+2.8	+3.8
6	5	OV_Detect	+5	+5
7	6	Burst (30-pin) 2.5V reference (28-pin)	2.5	2.5
8	7	Range_Cap (30-pin only)		
9	8	CV_Prog_2 (30-pin only)		
10	9	C_Mux_Ctrl_2 (30-pin only)		
11	10	+5Vs	+5	+5
12	11	Common	0	0
13	12	Common	0	0
14	13	+15Vs	+15	+15
15	14	-15Vs	-15	-15
16	15	HS_Therm	+2.5 (@25C)	+2.5 (@25C)
17	16	CC_Prog_2 (30-pin) Fuse (28-pin)	+2.4	+2.6
18	17	IMon_H	0	+3.5
19	18	Rdbk_16bit (30-pin) IMon_L (28-pin)	0	+14.7
20	19	IMon_P	0	0
21	20	VMon	+4.8	+4.8
22	21	Common	0	0
23	22	Common	0	0
24	23	Common	0	0
25	24	CV_Prog	-4.8	-4.8
26	25	CC_Prog	-4.8	-4.8
27	26	C_Mux_Ctrl_1 (30-pin) CC_Detect (28-pin)	+5	0
28	27	Common		
29	28	Status_Detect (30-pin) CV_Detect (28-pin)	0	+5
30		Status_Ctrl_2 (30-pin only)		

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 "1" 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 "1" 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

The dc source'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. The overvoltage protection function is not disabled by this procedure. To disable the protection:

- a. Simultaneously depress the "0" and "1" 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 either A1 or A2 are replaced, the supply must be re-calibrated as described in Appendix B of the User's Guide.

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

Calibration Password

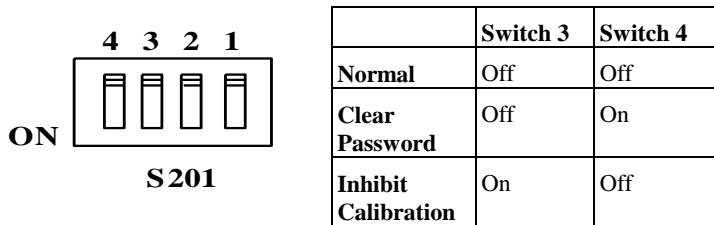
In order to enter the calibration mode, you must use the correct password as described in Appendix B of the User's Guide. As shipped from the factory, the number 0 (zero) is the password. If you use an incorrect password, "OUT OF RANGE" will appear on the display for front panel calibration (or error 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.

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 dc source 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 two 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.



Initialization

The dc source'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 dc source:

- Enable the Calibration mode by pressing "Shift", then "Cal", and then "Enter".
- Simultaneously depress the "0" and "1" keys. EEINIT <model> will be displayed.
- Using the Up/Down annunciator keys select ROMUPD <model>.
- Using the Up/Down arrows select the appropriate model number.
- Press "Enter".

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

There are two ways to identify the firmware of the unit, either from the front panel of the unit or over the GPIB. To display the firmware revision from the front panel of the unit,

- Press the "Address" key.
- Using the Up/Down annunciator keys, scroll to ROM: <A.xx.xx>

