SERVICE MANUAL

AUTORANGING
DC POWER SUPPLY
AGILENT MODELS 6010A, 6011A,
6012B and 6015A

Agilent Part No. 06010-90001

FOR INSTRUMENTS WITH SERIAL NUMBERS

Agilent Model 6010A; Serials	**US37110171 and above**
Agilent Model 6011A; Serials	**US35460156 and above**
Agilent Model 6012B; Serials	**US35430336 and above**
Agilent Model 6015A; Serials	**US37050146 and above**

For instruments with higher serial numbers, a change page may be included.

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CERTIFICATION

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

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

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SAFETY SUMMARY

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

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

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

INPUT POWER MUST BE SWITCH CONNECTED.
For instruments without a built-in line switch, the input power lines must contain a switch or another adequate means for disconnecting the instrument from the ac power lines (supply mains).

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

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

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

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

SAFETY SYMBOLS.

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

⚡ Indicates hazardous voltages.

⏚ or ⊥ Indicate earth (ground) terminal.

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

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

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

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

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Introduction

Scope

This manual contains information for troubleshooting the Agilent Models 6010A, 6011A, 6012B, or 6015A 1000W Autoranging Power Supply to the component level. Wherever applicable, the service instructions given in this manual refer to pertinent information provided in the Operation Manual. Both manuals cover Agilent Models 6010A/11A/12B/15A; differences between models are described as required.

The following information is contained in this manual.

Calibration and Verification

Contains calibration procedures for Agilent Models 6010A/11A/12B/15A. Also contains verification procedures that check the operation of the supplies to ensure they meet the specifications of Chapter 1 in the Operating Manual.

Troubleshooting

Contains troubleshooting procedures to isolate a malfunction to a defective component on the main circuit board or to a defective assembly (front panel, power transformer, or cable assembly). Board and assembly level removal and replacement procedures are also given in this section.

Principles of Operation

Provides block diagram level descriptions of the supply's circuits. The regulation and control, protection, input power, dc power conversion and output circuits are described. These descriptions are intended as an aid in troubleshooting.

Replaceable Parts

Provides a listing of replaceable parts for all electronic components and mechanical assemblies for Agilent Models 6010A/11A/12B/15A.

Circuit Diagrams

Contains functional schematics and component location diagrams for all Agilent 6010A/11A/12B/15A circuits. The names that appear on the functional schematics also appear on the block diagrams in Chapter 4. Thus, the descriptions in Chapter 4 can be correlated with both the block diagrams and the schematics.

Safety Considerations

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

Manual Revisions

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

Item	Description
US	The first two letters indicates the country of manufacture, where US = USA.
3648	This is a code that identifies either the date of manufacture or the date of a significant design change.
0101	The last four digits are a unique number assigned to each power supply.

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

Note that because not all changes to the product require changes to the manual, there may be no update information required for your version of the supply.

Older serial number formats used with these instruments had a two-part serial number, i.e. 2701A-00101. This manual also applies to instruments with these older serial number formats. Refer to Appendix B for backdating information.

2

Calibration and Verification

Introduction

This section provides test and calibration procedures. The operation-verification tests comprise a short procedure to verify that the unit is performing properly, without testing all specified parameters. After troubleshooting and repair of a defective power supply you can usually verify proper operation with the turn-on checkout procedure in the Operating Manual. Repairs to the A1 main board and the A2 control board can involve circuits which, although functional, may prevent the unit from performing within specified limits. So, after A1 or A2 board repair, decide if recalibration and operation verification tests are needed according to the faults you discover. Use the calibration procedure both to check repairs and for regular maintenance.

When verifying the performance of this instrument as described in this chapter, check only those specifications for which a performance test procedure is included.

Test Equipment Required

Table 2-1 lists the equipment required to perform the tests of this section. You can separately identify the equipment for performance tests, calibration and troubleshooting using the USE column of the table.

Operation Verification Tests

To assure that the unit is performing properly, without testing all specified parameters, first perform the turn-on checkout procedure in the Operating Manual. Then perform the following performance tests, in this section.

CV Load Effect
CC Load Effect

Calibration Procedure

Calibrate the unit twice per year and when required during repair. The following calibration procedures which follow should be performed in the sequence given. Table 2-2 describes in detail these calibration procedures and lists the expected results to which each adjustment must be made.

Note: Some of the calibration procedures for this instrument can be performed independently, and some procedures must be performed together and/or in a prescribed order. If a procedure contains no references to other procedures, you may assume that it can be performed independently.

To return a serviced unit to specifications as quickly as possible with minimal calibration, the technician need only perform calibration procedures that affect the repaired circuit. Table 2-3 lists various power supply circuits with calibration procedures that should be performed after those circuits are serviced.

Table 2-1. Test Equipment Required

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Oscilloscope	Sensitivity: 1mV Bandwidth: 20MHz & 100MHz Input: differential, 50Ω & 10MΩ	P,T	Agilent 1740A
Isolation Transformer	100VA 4KVA minimum	T	
RMS Voltmeter	True rms, 10MHz bandwidth Sensitivity: 1 mV Accuracy: 5%	P	Agilent 3400A
Logic Pulser	4.5 to 5.5Vdc @ 35mA	T	Agilent 546A
Multimeter	Resolution: 100nV Accuracy: 0.0035%, 6½ digit	P,A,T	Agilent 3456A
CC PARD Test Current Probe	No saturation at: 6010A 20Adc 6011A 100Adc 6012B 51Adc 6015A 51Adc Bandwidth: 20Hz to 20MHz	P	Tektronix P6303 Probe/AM503 Amp/ TM500 Power Module
Electronic Load*	Power range: 1000 watts Open and short switches 6010A Voltage range: 200Vdc Current range: 20Adc 6011A Voltage range: 30Vdc Current range: 120Adc 6012B Voltage range: 65Vdc Current range: 55Adc 6015A Voltage range: 200Vdc Current range: 5Adc	P,A	Transistor Devices Model DLP 130-50-2500 DLR-400-15-2500 DLP 50-150-3000 DLP 130-50-2500 DLR-400-15-2500
CC PARD Test Resistive Load	Value: 6010A 3.5 ohms >1000W Accuracy: 1% 6011A 0.058 ohms >1000W Accuracy 1% 6012B 0.4 ohms >1000W Accuracy: 1% Rheostat or Resistor Bank	P,A	

Table 2-1. Test Equipment Required (continued)

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Load Resistors (6015A)	40Ω, ±1%, 1000W 250Ω, ±1%, 1000W	P,A	
Current-Monitoring Resistors	Value: 6010A 100mV @ 10A (10mΩ must be capable of 20Amps) Accuracy: 0.02% ** TC: 10ppm/°C 6011A 50mV @100A (0.5mΩ) Accuracy: 0.05% ** TC: 30ppm/°C 6012B 50mV @ 50A (1.0mΩ) Accuracy: 0.02% ** TC: 30ppm/°C 6015A 0.1Ω, 15A, ±0.04%**	P,A	
Calibration and Test Resistors	Value: 50Ω, 5%, 40W 2KΩ, 0.01%, ¼W	A,T	
Terminating Resistors (4)	Value: 50Ω ± 5%, noninductive	P	
Blocking Capacitors (2)	Value: 0.01µF, 600Vdc	P	
Common-Mode Toroidal Core	≥3.7µH/turn^2 ≅23mm I.D .	P	Ferrox-Cube 500T600-3C8, Agilent 9170-0061
DC Power Supply	Voltage range: 0-60Vdc Current range: 0-50Adc	T,P	Agilent 6012B
Variable Voltage Transformer (autotransformer)	Range greater than -13% to +6% of nominal input AC voltage 4KVA	P,A	

P = performance testing A = calibration adjustments T = troubleshooting

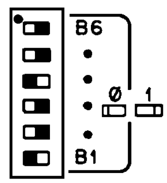
* Resistors may be substituted for test where an electronic load is not available.

** Less accurate, and less expensive, current-monitor resistors can be used, but the accuracy to which current programming and current meter reading can be checked must be reduced accordingly.

Initial Setup

WARNING Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Turn off ac power when making or removing connections to the power supply. Where maintenance can be performed without power applied, the power should be removed.

a. Unplug the line cable and remove the top cover by removing the two screws.
b. Slide the cover to the rear.
c. Plug a control board test connector A2P7 onto the A2J7 card-edge fingers.
d. Turn OVERVOLTAGE ADJUST control A3R97 fully clockwise.
e. Disconnect all loads from output terminals.
f. Connect power supply for local sensing, and ensure that MODE switches are set as shown below.



g. Reconnect the line cable and turn on ac power.
h. Allow unit to warm up for 30 minutes.
i. At the beginning of each calibration procedure, the power supply should be in its power-off state, with no external circuitry connected except as instructed.
j. The POWER LIMIT adjustment (A2R25) must be adjusted at least coarsely before many of the calibration procedures can be performed. If you have no reason to suspect that the Power Limit circuit is out of adjustment, do not disturb its setting. Otherwise, center A2R25 before you begin to calibrate the power supply.

Table 2-2. Calibration Procedure

TEST	TESTED VARIABLE	TEST POINTS	TEST SEQUENCE AND ADJUSTMENTS	EXPECTED RESULTS
Meter F/S Adjust.	Meter Ref. Voltage	6010A, 6012B A2J3 pin 7 (+) A2J3 pin 10 (-) 6011A, 6015A A2J3 pin 6 (+) A2J3 pin 9 (-)	a. Connect DVM across test points and turn on ac power. b. Adjust A2R24 to obtain the voltage range specified in the results.	0.5V ± 50µV
Resistance Programming F/S Adjust.	Prog. Voltage	VP (+) ⏚P (-)	a. Connect a 2KΩ 0.01%, ¼W resistor and DVM between test points. b. Set MODE switch as in Figure 2-1 and turn on ac power. c. Adjust A2R23 to obtain the voltage range specified in the results.	2.5V ±4mV

Table 2-2. Calibration Procedure (continued)

TEST	TESTED VARIABLE	TEST POINTS	TEST SEQUENCE AND ADJUSTMENTS	EXPECTED RESULTS
V-MON Zero Adjust.	V-MON	VM (+) ⏚M (-)	a. Set voltage and current controls to minimum settings. b. Disable power supply as in Initial Setup step i. c. Short circuit output terminals and connect the DVM between test points. Turn on power supply. d. Adjust V-MON Zero trim pot A2R22 to voltage range specified in the results.	0 ± 80µV
Common Mode Adjust.	Residual Output Voltage VM(+)	VM (+) ⏚M (-)	a. Set voltage and current controls to minimum and short the unit's sense terminals (+ S & - S). b. Attach the DVM across test points and disable power supply as Initial Setup step i. c. Turn on ac power and record the initial voltage (IR) with DVM across test points. d. Remove the local sensing straps and connect a 1Vdc power supply between - S(+) and – OUT(-). See Figure 2-1. e. Adjust A2R21 to the voltage range specified. f. Remove the 1V supply and replace jumpers.	IR* ±80µV IR* ±40µV (6015A)
I-MON Zero Adjust.	I-MON	IM (+) ⏚M (-)	a. Set voltage and current controls to minimum. b. Disable power supply as in Initial Setup step I and short output terminals. Turn on ac power. c. Connect DVM across test points and adjust I-MON Zero trim pot A2R8 as shown in results.	0± 100µV
I-MON F / S Adjust.	I-MON	IM (+) ⏚M (-)	a. Perform I-MON Zero Adjust before proceeding . b. Connect a 0.010Ω (6010A), 0.0005Ω (6011A) 0.0001Ω (6012B), current monitoring resistor Rm across the output terminals. c. Turn on ac power and using the "Display Setting", set current control to 17A (6010A), 120A (6011A), 50A (6012B), 5A (6015A), and voltage control to 5V. d. Connect DVM across test points and take an initial reading (IR).	IR*
		Rm (+) Rm (-)	e. Connect DVM across Rm monitoring terminals and adjust A2R9 as shown in the results.	0.034 IR*± 33.5µV (6010A, 6015A) 0.012 IR* ±40µV (6011A, 6012B)

*IR = Initial Reading

Table 2-2. Calibration Procedure (continued)

TEST	TESTED VARIABLE	TEST POINTS	TEST SEQUENCE AND ADJUSTMENTS	EXPECTED RESULTS
Power Limit Adjust.	V(OUT) I(OUT)		a. Perform I-MON F/S Adjust before proceeding. b. Connect the unit to the ac power line via a variable transformer. Set input power rail to 240Vdc; DVM (+) on rear of A1R3 and DVM (-) to rear of A1R1. Note that power rail must be maintained at 240Vdc during calibration. **WARNING** The inner cover must be removed to connect the voltmeter. Disconnect the power line and wait two minutes before connecting or disconnecting the voltmeter. c. Connect a 3.8Ω (6010A), 0.066Ω (6011A), 0.44Ω (6012B), 40Ω (6015A) resistor or an electronic load across the unit's output terminals. d. Set the load for 18A (6010A), 120A (6011A), 50A (6012B), 5A (6015A), in CC mode, and turn A2R25 (lower knee) fully counter clockwise. e. Turn on power supply and set voltage at 65V (6010A), 8V (6011A), 22V (6012B), 204V (6015A), and current at 17.5A (6010A), 121A (6011A), 51A (6012B), 5.1A (6015A), using DISPLAY SETTINGS. f. Turn A2R25 clockwise until CV LED lights. Output should be 65V ± 0.6V (6010A), 8 ±0.08V (6011A), 22 ±0.2V (6012B), 204V (6015A), and 17A (6010A), 120A (6011A) 51A (6012B), 5.1A (5015A) in CV mode. g. Turn off ac power and replace the 3.8Ω (6010A), 0.066Ω (6011A), 0.44Ω (6012B), 40Ω (6015A), resistor with a 38Ω (6010A), 0.36Ω (6011A), 3.3Ω (6012B), 250Ω (6015A), resistor or reset electronic load for 5.5A (6010A), 55A (6011A), 18.2A (6012B) in CC mode.	

Table 2-2. Calibration Procedure (continued)

TEST	TESTED VARIABLE	TEST POINTS	TEST SEQUENCE AND ADJUSTMENTS	EXPECTED RESULTS
Power Limit Adjust (continued)			h. Turn A2R26 (upper knee) fully counter clockwise. Turn on the supply and set voltage at 200V (6010A), 20V (6011A), 60V (6012B), 500V (6015A), and current at 5.25A (6010A), 56A (6011A), 19A (6012B) 2.25A (6015A), using DISPLAY SETTINGS. i. Turn A2R26 (upper knee) clockwise until CV LED lights. Output should be 200 ± 2V (6010A), 20 ±0.5V (6011A), 60 ±0.4V (6012B), and 5.25A (6010A), 55A (6011A), 18.2A (6012B), 2.2A (6015A), in CV mode.	

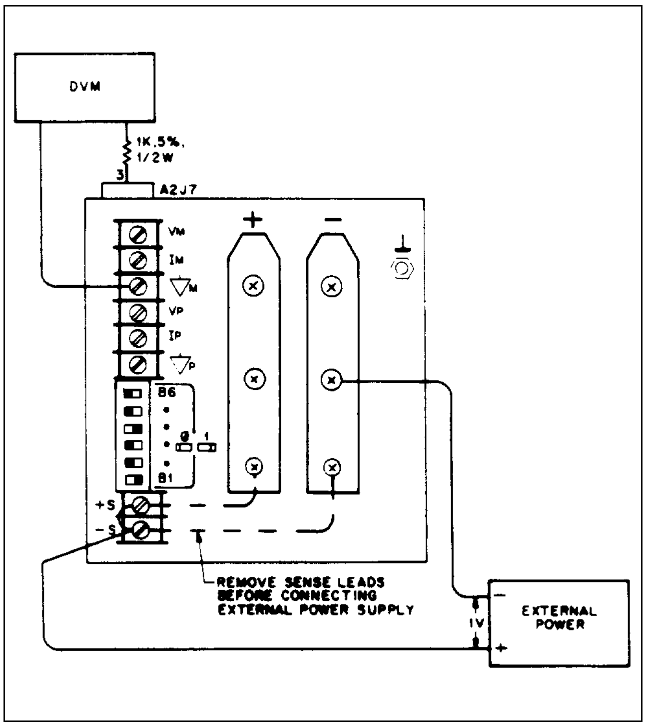


Figure 2-1. Common Mode Setup

Table 2-3. Guide to Recalibration After Repair

Printed Circuit Board	Block Name	Circuit Within	Ref. Designator	Perform These Procedures*
A1 Main Board			R11 R13 (6011A)	3 then 4
A1 Main Board			T1, T2	5
A5 Diode Board			CR4 CR5, CR1 (6011A)	5
A2 Control Board	Constant Voltage (CV) Circuit	All Except Current Source	All	1 then 2
A2 Control Board	Constant Voltage (CV) Circuit	Current Source	All	6
A2 Control Board	Constant Current (CC) Circuit		All	3 then 4
A2 Control Board	Power Limit Comparator		All	5
A2 Control Board	Bias Power Supplies	± 15V Supplies	All	All
A2 Control Board			U7, R84, R85, R24	7

* Code To Calibration Procedure To Be Performed

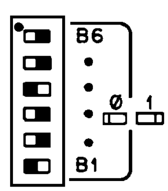
1. V-MON Zero Calibration
2. Common-Mode Calibration
3. I-MON Zero Calibration
4. I-MON Full Scale (F/S) Calibration
5. Power Limit Calibration
6. Resistance Programming Full Scale (F/S) Calibration
7. Meter Full Scale (F/S) Calibration

Performance Tests

The following paragraphs provide test procedures for verifying the unit's compliance with the specifications of Table 1-1 in the Operating Manual. Please refer to CALIBRATION PROCEDURE or TROUBLESHOOTING if you observe out-of-specification performance.

Measurement Techniques

Setup For All Tests. Measure the DC output voltage directly at the + S and - S terminals. Connect unit for local sensing, and ensure that MODE switches are set as shown below. Select an adequate wire gauge for load leads using the procedures given in the Operating Manual for connecting the load.



Electronic Load. The test and calibration procedures use an electronic load to test the unit quickly and accurately. If an electronic load is not available, you may substitute:

3.5Ω 1000W load resistor (6010A)
0.4Ω 1000W load resistor (6011A)
0.4Ω 1000W load resistor (6012B)
250Ω 1000W load resistor (6015A)

for the electronic load in the following tests:
- CV Source Effect (Line Regulation)
- CC Load Effect (Load Regulation)
- Temperature Coefficient (6015A)
- Drift (stability) (6015A)

You may substitute:
- 40Ω 1000W load resistor (6010A)
- 0.058Ω 1000W load resistor (6011A)
- 3.4Ω 1000W load resistor (6012B)
- 40Ω 1000W load resistor (6015A)

in these tests:
- CV Load Effect (Load Regulation)
- CV PARD (Ripple and Noise)
- CC Source Effect (Line Regulation)
- CC PARD (Ripple and Noise)

The substitution of the load resistor requires adding a load switch to open and short the load in the CC or CV load regulation tests. The load transient recovery time test procedure is not amenable to modification for use with load resistors.

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

Current-Monitoring Resistor Rm. To eliminate output current measurement error caused by voltage drops in the leads and connections, connect the current-monitoring resistor between -OUT and the load as a four-terminal device. Figure 2-2 shows correct connections. Select a resistor with stable characteristics:
- 0.010, 0.02% accuracy, 30 ppm/°C (6010A)
- 0.0005Ω, 0.05% accuracy, 30ppm/°C (6011A)
- 0.0010Ω, 0.05% accuracy, 30ppm/°C (6012B)
- 0.010Ω, 0.02% accuracy, 30ppm/°C (6015A)

or lower temperature coefficient and a current rating of:
- 17A (6010A).
- 120A (6011A).
- 50A (6012B)
- >5A (6015A)

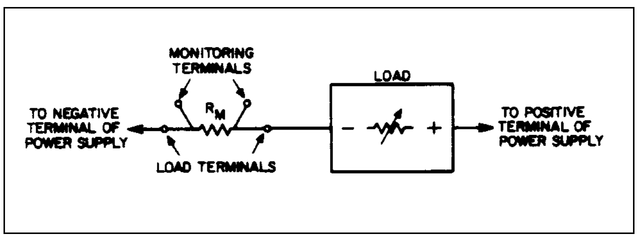


Figure 2-2. Current-Monitoring Resistor Setup

Constant Voltage (CV) Tests

CV Setup. If more than one meter or a meter and an oscilloscope are used, connect each to the + S and - S terminals by a separate pair of leads to avoid mutual coupling effects. Connect only to + S and -S (except for peak-to-peak PARD) because the unit regulates the output voltage between + S and - S, not between + OUT and -OUT. Use coaxial cable or shielded 2-wire cable to avoid pickup on test leads. For all CV tests set the output current at full output to assure CV operation.

Load Effect (Load Regulation). Constant-voltage load effect is the change in dc output voltage (Eo) resulting from a load-resistance change from open-circuit to full-load. Full-load is the resistance which draws the maximum rated output current at voltage Eo. Proceed as follows:

a. Connect the test equipment as shown in Figure 2-3. Operate the load in constant resistance mode (Amps/Volt) and set resistance to maximum.
b. Turn the unit's power-on, and turn up current setting to full output.
c. Turn up output voltage to:
   60Vdc (6010A)
   7.0Vdc (6011A)
   20.0Vdc (6012B)
   200Vdc (6015A)
   as read on the digital voltmeter.

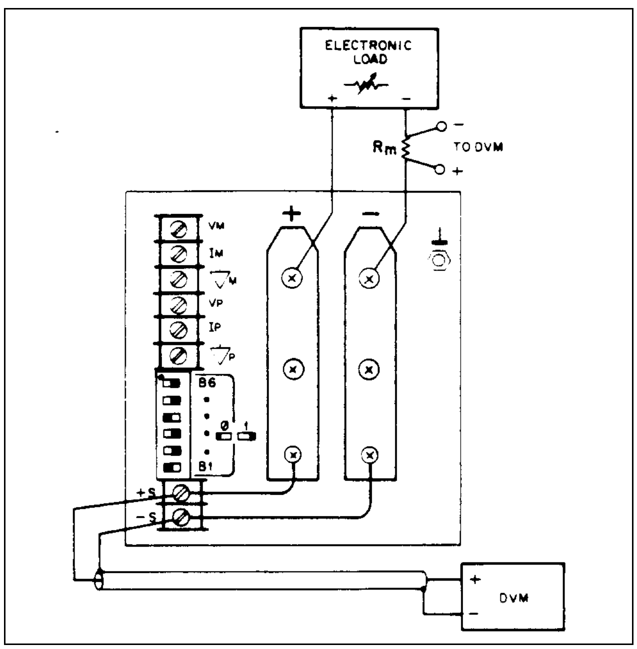


Figure 2-3. Basic Test Setup

d. Reduce the resistance of the load to draw an output current of:
   17.0Adc (6030A)
   120Adc (6011A)
   50Adc (6012B)
   5.0Adc (6015A)
   Check that the unit's CV LED remains lighted.
e. Record the output voltage at the digital voltmeter.
f. Open-circuit the load.

g. When the reading settles, record the output voltage again. Check that the two recorded readings differ no more than:
± 0.011Vdc (6010A)
± 0.0037Vdc (6011A)
± 0.007Vdc (6012B)
± 0.033Vdc (6015A)

Source Effect (Line Regulation). Source effect is the change in dc output voltage resulting from a change in ac input voltage from the minimum to the maximum value as specified in Input Power Requirements in the Specifications Table, in the Operating Manual. Proceed as follows:

a. Connect the test equipment as shown in Figure 2-3. Operate the load in constant resistance mode (Amps/Volt) and set resistance to maximum.
b. Connect the unit to the ac power line through a variable autotransformer which is set for low line voltage (104Vac for 120Vac).
c. Turn the unit's power-on, and turn up current setting to full output.
d. Turn up output voltage to:
60.0Vdc (6010A)
20.0Vdc (6011A)
20.0Vdc (6012B)
500Vdc (6015A)
as read on the digital voltmeter.
e. Reduce the resistance of the load to draw an output current of:
17.0Adc (6010A)
50Adc (6011A)
50Adc (6012B)
2.0Adc (6015A)
Check that the unit's CV LED remains lighted.
f. Record the output voltage at the digital voltmeter.
g. Adjust autotransformer to the maximum for your line voltage.
h. When the reading settles record the output voltage again. Check that the two recorded readings differ no more than:
± 0.011Vdc (6010A)
± 0.004Vdc (6011A)
± 0.005Vdc (6012B)
± 0.063Vdc (6015A)

PARD (Ripple And Noise). Periodic and random deviations (PARD) in the unit's output-ripple and noise-combine to produce a residual ac voltage superimposed on the dc output voltage. Constant-voltage PARD is specified as the root-mean-square (rms) or peak-to-peak (pp) output voltage in a frequency range of 20Hz to 20MHz (10MHz, 6010A).

RMS Measurement Procedure. Figure 2-4 shows the interconnections of equipment to measure PARD in Vrms. To ensure that there is no voltage difference between the voltmeter's case and the unit's case, connect both to the same ac power outlet or check that the two ac power outlets used have the same earth-ground connection.

Use the common-mode choke as shown to reduce ground-loop currents from interfering with measurement. Reduce noise pickup on the test leads by using 50Ω coaxial cable, and wind it five turns through the magnetic core to form the common-mode choke. Proceed as follows:

a. Connect the test equipment as shown in Figure 2-4. Operate the load in constant resistance mode (Amps/Volt) and set resistance to maximum.
b. Turn the unit's power-on, and turn up current setting to full output.
c. Turn up output voltage to:
60Vdc (6010A)
7Vdc (6011A)
60Vdc (6012B)
200Vdc (6015A)

d. Reduce the resistance of the load to draw an output current of:
   17.0Adc (6010A)
   120Adc (6011A)
   17.5Adc (6012B)
   5.0Adc (6015A)
   Check that the unit's CV LED remains lighted.
e. Check that the rms noise voltage at the true rms voltmeter is no more than:
   22mV rms (6010A)
   8.0mV rms (6011A)
   8.0mV rms (6012B)
   50mV rms (6015A)

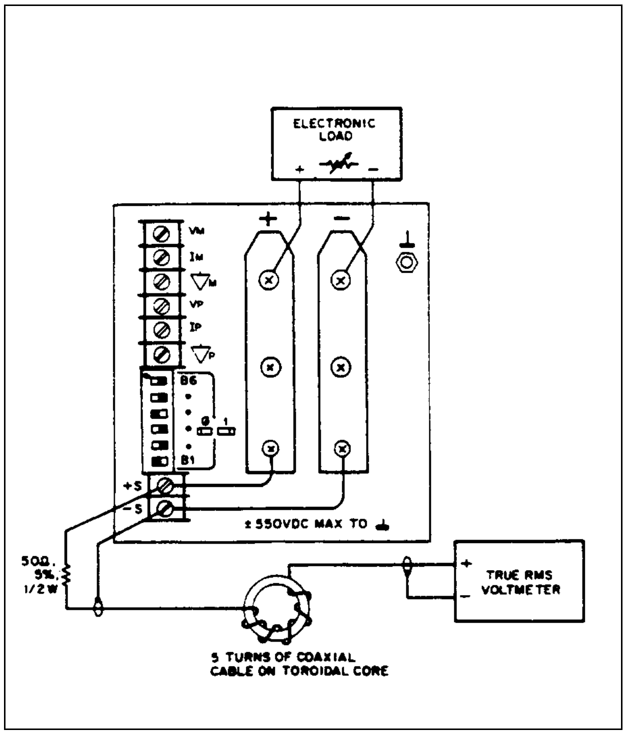


Figure 2-4. RMS Measurement Test Setup, CV PARD Test

Peak Measurement Procedure. Figure 2-5 shows the interconnections of equipment to measure PARD in Vpp. The equipment grounding and power connection instructions of PARD rms test apply to this setup also. Connect the oscilloscope to the + OUT and - OUT terminals through 0.01µF blocking capacitors to protect the oscilloscope's input from the unit's output voltage. To reduce common-mode noise pickup, set up the oscilloscope for a differential, two-channel voltage measurement. To reduce normal-mode noise pickup, use twisted, 1 meter or shorter, 50Ω coaxial cables with shields connected to the oscilloscope case and to each other at the other ends. Proceed as follows:

a. Connect the test equipment as shown in Figure 2-5. Operate the load in constant resistance mode (Amps/Volt) and set resistance to maximum.
b. Turn the unit's power-on, and turn up current setting to full output.
c. Turn up output voltage to:
   60Vdc (6010A)
   7.0Vdc (6011A)

60Vdc (6012B)
200Vdc (6015A)

d. Reduce the resistance of the load to draw an output current of:
17.0Adc (6010A)
120Adc (6011A)
17.5Adc (6012B)
5.0Adc (6015A)
Check that the unit's CV LED remains lighted.

e. Set the oscilloscope's input impedance to 50Ω and bandwidth to 20MHz. Adjust the controls to show the 20KHz and higher frequency output-noise waveform of Figure 2-6.

f. Check that the peak-to-peak is no more than:
50mV (6010A)
50mV (6011A)
50mV (6012B)
160mV (6015A)

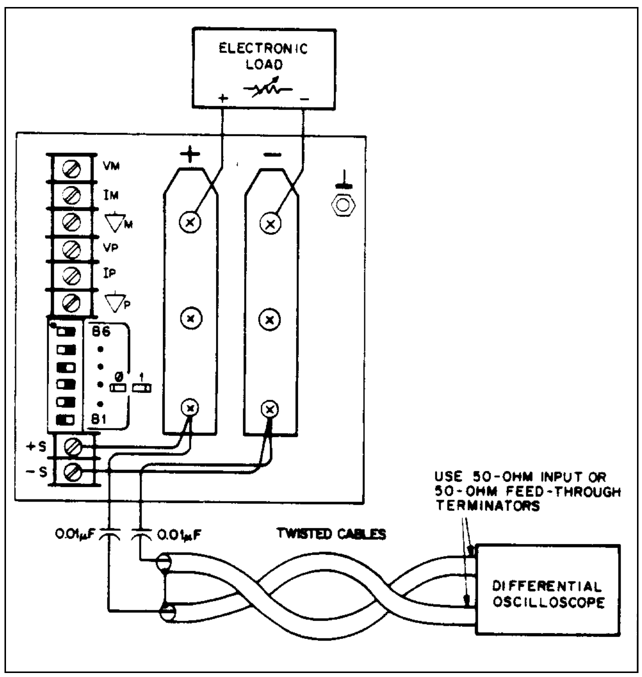


Figure 2-5. Peak-To-Peak Measurement Test Setup, CV PARD Test

Load Transient Recovery Time. Specified for CV operation only; load transient recovery time is the time for the output voltage to return to within a specified band around its set voltage following a step change in load.