3 - Troubleshooting

To identify the firmware revision over the GPIB bus, use the *IDN? query . The query will read back the revisions of the Primary Interface ROM (U205) located on the A2 Interface board. The manufacturer and model number of the unit are also returned. The following is a sample program:

```
10 ALLOCATE L$ [42]
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: "HEWLETT-PACKARD,66312A,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

CAUTION: The dc source 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 source, observe all standard, antistatic work practices (see chapter 1).

- Under the Disassembly Procedures, in the section titled "A2 Interface Board, Removal and Replacement" perform steps a. through f.
- The board is now in a good position to replace the ROM. Use a chip removal tool (PLCC SMT Removal Tool, p/n 5041-2553 or equivalent).
- Carefully pull the U205 chip out of its socket using the access slots located in the two diagonal corners of the chip socket.
- To insert the new chip, place it over the chip socket. Face the bevel (or the dot on the chip) toward the back of the board, away from the GPIB connector. Push the chip down into the socket.
- After the Interface board ROM is upgraded you can re-initialize the supply without affecting the calibration. See "Initialization".

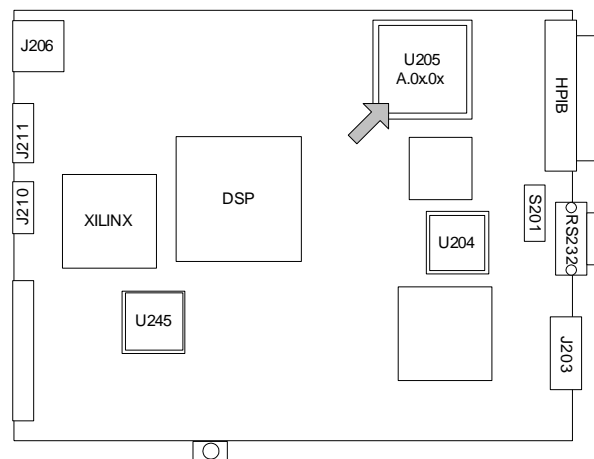


Figure 3-2. Firmware component Locations

Disassembly Procedures

The following paragraphs provide instructions on how to disassemble various components of the dc source. Once disassembled, the components can be reassembled by performing the disassembly instructions in reverse order.

Figure 3-3 shows the location of the major components of the unit. Note that not all boards are included with every model. Figure 3-4 shows the location of the cables that interconnect all of the boards. This figure shows only the boards, not the chassis of the unit.

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.

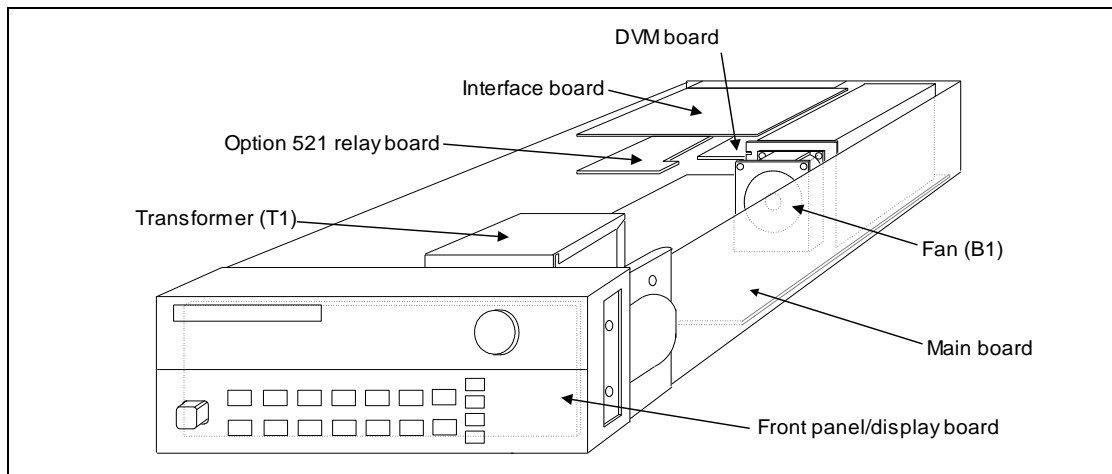


Figure 3-3. Component Location

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,
8 mm for toggle switch located on the back of Keysight 66311A and earlier 66311B units
- d. Long nose pliers.
- e. Antistatic wrist discharge strap.

3 - Troubleshooting

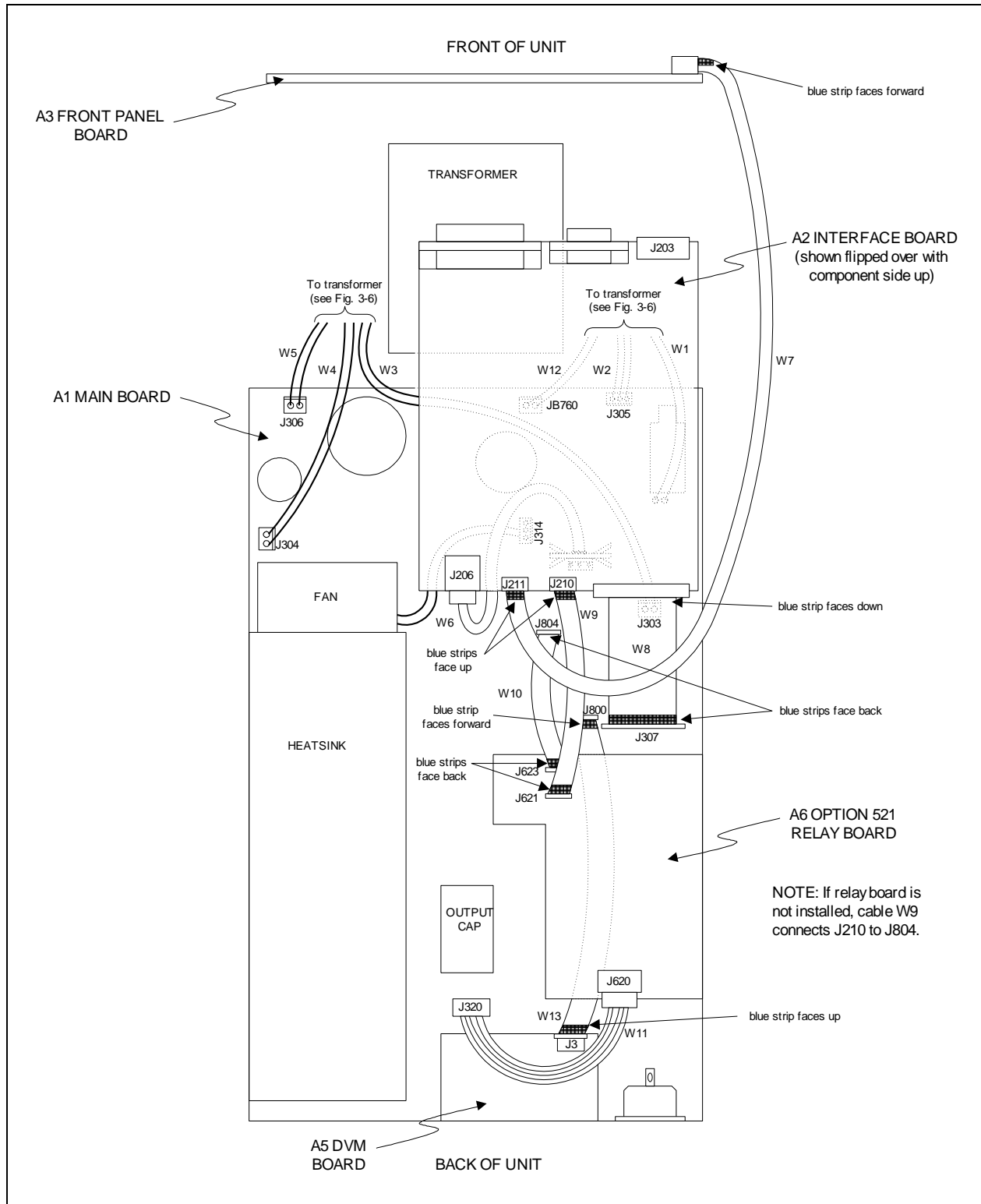


Figure 3-4. Cable Locations

Cover, Removal and Replacement

- a. Using a T15 Torx screwdriver, unscrew the two captive screws that hold the rear bezel on the unit.
- b. Remove the two screws from the bottom of the case.
- c. Slide the cover back until it clears the rear of the dc source.

A2 Interface Board, Removal and Replacement

To remove the Interface Board, proceed as follows:

- a. Remove the cover of the dc source as described under, "Cover Removal and Replacement."
- b. Remove the two 7 mm and two 3/16 inch hex screws that hold the GPIB and RS-232 connectors in place.
- c. Slide the board forward, lift up on the side of the board closest to the heatsink, and slide the board out.
- d. Place a piece of non-conducting material (stiff paper or cardboard) on top of the transformer, flip the interface board over, and place it on top of the non-conducting material.
- e. Unplug the 3-conductor cable from J206. Push down on the locking tab to release the connector.
- f. Unplug the ribbon cables. Note the position of the blue conductive side for reinstallation as shown in figure 3-4. Release the cable by pulling out the end tabs as shown by the arrows in figure 3-5.

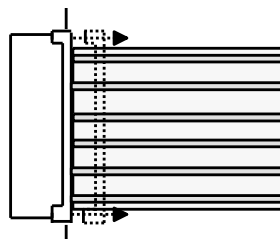


Figure 3-5. Cable Release

- g. To reinstall the Interface board, perform steps a through e in reverse order.

Front Panel Assembly, Removal and Replacement

This procedure removes the front panel assembly from the dc source.

- a. Remove the cover as described earlier in, "Top Cover Removal and Replacement."
- b. Using a Torx T10 driver remove the screw from the **right** side of the supply that holds the front panel bracket to the chassis.
- c. Locate and carefully peel off the **left** vinyl trim to gain access to the side screw that secures the front panel to the chassis. Using a Torx T15 driver remove the screw located behind the vinyl trim.
- d. Place the power switch in the on position. Slide the switch extension forward as far as it can go and lift it up to disengage from switch. Remove the extension from the unit.
- e. Rotate the front panel forward from right side to disengage the left mounting studs. Pull the entire panel forward. Be careful not to break the Front panel ribbon cable. (To remove the ribbon cable you must first remove the front panel board from the front panel assembly).
- f. To remove the right bracket, depress the plastic tab located behind the front panel in the upper right corner.
- g. To reinstall the Front Panel Assembly, perform the above steps in reverse order.

3 - Troubleshooting

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. Pull back the right side of the board near the RPG about 1/8th of an inch. Slide the board to the left to disengage the holding clips.
- c. Once the board is free, you can remove the ribbon cable (see figure 3-5).
- d. To reinstall the Front Panel board, perform the above steps in reverse order.

A6 Option 521 Relay Board (not on all models)

- a. Remove the top cover and flip over the A2 Interface board as previously described.
- b. Unplug the wiring harness from J620. Push down on the locking tab to release the connector.
- c. Unplug the ribbon cables. Note the position of the blue conductive side for reinstallation as shown in figure 3-3. Release the cable by pulling out the end tabs as shown by the arrows in figure 3-5.
- d. Using a T15 Torx screwdriver, unscrew the two screws that attach the board to the chassis.
- e. To reinstall the Option 521 board, perform the above steps in reverse order.

A7 DVM Board (not on all models)

- a. Remove the top cover and flip over the A2 Interface board as previously described.
- b. If your unit has an Option 521 board, remove the two screws that attach the board to the chassis and move the board out of the way.
- c. Unplug the ribbon cable from the DVM board. Note the position of the blue conductive side for reinstallation as shown in figure 3-4. Release the cable by pulling out the end tabs as shown by the arrows in figure 3-4.
- d. Using a #2 Pozidrive, unscrew the screw that attaches the board to the chassis.
- e. To reinstall the DVM 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. Place the power switch in the on position. Slide the switch extension forward as far as it can go and lift it up to disengage from switch. Remove the extension from the unit.
- c. If your unit has a DVM board or an Option 521 board, remove these boards as previously described.
- d. 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 when reinstalling these cables (see figure 3-4).

- e. Disconnect the ground wire between the main board and the chassis. This wire is secured to the side of the chassis near the AC input by a Torx T15 screw.
- f. Remove the three Torx T15 screws that secure the main control board to the chassis.
- g. Slide the main board towards the front panel to release it from chassis mounted standoff. Carefully lift the board out of the chassis.

T1 Power Transformer, Removal and Replacement

NOTE: The transformer primary connections are line voltage dependent. Figure 3-6 illustrates the primary wiring configuration of the power transformer for various ac line voltages.

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.

- Remove the front panel assembly as previously described.
- Remove the two 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 bracket.
- Use long nose pliers to disconnect all wires going to the transformer terminals.
- Lift the transformer out of the chassis.

CAUTION: Install the correct fuse when changing the ac line voltage from a previous setting:
 for 110/120 Vac: 3.15 AT, 250V, p/n 2110-0638;
 for 220/230 Vac: 1.6 AT, 250V, p/n 2110-0773
 The fuse is located on the A1 Main board assembly right behind the line switch.

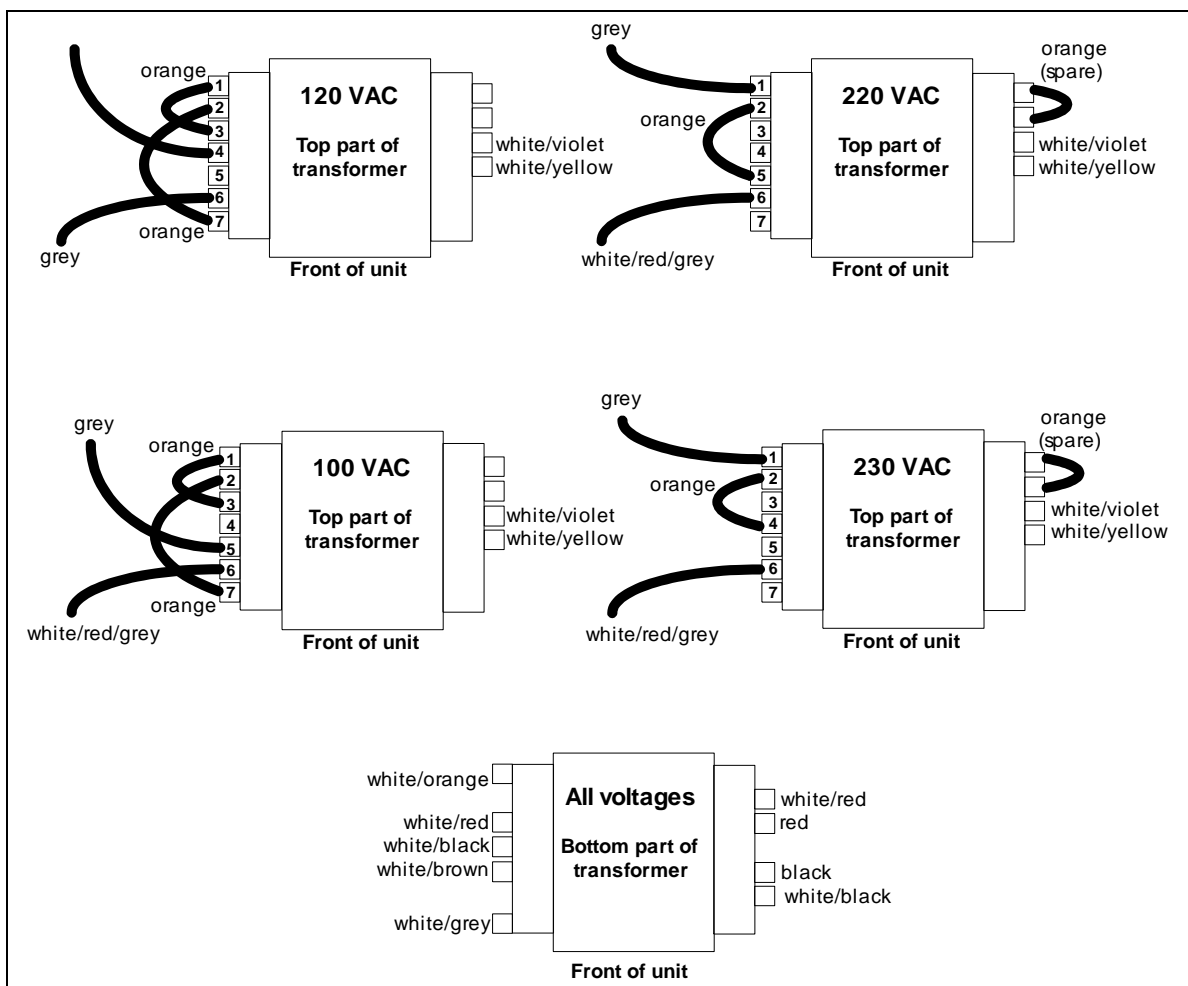


Figure 3-6. Transformer Wiring

Principles of Operation

Introduction

This section describes the different functional circuits used in the dc source. First, the I/O external signals that connect to the dc source are described. Next, the overall block diagrams for the dc source are described in detail. The simplified block diagrams found in chapter 6 show the major circuits on the dc source as well as the signals between circuits. They also show the reference designations of some of the components in the functional circuit.

I/O Interface Signals

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

Table 4-1. Dc source Interface signals

Connector	Signal	Description										
Rear panel Output 1 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										
Rear panel Output 2 screw terminals (Keysight 66309B/D only)	+OUT 2 -OUT 2 + sense 2 - sense 2 common	Positive dc output 2 voltage Negative dc voltage 2 (or return) +OUT sensing terminal -OUT sensing terminal connected to ground conductor										
Rear panel DVM screw terminals (Keysight 66311D/66309D only)	+IN -IN common	Positive dc input Negative dc input connected to ground conductor										
INH/FLT connector (units are shipped set to INH/FLT)	pin 1 pin 2 pin 3 pin 4	<table border="0"> <tr> <td><u>FLT/INH mode</u></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>	<u>FLT/INH mode</u>	<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>	<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	Interface to an external GPIB controller										