Use the equipment setup of Figure 2-3 to display output voltage transients while switching the load between 10% with the output set at:

60Vdc (6010A)
7Vdc (6011A)
20Vdc (6012B)
200Vdc (6015A)

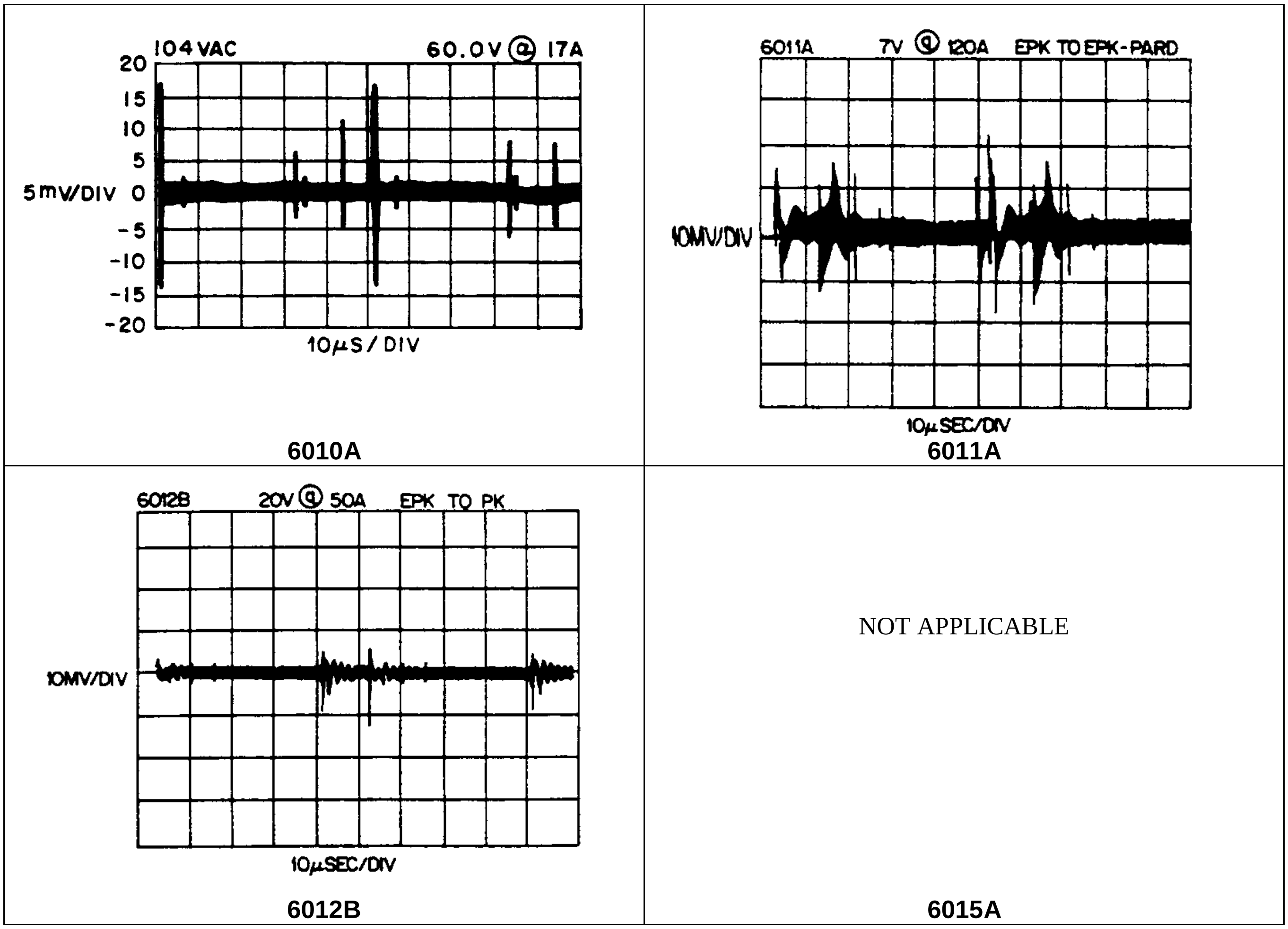


Figure 2-6. 20KHz Noise, CV Peak-to-Peak PARD

Proceed as follows:

a. Connect the test equipment as shown in Figure 2-3. Operate the load in constant-current mode and set for minimum current.
b. Turn the unit's power-on, and turn up current setting to full output.
c. Turn up output voltage to:
60Vdc (6010A)
7.0Vdc (6011A)
20.0Vdc (6012B)
200Vdc (6015A)
as read on the digital voltmeter.
d. Set the load to vary the load current between:
15 and 17Adc (6010A)
108 and 120Adc (6011A)
45 and 50Adc (6012B)
4.5 and 5.0Adc (6015A)
at a 30Hz rate for the 10% RECOVERY TEST.
e. Set the oscilloscope for ac coupling, internal sync and lock on either the positive or negative load transient.
f. Adjust the oscilloscope to display transients as in Figure 2-7.

g. Check that the pulse width of the transient pulse is no more than:
150mV/2ms (6010A)
100mV/2ms (6011A)
100mV/2ms (6012B)
200mV/5ms (6015A)

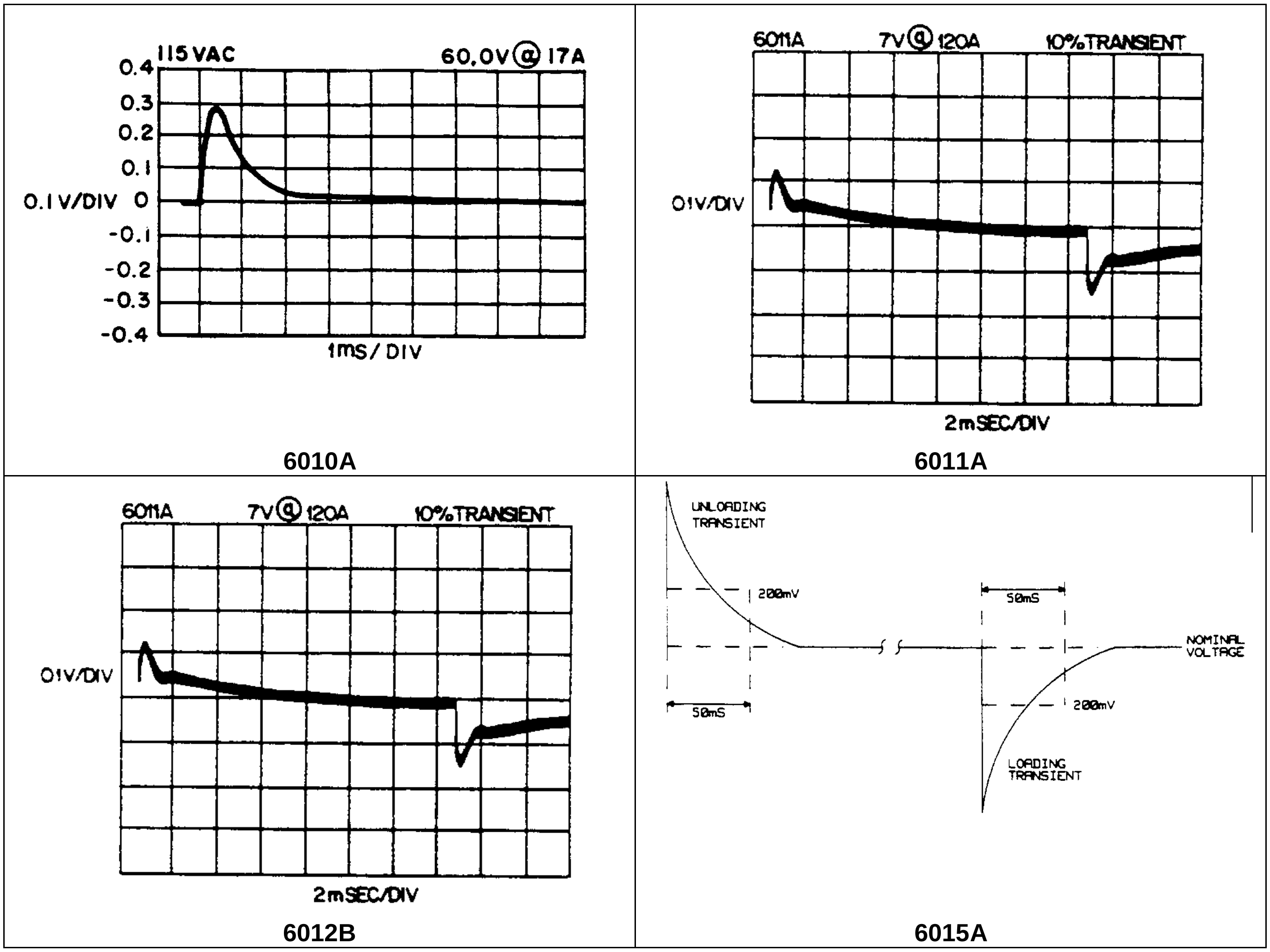


Figure 2-7. Load Transient Recovery Waveform

Temperature Coefficient. Temperature coefficient (TC) is the change in output voltage for each °C change in ambient temperature with constant ac line voltage, constant output voltage setting and constant load resistance. Measure temperature coefficient by placing the unit in an oven, varying the temperature over a range within the unit's operating temperature range, and measuring the change in output voltage. Use a large, forced air oven for even temperature distribution. Leave the unit at each temperature measurement for half hour to ensure stability in the measured variable. Measure the output voltage with a stable DVM located outside the oven so voltmeter drift does not affect the measurement accuracy. To measure offset TC, repeat the procedure with output voltage set to 0.10Vdc.
Proceed as follows:

a. Connect DVM between +S and -S.
b. Place power supply in oven, and set temperature to 30°C.
c. Turn the unit's power-on and turn up current setting to full output.
d. Turn up output voltage to the following:

200Vdc (6010A)
20.0Vdc (6011A)
60.0Vdc (6012B)
500Vdc (6015A)
as read on the DVM.

e. After 30 minutes stabilization, record the temperature to the nearest 0.1°C. Record the output voltage on the DVM.
f. Set oven temperature to 50°C.
g. After 30 minutes stabilization, record the temperature to the nearest 0.1°C. Record output voltage.
h. Check that the magnitude of the output voltage change is no greater than
620mV.(6010A)
80mV (6011A)
176mV (6012B)
1.6V (6015A)

Drift (Stability). Drift is the change in output voltage beginning after a 30-minute warm-up during 8 hours operation with constant ac input line voltage, constant load resistance and constant ambient temperature. Use a DVM and record the output at intervals, or use a strip-chart recorder to provide a continuous record. Check that the DVM's or recorder's specified drift during the 8 hours will be no more than 0.001%. Place the unit in a location with constant air temperature preferably a large forced-air oven set to 30°C and verify that the ambient temperature does not change by monitoring with a thermometer near the unit. Typically the drift during 30 minute warm-up exceeds the drift during the 8-hour test. To measure offset drift, repeat the procedure with output voltage set to 0.10Vdc.

a. Connect DVM between + S and - S.
b. Turn the unit's power-on and turn up current setting to full output.
c. Turn up output voltage to:
200Vdc (6010A)
20Vdc (6011A)
60.0Vdc (6012B)
500Vdc (6015A)
as read on the digital voltmeter.
d. After a 30 minute warmup, note reading on DVM.
e. The output voltage should not deviate more than
77mV (6010A)
9mV (6011A)
23mV (6012B)
190mV (6015A)
from the reading obtained in step d over a period of 8 hours.

Constant Current (CC) Tests

CC Setup. Constant-current tests are analogous to constant-voltage tests, with the unit's output short circuited and the voltage set to full output to assure CC operation. Follow the general setup instructions on Page 16.

Load Effect (Load Regulation). Constant current load effect is the change in dc output current (Io) resulting from a load-resistance change from short-circuit to full-load, or full-load to short-circuit. Full-load is the resistance which develops the maximum rated output voltage at current Io. Proceed as follows:

a. Connect the test equipment as shown in Figure 2-3. Operate the load in constant resistance mode (Amps/Volt) and set resistance to minimum.
b. Turn the unit's power-on, and turn up voltage setting to full output.
c. Turn up output current to:
5.0Adc (0.050Vdc across Rm) (6010A) Check that the AMPS display reads about 5 amps.
50Adc (0.25Vdc across Rm) (6010A) Check that the AMPS display reads about 50 amps.

17.5Adc (0.0175Vdc across Rm) (6012B) Check that the AMPS display reads about 17.5 amps.
2Adc (0.20Vdc across Rm) (6015A) Check that the AMPS display reads about 2 amps.

d. Increase the load resistance until the output voltage at +S and -S increases to:
   200Vdc (6010A)
   20Vdc (6011A)
   60Vdc (6012B)
   500Vdc (6035A)
   Check that the CC LED is lighted and AMPS display still reads ≈ current setting.
e. Record voltage across Rm.
f. Short circuit the load.
g. When the reading settles (≈ 10s), record the voltage across Rm again. Check that the two recorded readings differ no more than:
   0.105mVdc (6010A)
   ± 0.010mVdc (6011A)
   ± 0.0118mVdc (6012B)
   ± 3.4mVdc (6015A)
h. Disconnect the short across the load.

Source Effect (Line Regulation). Constant current source effect is the change in dc output current resulting from a change in ac input voltage from the minimum to the maximum values listed in the Specifications Table in the Operating Manual. Proceed as follows:

a. Connect the test equipment as shown in Figure 2-3. Operate the load in constant resistance mode (Amps/Volt) and set resistance to minimum.
b. Connect the unit to the ac power line through a variable autotransformer set for low line voltage (e.g. 104Vac for 120Vac).
c. Switch the unit's power-on and turn up output voltage setting to full output.
d. Turn up output current to:
   17.0Adc (6010A)
   120Adc (6011A)
   50Adc (6012B)
   5.0Adc (6015A)
   Check that the AMPS display reads ≈ current setting.
e. Increase the load resistance until the output voltage between + S and - S increases to:
   60Vdc (6010A)
   7.0Vdc (6011A)
   20.0Vdc (6012B)
   200Vdc (6035A)
   Check that the CC LED is still on and the AMPS display still reads ≈ current setting.
f. Record the voltage across Rm.
g. Adjust autotransformer to the maximum for your line voltage.
h. When the reading settles record the voltage across Rm again. Check that the two recorded readings differ no more than:
   ± 0.067mVdc (6010A)
   ± 0.018mVdc (6011A)
   ± 0.015mVdc (6011A)
   ± 18mVdc (6015A)

PARD Ripple And Noise. Periodic and random deviations (PARD) in the unit's output (ripple and noise) combine to produce a residual ac current as well as an ac voltage super-imposed on the dc output. The ac voltage is measured as constant-voltage PARD. Constant-current PARD is specified as the root-mean-square (rms) output current in a frequency range 20Hz to 20MHz with the unit in CC operation. To avoid incorrect measurements, with the unit in CC operation, caused by the impedance of the electronic load at noise frequencies, use a:

0.4Ω (6010A)
0.058Ω (6011A)
0.4Ω (6012B)
40Ω (6015A)

load resistor that is capable of safely dissipating 1000 watts. Proceed as follows:

a. Connect the test equipment as shown in Figure 2-8.
b. Switch the unit's power-on and turn the output voltage all the way up.
c. Turn up output current to:
   17.0Adc (6010A)
   120Adc (6011A)
   50Adc (6012B)
   5.0Adc (6015A)

Check that the unit's CC LED remains lighted.

d. Check that the rms noise current measured by the current probe and rms voltmeter is no more than:
   15mA rms (6010A).
   120mA rms (6011A)
   25mA rms (6012B)
   50mA rms (6015A)

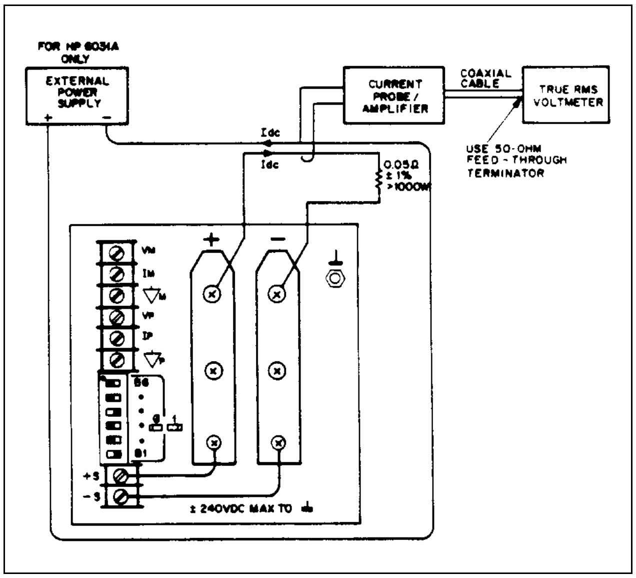


Figure 2-8. CC PARD Test Setup

3

Troubleshooting

WARNING Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

Introduction

Before attempting to troubleshoot this instrument, ensure that the fault is with the instrument itself and not with an associated circuit. The performance test enables this to be determined without having to remove the covers from the supply.

The most important aspect of troubleshooting is the formulation of a logical approach to locating the source of trouble. A good understanding of the principles of operation is particularly helpful, and it is recommended that Chapter 4 of this manual be reviewed before attempting to troubleshoot the unit. Often the user will then be able to isolate a problem simply by using the operating controls and indicators. Once the principles of operation are understood, refer to the following paragraphs.

Table 2-1 lists the test equipment for troubleshooting. Chapter 6 contains schematic diagrams and information concerning the voltage levels and waveforms at many of the important test points. Most of the test points used for troubleshooting the supply are located on the control board test "fingers", which are accessible close to the top of the board. See Table 3-1.

If a component is found to be defective, replace it and re-conduct the performance test. When a component is replaced, refer to Calibration Procedure (Chapter 2). It may be necessary to perform one or more of the adjustment procedures after a component is replaced.

Initial Troubleshooting Procedures

If a problem occurs, follow the steps below in sequence:

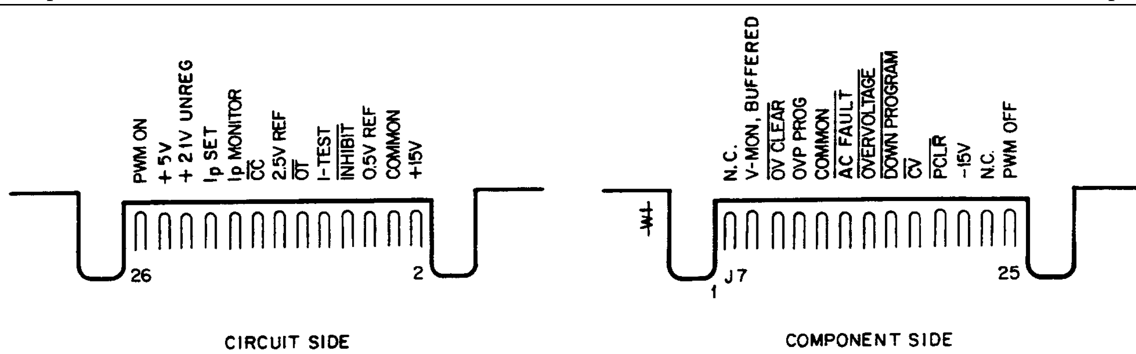
a. Check that input power is available, and check the power cord and rear-panel circuit breaker.
b. Check that the settings of mode switch A2S1 are correct for the desired mode of operation. (See Operating Manual).
c. Check that all connections to the power supply are secure and that circuits between the supply and external devices are not interrupted.
d. If the power supply fails turn-on self-test or gives any other indication of malfunction, remove the unit from the operating system before proceeding with further testing.

WARNING Some circuits on the power mesh are connected directly to the ac power line. Exercise extreme caution when working on energized circuits. Energize the supply through an isolation transformer to avoid shorting ac energized circuits through the test instrument's input leads. The isolation transformer must have a power rating of at least 4KVA. During work on energized circuits, the safest practice is to disconnect power, make or change the test connections, and then re-apply power.

Make certain that the supply's ground terminal (⊥) is securely connected to an earth ground before applying power. Failure to do so will cause a potential shock hazard that could result in personal injury.

Table 3-1. Control Board Test Connector, A2J7

PIN NO.	SIGNAL NAME	Vdc	WAVEFORM/CONDITIONS	SOURCE
Digital-Circuits Bias & Reference Voltages				
24	+5V	5.0		A2Q9 (emitter)
22	+ 20V(5V UNREG)	20.0	with 120Hz & 40KHz ripple	A1CR2, A1CR5
14	2.5V ref	2.50		A2U7 (OUT)
6	0.5V ref	0.50		A2R84,A2R85, A2R24
Analog-Circuits Bias Voltages				
2	+ 15V	15.0		A2U11 (OUT)
21	- 15V	-15.0		A2U12 (OUT)
Status Signals				
17	$\overline{\text{CV}}$	TTL Lo	if in CV operation	A2Q2 (collector)
16	$\overline{\text{CC}}$	TTL Lo	if in CC operation	A2Q1 (collector)
13	$\overline{\text{OV}}$	TTL Hi	if not OVP shutdown	A2U15-13
11	$\overline{\text{DROPOUT}}$	TTL Hi	if ac mains okay	A2U15-10
12	$\overline{\text{OT}}$	TTL Hi	if not overtemp shutdown	A4TS1,A5TS1
Control Signals				
25	PWM OFF		10µs TTL pulses, 20KHz	A2U16-5
26	PWM ON		1.7µs TTL pulses, 20KHz	A2U15-1
18	Ip MONITOR		½ sawtooth, 20KHz	A2CR27 (cathode)
15	$\overline{\text{DOWN PROGRAM}}$	TTL Hi (6010A, 6015A) 1.2-3.0 (6011A, 6012B)	while not down programming	A2CR17, CR31(anode)
7	OVP PROGRAM	1/100 OVP (6010A) 1/10 OVP (6011A) 1/30 OVP (6012B) 1/100 OVP (6015A)	e.g.: 2Vdc if OVP set to 200 voltage output (6010A)	A3R97 (wiper)
19	$\overline{\text{PCLR}}$	TTL Hi	if +5V bias OK	A2UQ11-4
Commons & Current-Monitor				
4	L COMMON		common return for all bias voltages, and status and control signals	
9	M COMMON	0.0	common return for 2.5V ref. and 0.5V ref.	
10	I-TEST	≈0.0017 (Iout)	inboard-side monitoring res.	A1R11 AlR13 (6011A))
3	NOT USED			
20	Ip-SET	≈0.9		A2R25 wiper



Electrostatic Protection

The following caution outlines important precautions which should be observed when working with static sensitive components in the power supply.

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

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

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

g. All grounding (device being repaired, test equipment, soldering iron, work surface, wrist strap, etc.) should be done to the same point.
h. Do not wear nylon clothing. Keep clothing of any kind from coming within 12 inches of static-sensitive devices.
i. Low-impedance test equipment (signal generators, logic pulsers, etc.) should be connected to static-sensitive inputs only while the components are powered.
j. Use a mildly activated rosin core solder (such as Alpha Metal Reliacor No. 1, Agilent Part No. 8090-0098) for repair. The flux residue of this type of solder can be left on the printed circuit board. Generally, it is safer not to clean the printed-circuit board after repair. Do not use Freon or other types of spray cleaners. If necessary, the printed-circuit board can be brushed using a natural-bristle brush only. Do not use nylon-bristle or other synthetic-bristle brushes. Do not use high-velocity air blowers (unless ionized).
k. Keep the work area free of non-conductive objects such as Styrofoam-type cups, polystyrene foam, polyethylene bags, and plastic wrappers. Non-conductive devices that are necessary in the area can be kept from building up a static charge by spraying them with an anti-static chemical (Agilent Part No. 8500-3397).
l. Do not allow long hair to come in contact with static-sensitive assemblies.
m. Do not exceed the maximum rated voltages specified for the device.

Repair and Replacement

Repair and replacement of most components in the power supply require only standard techniques that should be apparent to the technician. The following paragraphs provide instructions for removing certain assemblies and components for which the procedure may not be obvious upon inspection.

WARNING To avoid the possibility of personal injury, remove the power supply from operation before opening the cabinet. Turn off ac power and disconnect the line cord, load, and remote sense leads before attempting any repair or replacement.

CAUTION When replacing any heatsink-mounted components except thermostat, smear a thin coating of heatsink compound between the component and heatsink. If a mica insulator is used, smear a thin coating of heatsink compound on both sides of the mica insulator.

Do not use any heatsink compound containing silicone, which can migrate and foul electrical contacts elsewhere in the system. An organic zinc oxide cream, such as American Oil and Supply Company Heatsink Compound #100, is recommended.

CAUTION Most of thc attaching hardware in this unit is metric. The only non-metric (sometimes called English or inch) fittings are listed below. Be careful when both types of screws are removed not to get them mixed up.

a. Screws that secure the input and output capacitors to A1 main board and output bus.
b. Rear-panel circuit breaker.
c. Rear-panel ground binding post.

Top Outside Cover Removal. Remove the two top rear screws using a Size 2, Pozidriv screwdriver. A Phillips head screwdriver does not fully seat into Pozidriv screws and risks stripping the heads. Remove the top cover by sliding it to the rear and lifting at the front.

Bottom Cover Removal. Remove the handles from both sides of the unit and remove the bottom cover by sliding it to the rear. Use a Phillips head #2 screwdriver to remove the handle screws. You do not need to remove the unit's feet.

Inside Top Cover Removal. The unit includes an inside cover which secures the vertical board assemblies. Remove the inside cover for repair but not for calibration. Remove the nine mounting screws (Pozidriv, M4x7) – two in the left side, three on the right side, and four on top. Remove the inside cover by lifting at the front edge.

When installing the inside cover, insert it first at the right side. While holding it tilted up at the left, reach through the cutouts in the cover and fit the top tabs of the A2 control board into the mating slots in the cover. Then repeat the process for the A4 FET board, and the A5 Diode board. Press the inside cover down firmly while tightening screws that secure cover to chassis. Be careful when replacing printed-circuit assemblies and covers not to bend any boards or components.

A2 Control Board Removal

After removing the inside cover, unplug the W1 ribbon cable at the front edge of the A2 control board and unplug the W7 and W8 ribbon cables from the lower center of the A2 control board. Remove the A2 board by lifting first at the front edge and than pulling it up and out of the unit.

When installing the A2 board, insert it first at the rear of the unit. While holding it tilted up at the front, fit the A2TB1 terminal strip into the mating cutout in the rear panel. Then lower the A2 board's bottom tabs into the mating slots on the chassis. Re-install the W1, W7, and W8 ribbon cables.

A4 FET Board Removal

After removing the inside cover, remove the A4 FET board by lifting, using the large aluminum heatsink as a handle. One connector and one tab holds the A4 board at its bottom edge.

When installing the A4 power mesh board, lower it vertically, placing its tab into the A1 board slot first, align the connector and press in place.

A5 Diode Board Removal

After removing the cover, remove the A5 Diode board by first removing the two cover screws (Pozidriv) that hold heatsinks to the A1 board, then lift vertically to remove the A5 Diode board from the connector.

When installing the A5 Diode board, lower it into the mating connector on the A1 board, then install a screw between each heatsink and Al board.

A3 Front Panel Board Removal

Remove the A3 front panel board by first removing the entire front panel assembly. You do not need to remove the top cover. Follow this procedure:

a. Remove the top plastic insert by prying up with a flat-blade screwdriver.
b. Remove the four front panel assembly mounting screws (Phillips 6-32) two on the top and two on the bottom.
c. Gently pull the front panel assembly away from the unit as far as permitted by the connecting cables.
d. Note the locations of the four power-wire connections to the power switch and then unplug the quick-connect plugs.
e. Unplug the W1 ribbon cable from connector A2J3 on the A2 control board.
f. Remove the A3 board from the front panel assembly by removing the six mounting screws (Pozidriv, M4x.7)

Install the A3 Board by reversing the steps above. Connect the power switch wires in the exact locations from which they were removed. See A1 Main Board Removal.

A1 Main Board Removal

Removing the A1 main board requires removing all the vertical boards except the A3 front panel board, and 17 A1 board mounting screws, four standoffs, and two bus-bar mounting screws. Component-access cutouts in the bottom inside cover allow unsoldering most A1 board components for repair without removing the A1 board.
Proceed as follows:

To remove the A1 board, proceed as follows:

a. Remove the A2, A4, and A5 boards according to the above instructions.
b. Remove the AC power cord from the cooling fan and the four AC Input Power wires.

AC Input Wire		Terminal Destination	
from	**color**	**designator**	**location**
L6 (chassis)	white	P	left rear
RFI filter	white/gray	N	behind A1K1
Circuit breaker	white/brown/gray	L	behind A1K1
L6 (chassis)	white		A1K1 front armature

c. Remove the following mounting screws:
   2 (1 each) from the output bus bars
   7 from the A1 board
   4 from transformer AlT2
   4 from transformer AlT3
   2 from relay AlK1
   4 inside-cover mounting posts 5/16 hex

d. Lift the A1 board up and toward the rear, then remove the wires from the front panel switch A3S1.

A1 Designator	Wire color	A3S1 Position (Rear View)
A	white/gray	Upper right
B	gray	Upper left
C	white/brown/gray	Lower left
D	white/red/gray	Lower right

A3 FRONT PANEL ASSEMBLY

REAR VIEW

S1

B-- | --A

C-- | --D

Install the A1 board by reversing the above steps. Be careful to follow the wire color code mentioned above.

Overall Troubleshooting Procedure

WARNING Perform the troubleshooting and repair procedures which follow only if you are trained in equipment service and are aware of the danger from fire and electrical-shock hazards. Some of the procedures include removing the unit's protective covers which may expose you to potentially lethal electrical shock. Whenever possible, make test connections and perform service with the power removed.

After performing the Initial Troubleshooting Procedures, focus on developing a logical approach to locating the source of the trouble. The underlying strategy for the troubleshooting procedures here is to guide you to the faulty circuit nodes which have improper signals or voltages. It relies on you to identify the particular functional circuit to troubleshoot from symptom tables and by understanding how the unit works. It then relies on you to discover the defective component or components which cause the faulty circuit nodes. So, read the BLOCK DIAGRAM overview in Chapter 4 and read the functional circuit descriptions for the circuits that you suspect may be defective. Then return to this section for help finding the faulty circuit nodes.