Ac input connector	ac mains	Can be 100Vac, 120Vac, 220Vac or 240Vac Input										

A3 Front Panel Circuits

As shown in Figure 6-3, the supply's front panel assembly contains a circuit board, a keypad, a display, 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. The Keysight 66311A unit has a separate front panel binding post board. All circuit boards are available as assembly-level replaceable parts.

The A3 front panel board contains microprocessor circuits, which decode and execute all keypad and RPG commands that are transferred to the dc source output via the serial I/O port to the primary interface circuits on the A2 interface board. The front panel microprocessor circuits also process dc source measurement and status data received on the serial I/O port and send them to the display.

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 source. Communication between the dc source and an 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 source are located on the A2 Interface board. 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 processes 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 (referenced to the supply's output common).

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. Communication between the A1 and A2 boards is accomplished via a 30-pin connector.

NOTE: Keysight 66111A, 66311A, and earlier 66311B units with through-hole boards have a 28-pin connector between the A1 and A2 boards. Some signals on the 28-pin connector differ from the signals on the 30-pin connector described in this section. Refer to Table 3-4 for the differences.

The logic array also directly communicates with the A1 main board via a number of level-sensitive signal lines, which perform the following functions: C_Mux_Ctrl_1 and C_Mux_Ctrl_2 control the readback multiplexer for output 2 and the DVM; Status_Ctrl_1 and Status_Ctrl_2 control the Status readback multiplexer. The PM_Inhibit control signal is used to shut down the bias voltage to the output stages and keep the dc source output off. The OV_SCR* control signal is used to fire the SCR. The Status_Detect signal informs the array of the present operating mode (either CV or CC) of both the main output and output 2. The OV_Detect signal indicates if an overvoltage condition has occurred on the Main output.

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 source.

The Quad 8-bit DAC converts programmed information for the following circuits into analog format: output 2 voltage programming (CV_Prog_2), output 2 current programming (CC_Prog_2), overvoltage setting (OV_Prog), and fan speed programming (Fan_Prog). The CV_Prog_2 and CC_Prog_2 signals control the magnitude of the output 2 voltage in the CV mode and output 2 current in CC mode. The OV_Prog signal is applied to the OV detect circuit of the main output, which compares the programmed overvoltage setting with the actual output voltage. The Fan_Prog signal is applied to the fan speed control circuit in order to speed up the fan as temperature or output current increases, and to slow the fan speed down as temperature or current decreases.

The 16-bit ADC in conjunction with a 4x1 multiplexer returns data from the following measurement signals to the logic array: monitored peak current (Imon_P), monitored high-range current (Imon_H), readback signal for output 2 and the DVM (Rdbk_16bit), and monitored output voltage (VMon). All measurement signals are in the range of 0 to +5V, which corresponds to the zero to full-scale readback capability of the dc source.

The 8-channel, 8-bit ADC returns the following signals to the logic array: overvoltage programming (OV_Prog), high-range output current (Imon_H), voltage and current of output 2 (Rdbk_16bit), main output voltage (V_Mon), ambient temperature (Temp_Amb), and heatsink temperature (HS_Therm). The logic array varies the Fan_Prog signal depending upon the ambient temperature and the main output current.

A1 Main Board Circuits

Power Circuits

As shown in figures 6-2 and 6-4, the power circuits consist of: input power rectifiers and filter, primary and secondary bias circuits, an output regulator, a downprogrammer circuit, current-monitoring resistors, an overvoltage SCR, and an output filter. All bias circuits are located on the A1 pc board. Bias voltage test points are shown in figure 6-1 and transformer wiring diagrams are shown in figure 3-3.

The primary bias circuits are referenced to chassis (earth) ground. They provide the bias for the GPIB, RS232 and RI/DFI interfaces, the interface micro-processor circuits and the front panel.

The secondary bias circuits are referenced to secondary (output) common and are isolated from the chassis ground. They provide the bias for the amplifier and output circuits located on the A1 pc board. They also provide the bias for the logic array, EEPROM, DAC and ADC circuits and the secondary side of the Opto-isolators on A2.

As shown in figure 6-2, the ac input rectifier and filter converts ac input to a dc level. The output regulator regulates this dc level at the output of the dc source. The output regulator stage consists of two parallel NPN series regulators mounted on a heatsink and connected between the +Rail and the +Output. The conduction of these series regulators is increased or decreased by the Control signal from the CV/CC control circuits in order to regulate the output voltage (in CV mode), or output current (in CC mode).

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An NPN downprogramming transistor is connected between the +Output and the -Rail. The conduction of the downprogramming transistor is controlled by the DP_Control signal from the CV/CC control circuits. Whenever the output voltage is greater than the programmed voltage setting, the downprogramming transistor conducts and shunts current away from the load until the output voltage equals the programmed setting.

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).

Two current shunt resistors (RmHi and RmLo) monitor the output current. RmHi monitors the high current range; RmLo monitors the low current range. Shunt clamps are connected in parallel across RmLo to limit the voltage across RmLo to about 1.5 volts. This corresponds to approximately 30 mA (20mA is the maximum rating of the low current range). An output filter capacitor provides additional filtering of the dc output.

Control Circuits

As shown in Figure 6-2, the control circuits consist of the CV/CC control, output voltage/current monitor, bias supplies, and SCR control.

The CV/CC control circuits provide a CV control loop and a 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. A low level CV_Detect or CC_Detect signal is returned to the secondary interface to indicate that the corresponding mode is in effect.

With the CV loop in control, the output voltage is regulated by comparing the programmed voltage signal CV_Prog (0 to -5V) 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, the Control signal goes low, causing the output regulator to conduct less and decrease the output voltage. Conversely, if the output voltage is less than the programmed voltage, the Control signal goes high, causing the regulator to conduct more and increase the output voltage. The output voltage is monitored through the +S and -S sensing terminals. If local sensing is being used, the output voltage is monitored at the output terminals. If remote sensing is being used, the output voltage is monitored where the remote sense leads are connected to the load. If the output voltage goes higher than the programmed value, the downprogramming stage is turned on.

With the CC loop in control, the output current is regulated by comparing the programmed current signal CC_Prog (0 to -5V), with the output current monitor signal Imon_H. The Imon_H signal is produced by measuring the voltage drop across current monitoring resistor and is in the 0 to +3.5 V range, which corresponds to the zero to full-scale output current range. If the output current exceeds the programmed value, the Control signal goes low, causing the output regulator to conduct less and thus decrease the output current. Conversely, if the output current is less than the programmed value, the Control signal goes high, causing the output transistors to conduct more and increase the output current. A positive gross current limit circuit protects the output if the output current exceeds the maximum current rating of the unit. A negative gross current limit prevents the unit from sinking too much current.

When the downprogramming stage is turned on (in either CV or CC mode), the CV/CC control circuit causes the Control signal to go low, which in turn causes the downprogramming transistors to conduct current away from the load and speed up downprogramming.

During operation, a PM_Inhibit signal will cause the output stage bias/shutdown circuit to turn off the gated 15 V bias voltages 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. A shunt clamp (Q302 and Q304) clamps the voltage across RmLo to approximately 1.5 V. The third current readback circuit 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 signals 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 gated 15V bias supplies, and update the status of the unit.
3. The PM_Inhibit signal goes high, programming the output off and shutting down the gated 15V bias for the output regulators.