Table 3-1 gives the signals for each of the test points on the control board test connector. This connector is provided in service kit P/N 5060-2865. The measurements given here include bias and reference voltages as well as power supply status signals and waveform information. To troubleshoot the power supply the A4 power FET board and A2 control board can be raised out of the unit using extender boards and cables provided in service kit P/N 5060-2865.

WARNING The A4 power FET board should only be raised on its extender when using the Main Troubleshooting Setup; NEVER when the unit is operated with its normal (≈ 300Vdc) bus voltage. To do so can cause damage to the unit and is a shock hazard.

Table 3-2 provides troubleshooting information based on the status of the PWM-ON and PWM-OFF signals which drive the PFETs. This table is used for no-output failures.

Tables 3-3 and 3-4 give measurements for the test points on the A3 front panel board and possible failure symptoms respectively.

Table 3-5 describes possible symptoms for overall performance failures of the power supply. It is necessary to have a properly working front panel before using this table.

Chapter 6 contains schematic diagrams and voltage levels, and component location diagrams to help you locate components and test points.

Make most voltage measurements (except DC-to-DC Converter and ac mains-connected circuits) referenced to the unit's output common. The output common is accessible at rear-panel ⏚M terminal. All voltages are ± 5% unless a range is given.

Using the Tables

Typically there will be two types of power supply failures; no-output and performance failures.

1. NO-OUTPUT FAILURE: Start with the TROUBLESHOOTING NO-OUTPUT FAILURES section which references Tables 3-1 and 3-3.

2. PERFORMANCE FAILURE: If the power supply produces an output but does not perform to specifications, begin by verifying the measurements at the A2J7 test connector using Table 3-1. Next, verify the front panel by doing the procedure outlined in the FRONT PANEL TROUBLESHOOTING section. After the front panel has been verified consult Table 3-5 for the performance failure symptom which seems closest to the one observed and proceed to the functional circuit given for that failure.

The circuits referenced in Tables 3-2 and 3-5 are derived from functional blocks of circuits in the power supply. These blocks are given in the Power Supply Blocks section starting on page 40. Troubleshooting information for each block will include a brief description of the circuit involved. The columns provided in each block are as follows:

NODE:	This column lists the nodes where the measurements should be taken. In some cases this will be stated as NODE (+) and NODE (-) where the first is the test node and the second is the reference.
SETUP:	If a certain setup is required for the measurement, it will be given in this column.
MEASUREMENT:	This column indicates what the expected measurement is for the given node.
SOURCE:	If applicable, the components which generate the signal will be provided in this column .

Some blocks will have Input and Output sections. The input section will have a source column to indicate which components generated the measured signal. The output section will list all the important output signals from that block. However, because the outputs of one block are the inputs to another, the schematic should be consulted if an output measurement is incorrect. This will indicate the next circuit block to be trouble shot.

Main Troubleshooting Setup

Figure 3-1 shows the troubleshooting setup for troubleshooting all of the unit except the front panel and initial no output failures (see page 36). The external power supply provides the unit's internal bus voltage. The ac mains cord connects to the unit's A1T3 bias transformer via an isolation transformer, thereby energizing the bias supplies, but it does not connect to the input rectifier and filter because that would create the bus voltage. With the external supply the unit operates as a dc-to-dc converter. The supply biases the A4Q1, A4Q2, A4Q3 and A4Q4 PFETs with a low voltage rather than the 320Vdc bus voltage. This protects the PFETs from failure from excess power dissipation if the power-limit comparator or the off-pulse circuitry are defective. It also reduces the possibility of electrical shock to the troubleshooter.

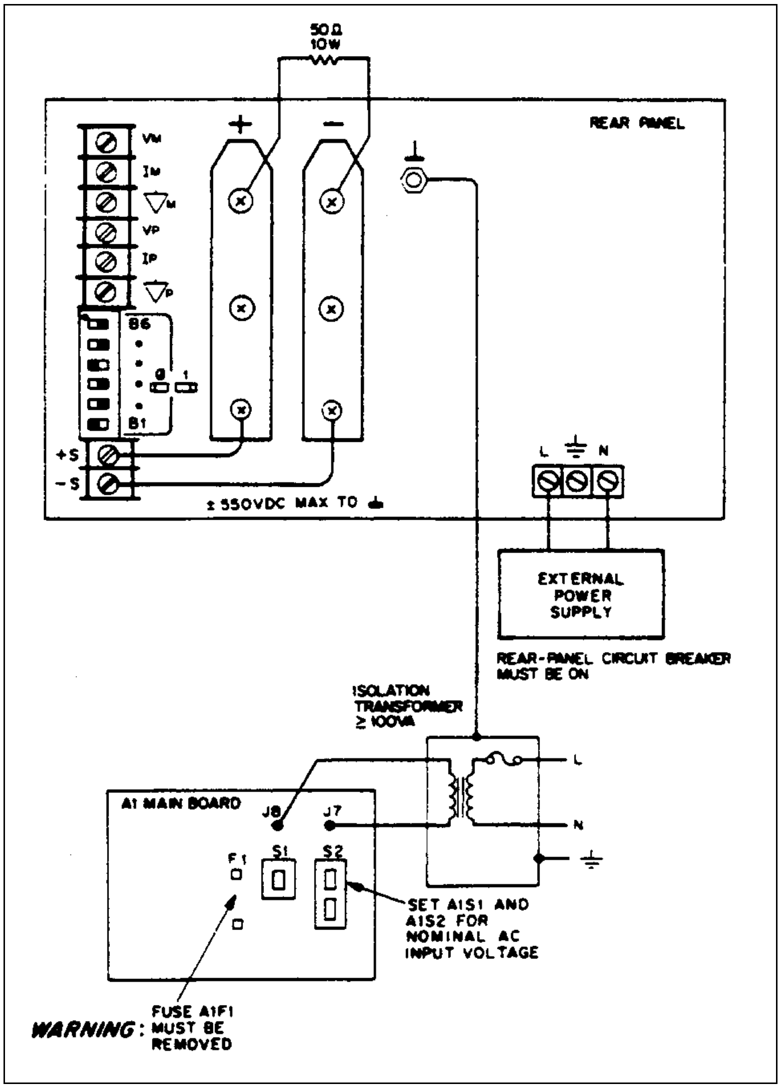


Figure 3-1. Main Troubleshooting Setup

WARNING An isolation transformer provides ac voltage that is not referenced to earth ground, thereby reducing the possibility of accidentally touching two points having high ac potential between them. Failure to use an isolation transformer as shown in Figure 3-1 will cause the ac mains voltage to be connected directly to many components and circuits within the power supply, including the FET heatsinks, as well as to the terminals of the external dc power supply. Failure to use an isolation transformer is a definite personal-injury hazard.

The troubleshooting setup of Figure 3-1 connects high ac voltage to relay K1, fan B1, fuseholder A1F1, and other components and circuits along the front of the A 1 main board.

As a convenience in implementing the troubleshooting setup, prepare cord sets as shown in Figure 3-2. This facilitates connecting the unit's input power rail to the external supply and connecting the bias transformer to the isolation transformer.

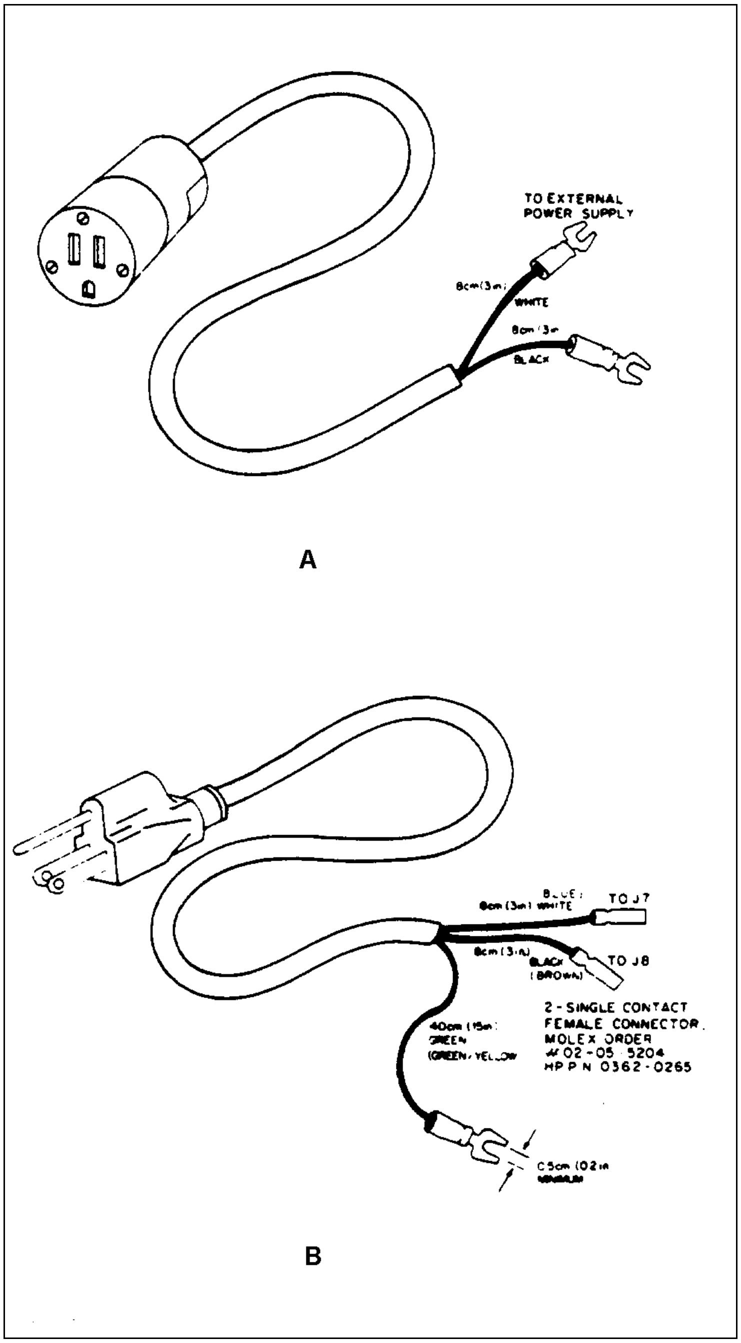


Figure 3-2. Modified Mains Cord Set For Troubleshooting

With the mains cord unplugged proceed as follows:

a. Remove the top cover and the inside cover as described on page 30. Remove fuse A1F1.

WARNING Failure to remove fuse AlF1 will result in damage to the unit; damage to the external DC supply and a shock hazard to you.

b. Install control board test connector onto the A2J7 card edge fingers.
c. Connect a 50 Ω, 40W, load resistor to the unit's output terminals.

d. Place the front panel power-on switch in the off position. Remove the ac input cover from the rear panel and connect the "L" and "N" screws on the barrier block to the output of the external DC supply. If a line cord is already connected to these terminals, construct an adapter as shown in Figure 3-2 (a), which allows you to connect the cord to the DC supply. In either case ignore polarity as the unit's rectifying diodes steer the dc power to the correct nodes.
e. Complete the setup of Figure 3-1 by attaching an ac mains cord to test points J8 (L, black wire) and J7 (N, white wire) and connect the green ground wire to the unit's case ground terminal or a suitably grounded cabinet screw. See Figure 3-2 (b). Plus the mains cord into an isolation transformer.

Troubleshooting No-Output Failures

Note The main troubleshooting setup is not used for the No Output Failures and Front Panel troubleshooting tests.

No-output failures often include failure of the A4Q1 through A4Q4 PFETs and their fuses, A4F1 and A4F2. When either the off-pulses or the power-limit comparator fails, the PFETs can fail from excessive power dissipation. The strategy for localizing no-output failures is to check the voltages and waveforms at the control board test connector to predict if that circuit failure would cause the PFETs to fail. This makes it possible to develop your troubleshooting approach without an extensive equipment setup. Proceed as follows:

a. With the mains cord unplugged remove the A4 FET Driver board as described on page 30. Plug in the mains cord and switch on power.
b. Using Table 3-1 check the bias voltages, the PWM-OFF, PWM-ON and Ip MONITOR Control signals and other signals of interest at the A2 control board test fingers, A2J7.
c. Check for the presence of program voltages, VP and IP, at the rear panel.
d. Check for presence of the 320Vdc rail voltage between the rear facing end of AlR3 and the rear facing end of AlR1. If there is no rail voltage, check diode Assembly A1U1.

WARNING A1R1, A1R3, and AlU1 connect to the ac mains voltage. Use a voltmeter with both input terminals floating to measure the rail voltage.

e. Select the functional circuit for troubleshooting based on your measurements and Table 3-2, which provides direction based on the status of the PWM OFF and PWM ON signals .

Front Panel Troubleshooting

Troubleshoot the A3 front panel board by first doing the following setup:
a. Remove the top plastic insert from the front frame by prying up with a flat-blade screwdriver.
b. Remove the 4 front panel assembly mounting screws (Phillips 6-32), two on top and two on the bottom.
c. Detach the A3 board from the front panel assembly by removing the 6 mounting screws (Pozidriv, M4x7).
d. Place the A3 board vertically against the supply with a piece of insulating material between. The test connector can then be attached to the A3 board. The rest of the front panel assembly can stand vertically so that the pots and the switches can be accessed while troubleshooting.
e. Plug in the mains cord and switch on power.

WARNING The ac mains voltage connects directly to the LINE switch and to components and traces at the front of the A1 main board. Be extremely careful to avoid touching the ac mains voltage.

Start troubleshooting by performing the tests given in Table 3-3. This table provides the measurements for the test points on the test connector as well as the source components for that measurement. Table 3-4 gives front panel symptoms as well as the circuits or components that may cause the supply to exhibit those symptoms. Both Tables 3-3 and 3-4 should be used to check out and troubleshoot the front panel.

Table 3-2. No-Output Failures
(Bias supplies and AC turn-on circuit functioning)

Status of PFET on/off-Pulses

PWM-ON A2J7-26	PWM-OFF A2J7-25	DEFECTIVE BOARD	CHECK FUNCTIONAL CIRCUITS
lo	lo	A2	Control ckts: CV & CC thru on- & off-Pulse Oneshots *
lo	hi	A2 & A4	PWM and DC-to-DC Converter: A4Q1, A4Q2, A4Q3 and A4Q4 probably failed
hi	lo	A2 & A4	PWM and DC-to-DC Converter: A4Q1, A4Q2, A4Q3 and A4Q4 probably failed
hi	hi	A2 & A4	PWM and DC-to-DC Converter: A4Q1, A4Q2, A4Q3 and A4Q4 probably failed
lo	N	A2	A2U15A,on-Pulse Oneshot and A2Q11
N	lo	A2 & A4	Off-Pulse Oneshot and DC-to-DC: A4Q1, A4Q2, A4Q3 and A4Q4 probably failed
hi	N	A2 & A4	A2U15A, on-Pulse Oneshot & DC-to-DC: A4Q1, A4Q2, A4Q3, and A4Q4 probably failed
N	hi	A2 & A4	off-Pulse Oneshot and DC-to-DC: A4Q1, Q4Q2, A4Q3 and A4Q4 probably failed
N	N	A2 & A4	Power-Limit Comparator and DC-to-DC: A4Q1, A4Q2, A4Q3 and A4Q4 probably failed

lo= TTL low hi= TTL high N = normal 20KHz pulse train, TTL levels

* Decide which to troubleshoot -- the CV Circuit, the CC Circuit, or the PWM and Off-Pulse & On-Pulse Oneshots -- by measuring the CV CONTROL (A2CR24, cathode) and the CC CONTROL (A2CR11 cathode) voltages. Troubleshoot whichever is negative, and if neither is negative, troubleshoot the PWM. Make these voltage measurements after you have implemented the Main Troubleshooting Setup.

Table 3-3. Front Panel Board Tests

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Pin No	Signal Name	Measurement	Description	Source
1	+7.5V	7.5V	Derived from + 15V bias.	A3VR2, A3R93
2	-1V	-1.0V	Derived from –15V bias.	A3R89, A3R94, A3C17
3	CV VOLTAGE	0-5V	For 0 to full scale output voltage.	A3U6-6, A3R88, A3CR1
4	CC VOLTAGE	0-5V	For 0 to full scale output current.	A3U7-1, A3R58
5	VOLTS test	-1888 on volts display	Jumper to + 5V on A3 board.	A3U1-37
6	AMPS test	-1888 on amps display	Jumper to + 5V on A3 board.	A3U2-37
7	VOLTS input	0-1V	For 0 to full scale output voltage.	A3U4-2,3,10
8	VOLTS low range	TTL high	If VOLTS display is below 20 volts (press DISPLAY SETTINGS).	A3U5-13
9	DISPLAY SETTINGS	TTL lo	If DISPLAY SETTINGS switch on front panel is depressed.	A3S1,A3R85
10	DISPLAY OVP	TTL high	If DISPLAY OVP switch on front panel is depressed.	A3S2,A3R64
11	AMPS input	0-600mV	For 0 to full scale output current.	A3R56,A3R58
12	-5V	-5.0V	Derived from -15V bias.	A3VR1, A3R90
13	buffered OVP	0-2.2V	1/30 of OVP voltage setting when DISPLAY OVP switch is depressed varies with OVP ADJUST pot.	A3U7-7,A3CR5

Troubleshooting Bias Supplies

+5V on A2 Control Board. The PWM A2U22 includes a clock generator (40KHz set by A2R170, A2C79, and A2Q10), and a current limit (2Adc set by 0.15Vdc across A2R172). It turns off each output pulse using the difference between the voltage at voltage divider A2R161-A2R163 and the 2.5Vdc set by voltage regulator A2U21.

Circuit Included. + 5Vdc bias supply circuitry from connector pin A1J5-1,3 (1,3 both pins) through jumper A2W3 on A2 control board.

Setup. The Main Troubleshooting Setup, page 33. Apply the ac mains voltage to the isolation transformer, and set the external supply to 0Vdc.

Input:

NODE +	NODE -	MEASUREMENT	SOURCE
A2J7-22	A2J4-4.	≈ 20Vdc	A1CR2,AlCR5

Outputs

NODE	MEASUREMENT
A2U22-6	≈ 2 to 4Vdc sawtooth, 40KHz
A2U22-12,13	≈ 19Vpk, 15µs pulses, 40KHz
A2Q9 (emit)	≈ 20Vpk, 5µs pulses, 40KHz
A2U21 -2	2.5Vdc
A2R161, A2R163	2.5Vdc

To check if load on + 5V is shorted, remove jumper A2W3

Table 3-4. A3 Front Panel Board Failure Symptoms

SYMPTOMS	DEFECTIVE CIRCUIT	CHECK COMPONENTS
Error when pressing DISPLAY SETTINGS	Limits display.	A3U5, A3U8
Error in VOLTS or AMPS	Input ranging or DVMS.	A3U8,A3U6,A3U4,A3U1,A3U2, A3U7
* One or more display digits out	Display LEDs.	A3DS1 through A3DS8
Unable to adjust VOLTAGE or CURRENT or always max	Potentiometers.	A3R99, A3R100
VOLTS decimal point error	Decimal drivers.	A3U3

* Note that the Volts and Amps tests (Table 3-3 pins 5 and 6) verify that all the current and voltage display segments light except for the decimal points.

Table 3 5. Performance Failure Symptoms

SYMPTOMS	DEFECTIVE BOARD	CHECK FUNCTIONAL CIRCUITS
Unexplained OVP shutdowns	A2	OVP Circuit, CV Circuit
No current limit	A2	CC Circuit
Max current < 17Adc	A2	CC Clamp, CC Circuit
Max power < specified	A2, A1	Power Limit, 20KHz clock, transformer A1T2
Max voltage < 200Vdc	A2, A1	CV Circuit, diodes A1U1, mains voltage select jumper A1W1
Cycles on & off randomly	A2, A1	AC-Surge-&-Dropout Detector, Mains Voltage Select switch A1S2

Table 3 5. Performance Failure Symptoms (continued)

SYMPTOMS	DEFECTIVE BOARD	CHECK FUNCTIONAL CIRCUITS
CV overshoots	A2	A2U5A, A2CR19, A2R62
Output noise (< 1KHz)	A2, A1	CV Circuit, Input Filter
Output noise (> 1KHz)	A1, A4	Transformer A1 T2, output Filter, snubbers A4R1 to A4R11, A4R13 to A4R19, A4C1 to A4C4, A4CR1 to A4CR4
CV regulation, transient response, programming time	A2, A1	Wrong sensing (paragraph 3-40), low ac mains voltage, CV Circuit
CC regulation	A2	Low ac mains voltage, CC circuit
CV oscillates with capacitive loads	A2	A2R61, A2R60, A2R58, A2R59, A2C33, A2R64, A2R68, A2C36, A2C37, A2U5, A2R65
CC oscillates with inductive loads	A2	A2R61, A2R60, A2R58, A2R57, A2C33, A2R19, A2C11, A2R58, A2C12, A2U4, A2R35, A2C20, A2R37, A2C17, A2R29, A2C18, A2R31

+15V on A2 Control Board. Voltage regulator A2U11 regulates the voltage across resistor A2R99 to be 1.25Vdc. That sets the current through zener diode A2VR3 at 7.5mAdc. The output voltage is 1.25Vdc plus 11.7Vdc across A2VR3 plus the voltage across A2R100.

Circuit Included. + 15Vdc bias supply circuitry from connector pin A2J5-5 through test point A2J7-2 on A2 control board.

Setup. The Main Troubleshooting Setup, page 33. Apply the ac mains voltage to the isolation transformer, and set the external supply to 0Vdc.

Input:

NODE (+)	NODE (-)	MEASUREMENT	SOURCE
A2C52(+)	A2C52(-)	≈ 27Vdc	A1U4 ,AlC15 (+) A1U4,A1C17 (+) (6011A)

Outputs:

NODE (+)	N0DE (-)	MEASUREMENT
A2J7-2	A2U11 (ADJ)	1.25Vdc
A2J7-2	A2VR3 (Anode)	12.9Vdc
A2J7-2	A2VR2 (Anode)	6.2Vdc
A2C50 (+)	A2C50 (-)	13.8Vdc

To check if load on + 15V is shorted, remove jumper A2W1 .

-15V on A2 Control Board. Voltage regulator A2U12 regulates the voltage across resistor A2R103 to be 1.25Vdc.

Circuit Included. -15Vdc bias supply circuitry from connector pin A2J5-6 through test point A2J7-21 on A2 control board.

Setup. The Main Troubleshooting Setup, page 33. Apply the ac mains voltage to the isolation transformer, and set the external supply to 0Vdc.

Input:

NODE (+)	NODE (-)	MEASUREMENT	SOURCE
A2C55(+)	A2C55(-)	≈ 27Vdc	A1U4, AlC16 (-) A1U4, AlC18 (-) (6011A)

Outputs:

NODE (+)	N0DE (-)	MEASUREMENT
A2J7-21	A2U12-3 (ADJ)	-1.25Vdc
A2J7-21	A2VR4 (Anode)	-12.9Vdc
A2C54 (+)	A2C54 (-)	13.8Vdc

To check if load on -15V is shorted, remove jumper A2W3.

Refer to Down Programmer, page 42, for the + 10.6V bias supply, and refer to OVP Circuit, page 45, for the +2.5V bias supply.

Power Section Blocks

This section contains the blocks referenced in Tables 3-2 and 3-5.

Troubleshooting AC-Turn-on Circuits

Relay A1K1 closes at 2.5 seconds and DROPOUT goes high at 2.9 seconds after 20V (5V UNREG) reaches about 13Vdc. DROPOUT high enables the PWM if OVERVOLTAGE, and OVERTEMPERATURE are also high.

Circuits Included. AC-Surge-&-Dropout Detector, Bias Voltage Detector, Delay Circuits, and Relay Driver--all on A2 control board.

Setup. The Main Troubleshooting Setup, page 33. Apply the ac mains voltage to the isolation transformer, and set the external supply to 0Vdc.

Inputs:

NODE (+) *	SETUP	MEASUREMENT	SOURCE
A2J7-24		5.0Vdc	A2Q9 (emit.)
A2J7-22		≈ 21Vdc	A1CR2,AlCR5
A2U11-16		f.w.rect.,0.8Vpk	A1CR3,AlCR4
A2U20-13		TTL sq wave,20KHz	A2U20-6

Outputs:

NODE (+) *	SETUP	MEASUREMENT
A2U17-9	cycle power	≈ 13.5Vdc
A2U17-14	cycle power	≈ 1.4Vdc
A2Q11-14	cycle power	transition 0 to 5Vdc at 2.5 sec
A2Q11-4		hi (5Vdc)
A2U9-10	cycle power	2.9 s burst 1.25KHz sq. wave
A2U9-15	cycle power	one 840ms pulse then hi at 2.5 sec
A2U9-14	cycle power	three 420ms pulses then hi at 2.9 sec
A2U9-1	cycle power	transition lo to hi at 1.7 sec

A2U15-10 ($\overline{\text{AC FAULT}}$)	cycle power	transition lo to hi at 2.9 sec
A2Q7-C ($\overline{\text{RELAY ENABLE}}$)	cycle power	transition 5.0 to 0.3Vdc at 2.5 sec

* NODE (-) = A2J7-4

Troubleshooting PWM & Clock

The inputs to inhibit Gate A2U18A and PWM gate A2U18B are the keys to PWM troubleshooting. The 20KHz clock starts each PWM output pulse, and the pulse stops when any of the inputs to A2U18A or A2U18B goes low. The PWM is inhibited and prevented from initiating output pulses as long as any of the seven inputs is low.

Circuit Included. Pulse Width Modulator (PWM), Off-Pulse Oneshot, On-Pulse one-Shot, 20KHz Clock.

Setup. The Main Troubleshooting Setup, page 33. Apply the ac mains voltage to the isolation transformer. Adjust the units current setting above 1.0Adc. Set the external supply (EXTERNAL) and adjust the unit's voltage setting (INTERNAL) as instructed below. Use the "DISPLAY SETTINGS" switch to make adjustments to the unit's current or voltage setting.

Inputs:

NODE (-) = A2J7-4

NODE (+)	**SETUP**	**MEASUREMENT**	**SOURCE**
A2J7-24		5.0Vdc	A2Q9, A2W3
A2U18-10		hi	A2U15-10
A2U18-12		hi	A2U15-13
A2U18-13		hi	A5TS1, A4TS1
A2U18-5		hi	A2U18-8
A2U18-2		hi	A2U8-2
A2U18-1	Set OUTPUT ADJUST for 1Vdc	hi	A2U10-7

Outputs:

	SET VOLTAGE (Vdc)		
NODE (+)	**EXTERNAL**	**INTERNAL**	**MEASUREMENT**
A2U20-1	0	0	TTL sq wave, 320KHz
A2U20-5	0	0	TTL sq wave, 40KHz (80KHz, 6015A)
A2U20-6	0	0	TTL sq wave, 20KHz
A2U19-5	0	2	20KHz
A2U19-6	0	2	20KHz
A2U16-5	40	2	10µs pulse, 20KHz
A2U16-5	40	0	lo
A2U16-4	40	20	48µs pulse, 20KHz
A2U16-4	40	0	hi
A2U15-1	40	20	1.7µs pulse, 20KHz (80Vdc, 6015A)
A2U15-1	40	0	lo
+ OUT	40	20	≈ 40Vdc (UNREGULATED) 14Vdc (6011A, 6012B) 80Vdc (6015A)
+ OUT	40	2	20Vdc (CV) 2.0Vdc (6011A, 6012B, 6015A)

Troubleshooting DC-To-DC Converter

Parallel NOR gates A4U1, A4U2 and A4U3A act as drivers and switch on FETs A4Q1, Q2, Q3 and Q4 through pulse transformer A4T1. NOR gate A4U3B turns off the FETs through pulse transformer A4T2 and transistors A4Q5 and A4Q6.

Circuits Included. On-Pulse Driver, Off-Pulse Driver, FET Switches and Drivers on A4 FET board.

Setup. The Main Troubleshooting Setup, page 33. Apply the ac mains voltage to the isolation transformer, and set the external supply to 40Vdc. Set the unit's output voltage to 20Vdc and current to above 1Adc using "DISPLAY SETTINGS" switch. Verify that the UNREGULATED LED lights. See Figure 3-3 for waveforms.

Inputs:

NODE (+)	NODE (-)	MEASUREMENT	SOURCE
A2J7-26 (PWM-ON)	⏚M	1.7µs 20KHz pulse (see Waveform 1)	A2J5-11, A2U15-1, A4P1-A3
A2J7-25 (PWM-OFF)	⏚M	10µs 20KHz pulse (see Waveform 2)	A2U16-5, A2J5-13, A4P1-A2
A4P1-C1	⏚M	10.6Vdc	A1U3-2
A4Q2-D	A4Q4-S	39Vdc	A1C5 (+), A4P1-22 to 25 A1C1(-), A4P1-16 to 18

Outputs:

NODE (+)	NODE (-)	MEASUREMENT
A4Q1/Q2-G	A4Q2-S	(see Waveform 3)
A4Q3/Q4-G	A4Q4-S	(see Waveform 3)
A4Q2-S	A4Q4-D	(see Waveform 4)
A2J7-18	A2J7-4	(see Waveform 5)

If you replace the FETs, replace both the FETs and associated drive components as furnished in FET Service Kit, Agilent Part No. 5060-2866.

CAUTION The FETs are static sensitive and can be destroyed by relatively low levels of electrostatic voltage. Handle the A4 FET board and the FETs only after you, your work surface and your equipment are properly grounded with appropriate resistive grounding straps. Avoid touching the FET's gate and source pins.

Troubleshooting Down Programmer

The down programmer discharges the output when either PWM OFF is generated or CV ERROR is more negative than about - 3Vdc. Comparator A5U1 triggers down programming when the voltage at A5U1-5 is less than about 4Vdc.

Circuit Included. Down programmer and 10.6V bias supply on A1 main board.

Setup. The Main Troubleshooting Setup, page 33, except connect the external supply to the unit's + OUT (+) and – OUT (-) terminals. Apply the ac mains voltage to the isolation transformer. Set the external supply for an output voltage of 10Vdc and set current limit for 2.5 Amps. Set the power supply under test for a voltage setting of 8.0Vdc and current setting of 2.0Adc using "DISPLAY SETTINGS".