4. When a output protection clear command is executed, the microprocessor circuits resets the OV circuits, turns on the gated 15V biases, 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.

Output 2

As shown in Figure 6-5, the output 2 circuits consist of input power rectifiers and filter, an output regulator, a downprogrammer circuit, current-monitoring resistor, an output filter, the CV/CC control, output voltage/current monitor, and an inhibit circuit. Output 2 data is transferred between the output 2 circuits and the primary interface via the CV_Prog2, CC_Prog2, Status_Detect, and the Rdbk_16bit signals.

NOTE: Isolation between the main output and output 2 is provided by isolation amplifiers and optical isolation chips.

The ac input rectifier and filter converts ac input to a dc level. The output regulator regulates this dc level at the output. The output regulator stage consists of a P-channel FET series regulator connected between the +B Rail and the +B Output. The conduction of the series regulators is increased or decreased by the Control_2 signal from the CV/CC control circuits in order to regulate the output voltage (in CV mode), or output current (in CC mode).

A downprogramming FET is connected between the +B Output and the -B Output. The conduction of this FET is controlled by the Drive signal from the CV/CC control circuits. When the output is turned off, the downprogramming FET conducts and shunts current away from the load.

A current shunt resistor monitors the output current. A gross current limit circuit protects the output if the output current exceeds the maximum current rating of the output. An output filter capacitor provides additional filtering of the dc output.

The CV/CC control circuits provide a CV control loop and a 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. A low level B_CV_Detect or B_CC_Detect signal is returned to the secondary interface to indicate that the corresponding loop is in control.

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With the CV loop in control, the output voltage is regulated by comparing the programmed voltage signal CV_Prog2 (0 to +5V) with the output voltage sensed at the +B and -B Output. If the output voltage exceeds the programmed voltage, the Control_2 signal goes low, causing the output regulator to conduct less and decrease the output voltage. Conversely, if the output voltage is less than the programmed voltage, the Control_2 signal goes high, causing the regulator to conduct more and increase the output voltage. Depending on where the output sense leads are connected, the output voltage is either monitored at the supply's B Output terminals, or at the load, with the the remote sense leads connected to the load.

With the CC loop in control, the output current is regulated by comparing the programmed current signal CC_Prog2 (0 to +5V), with the output current monitor B_Imon. The B_Imon signal is produced by measuring the voltage drop across current monitoring resistor and is in the 0 to +5V range, which corresponds to the zero to full-scale output current range. If the output current exceeds the programmed value, the Control_2 signal goes low, causing the output regulator to conduct less and thus decrease the output current. Conversely, if the output current is less than the programmed value, the Control_2 signal goes high, causing the output regulator to conduct more and increase the output current.

When the downprogramming FET is turned on (in either CV or CC mode), current is conducted away from the load, which speeds up downprogramming.

During operation, an Inhibit_2 signal causes the Output Regulator to turn off if any of the following occur:

- The output 2 is programmed off.

- The line voltage falls below 90 volts (approximately).

Current readback is provided by a multiplexer that alternately reads both output voltage and output current. Switches at the front end of the multiplexer toggle between the B_Imon and the B_Vmon signal depending on whether the C_Mux_Ctrl_1 signal is high or low. When the signal is low, the output voltage is read. When the signal is high, the output current is read.

A5 DVM Circuits

The circuits on the A5 DVM board measure the voltage signal applied to its input terminals. Differential amplifiers on the A5 board amplify and subtract the + and - DVM inputs and create an output signal referenced to Output 1 common. The resultant signal is transferred from the A5 board to the A2 interface assembly via cable W13. All analog-to-digital conversion functions are accomplished on the A2 interface board using the same ADC circuits that are used to perform the readback functions on the dc source output. Because the inputs to these measurement circuits are multiplexed, you cannot simultaneously make DVM measurements while measuring the dc source output. Also, because the measurement circuits of the DVM are internally referenced to the minus terminal of the main output, the DVM cannot measure voltages greater than +25 Vdc or less than -4.5 Vdc with respect to the negative terminal of the main output. The A5 DVM board is assembly-level replaceable; it contains no user-replaceable parts.

A6 Option 521 Relay Circuits

The A6 Option 521 relay board incorporates solid-state relays to connect and disconnect the outputs of the dc source. The relays are available on the - Out and - sense terminals of Output 1 and on the + Out and + sense terminals of Output 2. When the solid state relays are open, the output impedance is effectively raised to about 500k ohms for output 1, and about 200k ohms for output 2. The output relays are controlled by signals generated on the A2 Interface board, which are transferred to the relay board via cable W9. Cable W10 is used to daisy-chain other signals such as the output on/off signals from the A2 Interface board to the A1 board. Cable W11 connects the relays to the outputs of the dc source. The A6 Option 521 relay board is assembly-level replaceable; it contains no user-replaceable parts.

Replaceable Parts List

Introduction

This section lists the replaceable parts for all models. Refer to figures 5-1 and 5-2 for the location of mechanical parts with the reference designators MP.

Table 5-1. Chassis, Electrical

Designator	Part Number	Qty	Description
***** SURFACE-MOUNT UNITS ONLY ***** (refer to title page for serial numbers)			
A1	66311-61021 66311-61027 ¹	1	66311B/D Tested PCA (printed circuit assembly)
	66309-61020 5064-0129 ¹	1	66309B/D Tested PCA
	66311-61028 66311-61029 ¹	1	66311B Tested PCA (J02)
	5064-0095 5064-0138 ¹	1	66309D Tested PCA (Option 521)
	5064-0094	1	66309D Tested PCA (Option 501)
A2	5064-0098	1	66311B/D, 66309B/D Tested Interface PCA
A3	66309-60001 66311-61021	1 1	Complete Front Assembly (includes frame, keypad, PCA, etc.) Tested Printed Circuit Assembly (PCA) only
A5	5064-0045 5064-0100 5064-0087 ¹	1 1	66311D, 66309D Tested DVM PCA 66311D, 66309D Tested DVM PCA (Option 521)
A6	5064-0092 66309-61025 ¹	1	Relay Board (Option 521)
A7	5064-0097	1	Output 2 Downprogrammer PCA (Option 501)
B1	06632-60002	1	Fan Assembly
F301	2110-0773 2110-0638	1 1	Fuse, 1.6AT, 250V, surface-mount (230Vac input) Fuse, 3.15AT, 250V, surface-mount (115Vac input)
F302, 04, 07	2110-0671	3	Fuse 0.125AM, 125V
F303, 05, 06	2110-0699	3	Fuse, submin, 5AM 125V
F309	2110-0951	1	Fuse, submin, 5AT 125V
F310	2110-0932	1	Fuse, surface-mount, 5AM 125V
F311	2110-1138	1	Fuse, surface-mount, 15AM
FB760	2110-0967	1	Fuse, submin, 4AT, 125V
FB761	2110-0712	1	Fuse, submin, 4AM, 125V (66309B/D output 2)
G1	0960-0892	1	Rotary pulse generator

¹These board assemblies are only used on units with firmware revision A.02.04 and up (see chapter 3).

5 - Replaceable Parts List

Table 5-1. Chassis, Electrical (continued)

Designator	Part_Number	Qty	Description
T1	9100-5276	1	Main Power Transformer
W1	06611-80033		Primary Power Cable (T1 to A1 E312/313)
W2	5063-3479	1	Secondary Power Cable (T1 to A1 J305)
W3	5064-0011	1	Secondary Power Cable (T1 to A1 J303)
W4	5064-0008	1	Secondary Bias Cable (T1 to A1 J304)
W5	5064-0010	1	66309B/D Output 2 Bias Cable (T1 to A1 J306)
W6	5080-2452	1	Interface Power Cable (E320/321 to A2J206)
W7	5080-2457	1	Display Power/Comm Cable (A2 J211 to A3)
W8	5080-2640	1	Interface Signal/Bias Cable (A1 J307 to A2 J207)
W9	5081-4996	1	Relay /Comm Cable (A2 J10 to A6 J621)
W10	5080-2683	1	Relay /Comm Cable (A1 J804 to A6 J623)
W11	5080-2682	1	Relay /Output Cable (A1 J320 to A6 J620)
W12	5064-0009	1	Secondary Power Cable (T1 to A1 JB760)
W13	5080-2644	1	DVM /Comm Cable (A5 J3 to A1 J800)
	06611-60056	2	T1 Primary Jumper (orange)
***** THROUGH-HOLE UNITS ONLY ***** (refer to title page for serial numbers)			
A1	66111-61020	1	66111A Printed Circuit Assembly (PCA)
	66311-61025	1	66311A/B Tested PCA (through-hole)
A2	5064-0086	1	66111A Tested Interface PCA (for through-hole units)
	5064-0085	1	66311A/B Tested Interface PCA (for through-hole units)
A3	5064-0016	1	Complete Front Assembly (includes frame, keypad, PCA, etc.)
	5063-3430	1	Tested Printed Circuit Assembly (PCA) only
A4	06611-60022	1	66311A Binding Post PCA
B1	06632-60002	1	Fan Assembly
F301	2110-0007	1	Fuse, 1AT, 250V, rear mounted (230Vac input)
	2110-0303	1	Fuse, 2AT, 250V, rear mounted (115Vac input)
F302, 04, 07	2110-0671	3	Fuse 0.125AM, 125V
F303, 05, 06	2110-0699	3	Fuse submin. 5AM, 125V
F308, 310	2110-0699	2	Fuse submin. 5AM, 125V
F309	2110-0951	1	Fuse submin. 5AT, 125V
G1	0960-0892	1	Rotary pulse generator
S1	5080-2600	1	66311A AC calibration switch (with R415)