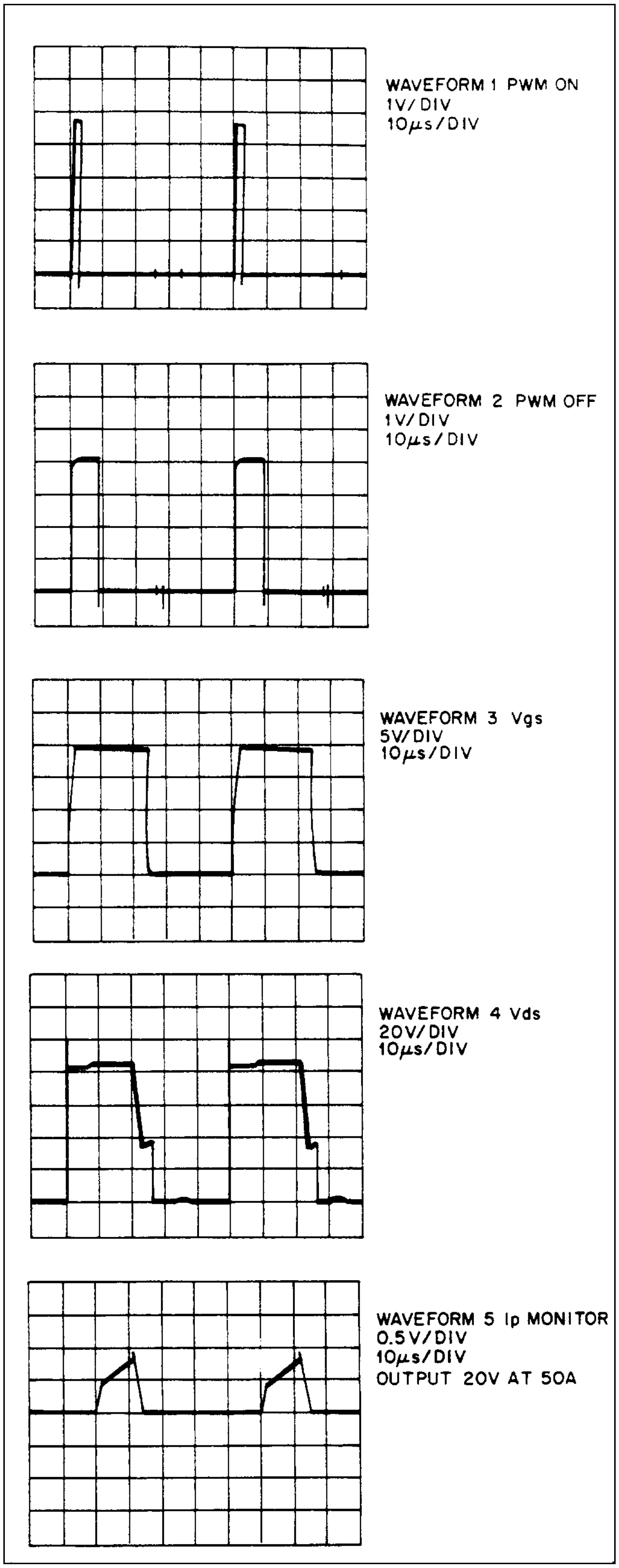


Figure 3-3. Waveforms

Outputs:

NODE (+)	EXTERNAL SUPPLY	MEASUREMENT
A5C3 (+)	ON/OFF	10Vdc
A5VR1(K)	ON/OFF	6.5Vdc
A5U1-3	ON/OFF	0.2Vdc
A5CR2(K)	OFF	1.8Vdc
A5CR2(K)	ON	0.2Vdc
A5U1-1	OFF	0.5Vdc
A5U1-1	ON	5.0Vdc
+R20	OFF	<0.001Vdc
+R20	ON	1.5Vdc

NODE (-) = A2J7-4

Troubleshooting CV Circuit

V-MON, the output of CV Monitor Amp A2U2, is 1/40 (1/4, 6011A, 6012B) the voltage between + S and - S. CV Error Amp A2U3 compares V-MON to CV PROGRAM. Innerloop Amp A2U5A stabilizes the CV loop with input from A2U5B. The measurements below verify that the operational amplifier circuits provide expected positive and negative dc voltage excursion when the CV loop is open and the power mesh shut down.

Circuits Included. Constant Voltage (CV) Circuit and buffer amplifier A2U5B.

Setup. The Main Troubleshooting Setup, page 33. Apply the ac mains voltage to the isolation transformer, and disconnect the external supply Remove the + S jumper and connect A2J7-2 (+ 15V) to + S. Set mode switch settings B4, B5 and B6 all to 0. Set VP to 0Vdc by connecting to ⏚P or set VP to + 5Vdc by connecting to A2J7-24 according to SETUP below. VP and ⏚P are on rear-panel terminal block.

Outputs:

NODE (+)	NODE (-)	SETUP	MEASUREMENT
VM	A2J7-4		3.75Vdc
A2U5-1	A2J7-4	VP = 0	-14Vdc
A2U3-6	A2J7-4	VP = 0	-14Vdc
A2U5-1	A2J7-4	VP = 5	13Vdc 4.7Vdc (6011A, 6012B, 6015A)
A2U3-6	A2J7-4	VP = 5	≈ 0Vdc 5.1Vdc (6011A, 6012B, 6015A)
A2U5-7	A2J7-4	short A2J7-24 to A2U5-5	+ 7.5Vdc

If the failure symptoms include output voltage oscillation, check if the CV Error Amp circuit is at fault by shorting A2U3-6 to A2U3-2. If oscillations stop, the CV Error Amp circuit is probably at fault.

Troubleshooting CC Circuit

I-MON, the output of CC Monitor Amp A2U1, in volts is ≈ 1/3 (1/24, 6011A) the output current in amperes. CC Error Amp A2U4C compares I-MON to CC PROGRAM. Differentiator circuit A2U4A differentiates the inboard voltage sense to stabilize the CC loop. Its output is summed with I-MON at CC Error Amp A2U4C.

The measurements below verify that the operational amplifier circuits provide expected positive and negative do voltage gain when the CC loop is open and the power mesh shut down.

Circuits Included. Constant Current (CC) Circuit on A2 control board.

Setup. The Main Troubleshooting Setup, page 33, except connect the external supply with polarity reversed to the unit's + OUT (-) and - OUT (+) terminals. Apply the ac mains voltage to the isolation transformer. Set the external supply to 3.0Adc constant current with a voltage limit in the range 5 to 20Vdc. Set mode switches B1, B2 and B3 to 0. Set IP to 0Vdc by connecting to ⏚P or set IP to + 5Vdc by connecting to A2J7-24 according to SETUP below.

Outputs:

NODE (+)	NODE (-)	SETUP	MEASUREMENT
IM	A2J7-4	IP = 5 (6015A)	0.125Vdc (0.88Vdc, 6015A)
A2U4-8	A2J7-4	IP = 0	-14Vdc
A2U4-8	A2J7-4	IP = 5	+14Vdc

If the failure symptoms include output current oscillation, check if the differentiator circuit is at fault by removing resistor A2R35 (1M ohm) (3.3M ohm, 6011A). If oscillations stop, the differentiator is probably at fault.

Troubleshooting OVP Circuit

Flip-flop A2U8A-A2U8D is set by comparator A2U8C and reset by $\overline{\text{PCLR}}$. TTL low at A2U18-12 inhibits the PWM. OVP Program Voltage on A2J7-7 is equal to Eout/10.

Circuit included. OVP Circuit and 2.5V bias supply on A2 control board.

Setup. The Main Troubleshooting Setup, page 33, except connect the external supply to the unit's + OUT (+) and - OUT (-) terminals. Apply the ac mains voltage to the isolation transformer. Adjust the unit's OVP limit to 10Vdc. Set the external supply (EXTERNAL) as instructed below.

Outputs:

NODE (-) = A2J7-4

NODE (+)	SET VOLTAGE EXTERNAL (Vdc)	SETUP	MEASUREMENT
A2U7-2	-		2.5Vdc
A2J7-7	-		1.0Vdc
			≈2.2Vdc (6015A)*
A2J7-13	5		hi
A2J7-13	15		lo
A2J7-13	5		lo
A2J7-13	5	cycle power	hi

* Front panel OVP control turned fully cw.

Note Connecting a test probe to either input of either comparator in the OV Flip flop (pins A2U8-1, 6, 7, 10, 11 or 13) may cause the flip flop to change states and cause the probed input to be low.

4

Principles of Operation

Autoranging Power

Autoranging allows the unit to be compact and light weight and yet to deliver a range of output voltage/current combinations which would otherwise require the use of more than one supply or a higher rated power supply. Autoranging is a name for circuitry which automatically makes full power available at all but low rated output voltages and currents. By comparison, a conventional constant voltage/constant current (CV/CC) power supply can provide full output power only at maximum rated output voltage and current.

Overview

The Simplified Schematic, Figure 4-1, shows how the major circuits are connected. Segmenting the Simplified schematic into functional circuit blocks will highlight how these blocks work and illustrate overall system function.

Table 4-1 briefly describes the major circuits employed in the design of this unit. When used in conjunction with the Simplified Schematic, the reader is provided with a quick overall appreciation of the unit's operation.

Power flows from the ac mains at the left of the schematic through circuit blocks connected by heavy lines to the output terminals at the right. Follow the schematic from right to left to see how the output voltage is regulated during CV mode of operation, The output voltage is monitored both at the output sense terminals + S and - S; OVS (Outerloop Voltage Sense) and also before the two stages of output filter IVS (InnerLoop Voltage Sense).

Sensing with output sense terminals provides accurate load-voltage control and sensing before the output filter stabilizes the supply and permits it to power reactive loads. The CV monitor amplifier buffers the OVS voltage to produce the V-MON output monitoring voltage. A buffer amplifier monitors the voltage before the output filter to produce the IVS voltage.

When in CC operation, the output current is regulated in a similar manner. Output current is sensed as the OCS outerloop voltage across a current monitoring resistor. OCS is buffered to produce l-MON. IVS is differentiated to produce an innerloop current sensing voltage.

System Description

The Agilent 6010A /6011A/6012B/6015A are power supplies which utilizes the principle of switching to achieve regulation. Basically, the power supply employs five major functional sub-systems together with the Front Panel to achieve its overall objective of delivering a maximum of 17A or 200V (6010A); 120A or 20V (6011A); 50A or 60V (6012B); 5A or 500V (6015B), at the power output of 1000W.

These sub-systems are
1. Regulation & Control
2. Protection
3. Input Power
4. DC Power Conversion
5. Output

Regulation & Control Subsystem

This sub-system may be considered to be the brains of the unit. It provides the control pulses to open and close the switching elements which deliver power to the output. This section also regulates the output to ensure that the unit is delivering a constant power at either a constant voltage or constant current setting. In the event that this cannot be achieved, then the protection subsystem is employed to limit the power to the output.

To understand how this control is achieved, consider Figure 4-1, the simplified schematic. Power from the output is sampled and attenuated before it is fed back to the Constant Voltage Error Amplifier. Another input to this amplifier is the Program Voltage which the user sets via the front panel. The difference between these two voltages is amplified and becomes the CV Error Signal. The output of the supply is also sampled by the CC Monitor Amp. This sample voltage is fed into the Constant Current Error Amp. The other input to the Constant Current Error Amp is the program current which the user sets via the front panel. The difference between these two voltages is amplified and becomes the Constant Current Error Signal. These two signals are connected in a wired-OR configuration and fed into the Constant Voltage Comparator.

The control mechanism which the unit employs to regulate its output comprises the Primary Current Monitor Transformer, the Control Voltage Comparator and the Pulse Width Modulator. The Primary Current Monitor Transformer senses the power transferred by the FETs and generates the Ip Ramp Voltage which continues to build up as the output increases. This Ramp Voltage and the Control Voltage are used as inputs to the control voltage Comparator. If the Ramp Voltage exceeds the Control Voltage, the output of the comparator goes low and resets the Pulse Width Modulator in the process. If the unit develops power in excess of its requirements, the power LIMIT Comparator effectively monitors this condition and returns a low signal which disables the Pulse Width Modulator and prevents any further power development.

The PULSE WIDTH Modulator (PWM) is the device which the unit employs to constantly alter the duty cycle of the switching waveform produced by the FETs. Once reset, it triggers the off-pulse one-shot which turns off the FETs via the off-pulse driver. The 20KHz entering the PWM holds it reset for 1.5µS and on the next clock pulse from the oscillator the output is clocked high. This in turn triggers the on-pulse one-shot which enables the FETs. Other inputs which can disable the PWM are the outputs from the Power Limit Comparator, the Master Enable, the CV and CC loop.

Figure 4-2 shows the timing diagram of the signals which control the FETs. Notice that on the rising edge of the on-pulse, the PWM is activated and remains on until the off pulse is sent. There is a slight delay in the time the off-pulse is sent and the time the FETs are actually turned off. This turn off delay results in greater power being generated than is required as shown by the Ramp Voltage exceeding the Control Voltage. To prevent this situation, there is an Initial Ramp Circuit which increases the Ramp Voltage and enables the voltage to ramp up to the Control Voltage level earlier.

The sampled output voltage is fed back through the Constant Voltage Circuit and the Constant Current Circuit before it becomes the Control Voltage. The CV and CC circuits provide the means for the instrument to deliver power at either constant voltage or constant current.

The CONSTANT VOLTAGE circuit takes its input from two positions on the output voltage rail: the Innerloop Voltage Sense (IVS), and the outerloop Voltage Sense (OVS) at the + S and - S terminals. The CV Monitor Amplifier attenuates the OVS in the ratio of 1:40 (6010A); 1:4 (6011A); 1:12 (6012B); 1:100 (6015A), and produces the Voltage Monitor(V-MON) signal. This signal connects through protective circuitry to the rear panel and display circuits on the front panel, and also forms the input to the CV Error Amplifier. The Program Voltage which the user sets at the front panel voltage control is also an input to this amplifier. The output is the error signal which together with the output from the Innerloop Voltage Sense (IVS) generates the CV Control Voltage.

In addition to the Front Panel settings, the CV Program Voltage can be set from an external voltage applied between rear panel terminals VP and ⏚ P, or from an external resistor between these same terminals.

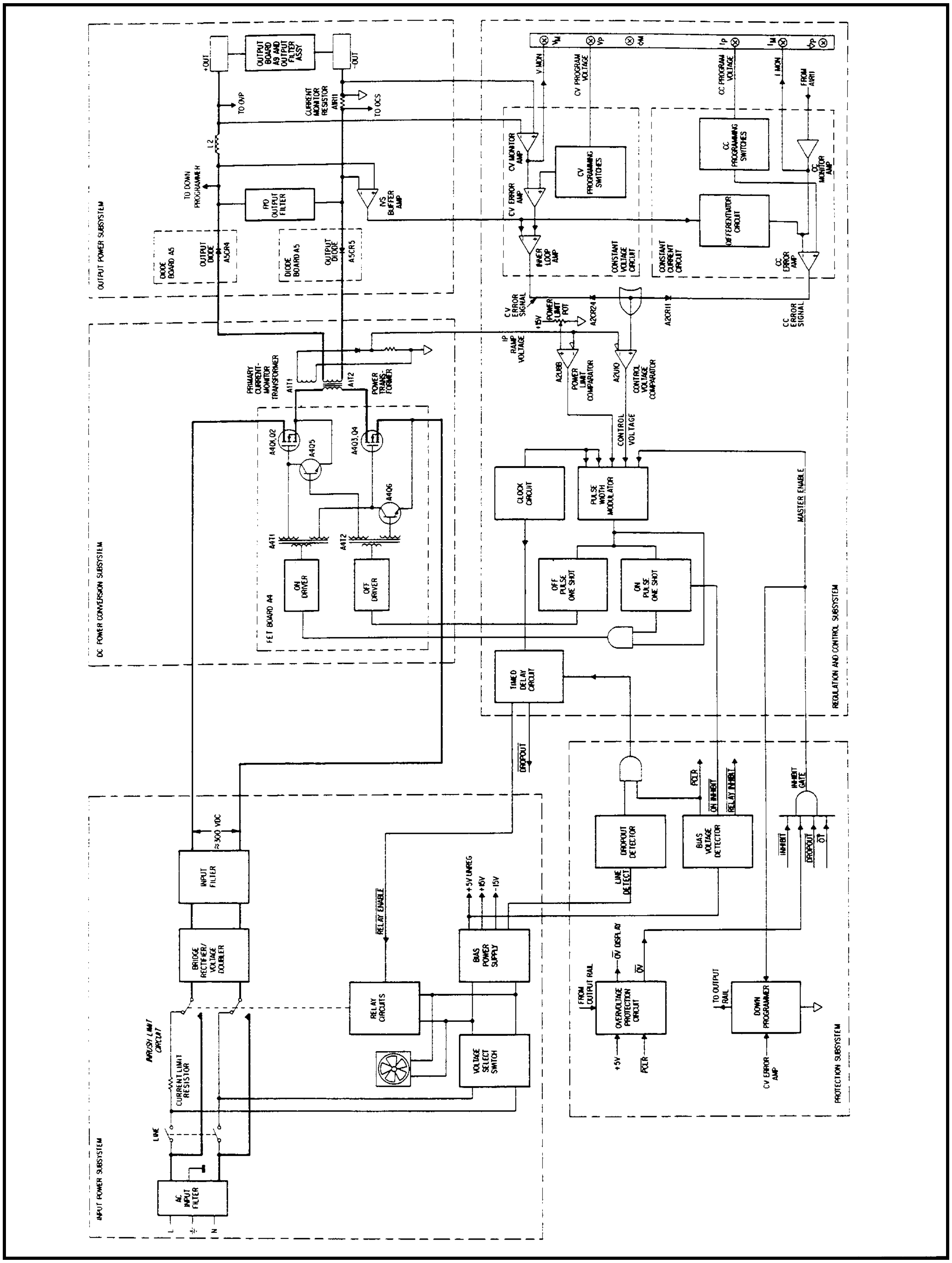


Figure 4-1. 6010A and 6015A Simplified Schematic

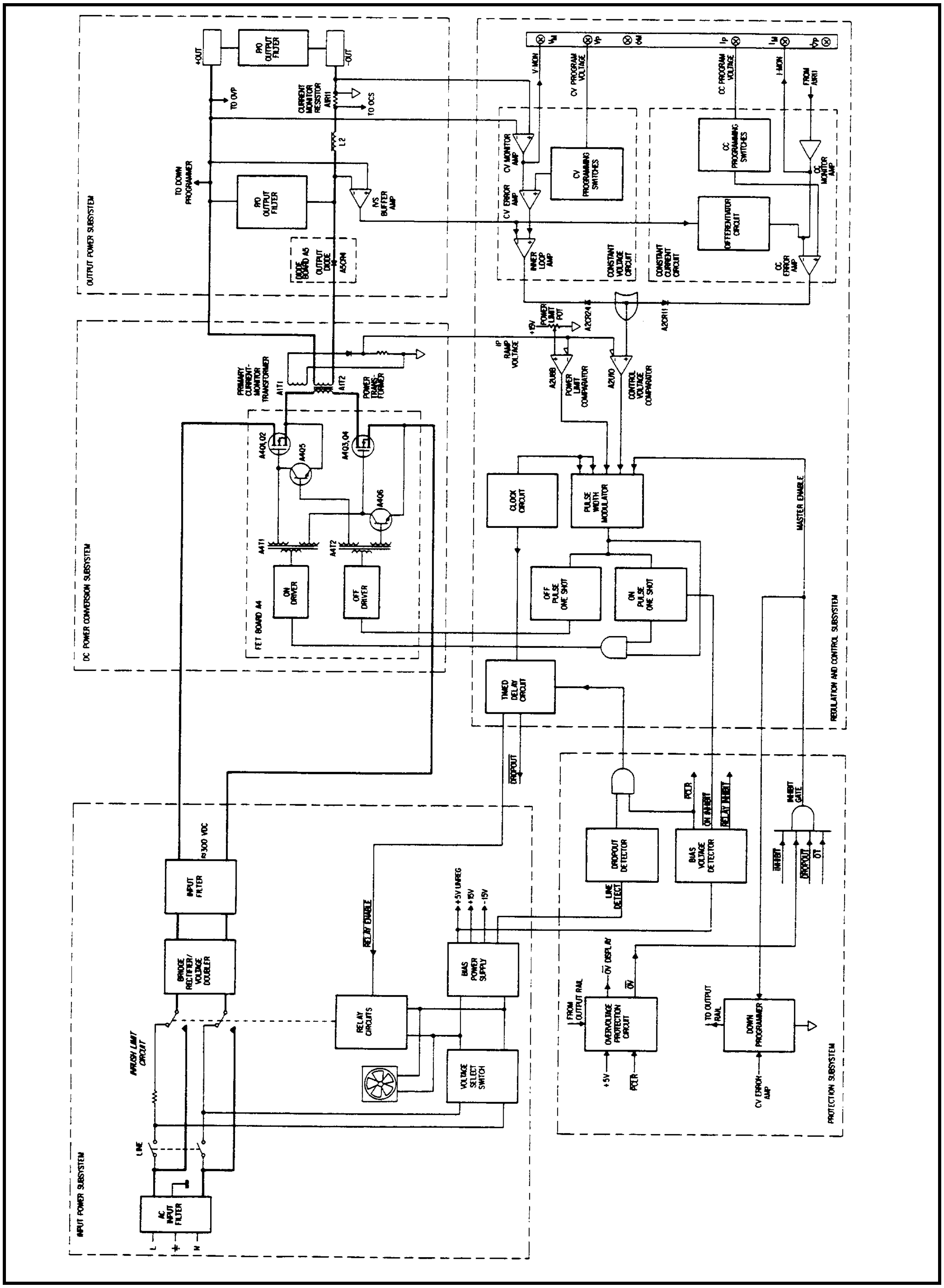


Figure 4-1. 6011A and 6012B Simplified Schematic

Table 4-1. Quick Reference Guide to Major Circuits

Circuit	Major Function	Dependent Circuits Input from	Dependent Circuits Output to	Operation
Bias Power Supply (BPS)	Provides Bias and Reference Voltage.	Mains	Control Circuits	Mains voltage at BVS input is converted to lower voltage levels to provide the internal operating voltages for the various circuits.
Bias Voltage Detector (BVD)	Delays the unit's operation at power-on.	BVS	Delay Circuit, OVP	Holds all circuits reset until all internal voltages are at acceptable levels.
Timed Delay Circuit (TDC)	Enables power circuits.	BVD: DOD	PWM; Relay	Waits for 3 seconds after power-on and then shuts out inrush current limiting resistor. The circuit is triggered by the BVD when the + VDC is stable.
Power Limit Comparator (PLC)	Determines maximum primary current.	BVS; Ramp	PWM	Compares $V_{IP\ RAMP}$ with V_{REF} and produces a signal to inhibit the PWM when $V_{IP\ RAMP} > V_{REF.}$
Control Voltage Comparator (CVC)	Regulates the operation of the PWM.	$V_{IP\ RAMP}$ Control Port Voltage (V_{CP})	PWM	Compares $V_{IP\ RAMP}$ with V_{CP} and produces a signal to inhibit the PWM when $V_{IP\ RAMP} > V_{CP.}$
Constant Voltage Circuit (CV)	Produces CV Control Voltage.	Outer Voltage Sense (OVS) Innerloop Voltage Sense (IVS) CV Program Voltage	CVC, Display Circuits	Monitors OVS **s**ignals from which VMON is derived. Combines OVS and IVS to give CV Control Voltage.
Constant Current Circuit (CC)	Produces CC Control Voltage.	Outer Current Sense (OCS). CC Program Voltage	CVC; Display Circuits	Monitors OCS signals from which l-MON is derived. Combines OCS and; differentiated IVS to give the CC control voltage.
Pulse Width Modulator (PWM)	Switches FETs.	Master Enable; PLC, CVC	FETs	Switching action achieved at 20KHz rate with on-pulse activated by 20KHz clock and off-pulse by CVC, PLC, 20KHz clock or shutdown circuits.
Primary Current Monitor Transformer	Generates I_P Ramp Voltage.	FETs	CVC; PLC	Senses Ip current build-up while FETs are on.
Power Transformer	Stores and transfers output power.	FETs	Output Rectifier	When FETs are on, the primary windings of the transformer store energy until the FETs are switched off when the energy is transferred to the secondary for output circuits.
A4 Q1,2,3,4	Control gating of current in power, and Sense Transformers.	PWM	Sensing Transformer	FETs open and close in response to pulses from the PWM. The length of its on/off time depends on the duration of the PWM on or off pulse.
Down Programmer (DP)	Rapidly lowers output voltage.	CV Circuit, OVP, DOD	Output Rail	Output filter capacitor are rapidly discharged at varying ampere rates depending on output voltage. Circuit activated under condition of ac power loss, shut down or low voltage.

Table 4-1. Quick Reference Guide to Major Circuits (continued)

Circuit	Major Function	Dependent Circuits Input from	Output to	Operation
Drop out Detector (DOD)	Shuts down output power when line drops out for more than one cycle.	Bias Transformer	PWM; DP	If no ac pulse is detected after 20ms, the circuit inhibits the PWM and triggers the Down Programmer.
Over Voltage Protection (OVP) Circuit	Limits maximum output voltage.	+ Out Sense	DP; PWM	Senses Output Voltage and compares with a preset limit set by its reference circuit. It triggers the Down Programmer in extreme situations.
A9 Output board (6015A)	Protects output capacitors and power mesh from reverse voltage.	Power Mesh	Output terminals	Diodes provide protection against reverse voltage applied across the output terminals.

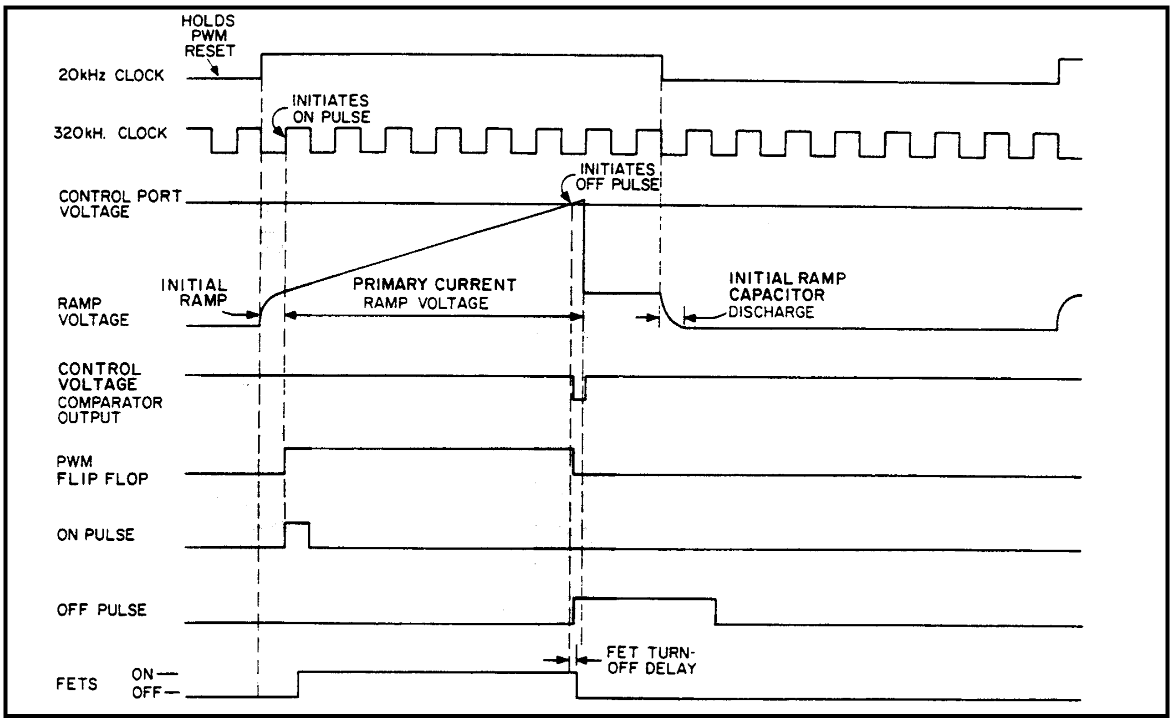


Figure 4-2. FET Control Signals Timing Diagram

The CONSTANT CURRENT CIRCUIT also produces a control voltage. The outerloop current sense (OCS) is taken across the current monitoring resistor and the combined signal is amplified by the CC Monitor amplifier to give the outerloop Current-Sense Voltage, I-MON. This signal is then diverted along two paths: one terminating at the barrier strip while along the other path the signal combines with the differentiated output of the Innerloop Voltage Sense (IVS). The CC error amplifier compares this combined output with the user-set CC Program Voltage to produce the CC Control Voltage.

The Control Voltage used to regulate the unit may be derived from either the CV or CC circuit. These circuits are connected via a wired-OR connection to the CV or CC circuit. If the CV Control Voltage exceeds the CC Control Voltage then diode A2CR24 is reversed biased but diode A2CR11 is forward biased and the CC Circuit provides the controlling signal. Similarly when CC Control Voltage exceeds CV Control Voltage, the CV circuit provides the regulating control voltage.

When the unit is operating in CV mode, the CV Control Voltage varies between - 0.5Vdc and + 0.5Vdc. It is most negative when the load is drawing no power but as power output increases the voltage becomes more positive.

Protection Subsystem

The diverse system configurations and operating environments under which the unit will be required to operate, will certainly require it to be adequately protected if it must function reliably. The protection circuits of the unit offer protection at turn-on and also during operation.

The CURRENT LIMIT RESISTORS is the first protection along the power rail which the unit utilizes. This circuit prevents any surges of AC input to the input filter by limiting the inrush current. After a predetermined elapsed time the resistor is bypassed and the unit is ready to deliver power. The circuit which carries out this function is the TIMED DELAY CIRCUIT. When both the Dropout Detector and the $\overline{\text{PCLR}}$ are high, this delay circuit is enabled and counting at the clock frequency of 1.25KHz begins. After 3 seconds, $\overline{\text{DROPOUT}}$ goes high and enables the PWM.

Turn-on protection is also offered by the BIAS VOLTAGE DETECTOR (BVD) which prevents spurious operation that may occur at power-on of the unit if circuits attempt to operate before the + 5Vdc bias voltage is at the clock, PWM, and logic circuits. After power-on, as the output of the + 5Vdc bias power supply rises the BVD is turned on inhibiting the Relay Driver and the On-Pulse Driver and creating the power clear signal $\overline{\text{PCLR}}$. The latter signal is held low until the unregulated input to the + 5Vdc bias supply is greater than an input voltage sufficient to assure a + 5Vdc output

Certain circuits also give the unit on-going protection during its operation The AC SURGE AND DROPOUT DETECTOR is such a circuit. This circuit protects the unit from damage from AC mains voltage surges. It shuts down the unit when there is either a 40% overvoltage or a 20 ms voltage interruption in the ac mains voltage. The mains detect signal senses the ac mains voltage and pulls the DROPOUT signal low thereby inhibiting the PWM and shutting off the power.