T1	9100-5232	1	Main Power Transformer
W1	06611-80003	1	Primary Power Cable (T1 to A1 E312/313)
W2	06611-80005	1	Secondary Power Cable (T1 to A1 J305)
W3	06611-80006	1	Secondary Power Cable (T1 to J303)
W4	06611-80004	1	Secondary Power Cable (T1 to A1 J304)
W6	5080-2452	1	Interface Power Cable
W7	5080-2457	1	Display Power/Comm Cable
W8	5080-2448	1	Interface Signal/Bias Cable
	06611-60056	2	T1 Primary Jumper (orange)
	06611-80007	1	Output Cable - 66311A only (E315B/E315R to A4 board)

Table 5-2. Chassis, Mechanical

Designator	Part Number	Qty	Description
***** SURFACE-MOUNT UNITS ONLY ***** (refer to title page for serial numbers)			
MP1	5002-1519	1	Chassis
MP3	33120-40200	1	Front Frame
MP4	66311-80002	1	Nameplate - 66311B
	66311-80003	1	Nameplate - 66311D
	66309-80001	1	Nameplate - 66309B
	66309-80002	1	Nameplate - 66309D
MP5	5080-2617	1	Window
MP6	06611-40001	1	Pushrod (Ref Line Switch)
MP7	06611-40002	1	Keypad
MP8	33120-87401	1	Knob
MP9	5001-0538	2	Side Trim
MP10	5040-1723	1	Side Bracket, Right
MP11	1400-0977	3	Ground Clip
MP12	0515-0433	7	Screw, M4x0.7x16mm, Torx T15, Pan, Conical cup
	0515-0433	2	Screw, M4x0.7x16mm, (Option 521 board)
MP13	5041-8801	4	Foot
MP14	06611-00002	1	Cover
MP15	03478-88304	1	Rear Bezel
MP16	1252-1488	1	Terminal Block, 4 Position, RI/DFI
MP17	0360-2604	2	Terminal Block, 5 Position, Output/Sense
MP18	8120-8821	1	Local sense jumper
MP19	1252-8670	1	Terminal Block, 3 Position, DVM
MP20	0380-4636	1	Spacer, snap-in (ref GPIB board)
MP21	0515-0374	7	Screw, M3x0.5x10mm, Torx T10, Pan, Conical cup
MP22	06611-00004	1	Transformer Bracket
MP23	06611-40006	1	Fan Spacer
MP24	5080-2649	1	Rear Panel Label
MP25	1252-3056	2	Screw Lock Kit (ref RS232 Connector)
MP26	3050-0849	2	Flat Washer, #10
MP27	2190-0586	2	Helical Lock Washer, M4
MP28	0380-0644	2	Stud Mounted Standoff (ref GPIB Connector)
MP29	0360-2670		Screw, DVM board
MP30	5080-2637		Front Panel Keypad Label

5 - Replaceable Parts List

Table 5-2. Chassis, Mechanical (continued)

Designator	Part Number	Qty	Description
***** THROUGH-HOLE UNITS ONLY ***** (refer to title page for serial numbers)			
MP1	5002-1510	1	Chassis
MP2	06611-00003	1	Side Bracket, Left
MP3	33120-40200	1	Front Frame
MP4	66111-80001	1	Nameplate - 66111A
	5080-2594	1	Nameplate - 66311A
	66311-80002	1	Nameplate - 66311B
MP5	5080-2617	1	Window
MP6	06611-40001	1	Pushrod (Ref Line Switch)
MP7	06611-40002	1	Keypad
MP8	33120-87401	1	Knob
MP9	5001-0538	2	Side Trim
MP10	06611-00005	1	Side Bracket, Right
MP11	1400-0977	3	Ground Clip
MP12	0515-0430	8	Screw M4x0.7x8mm, Torx T15, Pan, Conical cup
MP13	5041-8801	4	Foot
MP14	06611-00002	1	Cover
MP15	03478-88304	1	Rear Bezel
MP16	1252-1488	1	Terminal Block, 4 Position, RI/DFI
MP17	0360-2604	1	Terminal Block, 5 Position, Output/Sense
MP21	0515-0374	7	Screw, M3x0.5x10mm, Torx T10, Pan, Conical cup
MP22	06611-00004	1	Transformer Bracket
MP23	06611-40006	1	Fan Spacer
MP24	66311-80001	1	Rear Panel Label
MP25	1252-3056	2	Screw Lock Kit (ref RS232 Connector)
MP26	3050-0849	2	Flat Washer, #10
MP27	2190-0586	2	Helical Lock Washer, M4
MP28	0380-0644	2	Stud Mounted Standoff (ref GPIB Connector)
MP30	5080-2637		Front Panel Keypad Label (66111A, 66311B)
	06611-80001		Front Panel Keypad Label (66311A)
MP31	2110-0927	1	Fuseholder with cap
MP32	0370-2862	1	Pushbutton (Ref Sense Switch)
MP33	06611-40005	1	Support Plate
MP34	1400-1281	1	Cable Clip (ref 66311A)
MP35	0590-0305	2	Hex Nut 6-32 w/Lockwasher (ref 66311A)
MP36	1510-0091	2	Binding Post (ref 66311A)

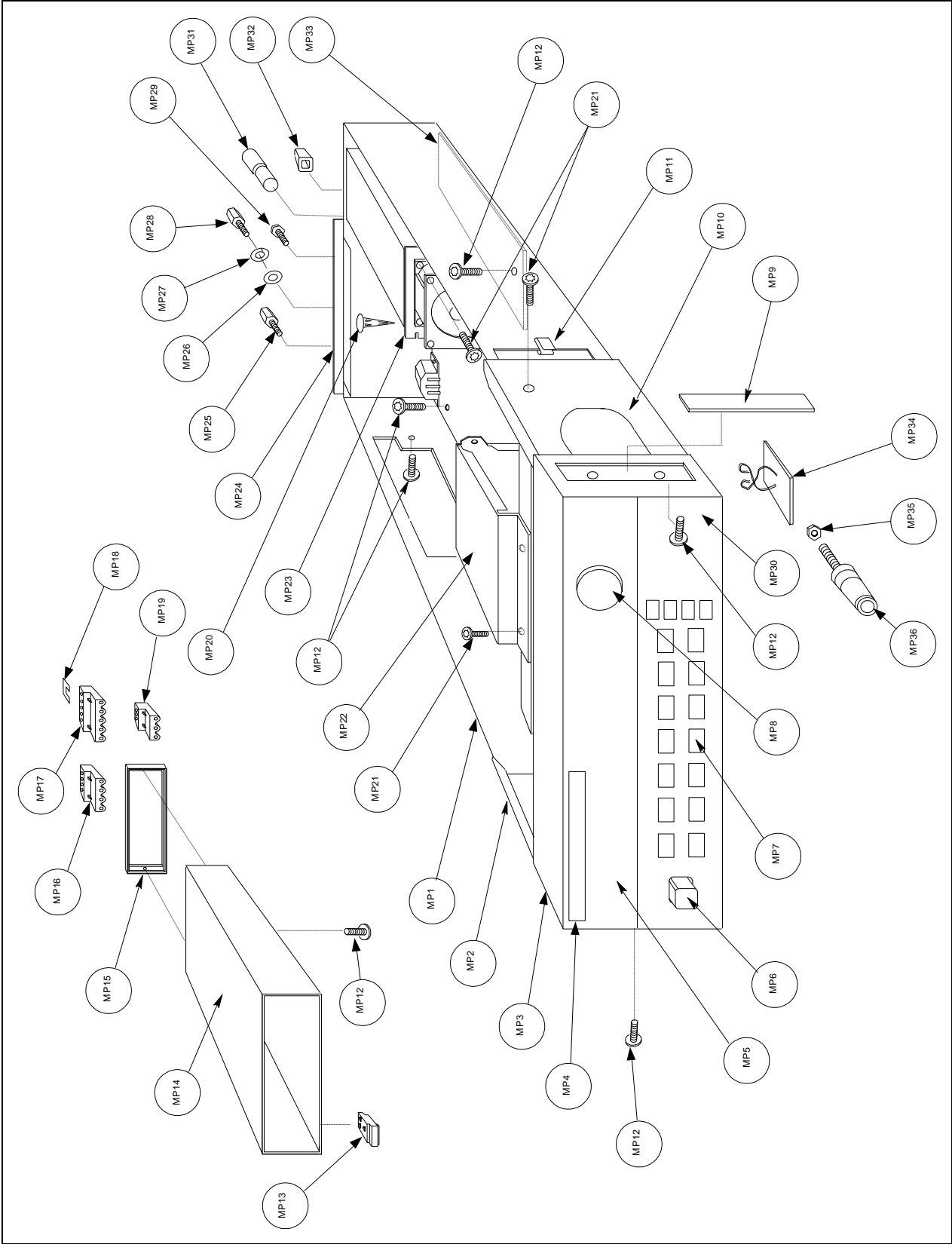


Figure 5-1. Mechanical Parts Identification

Diagrams

Introduction

This chapter contains drawings and diagrams for troubleshooting and maintaining the Keysight Model 66111A, 66311A/B/D, and 66309B/D Mobile Communications DC Sources.

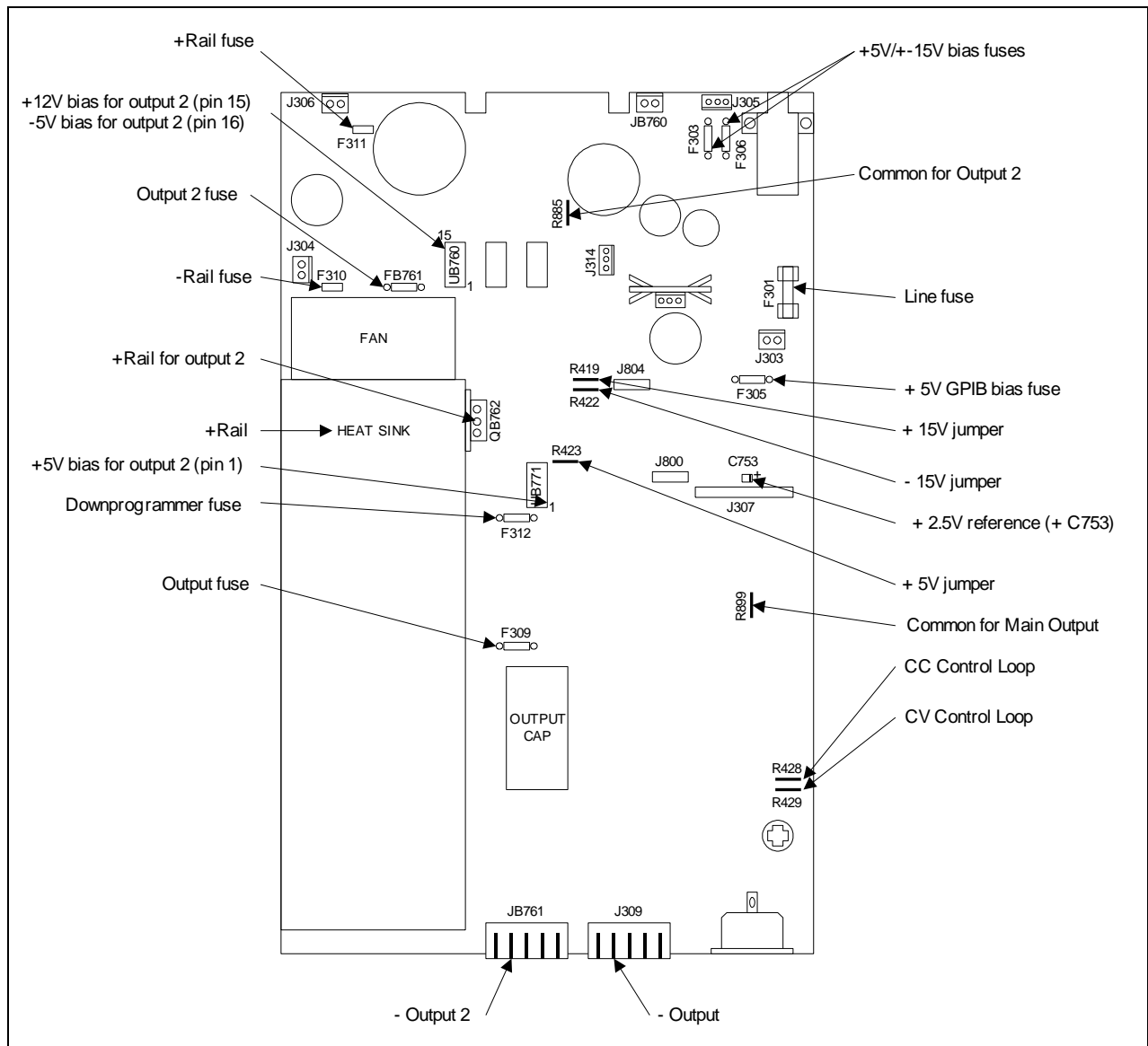


Figure 6-1A. A1 Main Board Test Points (surface-mount boards)

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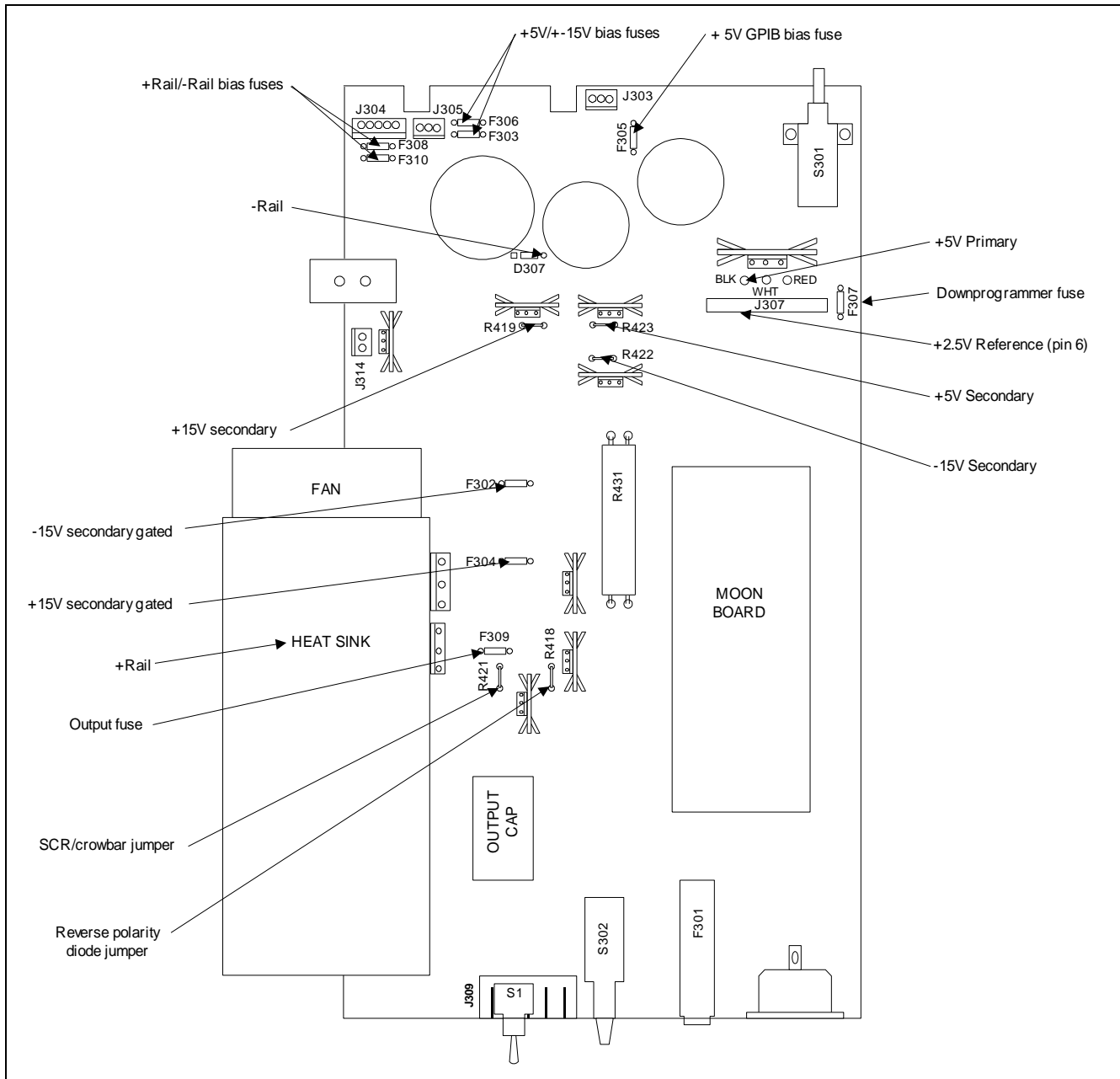


Figure 6-1B. A1 Main Board Test Points (through-hole boards)

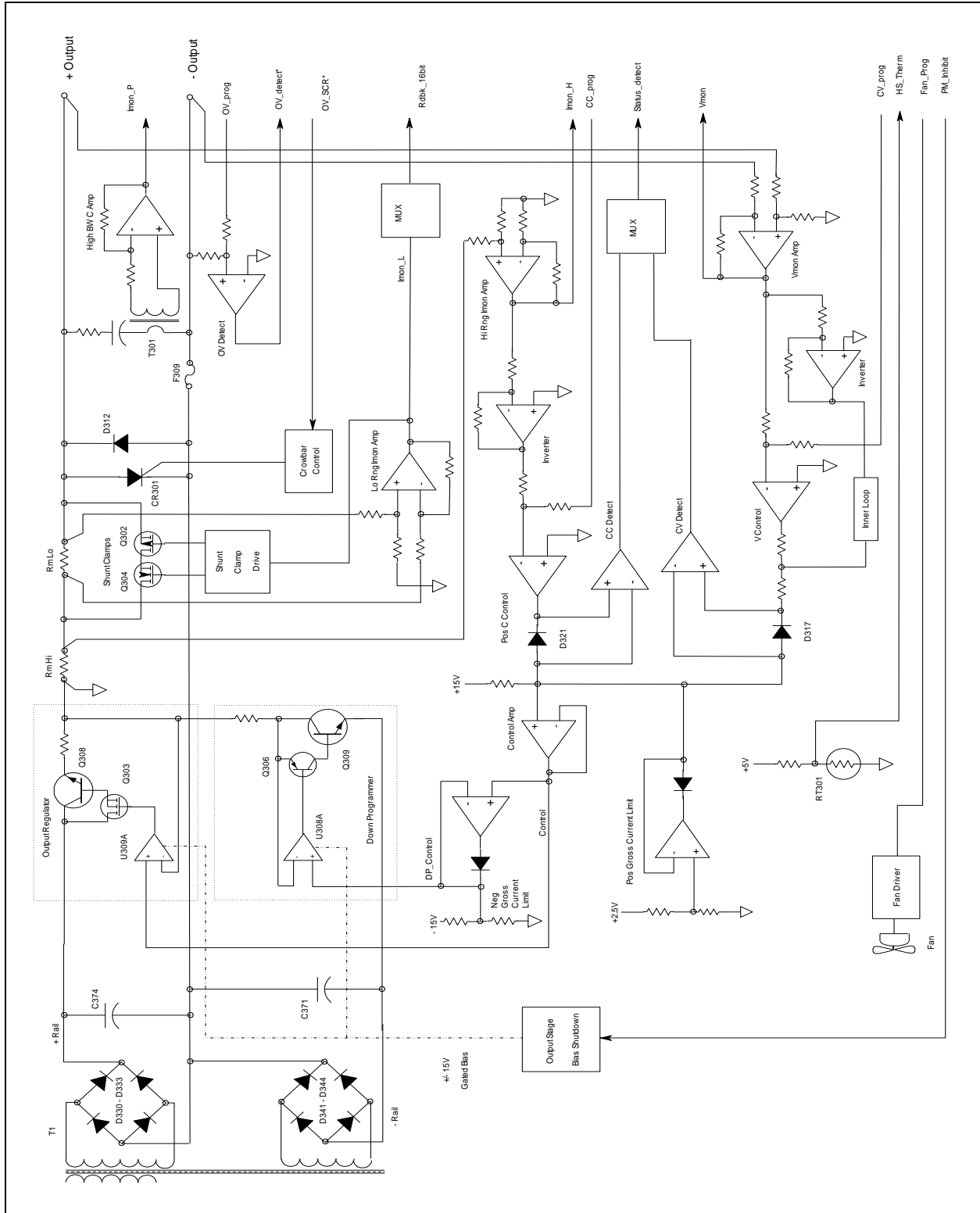


Figure 6-2. A1 Board Block Diagram

6 - Diagrams

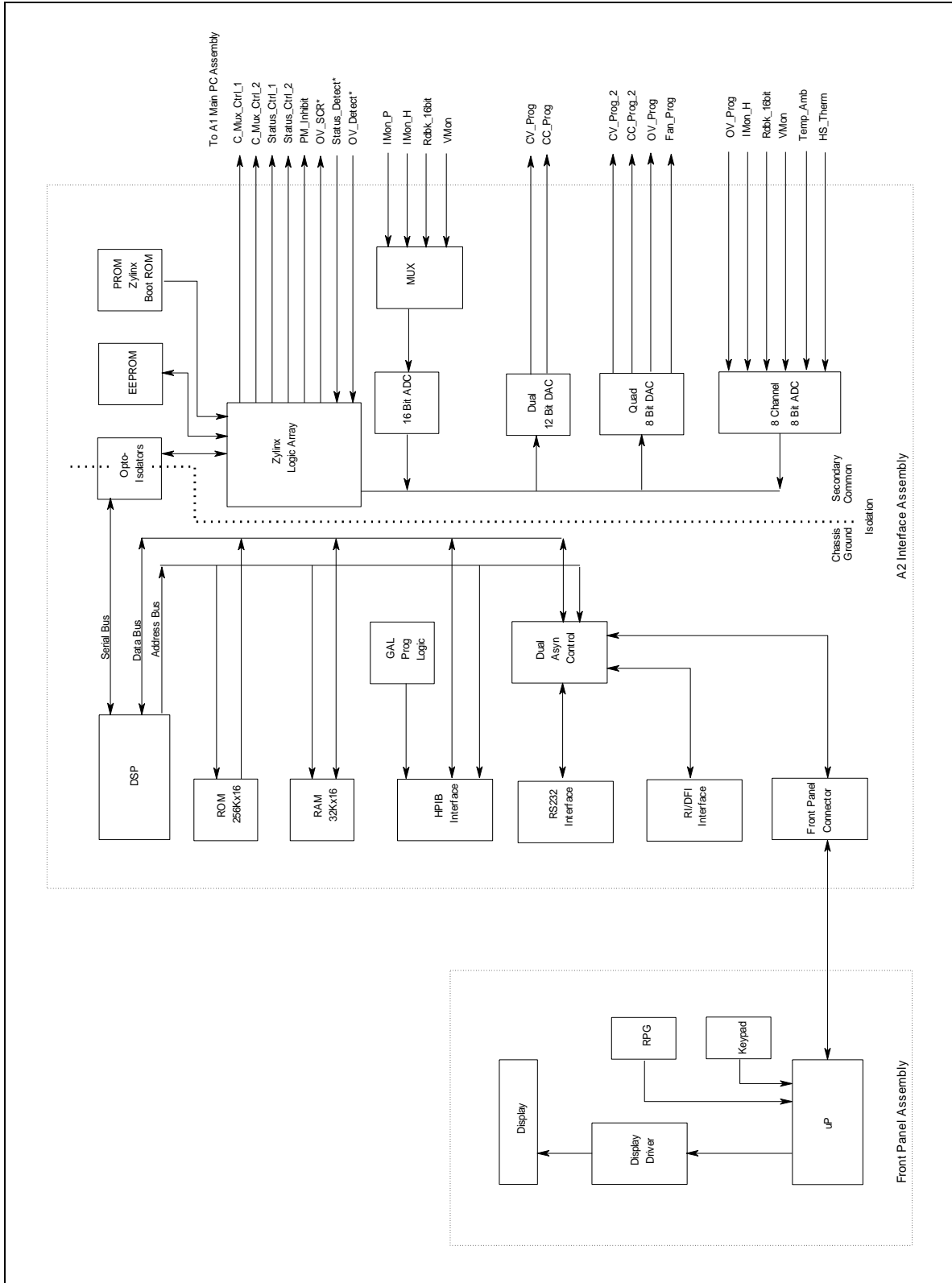


Figure 6-3. A2/A3 Boards Block Diagram

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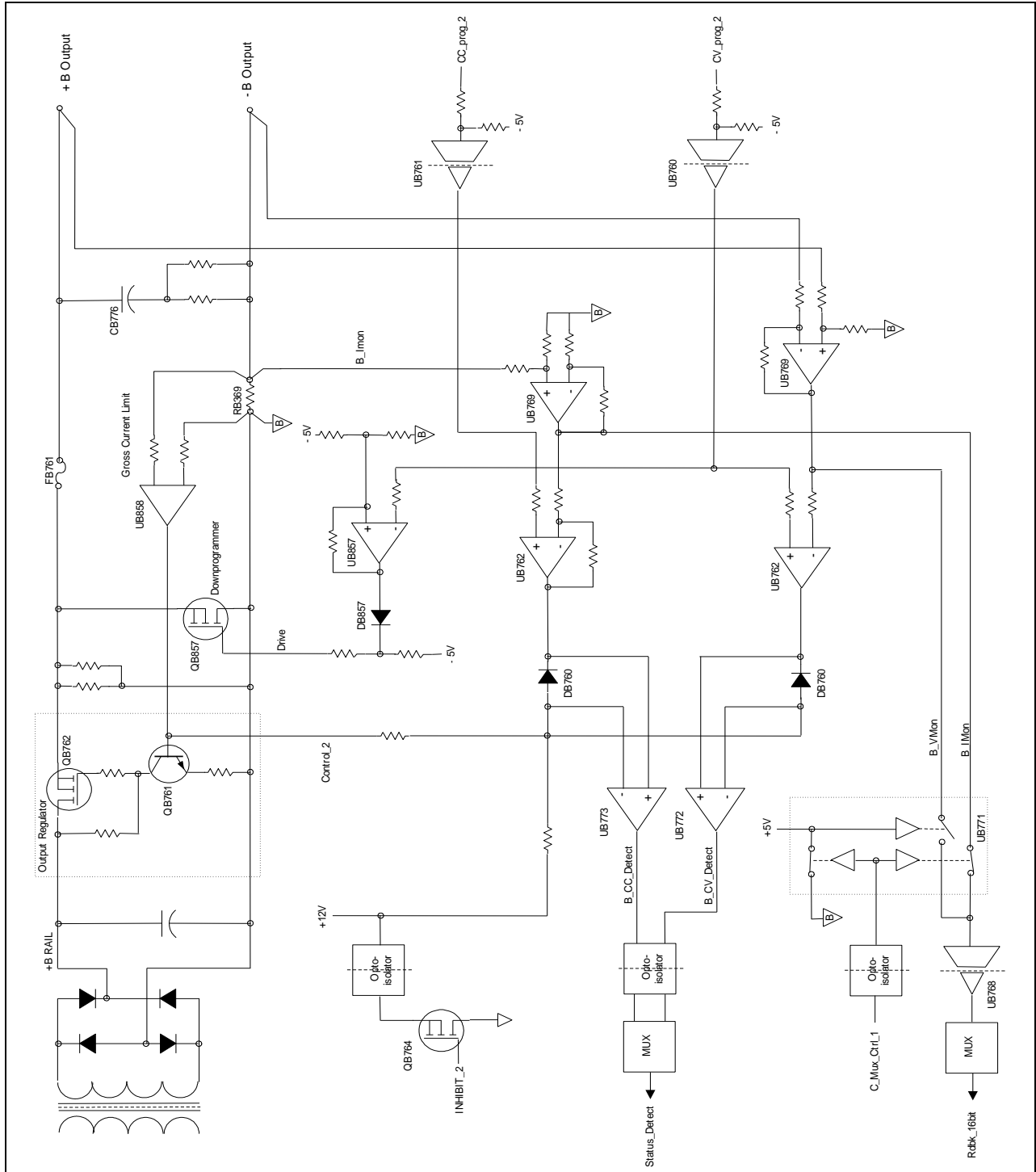


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For instruments with Serial Numbers:

- 66111A: US38460101 and up (through-hole)
- 66311A: US38180101 through US38180408 (through-hole)
- 66311B: US38440101 through US38442274 (through-hole)
- 66311B: US38442500 and up (surface-mount)
- 66311D: US39010101 and up (surface mount)
- 66309B: US39050101 and up (surface mount)
- 66309D: US39070101 and up (surface mount)



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