During conditions of overvoltage when a monitored fraction of the output voltage exceeds the limit set by the front panel OVP Adjust, the OVER VOLTAGE PROTECTION circuit inhibits the PWM and triggers the Down Programmer. This condition persists until the unit is turned off. At power-on, the Bias Voltage Detector resets the OVP.

The DOWN PROGRAMMER is another protection circuit which is activated when any of the following adverse operating conditions occurs: over voltage; over temperature; primary power failure; and programming of a lower output voltage. Under these conditions, the Down Programmer lowers the output voltage by rapidly discharging the output filter capacitors. The Down Programmer takes its input from the Master Enable and the CV Error Amplifier. When either of these signals is low, it is activated. The + 8.9Vdc bias supply provide enough energy to the Down Programmer to discharge the output circuit even when primary power is lost.

The TEMPERATURE PROTECTION circuit protects the FETs from excessive temperature gradients. A thermostat mounted on the FET heat sink monitors the temperature build up of the FETs and disables the PWM when the temperature exceeds a predetermined limit.

In addition to an over-temperature protection, there is also an OVERVOLTAGE PROTECTION circuit. When the FETs turn off, the leakage inductance of the power transformer forces current to continue to flow in the primary. Clamp diodes are employed to protect the FETs from excessive reverse voltage by bypassing the FETs and conducting the current to the input filter.

Input Power Subsystem

This subsystem forms the interface between the ac mains supply and the switching elements of the unit. It takes ac power from the mains, converts it to dc and delivers this unregulated dc to the switching elements and internal control circuitry. Input power takes two distinct pathways to carry out the above function: mains -rectifier/filter--switching elements and mains--bias supply--control circuits.

If the first pathway is taken, it is seen that primary power from the ac mains enters the INPUT RECTIFIER via the inrush current limiting resistor. The rectifier converts the ac voltage to dc voltage and passes its output to the input filter. The unit has a feature which allows it to operate either at 110/120 or 220/240Vac mains voltage. The voltage doubling capability as it is called is effected by connecting jumper AlW1 between the rectifier and filter. When the mains voltage is 220/240Vac, the jumper is open permitting the filter to develop a typical bus voltage of about 300Vdc. However, when the mains voltage is 110/1120Vac, the jumper terminals are connected and the rectifier/filter combination now behaves as a voltage doubler enabling a bus voltage of 300Vdc to be developed .

For the second pathway, primary power passes the Mains Voltage Select Switches to the BIAS POWER SUPPLIES which provide the operating voltages for the internal circuits. The Mains Voltage Select Switches connect the primary windings of the Bias-Supplies' transformer for operation at 120, 220, or 240Vdc.

The unit checks that the + 5Vdc bias voltage and the ac mains voltage are within acceptable limits as part of its turn-on sequence.

DC Power Conversion Subsystem

The current available at the input rails after rectification enters the power transformer A1T2 and Primary Current Monitor Transformer A1T1. This current flow is controlled by the FETs which act as high frequency switches. The FETs driver circuits are under the control of the Pulse Width Modulator where the On/Off pulses originate.

During the on-pulse the FETs are turned on and current enters the primaries of transformers A1T1 and A1T2 as described above. The output rectifiers A5CR4 and A5CR5 (6011A and 6015A) being reversed biased block the flow of current from the secondary of A1T2 to the output. There is therefore a current build up and the secondary windings of A1T2 act as a storage device. Meanwhile the current in the secondary of current transformer A1T1 develops a linearly increasing voltage waveform across resistors A2R116 and A2R117. This waveform is the Ip Ramp Voltage and corresponds to the energy build up in the secondary of the power transformer.

When the FETs are turned off, the collapsing magnetic field reverses the polarity across the power transformer causing the output rectifiers to be forward biased. Current therefore flows from the secondary windings to the output filters.

Output Subsystem

As discussed above, power reaches the output rail when the FETs are turned off and the output diodes are forward biased. The signal is first passed through the first stage of the output filter network where most of its 20KHz ripple derived from the switching FETs are attenuated. Part of the signal leaving the first stage filter is fed back to the CV and CC Circuits as the Innerloop Voltage Sense and becomes part of the inner control loop. The primary purpose of these feed-back loops is to impart sufficient stability to the power supply and enable it to cope with a variety of loads.

The signal from the first stage filter also becomes the input to the second stage capacitor filter which provides the additional filtering necessary for the unit to meet its specifications. This filter is close to + S and - S output terminals thereby ensuring that the filter is as close to the user's load as possible. The output from the + S and - S terminals is also fed back to the CV and CC Circuits and forms part of the outer feedback loop.

The 6015A units contain an A9 output board that provides protection against excessive reverse voltage applied across the output terminals.

The Front Panel Board

Figure 4-3 is a simplified schematic of the front panel board. The V-MON, I-MON, and OVP signals are passed to the front panel board from the A2 Control Board. The V-MON and I-MON signals are then. amplified by buffer amplifiers before they are directed to their respective digital voltmeters for display. As an intermediate step before display, the V-MON signal passes through a pair of bilateral range switches A3U4A and U4D which determine the resolution of the voltage display. When the voltage to be displayed is below a certain value, the unit selects the low-range bilateral switch A3U4 which enables the voltage to be displayed to an accuracy of two decimal places; however above this critical output voltage value, the high-range switch A3U4D assumes control and the voltage displayed is accurate to one decimal place.

In addition to providing the display voltage, the V-MON and I-MON signals are used to generate the CV and CC control voltages respectively. When the CV control voltage is found to be more negative than the Control Port Voltage, the power supply is operating in the CV Mode and the CV LED lights. Similarly the CC LED lights when the CC Control Voltage is below the Control Port Voltage confirming that the power supply is operating in CC Mode. When both CV and CC Control Voltages exceed the Control Port Voltage, the power supply becomes unregulated and the unregulated LED lights.

The CV of CC Program voltages are obtained by depressing the "DISPLAY SETTINGS" switch and reading the respective display. By depressing this switch and turning the Voltage or Current control, the technician can set the program voltage or current. If the instrument is operating in CV Mode for example, then the display voltage and the CV Program Voltage are identical but the display current may vary with the CC Program Voltage. This condition is reversed when the unit is under CC Mode.

The OVP set potentiometer is also located on the front panel. By depressing the “OVP DISPLAY” switch and adjusting the pot with a small flat screw-driver, the OVP limit can be set. When the output voltage exceeds this pre-set limit, the unit is disabled and the OVP LED lights.

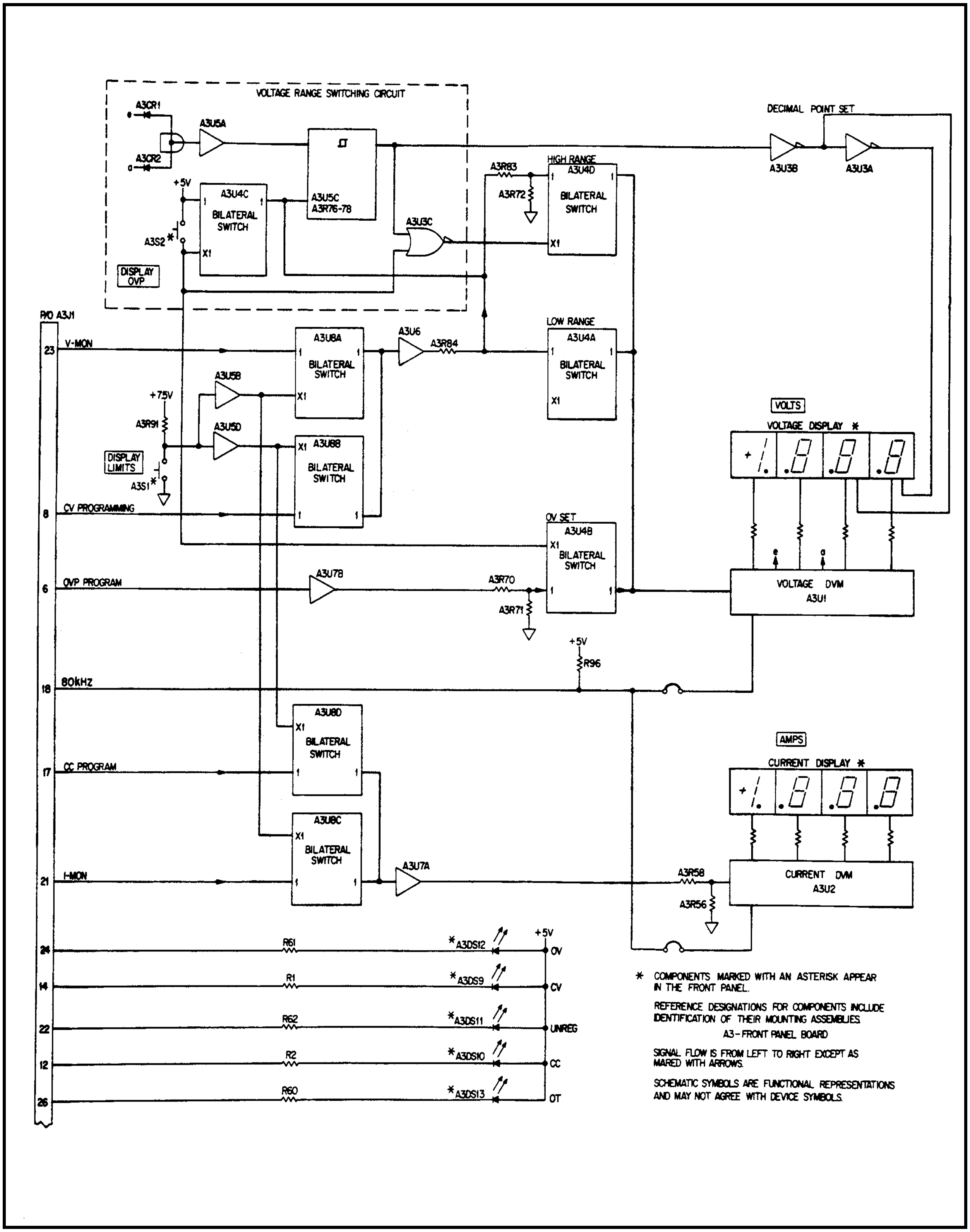


Figure 4-3. Simplified Front Panel Schematic

5

Replaceable Parts

Introduction

This chapter contains information for ordering replacement parts. Table 5-3 lists parts in alpha-numeric order by reference designators and provides the following information:

a. Reference Designators. Refer to Table 5-1.
b. Agilent model in which the particular part is used.
c. Agilent Part Number.
d. Description. Refer to Table 5-2 for abbreviations.

Parts not identified by reference designator are listed at the end of Table 5-3 under Mechanical and/or Miscellaneous.

Table 5-1. Reference Designators

A	Assembly
B	Blower
C	Capacitor
CR	Diode
DS	Signaling Device (light)
F	Fuse
FL	Filter
G	Pulse Generator
J	Jack
K	Relay
L	Inductor
Q	Transistor
R	Resistor
RT	Thermistor Disc
S	Switch
T	Transformer
TB	Terminal Block
TS	Thermal Switch
U	Integrated Circuit
VR	Voltage Regulator (Zener diode)
W	Wire (Jumper)
X	Socket*
Y	Oscillator

* Reference designator following "X" (e.g. XA2) indicates assembly or device mounted in socket.

Ordering Information

To order a replacement part, address order or inquiry to your local Agilent Technolgies sales office. Specify the following information for each part: Model, complete serial number, and any option or special modification (J) numbers of the instrument; Agilent part number; circuit reference designator; and description. To order a part not listed in Table 5-3, give a complete description of the part, its function, and its location.

Table 5-2. Description Abbreviations

ADDR	Addressable
ASSY	Assembly
AWG	American Wire Gauge
BUFF	Buffer
CER	Ceramic
COMP	Carbon Film Composition
CONV	Converter
DECODER/DEMULTI	Decoder/Demultiplexer
ELECT	Electrolytic
EPROM	Erasable Programmable Read-Only Memory
FET	Field Effect Transistor
FF	Flip-Flop
FXD	Fixed
IC	Integrated Circuit
INP	Input
LED	Light Emitting Diode
MET	Metalized
MOS	Metal-Oxide Silicon
OP AMP	Operational Amplifier
OPTO	Optical
OVP	Over Voltage Protection
PCB	Printed Circuit Board
PORC	Porcelain
POS	Positive
PRIOR	Priority
ROM	Read-Only Memory
RAM	Random Access Memory
RECT	Rectifier
REGIS	Register
RES	Resistor
TBAX	Tube Axial
TRIG	Triggered
UNI	Universal
VAR	Variable
VLTG REG	Voltage Regulator
WW	Wire Wound

Table 5-3. Replaceable Parts List

Ref. Desig.	Agilent Model	Agilent Part Number	Description
A1	**6010A, 6011A**	**06030-61032**	**MAIN BOARD ASSEMBLY**
A1	**6012B**	**06032-61032**	**MAIN BOARD ASSEMBLY**
A1	**6015A**	**06030-61033**	**MAIN BOARD ASSEMBLY**
B1	All	See Chassis Electrical	
C1,2, 4-*6,8	All	0180-4528	fxd elect 1800µF 200V
C9	All	0160-5932	fxd poly 0.47µF 250V
C10	All	0180-3699	fxd elect 470µF 20% 35V
C11,12	6010A	0160-6392	fxd poly .047µF 20V
C11,12	6011A	0160-5895	fxd poly .047µF
C11,12	6012B, 6015A	0160-5933	fxd elect .022µF 10%
C13,14	6010A	0180-3702	fxd elect 1600µF 125V-10% +50%
C13,14	6012B	0180-3492	fxd elect 2600µF 75V
C13,14	6015A	0180-4204	fxd elect 900µF 350V
C15,16	6010A, 6012B	0180-3693	fxd elect 1000µF 20%
C15,16	6015A	0180-3587	fxd elect 1000µF 20%
C13-16	6011A	0180-3425	fxd elect 5500µF 40V
C17,18	6010A, 6012B	0180-0291	fxd elect 1µF 35V
C17,18	6011A	0180-3693	fxd elect 1000µF 50V
C17,18	6015A	0180-4129	fxd elect 1µF 35V
*C19	6010A	0160-0260	fxd cer .047µF 20%
*C19,20	6011A	0160-0291	fxd cer 1µF 35V
*C19	6012B	0160-5286	fxd cer .47µF 20%
*C19	6015A	0160-0904	fxd ww 0.05µF 1KV
*C20-23	6010A, 6015A	0160-6392	fxd poly .047µF 20%
*C20,22	6012B	0160-7732	fxd poly .47µF
*C22	6011A	0160-5377	fxd poly, 2.2µF 10% 63V
*C23	6011A	0160-7732	fxd poly, .47µF
C24	6010A, 6015A	NOT USED	
*C24	6012B	0160-4281	fxd met 2200pf 20%
*C25	6010A	0160-0269	fxd cer .047µF 20%
*C25	6012B	0160-5286	fxd cer .47µF 20%
*C25	6015A	0160-0904	fxd ww 0.05µF 1KV
*C25,26	6011A	0160-5377	fxd cer 2.2µF 10% 63V
C26	6010A, 6015A	NOT USED	
*C26	6012B	0160-4281	fxd met 2200pf 20%
C27	6011A, 6012B, 6015A	0160-6805	fxd met 0.01µF 400V
C28	6010A, 6012B	See Chassis Electrical	
C28	6011A	0160-7732	fxd poly, .47µF
C28	6015A	NOT USED	
C29	6010A, 6012B, 6015A	0160-4323	fxd met .047µF 20% 250VAC
C29	6011A	0160-4281	fxd met 2200PF 20%
C30	6010A	See Chassis Electrical	
C30,31	6011A	NOT USED	
C30	6012B, 6015A	0160-4962	fxd poly 1.0µF 20%
C32	6011A	0160-4323	fxd met .047µF 20% 250V
C33	6011A	0160-4962	fxd poly 1.0µF 20%

* Part of output filter (6010A, 5060-3520; 6011A, 5060-3525; 6012B, 5060-3523; 6015A, 5060-3521) which is mounted on the output bus bars.

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
C34	All	0160-6805	fxd met 0.01μF 400V
CB1	6010A 6012B, 6015A	See Chassis Electrical	
CR1	All	1901-0731	power rect. 400V
CR2	All	1901-0731	power rect. 400V 1A
CR3,4	All	1901-0050	diode-switching 80V 200ma
CR5	All	1901-0731	Power rect. 400V
CR6-13	All	1901-0731	Power rect. 400V
DS1	All	1990-0517	LED visible
F1	All	2110-0001	fuse 1A 250V
F2	All	2110-0671	fuse .125A 125V
K1,2	All	0490-1834	Relay
L1	All	06012-80003	Snubber wire
		9170-0707	ferrite core, (ref. L1)
L2	6010A, 6012B, 6015A	9170-1267	Magnetic core
		5080-2040	jumper for L2
L3	6010A	9140-1064	Output Choke
L3	6012B	06012-80095	Output Choke
		9170-0721	ferrite core, (ref. L1)
L2,3	6011A	06011-80092	Output Choke
L3	6015A	5080-2131	Ind fxd 18μH 5A
L4	6010A, 6012B, 6015A	See Chassis Electrical	
L4	6011A	9170-1267	Magnetic core
		5080-2040	jumper for L2
Q1	6010A	1855-0456	MOSFET N-Chan
Q1	6015A	1855-0777	Trans FET N-Ch 600V 3.2A
Q2	All	1855-0665	FET N-Chan
R1-4	All	0811-1866	fxd ww 10K 1% 5W
R5	All	0757-0418	fxd comp 619 1% 1/8W
R7	All	0698-5525	fxd comp 6.8 5% 1/2W
R8	All	0757-0765	fxd comp 36.5K 1% 1/8W
R9	All	0811-3700	fxd ww 20 10% 20W
R10	All	0811-3699	fxd ww 6 10% 20W
R11	6010A, 6015A	5080-2079	current sensing resistor
R11	6012B	06032-80001	current sensing resistor
R11,12	6011A	NOT USED	
R12,13	6010A, 6012B	0699-0188	fxd film 2.2 5% 1/4W
R12,13	6015A	0698-3492	fxd film 26.1 5% 1/4W
R13	6011A	06011-80001	Current Sensing Resistor
R14,15	6010A, 6015A	NOT USED	
R14,15	6011A	7175-0057	solid tinned copper wire
R14,15	6012B	0812-0100	fxd ww 2K 5% 5W
R16,17	All	0683-1065	fxd comp 10M 5% 1/2W
R18	All	0757-0921	fxd film 750 1% 1/8W
R19	All	0757-0403	fxd film 121 l% 1/8W
R20-23	6010A, 6012B, 6015A	NOT USED	
R20,23	6011A	0699-0208	fxd film 1 5% 1/4W
R24	All	0686-2015	fxd comp 200 5% 1/2W
R25-R28	6010A, 6015A	NOT USED	
R25	6011A, 6012B	0811-1869	fxd ww 30 ohms 3W

* Part of output filter (6010A, 5060-3520; 6011A, 5060-3525; 6012B, 5060-3523; 6015A, 5060-3521) which is mounted on the output bus bars.

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R29,30	6010A	0811-1887	fxd ww .05 5% 10W
R29,30	6015A	0811-3557	fxd ww 0.5ohms 5% 10W
R31	6010A	0757-0367	fxd film 100K 1% 1/2W
R32	6010A	0686-7535	fxd comp 75K 5% 1/2W
R31,32	6015A	0698-8959	fxd film 619K 1%
R33	6010A	0757-0451	fxd film 24.3K 1% 1/8W
R33	6015A	0757-0471	fxd film 182K 1%
R34	6010A, 6015A	0757-0438	fxd film 5.11K 1% 1/8W
R35	6010A, 6015A	0698-8827	fxd film 1M 1% 1/8W
R36,37	6010A	0811-1909	fxd ww 500 5% l0W
R36,37	6015A	0811-1913	fxd ww 1.5K l0W
R38,39	6010A, 6015A	0757-0467	fxd film 121K 1% 1/8W
R40	6010A, 6015A	NOT USED	
R41	All	0764-0041	fxd ww 30 5% 2W
R43,44	All	0698-0085	fxd film 2.61K 1% 1/8W
R45	All	0698-8827	fxd film 1M 1% 1/8W
R46	All	0757-0419	fxd film 681 1% 1/8W
R47,48	All	0698-3622	fxd film 120 5% 2W
R49	All	0757-0401	fxd film 100 1% 1/8W
S1	All	3101-2046	switch, DPDT slide
S2	All	3101-1914	switch, 2-DPDT slide
S3	6010A, 6012B, 6015A	See Chassis Electrical	
T1	All	9100-4350	current transformer
T2	6010A	06030-80090	power transformer
T2	6012B	06032-80090	power transformer
T2	6015A	9100-4827	power transformer
T3	All	9100-4864	bias transformer
U1	All	1906-0218 or 1906-0389	diode bridge
U3	6010A, 6012B, 6015A	1826-0393	IC, volt-reg 1.2/37V
U3	6011A		U3 is included with heatsink assembly 5060-2942, see A1 Mechanical
U4	6015A	1906-0006	diode bridge 400V
U5	6010A, 6015A	1826-0643	IC, switched-mode ckt
U6	All	1990-1074	opto-isolator
VR1	All	1902-0955	diode zener 7.5V 5%
		A1 MECHANICAL	
	6010A, 6012B, 6015A	1205-0282	heatsink (ref. U3)
	6011A	5060-2942	heatsink assembly (includes U3)
	All	1205-0562	heatsink (ref. U1)
	All	21l0-0269	fuse clip (ref. F1)
	All	0403-0086	bumper foot (ref. R9,10)
	All	06032-60010	output bus bar
	All	0340-1095	insulator for buss bar
	6015A	2190-0586	lockwasher (ref. U1)
J1	All	NOT USED	
J2	All	1251-5384	Post-Type Connector,3pin
J3,4	All	NOT USED	
J5	All	5060-2877	ribbon cable(2inch)(ref.W8)
J6	All	5060-2878	ribbon cable(4inch)(ref.W7)

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
J7,8	All	1251-0600	connector, single contact
J9,10, L,N,P	All	1251-5613	connector, single contact
J11-14	All	1251-0600	connector, single contact
XA4,5	All	1252-1052	connector 64pin
A2	**6010A**	**06030-60022**	**Control Board Assembly**
A2	**6011A**	**06011-60022**	**Control Board Assembly**
A2	**6012B**	**06032-60022**	**Control Board Assembly**
A2	**6015A**	**06030-60028**	**Control Board Assembly**
C1-4	All	0160-5422	fxd cer .047µF 20% 50V
C5	All	0160-4801	fxd cer 100pf 5% 100V
C6-7	All	0160-5422	fxd cer .047µF 205 50V
C8	All	0160-5892	fxd poly .22µF 10%
C9	All	0160-5422	fxd cer .047 20% 50V
C10	All	0160-4807	fxd cer 33pf 5% 100V
C11	All	0160-5892	fxd poly .22µF 10%
C12	All	0160-4830	fxd cer 2200pf 10% 100V
C13-16	All	0160-5422	fxd cer .047µF 20% 50V
C17	6010A, 6012B, 6015A	0160-4833	fxd cer .022µF 10% 100V
C17	6011A	0160-4832	fxd cer .01µF 10% 100V
C18	All	0160-5892	fxd poly .22µF l0%
C19	6010A, 6011A, 6012B	0160-5469	fxd met 1µF 10% 50V
C19	6015A	0160-5534	fxd met .1µF 10% 63V
C20	6010A, 6012B, 6015A	0160-5892	fxd poly 22µF 10%
C20	6011A	0160-5534	fxd poly 0.1µF 10% 63V
C21,22	All	0160-5422	fxd cer .047µF 20% 50V
C23	All	NOT USED	
C24	6010A, 6012B, 6015A	0160-0162	fxd poly .022µF 10% 200V
C24	6011A	0160-0161	fxd poly .01µF 10% 200V
C25	6010A, 6012B, 6015A	0160-4812	fxd cer 220pf 5% 100V
C25	6011A	NOT USED	
C26	All	0160-4807	fxd cer 33pf 5% 100V
C27	6010A, 6012B, 6015A	0160-5892	fxd poly .22µF 10%
C27	6011A	0160-5534	fxd poly 0.1µF 10% 63V
C28	6010A, 6012B, 6015A	0160-4834	fxd cer .047µF 10% 100V
C28	6011A	0160-4833	fxd cer .022µF 10% 100V
C29	All	0160-5422	fxd cer .047µF 20S 50V
C30	All	0160-4807	fxd cer 33pf 5% l00V
C31	All	0160-5422	fxd cer .047µF 20% 50V
C32	6010A, 6012B, 6015A	0160-5644	fxd cer .033µF 10% 50V
C32	6011A	0160-4832	fxd cer .01µF 10% 100V
C33	6010A	0160-4822	fxd cer 1000pf 5% 100V
C33	6011A	NOT USED	
C33	6012B	0160-4831	fxd cer 4700pf 10% 100V
C33	6015A	0160-4824	fxd cer 680pf
C34	6010A, 6012B, 6015A	NOT USED	
C34	6011A	0160-4832	fxd cer .01µF 10% 100V
C35	All	0160-5422	fxd cer .047uf 20% 50V
C36	All	0160-4812	fxd cer 220pf 5% 100V

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
C37	6010A, 6011A, 6015A	NOT USED	
C37	6012B	0160-4830	fxd cer 2200pf 10% 100V
C38-40	All	0160-5422	fxd cer .047µF 20% 50V
C41	All	0160-4831	fxd cer 4700pf 10% l00V
C42	All	0160-4812	fxd cer 220pf 5% 100V
C43	All	0160-4831	fxd cer 4700pf 10% 100V
C44	All	0160-5422	fxd cer .047µF 20% 50V
C45	All	0160-4812	fxd cer 220pf 5% 100V
C46	6010A, 6011A, 6012B	0160-5166	fxd cer .015µF 20% 100V
C46	6015A	0160-4832	fxd cer .01µF 20% 100V
C47	All	0160-5422	fxd cer .047µF 20% 50V
C48,49	All	0160-4835	fxd cer .1µF 10% 50V
C50	6010A, 6011A, 6012B	0180-0291	fxd elect 1µF 10% 35V
C50	6015A	0180-4129	fxd elect 1µF 10% 35V
C51	All	0180-1731	fxd cer 4.7µF l00V
C52	All	0180-0230	fxd elect 1µF 20% 50V
C53	All	0180-1731	fxd cer 4.7µF 100V
C54	6010A, 6011A, 6012B	0180-0291	fxd elect 1µF 10% 35V
C54	6015A	0180-4129	fxd elect 1µF 10% 35V
C55	All	0180-0230	fxd elect 1µF 20% 50V
C56,57	All	0160-5422	fxd cer .047µF 20% 50V
C58	All	0160-4801	fxd cer l00pf 5% l00V
C59	All	0160-4835	fxd cer .1µF 10% 50V
C60	All	0160-5422	fxd cer .047µF 20% 50V
C61	All	0160-4812	fxd cer 220pf 5% l00V
C62	All	0160-4835	fxd cer .1µF 10% 50V
C63	All	0180-1980	fxd elect 1µF 5% 35V
C64	6010A, 6011A, 6012B	0180-0116	fxd elect 6.8µF l0% 35V
C64	6015A	0180-4132	fxd elect 6.8µF l0% 35V
C65	All	0160-5422	fxd cer .047µF 20% 50V
C66	All	0160-4801	fxd cer 100pf 5% l00V
C67	All	0160-5422	fxd cer .047µF 20% 50V
C68	All	0160-4822	fxd cer 1000pf 5% 100V
C69,70	All	0160-5422	fxd cer .047µF 20% 50V
C71	All	0180-0376	fxd elect .47µF 10% 35V
C72	All	0180-2624	fxd elect 2000µF 10V
C73	All	0180-3407	fxd elect 2200µF 35V
C74,75	All	0160-5098	fxd cer .22µF 10% 50V
C76	All	0160-4835	fxd cer .1µF 10% 50V
C77	All	0160-4833	fxd cer .022µF 10S 100V
C78	All	0160-4832	fxd cer .01µF 10% 100V
C79	All	0160-4830	fxd cer 2200pf 10% 100V
C80	All	0160-4813	fxd cer 180pf 52 l00V
C81	All	0160-5422	fxd cer .047µF 203 50V
C82	All	0160-4812	fxd cer 220pf 5% l00V
C83	All	0160-5422	fxd cer .047µF 20% 50V
C84	All	0160-4812	fxd cer 220pf 5% l00V
C85	All	0160-4832	fxd cer .01µF l0% l00V

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
CR1-6	All	1901-0033	gen prp 180V 200ma
CR7,8	All	1901-0050	switching 80V 200ma
CR9,10	All	1901-0033	gen prp 180V 200ma
CR11	All	1901-0050	switching 80V 200ma
CR12	All	1901-0033	gen prp 180V 200ma
CR13,14	All	1901-0050	switching a0V 200ma
CR15,16	All	1901-0033	gen prp 180V 200ma
CR17,18	All	1901-0050	switching 80V 200ma
CR19	All	1901-0033	gen prp 180V 200ma
CR20-31	All	1901-0050	switching 80V 200ma
CR32	All	1901-0992	schottky 40V 3A
L1	All	06023-80090	choke
Q1-3	All	1854-0823	NPN Si
Q4-6	All	1855-0413	J-FET P-chan Si
Q7	All	1854-0823	NPN Si
Q8	All	1853-0012	PNP Si
Q9	6010A, 6012B	1854-0635	NPN Si
Q9	6011A		NPN Si (included with heatsink 5060-2944, see A2 Mechanical)
Q9	6015A	5060-2944	NPN S/HS Assy
Q10	All	1853-0036	PNP Si
Q11	All	1858-0023	transistor array
R1,2	All	0686-5125	fxd comp 5.1K 5% 1/2W
R3	All	0683-5125	fxd film 5.1K 5% 1/4W
R4	All	0757-0483	fxd film 562K 1% 1/8W
R5	All	0683-2015	fxd film 200 5% 1/4W
R6	6010A	0698-6615	fxd film 3.75K .1%
R6	6011A	0699-1011	fxd film 3.32K .1% 1/8W
R6	6012B	0698-7631	fxd film 2.87K .1%
R6	6015A	0757-0424	fxd film 1.1K
R7	All	0683-5125	fxd film 5.1K 5% 1/4W
R8	All	2100-3353	trimmer 20K 10%
R9	6010A, 6011A, 6012B	2100-3352	trimmer 1K 10%
R9	6015A	2100-3351	trimmer 500 ohms
R10	All	0698-3433	fxd film 28.7 1% 1/8W
R11,12	6010A, 6012B, 6015A	0757-0465	fxd film 100K 1% 1/8W
R13	6010A, 6015A	0698-3430	fxd film 21.5 1% 1/8W
R11-13	6011A	NOT USED	
R13	6012B	0757-0379	fxd film 12.1 1% 1/8W
R14,15	All	0686-5125	fxd comp 5.1K 1/2W
R16	All	0683-2015	fxd film 200 5% 1/4W
R17	All	0698-7082	fxd film 100K 1% 1/8W
R18	6010A, 6011A, 6015A	0683-1025	fxd film 1K 5% 1/4W
R18	6012B	0683-1024	fxd film 1K 5% 1/4W
R19	All	0757-0442	fxd film 10K 1% 1/8W
R20	6010A, 6015A	0686-5135	fxd comp 51K 5% 1/2W
R20	6011A, 6012B	0686-1025	fxd comp 1K 5% 1/2W
R21	6010A, 6015A	2100-3274	trimmer 10K 10%
R21	6011A	2100-3350	trimmer 200 10%
R21	6012B	2100-3273	trimmer 2K 10%
R21	6015A	2100-3274	trimmer 10K 10%

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R22	All	2100-3353	trimmer 20K 10%
R23	All	2100-3273	trimmer 2K 10%
R24	All	2100-3350	trimmer 200 10%
R25	All	2100-3273	trimmer 2K 10%
R26	All	2100-3274	trimmer 10K 10%
R27	All	0157-0470	fxd film 162K 1% 1/8W
R28	All	0757-0464	fxd film 90.9K 1% 1/8W
R29	All	0698-4509	fxd film 80.6K 1% 1/8W
R30	All	0757-0280	fxd film 1K 1% 1/8W
R31	6010A, 6011A, 6012B	0698-3260	fxd film 464K 1% 1/8W
R31	6015A	0757-0471	fxd film 182K 1%
R32	All	0698-8827	fxd film 1M 1% 1/8W
R33	All	0698-3449	fxd film 28.7K 1% 1/8W
R34	6010A, 6012B, 6015A	0757-0458	fxd film 51.1K 1% 1/8W
R34	6011A	0757-0442	fxd film 10K 1% 1/8W
R35	6010A, 6015A	0683-l055	fxd film 1M 5% 1/4W
R35	6011A	0683-3355	fxd film 3.3M 5% 1/4W
R35	6012B	0683-l555	fxd film 1.5M 5% 1/4W
R36	All	0698-3455	fxd film 261K 1% 1/8W
R37,38	6010A, 6011A, 6015A	0698-4536	fxd film 340K 1% 1/8W
R37	6012B	0698-4536	fxd film 340K 1% 1/8W
R38	6012B	0698-3455	fxd film 261K 1% 1/8W
R39	All	0683-4725	fxd film 4.7K 5% 1/4W
R40	6010A	0699-1210	fxd film 80K .1% .1W
R40	6011A	NOT USED	
*R40	6015A		111.1K and 2M in parallel
R41	6010A	0699-1744	fxd film 280K 1% .1W
R41	6011A	0699-0118	fxd film 20K .1% .1W
R41	6015A	0699-3104	fxd film 250K 0.1%
R40,41	6012B	0699-1210	fxd film 80K .1% .1W
R42	6010A, 6015A	0699-1742	fxd film 70K .1% .1W
R42	6011A	0699-0059	fxd film 5K .1% .1W
R42	6012B	0699-0642	fxd film 10K .1% .1W
R43	6010A, 6015A	0699-1743	fxd film 345K .1% .1W
R43	6011A	0699-0118	fxd film 20K .1% .1W
R43	6012B	0699-1211	fxd film 95K .1% .1W
R44	All	0757-0199	fxd film 21.5K 1% 1/8W
R45	All	0698-8816	fxd film 2.15 1% 1/8W
R46	6010A, 6012B, 6015A	0683-1255	fxd film 1.2M 5% 1/4W
R46	6011A	0698-4359	fxd film 402K 1% 1/8W
R47	6010A, 6012B, 6015A	0757-0470	fxd film 162K 1% 1/8W
R48	6010A, 6012B, 6015A	0757-0458	fxd film 51.1K 1%
R47,48	6011A	0757-0458	fxd film 51.1K 1%
R49	6010A	0699-1745	fxd film 560K .1% 1/4W
R49	6011A		jumper (see W1-3)
R49	6012B	0698-7496	fxd film 20K .1% 1/4W
**R49	6015A	5060-3404	2M(two 1M in series)

*R40 is comprised of two 1% fixed film resistors, 11.1K (0698-6979) and 2M (0683-2055), assembled in parallel.
** R49 is comprised of two 1M 1% fixed film resistors (0698-6369) assembled in series.

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R50	6010A, 6015A	0686-5135	fxd film 51K 5% 1/2W
R50	6011A, 6012B	0686-1025	fxd film 1K 5% 1/2W
R51	6010A, 6012B, 6015A		jumper (see W1-3)
R51	6011A	0698-3433	fxd film 28.7 1% 1/8W
R52	6010A, 6015A	0699-1742	fxd film 70K .1% .1W
R52	6011A	0699-0059	fxd film 5K .1% .1W
R52	6012B	0699-0642	fxd film 10K .1% .1W
R53	6010A, 6015A	0757-0451	fxd film 24.3K 1% 1/8W
R53	6011A	0757-0462	fxd film 75K 1% 1/8W
R53	6012B	0757-0458	fxd film 51.1K 1% 1/8W
R54	All	0698-3450	fxd film 42.2K 1% 1/8W
R55	6010A, 6015A	0757-0451	fxd film 24.3K 1% 1/8W
R55	6011A	0757-0462	fxd film 75K 1% 1/8W
R55	6012B	0757-0458	fxd film 51.1K 1% 1/8W
R56	6010A, 6012B, 6015A	0757-0199	fxd film 21.5K 1% 1/8W
R56	6011A		jumper (see W1-3)
R57	6010A, 6011A, 6012B	0698-3155	fxd film 4.64K 1% 1/8W
R57	6015A	0757-0124	fxd film 39.2K 1% 1/8W
R58	6010A	0757-0344	fxd film 1M 1% 1/8W
R58	6011A	0757-0449	fxd film 20K 1% 1/8W
R58	6012B	0698-3572	fxd film 60.4K 1% 1/8W
R58	6015A	0699-1630	fxd film 4M
R59,60	6010A	0698-4486	fxd film 24.9K 1% 1/8W
R59,60	6011A	0698-0442	fxd film 10K 1% 1/8W
R59,60	6012B	0757-0438	fxd film 5.11K 1% 1/8W
R59,60	6015A	0698-7668	fxd film 39.91K 1%
R61	6010A	0757-0344	fxd film 1M 1% 1/4W
R61	6011A	0757-0449	fxd film 20K 1% 1/4W
R61	6012B	0698-3572	fxd film 60.4K 1% 1/8W
R61	6015A	0699-1630	fxd film 4M
R62	All	0757-0124	fxd film 39.2K 1% 1/8W
R63	All	0683-l015	fxd film 100 5% 1/4W
R64	6010A, 6012B, 6015A	0757-0124	fxd film 39.2K 1% 1/8W
R64	6011A	0757-0270	fxd film 249K 1% 1/8W
R65	6010A, 6011A, 6015A	NOT USED	
R65	6012B	0757-0473	fxd film 221K 1% 1/8W
R66	All	0683-4725	fxd film 4.7K 5% 1/4w
R67	6010A, 6015A	NOT USED	
R67	6011A	0757-0459	fxd film 56.2K 1% 1/8W
R67	6012B	0757-0123	fxd film 34.8K 1% 1/8W
R68	All	0757-0270	fxd film 249K 1% 1/8W
R69	All	0683-1015	fxd film 100 5% 1/4W
R70	All	0757-0449	fxd film 20K 1% 1/8W
R71	All	0698-0085	fxd film 2.61K 1% 1/8W
R72	All	0757-0452	fxd film 27.4K 1% 1/8W
R73	6010A, 6015A	0757-0289	fxd film 13.3K 1% 1/8W
R73	6011A	0757-0442	fxd film 10K 1% 1/8W
R73	6012B	0757-0461	fxd film 68.1K 1% 1/8W
R74	All	0757-0460	fxd film 61.9K 1% 1/8W
R75	All	0698-8827	fxd film 1M 1% 1/8W
R76	All	0757-0438	fxd film 5.11K 1% 1/8W

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R77	All	0683-4715	fxd film 470 5% 1/4W
R78	All	0698-6322	fxd film 4K 1% 1/8W
R79,80	All	0683-2035	fxd film 20K 5% 1/4W
R81	6010A, 6012B, 6015A	0757-0419	fxd film 681 1% 1/8W
R81	6011A	0698-3444	fxd film 316 1% 1/8W
R82	All	0683-4715	fxd film 470 5% 1/4W
R83	All	0698-6322	fxd film 4K 1% 1/8W
R84	All	0698-6320	fxd film 5K .1% 1/8W
R85	All	0698-6983	fxd film 20.4K .1% 1/8W
R86	All	0757-0465	fxd film 100K 1% 1/8W
R87	6010A, 6012B	0698-7933	fxd film 3.83K .1% 1/8W
R87	6011A	0698-6322	fxd film 4K 1% 1/8W
R87	6015A	0699-2850	fxd film 10.01K 0.1% 25PM
R88	6010A	0699-1745	fxd film 500 .1% 1/8W
R88	6011A	0698-8695	fxd film 36K .1% 1/8W
R88	6012B	0698-6979	fxd film 111.1K .1% 1/8W
*R88	6015A	5060-3405	2.5M (two 1.25M in series)
R89-91	All	0683-2225	fxd film 2.2K 55 1/4W
R92	6010A, 6015A	0898-4480	fxd film 15.8K 1% 1/8W
R92	6011A	0757-0457	fxd film 47.5K 1% 1/8W
R92	6012B	0757-0464	fxd film 90.9K 1% 1/8W
R93	All	0683-3325	fxd film 3.3K 5% 1/4W
R94,95	All	0683-2225	fxd film 2.2K 5% 1/4W
R96	All	0757-0481	fxd film 475K 1% 1/8W
R97	All	0757-0290	fxd film 6.19K 1% 1/8W
R98	All	0757-0444	fxd film 12.1K 1% 1/8W
R99	All	0698-4416	fxd film 169 1% 1/8W
R100	All	0757-0404	fxd film 130 1% 1/8W
R101	All	0698-4608	fxd film 806 1% 1/4W
R102	All	0698-4447	fxd film 280 1% 1/8W
R103	All	0698-4416	fxd film 169 1% 1/8W
R104,105	All	0683-4725	fxd film 4.7K 5% 1/8W
R106	6010A, 6015A	0757-0404	fxd film 130 5% 1/8W
R106	6010A, 6011A, 6012B	0683-2715	fxd film 270 5% 1/4W
R107	All	0683-1815	fxd film 180 5% 1/4W
R108	All	0683-2715	fxd film 270 5% 1/4W
R109	All	0683-1815	fxd film 180 5% 1/4W
R110	All	0683-5105	fxd film 51 5% 1/4W
R111	All	0683-2035	fxd film 20K 5% 1/4W
R112	All	0757-0199	fxd film 21.5K 1% 1/8W
R113	All	0757-0283	fxd film 2K 1% 1/8W
R114	All	0683-2225	fxd film 2.2K 5% 1/4W
R115	All	0757-0280	fxd film 1K 1% 1/8W
R116,117	All	0757-0346	fxd film 10 1% 1/8W
R118	All	0698-3498	fxd film 8.66K 1% 1/8W
R119	All	0757-0438	fxd film 5.11K 1% 1/8W
R120	All	0683-4725	fxd film 4.7K 5% 1/4W
R121	All	0683-2025	fxd film 2K 5% 1/4W
R122	All	0683-1025	fxd film 1K 5% 1/4W
R123	All	0683-4715	fxd film 470 5% 1/4W
R124	All	0757-0442	fxd film 10K 1% 1/8W

* R88 is comprised of two 1.25M 0.1% fixed film resistors (0698-6950) assembled in series.

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R125	All	0757-0465	fxd film 100K 1% 1/8W
R126	All	0757-0442	fxd film 10K 1% 1/8W
R127	All	0698-8827	fxd film 1M 1% 1/8W
R128	All	0698-3136	fxd film 17.8k 1% 1/8W
R129	All	0698-4121	fxd film 11.3K 1% 1/8W
R130	6010A, 6015A	NOT USED	
R131	All	0757-0449	fxd film 20K 1% 1/8W
R132	All	1810-0205	resistor network
R133	All	0683-5625	fxd film 5.6K 5% 1/4W
R134	All	0683-1025	fxd film 1K 5% 1/4W
R135	All	0683-1855	fxd film 1.8M 5% 1/4W
R136	All	0757-0420	fxd film 750 1% 1/4W
R137	All	0698-4435	fxd film 2.49K 1% 1/8W
R138	All	0757-0199	fxd film 21.5K 1% 1/8W
R139	All	0683-4725	fxd film 4.7K 5% 1/4W
R140	All	0683-2025	fxd film 2K 5% 1/4W
R141	All	0683-5135	fxd film 51K 5% 1/4W
R142	All	0683-6835	fxd film 68K 5% 1/4W
R143	All	0683-4725	fxd film 4.7K 52 1/4W
R144	All	0757-0415	fxd film 475 1% 1/8W
R145	All	0683-1005	fxd film 10 52 1/4W
R146	All	0683-1035	fxd film 10K 52 1/4W
R147	All	0683-5115	fxd film 510 5% 1/4W
R148	All	0757-0422	fxd film 909 1% 1/8W
R149	All	0683-2025	fxd film 2K 5% 1/4W
R150	6010A, 6015A	0754-0404	fxd film 130 5% 1/4W
R150	6011A, 6012B	0683-2715	fxd film 270 5% 1/4W
R151	All	0683-4725	fxd film 4.7K 5% 1/4W
R152	All	0757-0442	fxd film 10K 1% 1/8W
R153	All	0757-0443	fxd film 11K 1% 1/8W
R154	All	0757-0451	fxd film 24.3K 1% 1/8W
R155	All	0757-0444	fxd film 12.1K 1% 1/8W
R156	All	0683-4725	fxd film 4.7K 5% 1/4W
R157	All	0683-1005	fxd film l0 52 1/4W
R158	All	0686-2005	fxd comp 20 5% 1/2W
R159,160	All	0686-6215	fxd comp 620 5% 1/2W
R161	All	0757-0283	fxd film 2K 1% 1/8W
R162	All	0757-0442	fxd film l0K 1% 1/8W
R163	All	0757-0283	fxd film 2K 1% 1/8W
R164	All	0757-0434	fxd film 3.65K 1% 1/8W
R165	All	0683-1035	fxd film 10K 5% 1/4W
R166,167	All	0686-1315	fxd comp 130 5% 1/2W
R168	All	0683-1515	fxd comp 150 5% 1/4W
R169	All	0757-0124	fxd film 39.2K 1% 1/8W
R170	All	0698-3136	fxd film 17.8K 1% 1/8W
R171	All	0757-0280	fxd film 1K 1% 1/8W
R172	All	0811-3174	fxd WW .07 5% 5W
R173	All	0683-2225	fxd film 2.2K 5% 1/4W
R174	All	0683-3625	fxd film 3.6K 5% 1/4W
R175	All	0683-1525	fxd film 1.5K 55 1/4W
R176	All	0683-2225	fxd film 2.2K 5% 1/4W

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R177	All	0683-0335	fxd film 3.3 5% 1/4W
R178,179	All	0683-4725	fxd film 4.7K 5% 1/4W
R180	All	0683-l045	fxd film 100K 5% 1/4W
R181	All	0683-3335	fxd film 33K 5% 1/4W
R182	All	0698-8827	fxd film 1M 1% 1/8W
S1	All	3101-2097	switch (6) 1A
U1-3	All	1826-0493	IC op-amp
U4,5	All	1826-0161	IC op-amp
U6	All	1826-0346	IC op-amp
U7	All	1826-0544	IC voltage regulator
U8	All	1826-0138	IC voltage reg. Dual trkg.
U9	All	1820-0935	IC counter CMOS
U10	All	1826-0065	IC comparator
U11	6010A, 6012B	1826-0393	IC voltage regulator
U11	6011A		IC voltage regulator (incorporated into heatsink assy 5060-2942, see A2 Mechanical)
U11	6015A	5060-2942	IC volt reg/HS assy
U12	6010A, 6012B	1826-0527	IC voltage regulator
U12	6011A		IC voltage regulator (incorporated into heatsink assy 5060-2943, see A2 Mechanical)
U12	6015A	5060-2943	IC volt reg/HS assy
U13	All	1820-1287	IC buffer TTL LS
U14	6010A, 6015A	NOT USED	
U14	6011A, 6012B	Correct Designation is Q11	
U15	All	1820-1272	IC buffer TTL LS
U16	All	1820-1437	IC multivibrator TTL LS
U17	All	1826-0138	IC comparator
U18	All	1820-1205	IC gate TTL LS
U19	All	1820-1112	IC flip flop -type
U20	All	1820-2096	IC counter TTL LS
U21	All	1826-0544	IC voltage reg
U22	All	1826-0428	IC voltage regulator
U23	All	1826-0065	IC comparator
VR1	All	1902-3110	zener 5.9V 2%
VR2	All	1902-0777	zener 6.2V
VR3,4	All	1902-0018	zener 6.8V
VR5	All	1902-0575	zener 6.5V 2S
VR6	All		jumper (see W1-3)
W1-3 (R51,VR6)	6010A, 6012B, 6015A	7175-0057	jumper
W1-3 (R49, R51, VR6)	6011A	7175-0057	jumper
Y1	6010A, 6011A, 6015A	0960-0586	resonator- cer
Y1	6012B, 6015A	1960-0586	resonator- cer
		A2 MECHANICAL	
	6010A, 6012B, 6015A	1205-0282	heat sink (Q9,U11,U12)
	6011A	5060-2942	heatsink assy (includes U11)
	6011A	5060-2943	heatsink assy (includes U12)
	6011A	5060-2944	heatsink assy (includes Q9)

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
	All	1200-0485	IC socket (S1)
	All	1200-0181	insulator, (Q8)
J1,2	All	1251-8417	connector 16-pin
J3	All	1251-7743	connector 26-pin
J4	All	1251-8676	connector 5-pin
J5,6	All	1251-5240	connector 20-pin
J15	All	1251-0600	connector 1-pin
TB1	All	0360-2195	barrier block 6-pos.
TB2	All	0360-2192	barrier block 2-pos.
A3	**6010A**	**06010-60020**	**Front Panel Board**
A3	**6011A**	**06011-60020**	**Front Panel Board**
A3	**6012B**	**06012-60036**	**Front Panel Board**
A3	**6015A**	**06010-60023**	**Front Panel Board**
C1	All	0160-5893	fxd plyprpln .047µF 10% 100V
C2	All	0160-0168	fxd poly 0.1µF 10% 200V
C3	All	0160-4835	fxd cer 0.1µF 10% 50V
C4-6	All	0160-5422	fxd cer .047µF 20% 50V
C7	All	NOT USED	
C8	All	0160-5893	fxd plyprpln .047µF 10% 100V
C9	All	0160-0168	fxd poly 0.1µF 10% l00V
C10	All	0160-4835	fxd cer 0.1µF 10% 50V
C11	All	0160-5422	fxd cer .047µF 20% 50V
C12	All	NOT USED	
C13	All	0160-4835	fxd cer 0.1µF l0% 50V
C14	All	0160-5422	fxd cer .047µF 20% 50V
C15	All	0160-4831	fxd cer 4700pf l0% l00V
C16	All	0160-4807	fxd cer 33pf 5% l00V
C17-19	All	0160-5422	fxd cer .047µF 20% 50V
CR1,2	All	1901-0050	photoswitch IF=350ma VAX=15V
CR3-5	All	1901-0033	diode gen prp 180V 200ma
DS1-8	All	1990-0985	display kit
DS9,10	6010A, 6015A	1990-0995	led green IF=30ma BVR=5V
DS9,10	6011A, 6012B	1990-0521	led green IF=30ma BVR=5V
DS11-13	6010A, 6015A	1990-0895	led yellow IF=20ma BVR=5V
DS11-13	6011A, 6012B	1990-0524	led yellow IF=20ma BVR=5V
R1-17	All	0683-2015	fxd film 200 5% 1/4W
R18	All	0698-3456	fxd film 287K 1% 1/8W
R19-37	All	0683-2015	fxd film 200 5% 1/4W
R38	All	0683-1045	fxd film 100K 5% 1/4W
R39	All	NOT USED	
R40-44	All	0683-2015	fxd film 200 5% 1/4W
R45	All	0698-3456	fxd film 287K 1% 1/8W
R46-54	All	0683-2015	fxd film 200 5% 1/4W
R55	All	0683-1045	fxd film 100K 5% 1/4W
R56	6010A	0698-8871	fxd film 953 1% 1/8W
R56	6011A	0698-6348	fxd film 3K 1% 1/8W
R56	6012B, 6015A	0698-6362	fxd film 1K .1% 1/8W
R57	All	NOT USED	

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R58	6010A	0698-0533	fxd film 4.64K 0.1% 1/8W
R58	6011A	0698-6392	fxd film 22K 0.1% 1/8W
R58	6012B, 6015A	0699-1212	fxd film 19K 0.1% 1/8W
R59	All	0683-6215	fxd film 620 52 1/4W
R60-62	All	0683-2015	fxd film 200 5% 1/4W
R63	All	0683-5125	fxd film 5.1K 5% 1/4W
R64	All	0683-1025	fxd film 1K 5% 1/4W
R65,66	6010A, 6011A, 6012B	0683-5615	fxd film 560 5% 1/4W
R65,66	6015A	0683-3201	fxd film 560 5% 1/4W
R67	6010A, 6011A	0757-0449	fxd film 20K 1% 1/8W
R67	6012B	0757-0453	fxd film 30.1K 1% 1/8W
R67	6015A	0757-5615	fxd film 20K 1% 1/8W
R68	6010A, 6011A, 6015A	0698-3201	fxd film 80K 1% 1/8W
R68	6012B	0757-0449	fxd film 20K 1% 1/8W
R69	6010A, 6011A, 6015A	0757-0442	fxd film 10K 1% 1/8W
R70	6010A, 6011A	0698-7353	fxd film 19K 1% 1/8W
R70	6012B	0698-4493	fxd film 34K 1% 1/8W
R70	6015A	0698-6671	fxd film 7K 0.25% 1/8W
R71	6010A, 6011A, 6015A	0757-0280	fxd film 1K 1% 1/8W
R71	6012B	0698-3476	fxd film 6K 1% 1/8W
R72	All	0698-6362	fxd film 1K 0.1% 1/8W
R73	All	0757-0452	fxd film 27.4K 1% 1/8W
R74	All	NOT USED	
R75	All	0683-5135	fxd film 51K 5% 1/4W
R76	All	0757-0441	fxd film 8.25K 1% 1/8W
R77	6010A, 6011A, 6012B	0698-3159	fxd film 26.lK 1% 1/8W
R77	6015A	NOT USED	
R78	All	0757-0458	fxd film 51.1K 1% 1/8W
R79	All	0683-1025	fxd film 1K 5% 1/4W
R80	All	0683-5135	fxd film 51K 5% 1/4W
R81	All	0683-3025	fxd film 3K 5% 1/4W
R82	All	0683-1025	fxd film 1K 5% 1/4W
R83	6010A	0698-6363	fxd film 9K 0.1% 1/8W
R83	6011A, 6012B	0698-6343	fxd film 9K 0.1% 1/8W
R83	6015A	0698-6322	fxd film 4K 0.1%
R84	6010A	0698-6563	fxd film 40K 0.1% 1/8W
R84	6011A	0698-6363	fxd film 40K 0.1% 1/8W
R84	6012B	0698-8861	fxd film 6.66K 0.1% 1/8W
R84	6015A	0699-1211	fxd film 95K 0.1%
R85	All	0757-0438	fxd film 5.11K 1% 1/8W
R86	All	0683-5135	fxd film 51K 5% 1/4W
R87	All	0757-0199	fxd film 21.5K 1% 1/8W
R88	All	0683-3925	fxd film 3.9K 5% 1/4W
R89	All	0698-5808	fxd film 4K 1% 1/8W
R90	All	0686-6815	fxd comp 680 5% 1/2W
R91	All	0757-0452	fxd film 27.4K 1% 1/8W
R92	All	NOT USED	
R93	All	0683-2025	fxd film 2K 5% 1/4W
R94	All	0757-0280	fxd film 1K 1% 1/8W
R95	All	0683-l035	fxd film 10K 5% 1/4W
R96	All	0683-5125	fxd film 5.1K 5% 1/4W

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R97	All	2100-1775	var. ww. trimmer 5K 5%
R98	6010A, 6012B, 6015A	0698-4457	fxd film 576 ohms 1% 1/8W
R98	6011A	0757-0415	fxd film 475 1% 1/8W
R99,100	All	See Chassis Electrical	
S1,2	All	5060-9436	switch, rockerarm
U1,2	All	1826-0876	IC Converter A/D CMOS
U3	All	1820-1144	IC NOR Gate TTL LS Quad
U4	All	1826-0502	Analog Switch, 4SPST, 14pin dip
U5	All	1826-0138	IC Comparator, quad, 14pin dip
U6	All	1826-0493	IC Op Amp, Low-Bias-Hi-Impd.
U7	All	1826-0346	IC Op Amp, gen. purpose
U8	All	1826-0502	Analog Switch, 4SPST, 14pin dip
VR1	All	1902-3092	diode, zener, 4.99V 2%
VR2	All	1902-0064	diode, zener, 7.5V 5%
W1	All	8159-0005	res. 0 ohms
W2,4	All	7175-0057	jumper, solid tinned copper
W2,3	6011A, 6012B	7175-0057	jumper, solid tinned copper
W3,5-7	6010A, 6015A	NOT USED	
W5	6011A, 6012B	NOT USED	
W6,7	6011A, 6012B	7175-0057	jumper, solid tinned copper
W8	6010A	7175-0057	jumper, solid tinned copper
W8	6015A	NOT USED	
		A3 MECHANICAL	
J3	All	1251-5055	Connector Post Type
	6010A, 6015A	5041-0309	key cap (ref. S1,S2)
	6011A, 6012B	4040-2121	Plastic-misc (ref. DS9-13)
A4	**All**	**06011-60023**	**FET Board**
C1	All	0160-4569	fxd poly .01uf 10S% 800Vdc
C2	All	0160-5981	fxd poly .047µF 10% 630Vdc
C3	All	0160-4569	fxd poly .01µF 10% 800Vdc
C4	All	0160-5981	fxd poly .047µF 10% 630Vdc
C5,6	All	0160-4835	fxd cer .1µF 10% 50V
C7	6010A, 6011A, 6012B	0180-0116	fxd elect 6.8µF 10% 35V
C7	6015A	0180-4132	fxd elect 6.8µF 10% 35V
C8	All	0130-0228	fxd elect 22µF 10% 15V
**CR1	6010A, 6011A, 6012B	1901-1418	diode rect. /HA assy
CR1	6015A	5060-9667	diode rect. /HA assy
CR2,3	All	1901-1087	pwr rect. 600V
**CR4	All	1901-1418	diode rect. /HA assy
CR5-11	6010A, 6011A, 6015A	1901-0050	diode-switching 80V 200ma
CR5	6012B	NOT USED	
CR6-11	6012B	1901-0050	diode-switching 80V 200ma
F1,2	All	2110-0671	fuse .125A 125V
L1-4	All	9100-1610	coil 150µH 20%
Q1-4	All	1855-0473	MOS FET N chan.
Q5,6	All	1854-0585	NPN Si
R1-4	All	0811-1065	fxd ww 0.2 5% 1/2W
R5-8	All	0698-3609	fxd met 22 5% 1/2W

** If either diode needs replacement, replace both diodes.

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R9-11	All	0698-5139	fxd comp 3.9 5% 5W
R12	All	0757-0466	fxd film 110K 1% 1/8W
R13-16	All	0698-3609	fxd met 22 5% 2W
R17-19	All	0698-5139	fxd comp 3.9 5% .5W
R20	All	0757-0379	fxd film 12.l 1% 1/8W
R21	All	0683-1505	fxd film 15 5% 1/4W
R22	All	0683-1815	fxd film 180 5% 1/4W
R23,24	All	0686-2005	fxd comp 20 5% 1/2W
R25	All	0757-0466	fxd film 1l0K 1% 1/8W
R26	All	0683-1815	fxd film 180 5% 1/4W
R27	All	0757-0379	fxd film 12.1 1% 1/8W
R28	All	0683-1505	fxd film 5% 1/4W
R29-33	All	0683-0475	fxd film 4.7 5% 1/4W
R34	All	0683-0275	fxd film 2.7 5% 1/4W
TS1	All	3103-0081	switch-therm +202F
T1	All	06011-80091	Transformer
T2	All	06011-80095	Transformer
U1-3	All	1820-l050	DRVR TTL NOR DUAL
VR1,2	All	1902-0779	zener 11.8V 5%
		A4 MECHANICAL	
	6010A, 6012B	1205-0398	heatsink (ref. CR1,4)
	All	1252-0093	socket pin (ref. Q1-4)
	All	06032-20001	heatsink (ref. Q1,Q2)
	All	06032-20002	heatsink (ref. Q3,Q4)
	All	0380-1524	standoff (8mm)
P1	All	1252-1053	connector 64-pin
A5	**6010A**	**06030-60024**	**Diode Board**
A5	**6011A**	**06011-60024**	**Diode Board**
A5	**6012B**	**06032-60029**	**Diode Board**
A5	**6015A**	**06030-60029**	**Diode Board**
C1	6010A, 6012B, 6015A	0180-3167	fxd elect 1000µF 20% 25V
C1	6011A	0160-4832	fxd cer .01µF 10% 100V
C2	6010A	0160-5464	fxd poly .01µF 5% 1.5KVdc
C2	6011A	0160-5422	fxd cer .047µF 20% 50Vdc
C2	6012B	0160-4569	fxd poly .01µF 10% 800Vdc
C2	6015A	0160-7222	fxd poly .0022µF 1600Vdc
C3	6010A, 6012B, 6015A	0160-5422	fxd cer .047µF 20% 50Vdc
C3	6011A	0180-3167	fxd cer 1000µF 25Vdc
C4	6010A, 6012B	0160-4832	fxd cer .01µF 10% 100Vdc
C4	6015A	0160-4835	fxd cer .01µF
C4,5	6011A	0160-6077	fxd poly pr 0.015µF 200V
C5	6010A	0160-5464	fxd poly .01µF 5% 1.5KVdc
C5	6015A	0160-7222	fxd poly .0022µF 1600Vdc
C6	6010A	see chassis electrical	
C7	6015A	0160-5166	fxd cer 0.015µF 100V
CR1	6010A, 6012B, 6015A	1901-0050	diode-switching 80V 200ma
CR1	6011A	5080-2068	rectifier matched pair (with CR5)
CR2	6010A, 6012B, 6015A	1901-0731	pwr rectifier 400V 1A

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
CR3	6010A, 6012B, 6015A	1901-0050	diode-switching 80V 200ma
CR2,3	6011A	1901-0050	diode-switching 80V 200ma
CR4,5	6010A	1901-1542	pwr rectifier 400V 50A
CR4,5	6015A	1901-1388	diode pwr rectifier
CR4	6011A	1901-0731	pqr rectifier 400V 1A
CR4	6012B	1901-1182	pqr rectifier 300V 50A
CR5	6011A	5080-2068	rectifier matched pair (with CR1)
CR6	6010A, 6015A	1902-3203	diode 14.7V 5% 400mW
F1	6010A	NOT USED	
F1	6011A	2110-0699	fuse 5A 125V (axial)
F1	6012B	2110-0546	fuse 5A 125V (axial)
L1,2	6010A	9170-1334	ferrite core for L1,2
L1,2	6011A	9170-1272	core-magnetic ferrite
L1,2	6015A	5080-2132	inductor
L1	6012B	06012-80003	snubber wire
		9170-0707	ferrite core for L1
L3	6010A, 6015A	9170-0894	core-shield bead (ref. Q1)
Q1	6010A, 6015A	1855-0767	MOS FET N chan
Q1	6011A	1854-0264	NPN Si
Q1	6012B	1855-0549	MOS FET N chan
Q2	6011A	1855-0549	FET N-CHAN
Q2	6012B	1854-1070	NPN Si
R1	6010A, 6012B, 6015A	0683-1855	fxd film 1.8M 5% 1/4W
R1	6011A	0811-3460	fxd ww 0.05 5% 5W
R2	6011A	0686-1005	fxd comp 10 5% 1/2W
R2	6010A, 6012B, 6015A	0698-3151	fxd film 2.87K 1% 1/8W
R3	6010A, 6012B	0757-0459	fxd film 56.2K 1% 1/8W
R3	6011A	0683-1025	fxd film 1K 5% 1/8W
R3	6015A	0757-0459	fxd film 56.2K 1% 1/8W
R4	6010A, 6012B	0698-3202	fxd film 1.74K 1% 1/8W
R4	6011A	0757-0317	fxd film 1.33K 1% 1/8W
R4	6015A	0698-3202	fxd film 1.74K 1% 1/8W
R5	6010A, 6012B, 6015A	0757-0317	fxd film 1.33K 1% 1/8W
R5	6011A	0698-4196	fxd film 1.07K 1% 1/8W
R6	6010A, 6012B, 6015A	0683-l045	fxd film 100K 5% 1/4W
R6	6011A	0698-4211	fxd film 158K 1% 1/8W
R7	6010A, 6015A	0683-2735	fxd film 5% 1/4W
R7	6011A	0757-0465	fxd film 100K 1% 1/8W
R7	6012B	0683-1025	fxd film 1K 5% 1/8W
R8	6010A, 6012B, 6015A	0698-7332	fxd film 1M 1% 1/8W
R8	6011A	0757-0447	fxd film 16.2K 1% 1/8W
R9	6010A	0698-8144	fxd film 787K 1% 1/8W
R9	6011A	0757-0428	fxd film 1.62K 1% 1/8W
R9	6012B	0757-0480	fxd film 432K 1% 1/8W
R9	6015A	0683-2055	fxd film 2M 5%
R10	6010A, 6015A	0698-3512	fxd film 1.13K 1% 1/8W
R10	6012B	0698-4196	fxd film 1.07K 1% 1/8W
R10,11	6011A	0698-3601	fxd film 10 5% 2W
R11	6010A, 6015A	NOT USED	
R11	6012B	0686-1005	fxd comp 10 5% 1/2W

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
R12	6010A, 6015A	0757-0447	fxd film 16.2K 1% 1/8W
R12,13	6011A	0698-3609	fxd met 22 5% 2W
R13	6010A, 6012B, 6015A	0683-1005	fxd film 10 5% 1/4W
R14	6010A	0811-1746	fxd ww .36 5% 2W
R14	6011A	0757-0459	fxd film 56.2K 1% 1/8W
R14	6012B	0811-3290	fxd ww .1 5% 2W
R14	6015A	0811-0923	fxd ww 0.91ohms 2W
R15-18	6010A	0811-3729	fxd ww 250 5% 10W
R15-18	6015A	0811-3842	fxd ww 600 ohms 10W
R15	6011A	0683-1855	fxd film 1.8M 5% 1/4W
R15	6012B	0811-1068	fxd ww 50 5% 10W
R16	6011A	0698-7332	fxd film 1M 1% 1/8W
R17	6011A	0698-3151	fxd film 2.87K 1% 1/8W
R18	6011A	0683-1005	fxd film 10 10% 1/4W
R19	6010A	0689-8144	fxd film 787K 1% 1/8W
R19	6011A	0811-1903	fxd ww 100 5% 10W
R19	6015A	0683-2055	fxd film 2M 5%
R20	6010A, 6015A	0811-3731	fxd ww 1.2 5% 2W
TS1	6010A, 6011A, 6015A	3103-0082	switch-thermal 200 degree/C
TS1	6012B	3103-0081	switch-thermal 202 degree/C
U1	All	1826-0346	IC OP-Amp
VR1	6010A	1902-0515	zener 6.5V 2%
VR1	6011A, 6012B, 6015A	1902-0575	zener 6.5V 2%
		A5 MECHANICAL	
	6010A, 6015A	5020-2878	heatsink (ref. Q1)
	6010A, 6012B	1205-0398	heatsink (ref. Q1)
	6012B	1252-0093	socket pin (ref. Q2)
	6011A	1205-0520	heatsink (ref. Q1)
	6011A	06011-20001	heatsink (ref. diodes)
	6011A	1205-0398	heatsink (ref. Q2)
	6012B	06032-00018	outer heatsink
	6012B	06032-00017	heatsink bracket
	6010A, 6015A	1251-7600	connector sgl. Cont. skt.
	6010A, 6015A	5020-2877	front heatsink (ref. CR5)
	6010A, 6015A	5020-2878	rear heatsink (ref. CR4)
P1	All	1251-1053	connector 64-pin
	6010A, 6015A	0340-1123	Insulator (ref. L1,2)
	6010A, 6015A	5080-2065	Jumper (ref. L1,2)
	6011A	06011-00001	bracket (ref. diode heatsink)
	6011A	8150-4777	wire snubber (ref. T1, L1, L2)
	6015A	2190-0100	lockwasher (CR4 to HS)
A6	**All**	**5060-3522**	**AC Input Filter**
C101	6010A, 6011A, 6012B	0160-4355	fxd met .01µF 10% 250Vac
C101	6015A	0160-4048	fxd ppr-met .022µF 250V
C102	6010A, 6011A, 6012B	0160-4281	fxd met 2200pf 20% 250Vac
C102	6015A	0160-4439	fxd ppr-met .0047µF 250V
C103	6010A, 6011A, 6012B	0160-4355	fxd met .01µF 10% 250Vac
C103	6015A	0160-4048	fxd ppr-met .022µF 250V

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
C104	6010A, 6011A, 6012B	0160-4281	fxd met 2200pf 20% 250Vac
C105	All	0160-4962	fxd poly 1μF 20% 250Vac
C106,107	6010A, 6011A, 6012B	0160-4183	fxd met 1000pf 20% 250Vac
C106,107	6015A	0160-4439	fxd ppr-met .0047μF 250V
C108,109	All	0160-4962	fxd poly 1μF 20% 250V
L101	All	66000-80004	choke, input
R101	All	0686-3945	fxd comp 390K 5% .5W
W101-103	All	1251-5613	connector, single
		A6 MECHANICAL	
TB110	All	0360-2217	Barrier Block 3-pos
A9	**6015A**		**OUTPUT BOARD**
C1,2	6015A	0180-4231	fxd elect 750μF 350V
C3	6015A	0160-2569	fxd cer 0.02μF 2KV
CR1	6015A	1901-0325	diode 700V 35A
CR2,3	6015A	1901-0759	diode 600V PRV 3A
R1-4	6015A	0764-0027	fxd met 75K 5% 2W
		A9 MECHANICAL	
	6015A	06030-0005	heatsink (ref. CR1)
		CABLING	
W1	All	06011-60001	ribbon cable (A2 to A3)
W7	6011A		see A1 Main Board
W8	6011A		see A1 Main Board
	6015	5060-2864	cable assy (ref. fan)
		CHASSIS MECHANICAL	
	All	5021-8403	front frame casting
	All	5041-8802	top trim strip
	All	5001-0539	side trim strip
	All	06032-00015	front sub-panel
	6010A	06010-00009	lettered front panel
	6011A	06011-00009	lettered front panel
	6012B	06012-00018	lettered front panel
	6015A	06015-00001	lettered front panel
	All	0370-1091	knobs
	All	5041-0309	plain key cap (ref. Front)
	6012B, 6015A	5041-2089	lettered key cap
	All	4040-1954	display window
	All	06032-00025	Chassis
	All	06032-00024	Internal cover (under top cover, lettered)
	All	06032-00011	air baffle (ref. fan, attached to rear panel, sheet metal)
	All	06032-00012	DC output mounting plate
	All	0380-1362	standoff (12mm)
	6010A, 6011A, 6012B	06023-00026	cover plate (ref. rear panel)
	All	1510-0044	binding post, single,(ref. rear panel ground)
	All	0400-0086	insulated bushing (ref. rear panel AC Input Board)
	All	0380-1692	standoff (l09.4mm)
	All	5001-6739	top cover
	All	5001-6738	bottom cover

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
	All	5040-1626	DC output cover (ref. Barrier Block.)
	6010A, 6015A	5040-1627	AC output cover (ref. AC line cord)
	6011A, 6012B	5060-3237	AC output cover with strain relief (ref. AC line cord)
	6010A, 6015A	5040-1625	strain relief (power cord)
	All	5062-3703	strap handle
	All	5041-8819	handle retainer (front)
	All	5041-8820	handle retainer (back)
	All	5041-8801	Foot
	6010A, 6015A	06032-000l0	bus bar-output
	6015A	2190-0587	lockwashers
	6015A	3050-0894	flatwashers
	6015A	0535-0077	hex nuts
	6015A	0515-0155	screw mach M5x0.8 (ref. bus bar)
	6015A	0515-0064	screw mach M3x0.5 (ref. fan)
	6015A	0515-0156	screw mach M4x0.7 (ref. ac input cover)
	6015A	0515-0210	screw mach M4x0.7 (ref. baffle, top cover, diode board to main board, frame casting to frame)
	6015A	0515-0211	screw mach M3x0.5 (ref. rear plate, output bus assy)
	6010A, 6011A, 6015A	0515-0413	screw mach M3x0.7 (ref. main board to chassis, ac input board, front panel)
	6015A	0515-0414	screw mach M4x0.7 (ref. line choke, bus bar cover)
	6015A	0515-0610	screw mach M5x0.8 (ref. bus bar to main board)
	6015A	0515-0642	screw mach (ref. bus bar)
	6015A	0515-0751	screw mach M4x0.7 (ref. pwr xmfr, relay, ac input board)
	6015A	0515-0896	screw mach M4x0.7 (ref. inside top cover)
	6015A	0515-0968	screw mach (ref. output bus assy))
	6015A	0515-1132	screw mach M5x0.8 (ref. strap handle))
	6015A	0515-0031	nut hex w/lkwr (ref. fan front panel to subpanel)
	10,11,15	0515-0964	screw (ref. bias transformer A1T3)
	10,11,15	2190-0586	lock washer (ref. bias transformer A1T3)
	10,11,15	3050-0893	flat washer (ref. bias transformer A1T3)
	15	06671-40002	clamp (ref. bias transformer A1T3)
	15	06671-40003	bracket (ref. bias transformer A1T3)
		CHASSIS ELECTRICAL	
B1	6010A, 6012B, 6015A	3160-0097	Fan
B1	6011A	3160-0381	Fan
C6	6010A	0160-2569	fxd cer 0.02µF 20% 2KVdc

Table 5-3. Replaceable Parts List (continued)

Ref. Desig.	Agilent Model	Agilent Part Number	Description
C28	6010A	0180-3703	fxd elect 1500μF 250V
C28	6012B	0180-3491	fxd elect 2600μF 75V
C28	6015A	NOT USED	
C30	6010A	0160-4962	fxd poly 1.0μF 20%
C30	6011A	0160-0381	fxd poly .01μF 10% 400V
C31	6011A	0180-3491	fxd elect 10,000μF 40V
C34	6010A	0160-6805	fxd poly .01μF 10% 400V
CB1	All	3105-0126	Circuit Breaker 4A 65Vdc
L4	All	5080-2307	choke (input line)
R20-23	6015A	0699-0208	fxd comp 1 5% 1/4W
R99,100	All	2100-4060	5K pot. (ref. Frt. Panel)
S3	All	3101-0402	switch DPST (on/off)

6

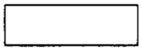
Component Location and Circuit Diagrams

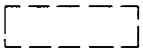
This chapter contains component location diagrams, schematics, and other drawings useful for maintenance of the power supply. Included in this section are:

a. Component location illustrations (Figures 6-1 through 6-8), showing the physical location and reference designators of almost all electrical parts. Components located on the A6 AC Input Board and on the output filter board mounted on the output bus bars are easily identified by reference designators silkscreened on the boards.
b. Notes (Table 6-1) that apply to all schematic diagrams.
c. Schematic diagrams (Figures 6-9 through 6-13).

WARNING	AC line voltage is present on the A1 Main Board Assembly whenever the power cord is connected to an ac power source.

Table 6-1. Schematic Diagram Notes

1.  denotes front-panel marking.

2.  denotes rear-panel marking.

3. Complete reference designator consists of component reference designator prefixed with assembly number (e.g.: A2R14).

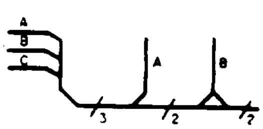
4. Resistor values are in ohms. Unless otherwise noted, resistors are either 1/4W, 5% or 1/8W, 1%. Parts list provides power rating and tolerance for all resistors.

5. Unless otherwise noted, capacitor values are in microfarads.

6. Square p.c. pads indicate one of the following:
   a. Pin 1 of an integrated circuit.
   b. The cathode of a diode or emitter of a transistor.
   c. The positive end of a polarized capacitor.

7. In schematic symbols drawn to show right-to-left signal flow, blocks of information are still read left to right. For example:

→ indicates shift away from control block (normally down and to right). ← indicates shift toward control block (normally up and to left).

8. 

indicates multiple paths represented by only one line. Reference designators with pin numbers indicate destination, or signal names identify individual paths. Numbers indicate number of paths represented by the line.

9. For single in-line resistor packages, pin 1 is marked with a dot. For dual in-line integrated circuit packages, pin 1 is either marked with a dot, or pin 1 is to the left (as viewed from top) of indication at end of integrated circuit package. e.g.:

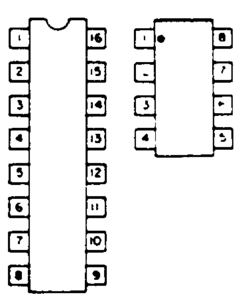
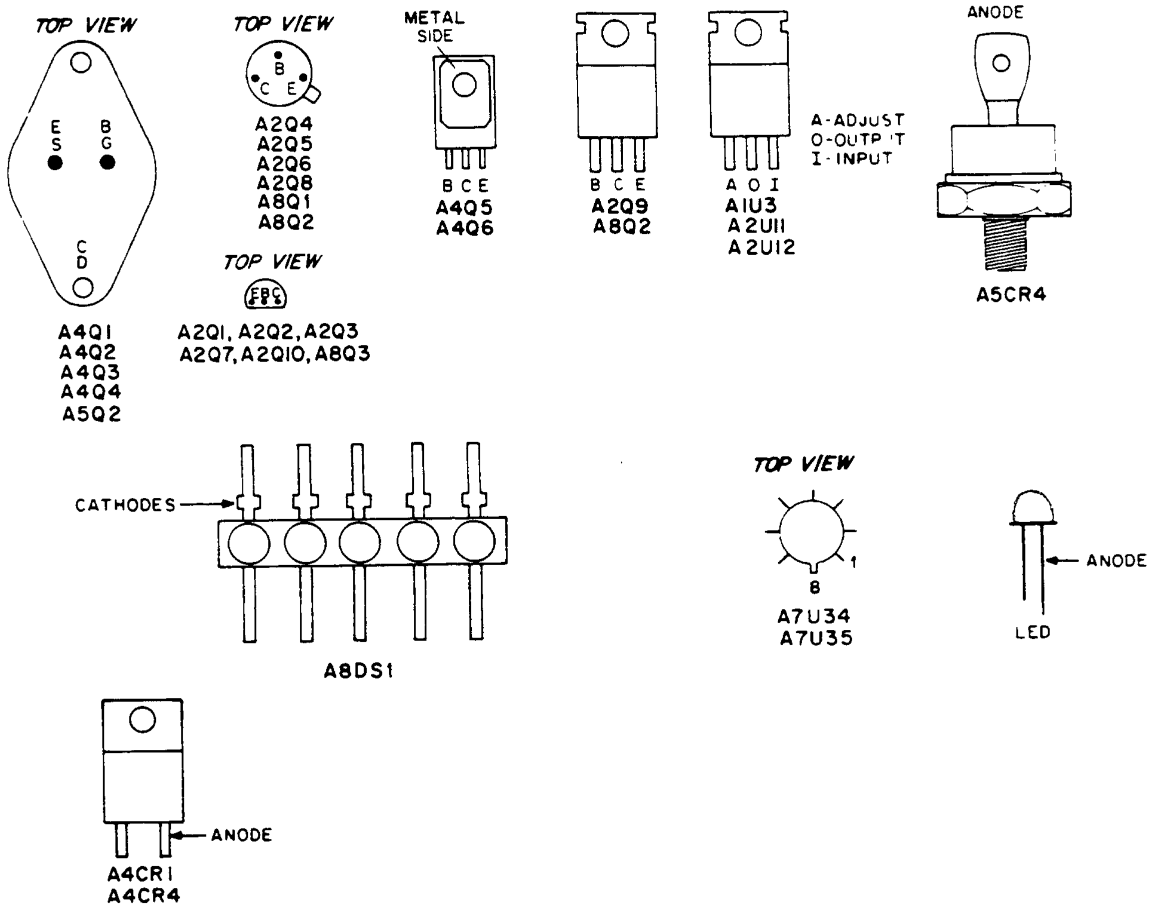


Table 6-1. Schematic Diagram Notes (continued)

Pin locations for other semi-conductors are shown below:



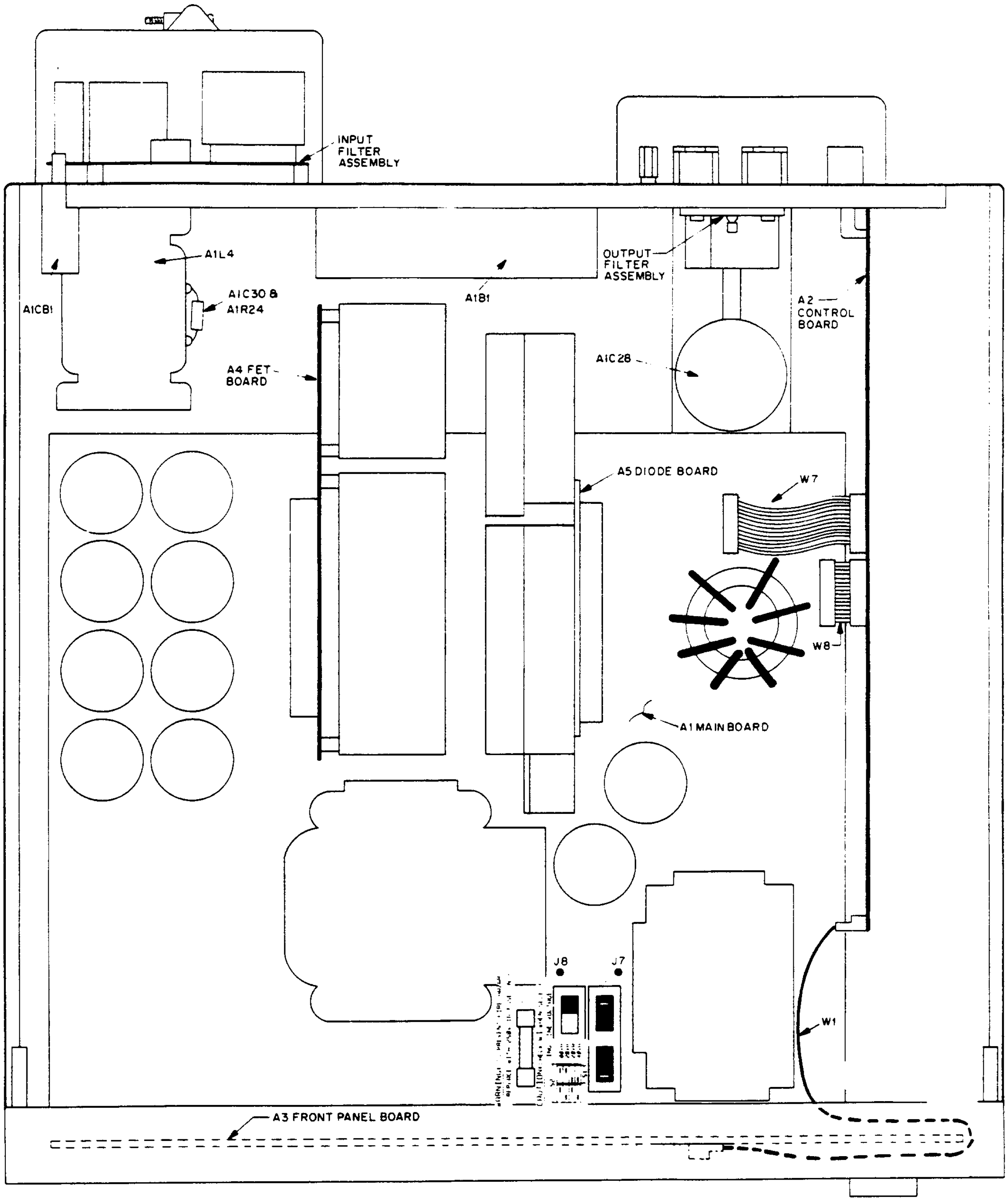


Figure 6-1. Top View, Top Covers Removed

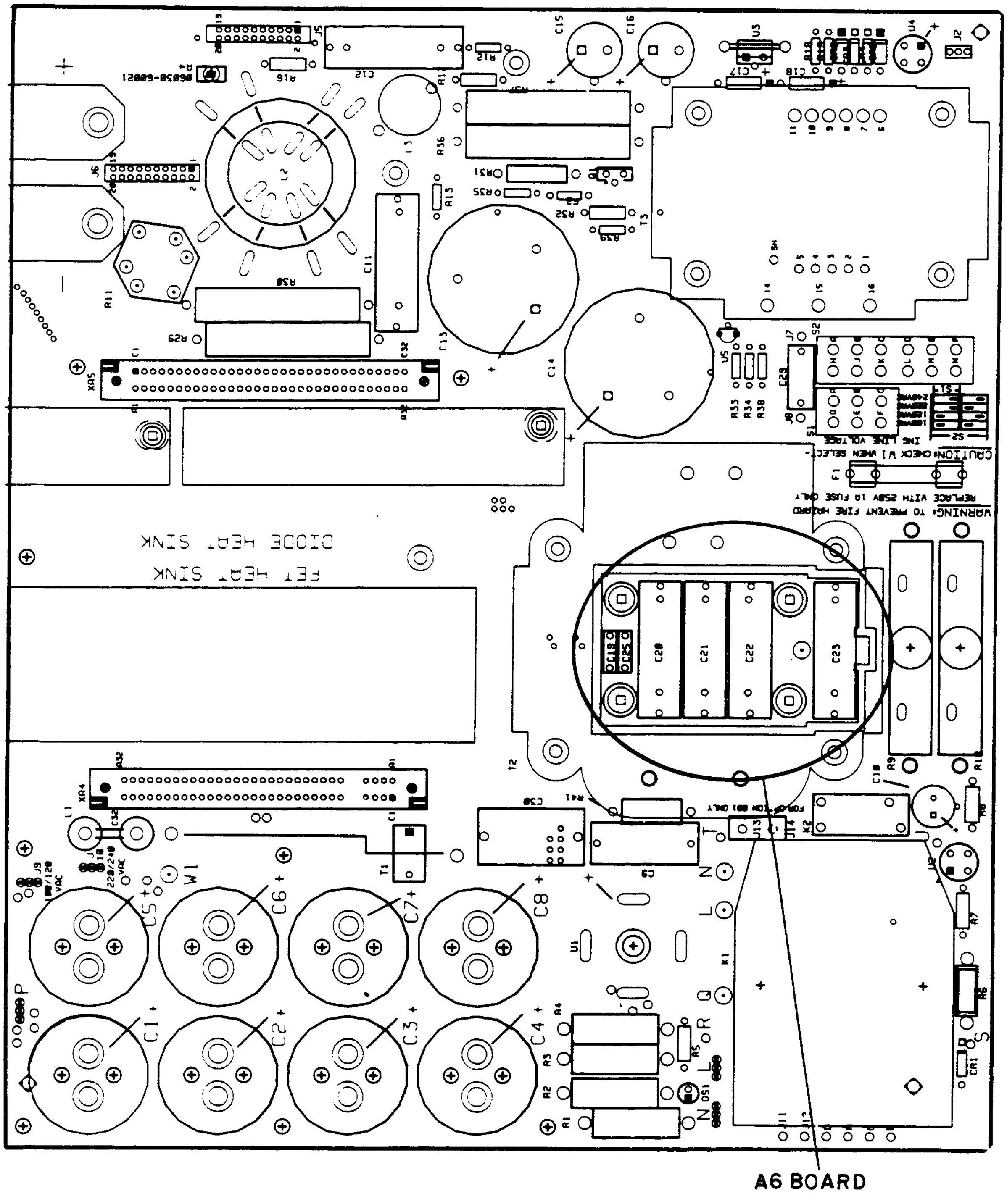


Figure 6-2. Main Board (A1) and Filter Board (A6) Component Location

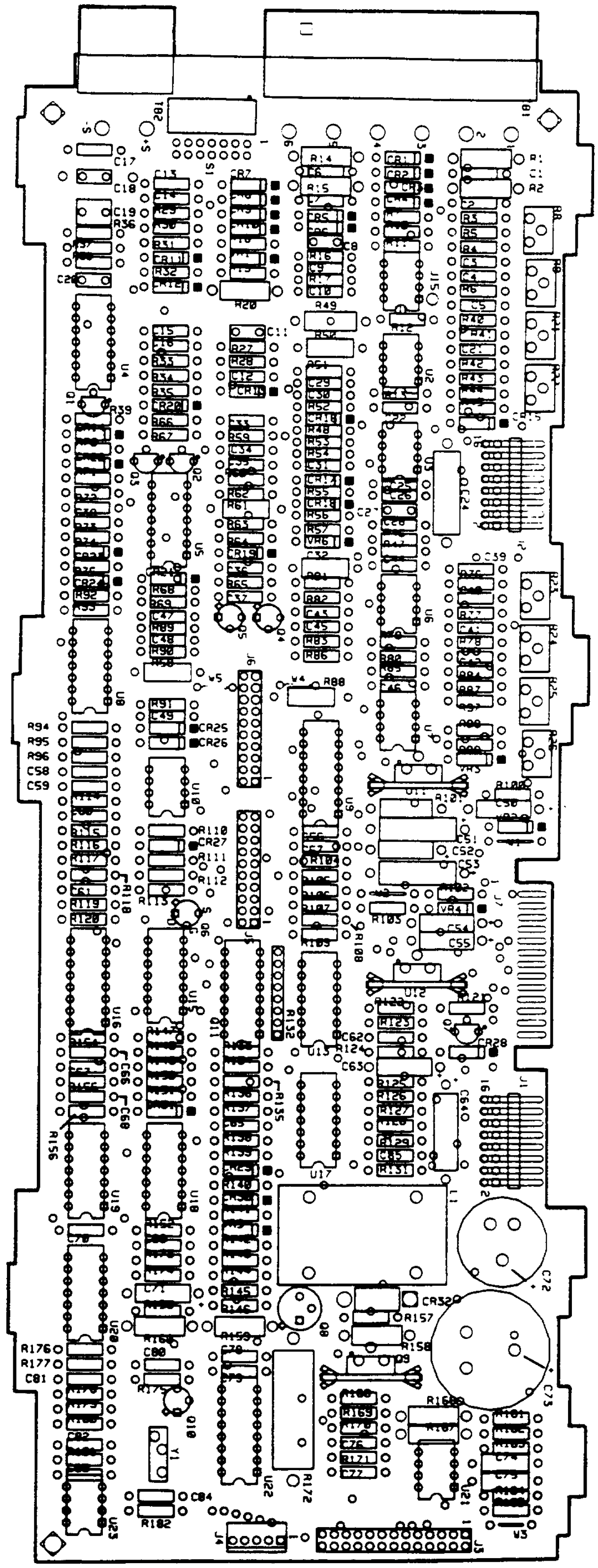


Figure 6-3. Control Board (A2) Component Location

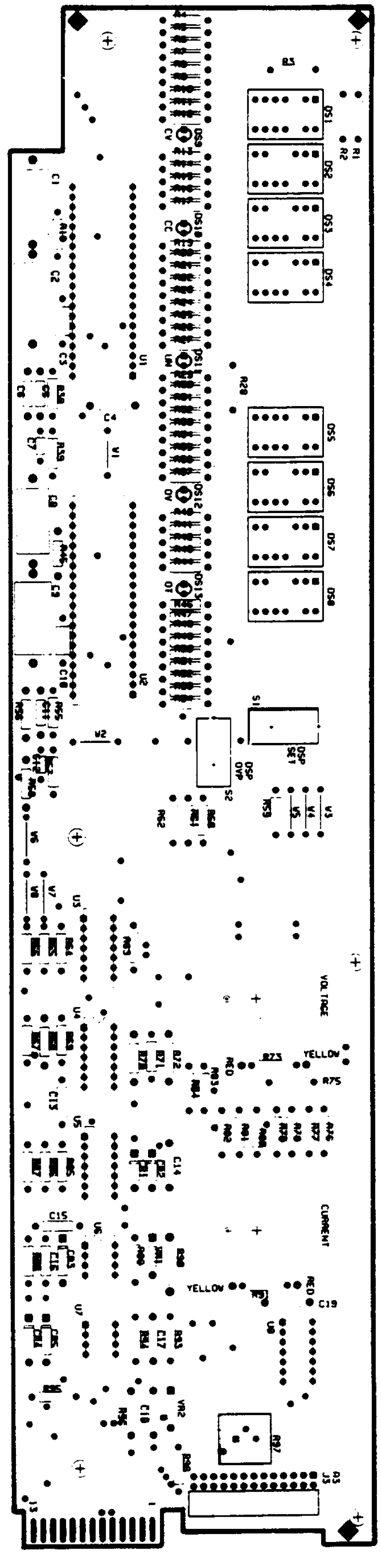


Figure 6-4. Front Panel Board (A3) Component Location

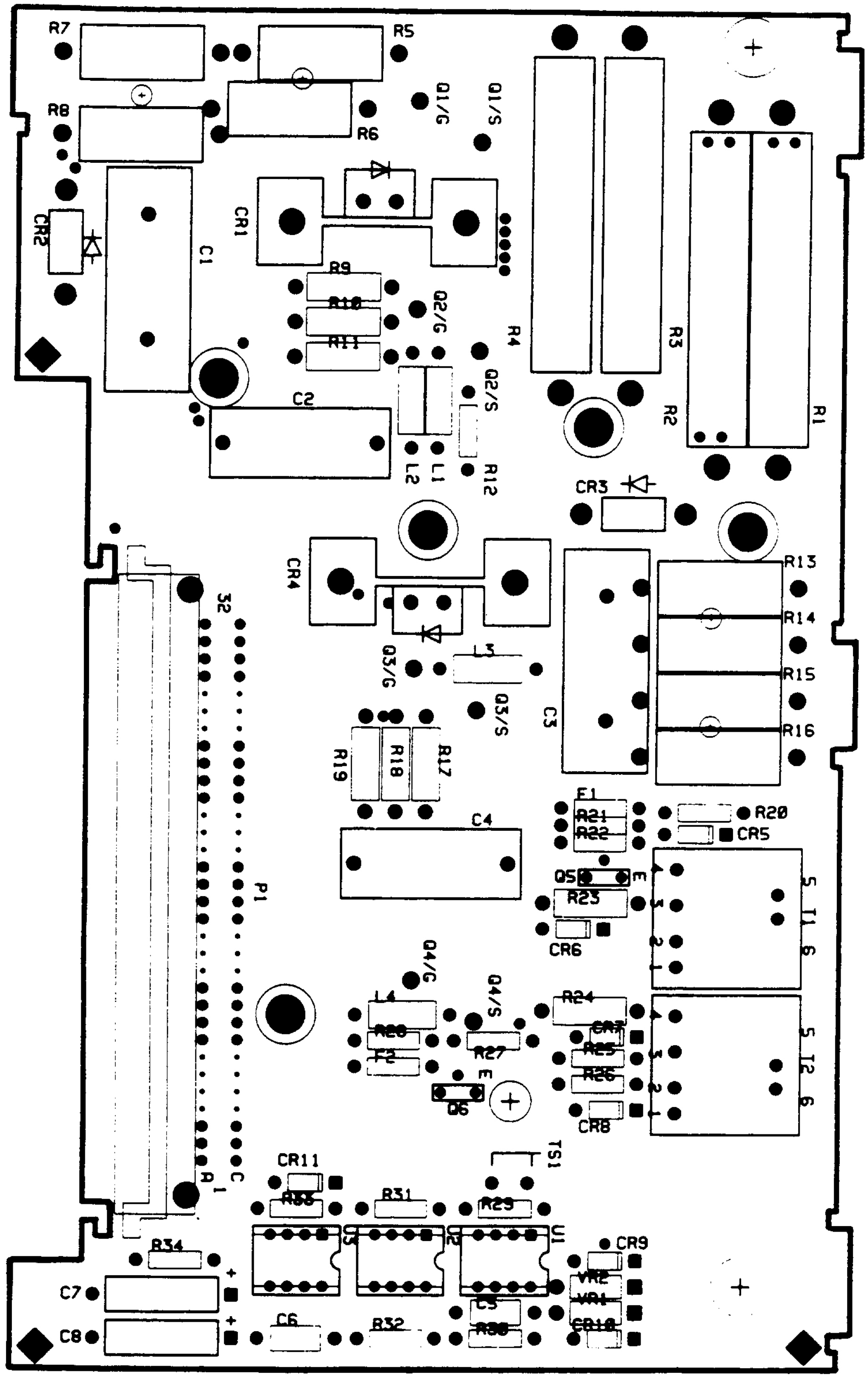


Figure 6-5. FET Board (A4) Component Location

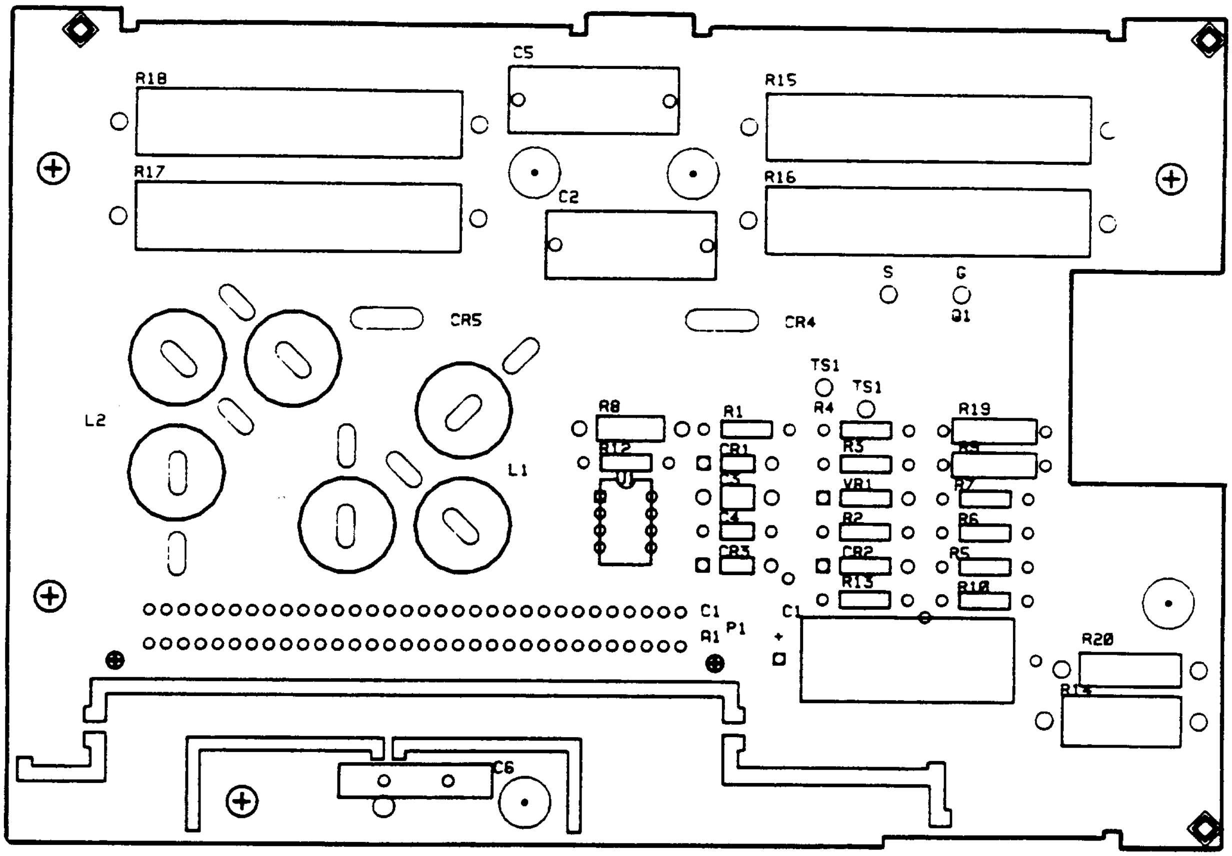


Figure 6-6. Diode Board (A5) Component Location

A

System Option 002 (6010A, 6011A, 6012B)

General Information

This option facilitates the operation of the power supply in an automated system. Four major circuit blocks provide: 1) remote analog programming of the supply's output by three different control methods; 2) signals indicating the power supply modes and conditions; 3) two different digital methods of remote control; and 4) the outputs of three bias supplies for use with external circuitry.

The power supply equipped with this option can be operated from either a 6940B Multiprogrammer equipped with a 69520A power supply programming card or a 6942A Multiprogrammer equipped with a 69709A power supply programming card.

Remote Programming. Through this interface both the output voltage and current can be remote programmed by either an external voltage source, resistance, or a current sink.

Status Indicators. Six optically isolated lines provide open-collector digital outputs which indicate the following states: constant voltage mode, constant current mode, output unregulated, ac dropout, overvoltage, and overtemperature.

Remote Control. Two optically isolated methods of remote control are available. 0ne method requires a negative going edge, which sets a latch on the 002 card to inhibit the power supply. The latch and OVP are reset by a negative-going pulse on another input line. The second method of remote control requires a low logic level to inhibit the power supply for the duration of the low level.

Bias Supplies. The outputs of three bias supplies are also available at the option connector. These outputs are + 15V, -15V, and +5V.

Monitoring. The 002 Option Board provides two monitoring outputs (I.MON. and V.MON) available at the option connector. They both vary from 0 to 5V corresponding to a 0 to full scale output.

Other modes of operation, such as multiple supply system control, are described in detail in later paragraphs. Modes such as Auto series, Auto Parallel, and Auto tracking operation are described in the Operating Manual.

Specifications

Table A-1 provides specifications for the Option 002. This table is referred to periodically throughout the text of this Appendix.

Option 002 Hardware

The Option 002 hardware consists of a single printed circuit board installed at the right side (facing the front panel) of the chassis. Two cables connect the option board to the A2 control board at A2J1 and A2J2. Connections between the option board and external circuits are made via the 37-pin connector mounted on the option board and available at the rear of the power supply. A mating connector is also included for the user's convenience.

Table A-1. Specifications, Option 002

Remote Programming

Resistance Programming: 0 to 4 k ohm provides 0 to maximum rated voltage or current output.

Accuracy:	@25°C ±5°C		
	CV: 0.5% ± 235mV (6010A)	0.5% ± 35mV (6011A)	0.5% ± 70mV (6012B)
	CC: 1.0% ± 170mA (6010A)	1.0% ± 800mA (6011A) *	1.0% ± 500mA (6012B)

Voltage Programming: 0 to 5V provides 0 to maximum rated voltage or current output.

Accuracy:	@25°C ± 5°C		
	CV: 0.3% ± 235mV (6010A)	0.25% ± 35mV (6011A)	0.3% ± 70mV (6012B)
	CC: 0.36% ± 170mA (6010A)	0.4% ± 800mA (6011A) *	0.36% ± 500mA (6012B)

Current Programming: 0 to 2mA current sink provides 0 to maximum rated voltage or current output.

Accuracy:	@25°C ± 5°C		
	CV: 0.43% ± 235mV (6010A)	0.25% ± 2mV (6011A)	0.43% ± 71mV (6012B)
	CC: 0.50% ± 170mA (6010A)	0.30% ± 35mV (6011A) *	0.50% ± 500mA (6012B)

* After 5 minute warm-up.a

Input Compliance Voltage: ± 1V

Current Programming Enable:
Relays K2 (CV) and K1 (CC) are biased from the Control Isolator Bias input (see Remote Shutdown and OVP Clear)

Relay Bias Voltage: +4V minimum + 7V maximum

Relay Resistance: 500Ω ± 10%

Note

For Control Isolator Bias voltages greater than 7V, a series resistor must be used to maintain the relay bias voltage within specified limits.

Enabling either relay is accomplished by bringing CV or CC enable line to Control Isolator Bias common via a suitable driver; maximum driver off-state leakage =0.5mA.

Output Voltage and Current Monitor: 0 to 5V output indicates 0 to maximum rated output voltage or current.

Accuracy:	@25°C ± 5°C	
	CV: 0.3% + 60mV (6010A)	0.3% ± 15mV (6011A, 6012B)
	CC: 0.36% + 10mA (6010A)	0.36% ± 20mA (6011A, 6012B)

Output Impedance: 10.2 k ohm ± 5%
Temperature Coefficient:

CV: 12.5 ppm/°C +2.4mV/°C (6010A)	12.5 ppm/°C +810µV/°C (6011A, 6012B)
CC: 47 ppm/°C + 0.54mA/°C (6010A)	47 ppm/°C + 1.6mA/°C (6011A, 6012B)

Status Indicators:
Status Isolator Bias input (referred to Status Isolator Common)

Table A-1. Specifications, Option 002 (continued)

Voltage Range: +4.75V to 16V
Current Drain: 20mA maximum

Status Indicator output:
Open collector output:
Maximum Output Voltage (logic high): + 16V
Logic Low output: + 0.4V maximum at 8mA

Remote Control (Trip, Reset, Inhibit) Control Isolator Bias Input.

Voltage Range: +4.75V to 16V

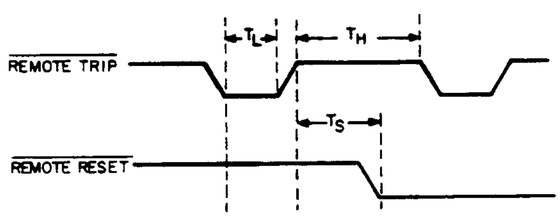
Remote Control Inputs ($\overline{\text{Remote Trip}}$, $\overline{\text{Remote Reset}}$) $\overline{\text{Remote Inhibit}}$

On State (logic low):
Minimum forward current required (I_f): 1.6mA Isolator forward voltage (V_f) at 1.6 mA (I_f): 1.4V typical, 1.75 maximum.

For Control Isolator Bias voltage greater than ± 5V, an optional resistor (Ropt) may be added to reduce drive current .

Off state (logic high) maximum leakage current: 100µA.

REMOTE TRIP and REMOTE RESET Timing



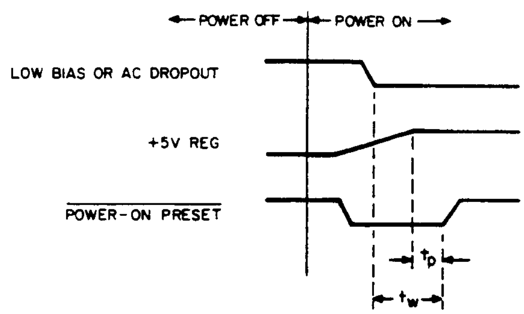
Pulse duration (TL): 15µS minimum
Reset time (TH): 125µs minimum
Set-up time (Ts): 25µs minimum
OVP clear delay: 1 sec ± 30% Bias Supplies DC output Ratings:

Power-on Preset
Output Ratings: open collector output (referred to power supply common).

Maximum output voltage (logic high): + 16V
Logic low output: +0.4V maximum at 8mA

Table A-1. Specifications, Option 002 (continued)

Pulse Timing



Low Bias or AC DROPOUT will go false after 5V supply stabilizes.

Bias Supplies
DC Output Ratings: (25°C ± 5)
No Load to Full Load 104V to 127V line.

+ 5 V ± 3% at 100mA
+15 V ± 3% at 75mA
-15V ± 4% at75mA

Short Circuit Output Current:

+5V	125mA ± 6%
+ 15V	103mA ± 6%
-15V	103mA ± 6%

PARD (Typical):

+ 5V	25mV pk-pk	1.5mV Rms
+ 15V	Same	Same
-15V	Same	Same

Isolation:

Status Indicator lines and Remote Control lines may be floated a maximum of 240Vdc (6010A, 250Vdc, 6011A, 6012B) from ground from the power supply or from each other. These lines may not be connected to any primary circuits.

Jumpers Designation

W1--jumpered:	OV indication @ A7J3-17 is active (lo) if OVP; Remote Trip or Remote Inhibit is active.
W1--open:	OV indication is active (lo) if OVP or Remote Trip is active.
Normal operation as shipped:	W3 and W4 jumpered W2 and W5 open.
OVP Programmable (6011A)	A7J3-25/CV: W2 jumpered; W3 open or AJ3-24/CC: W5 jumpered; W4 open S1A,B in open position.

Installation

When installing the board, perform the following steps:

a. Remove the top and inner cover of the power supply as discussed in Section 3 under Repair and Replacement.
b. Remove the plate next to the barrier strip on the rear panel of the supply by unscrewing the 2 M3 screws.
c. Insert the already prepared 002 board in the slot closest to the right side (looking from the front panel) of the supply.
d. Use the two M3 screws to connect the rear end of the 002 board to the rear panel of the supply.
e. Attach ribbon cables from the A2 Control Board A2J 1 to A7J1 and A2J2 to A7J2.
f. Replace the inner and outer cover of the supply.
g. Remove 550V label from rear of unit.

Connector Assembly Procedure

The following instructions describe assembly of the mating connector provided to interface the user's system with the option connector, J3. Figure A-1 identifies the parts of the mating connector.

Proceed as follows:

Note: It may be desirable to set up a test interface before final assembly of the mating connector to allow checkout of the system. A mating connector with pins accessible for temporary wiring is available from Agilent Technologies, Agilent part number 1251-4464.
If the cable assembly presents RFI or ESD problems, a shielded cable assembly accessory Agilent part number 5060-2890 can be ordered.

a. If a multi-wire cable is being used as opposed to individual wires), remove approximately 1 1/2 inches of cable insulation from the end. Be careful not to cut the insulation on the individual wires.

b. Strip 3/16 inch of insulation from the end of each wire to be used.

c. Insert each wire into a contact pin (1) and crimp firmly.

d. Insert each pin into a proper hole in connector-pin house (2) from rear. Pins will lock into housing when fully inserted.

Note Once the pins are locked into the connector-pin housing, they are extremely difficult to remove. Therefore, be certain pin is in proper hole before inserting fully.

e. Screw a slotted setscrew (3) partially into a square nut (4) and place in position in connector shield assembly (6).

f. Place strain relief (5) in position in connector shield assembly (6), just under set screw (3). Be certain that strain relief is oriented as shown in Figure A-1.

g. Place connector pin housing (2) in shield assembly (6) and route cable through cable entrance.

h. Fold connector assembly (6) and secure with three screws.

i. Strain relief set screw (3) can now be adjusted from top of connector to clamp firmly on cable.

j. Clip fasteners (7) onto ends of connector pin housing (2).

k. Connector can now be plugged onto option connector J3 and secured with two screws (8) into the threaded stand-offs on either side of J3.

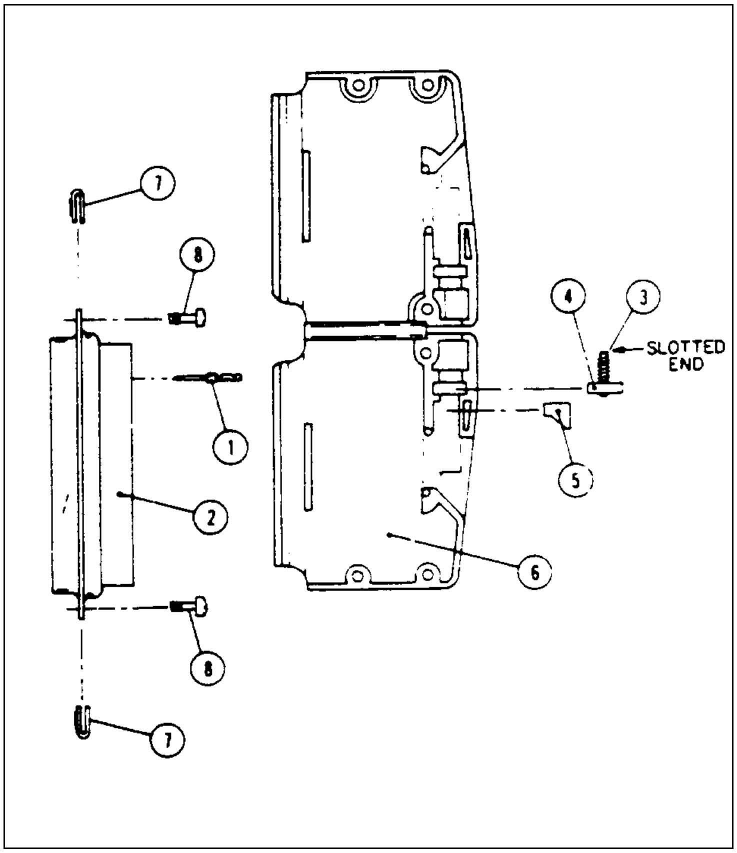


Figure A-1. Mating Connector Assembly

Operation

The following paragraphs provide the operating instructions necessary to interface a 002-equipped power supply into an automated system. A brief description of some circuits is also provided. The unit is shipped for front panel operation with mode switch settings as follows:

B1	B2	B3	B4	B5	B6
0	1	1	0	1	1

Before beginning, switch the power supply's rear panel MODE switches B1 through B6 to their correct positions for the programming source being used, (see Table A-2).

Next switch A1 and A2 also on the rear panel, to the correct program source function, see Figure A-2. All connections are made at the 37-pin rear panel connector J3, and can be wired directly into the mating connector supplied for this purpose.

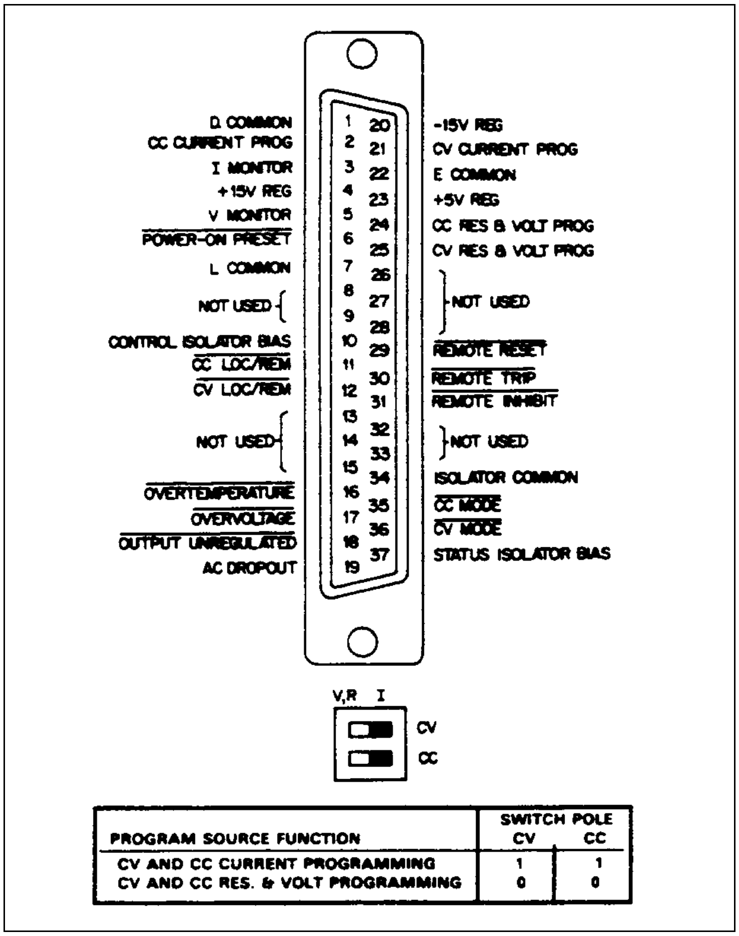


Figure A-2. 002 Option Rear Panel Connector J3 and Switches A1 and A2.

Local/Remote Programming

WARNING When switching to local/ control, remember to set Front Panel Voltage and Current Control to safe levels.

Local Programming (Figure A-3). The supply can be switched back and forth between remote and local programming while initially checking out a remote programming circuit. For proper operation of local programming, the user must supply the bias voltage (CONTROL ISOLATOR BIAS). The Control Isolator Bias voltage can range from +4.75V to + 16V depending upon the user's interface circuits. Refer to Specifications Table A-1. For local programming, take the Control Isolator Bias common and connect it to both of the LOC/REM terminals, and position mode switch as indicated in Operation.

CAUTION Although CONTROL ISOLATOR BIAS can be + 4.75V to + 16V, a supply voltage of more than 7V may damage the relays. Therefore, if CONTROL ISOLATOR BIAS exceeds 7V it is necessary to use a resistor in series with each of the LOC/REM terminals. Figure A-4 provides a graph from which the proper series resistance value can be determined. Note that the tolerances of both the Control Isolator Bias and the resistor must be taken into account. The actual Control Bias used in Figure A-4 is obtained after subtracting any driver gate voltage drop.

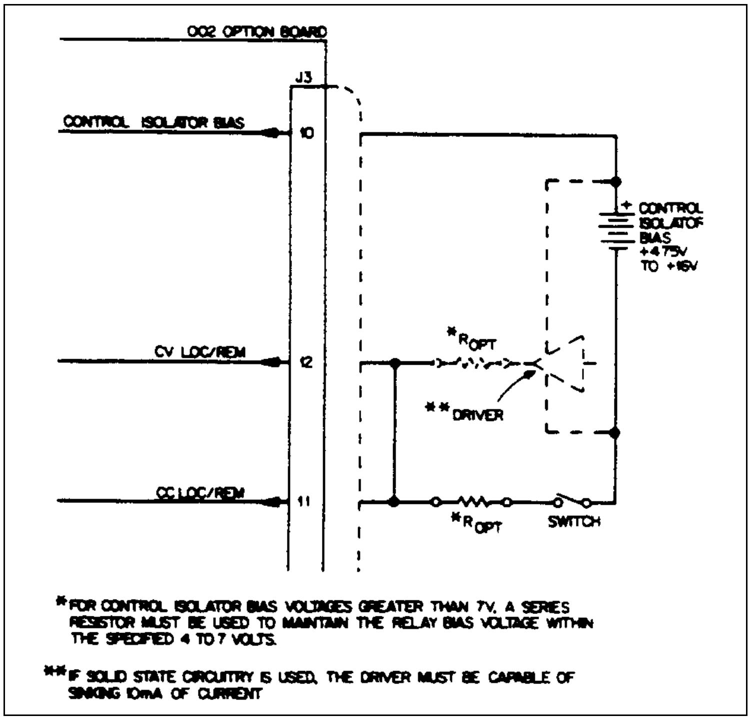


Figure A-3. Accessing Local Programming while in Remote Programming Mode

If solid state circuitry is used, connect the Control Isolator Bias to a driver capable of sinking 10mA of current, then connect the driver's output to both of the LOC/REM terminals. Refer to Figure A-3. Either method will enable relays K1 (CV) and K2 (CC) to switch regulation to the front panel VOLTAGE and CURRENT controls. For Control Isolator Bias voltages greater than 7V, a resistor (Ropt) must be used in series with the Control Isolator Bias common or the Driver's output. Figure A-4 provides a graph for determining the proper series resistance value depending on the Control Isolator Bias voltage being used.

The supply can be returned to the remote programming mode by switching off the Control Isolator Bias common or by increasing the Driver's output signal to within 1V of the Control Isolator Bias voltage. If remote programming is solely desired, leave the LOC/REM terminals open and make the proper connections to the RESISTOR/VOLTAGE PROG. or CURRENT PROG. terminals (see Figures A-5, A-6, A-7).

Table A-2. Mode Switch settings for enabling different Programming Sources

Program Source	Switch Pole Settings					
	Mode					
	B1	B2	B3	B4	B5	B6
Resistance	0	0	1	0	0	1
Voltage or Current	0	1	0	0	1	0

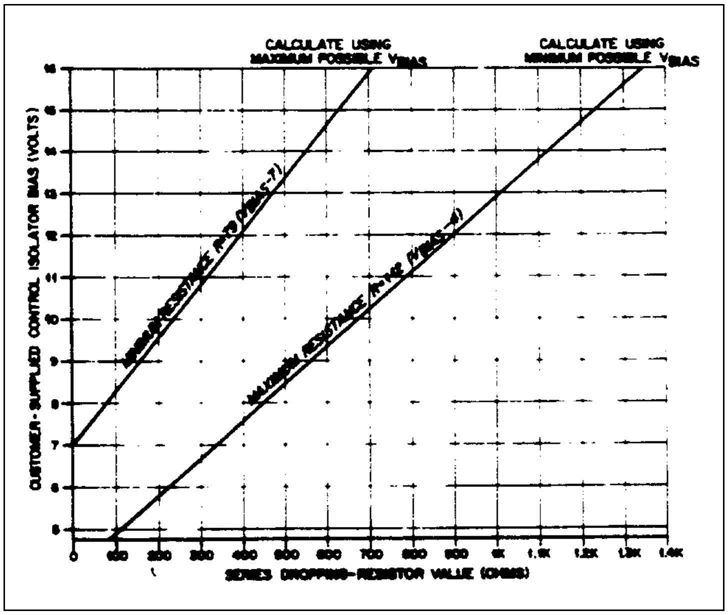


Figure A-4. Calculating Value of Series Dropping Resistor

Remote Resistance Programming

Check switches A1 and A2 on the rear panel, they must be in their correct positions for CV and CC resistance/voltage programming (see Figure A-2). A resistance variable from 0 to 4K ohms can be used to program the output voltage or current from 0 to full scale. To program the output voltage, connect the variable resistance between J3-25 (CV RES/VOLT PROG.) and J3-22 (E COM.). To program the output current, connect the variable resistance from J3-24 (CC RES/VOLT PROG.) to J3-22 (E COM.).

CAUTION If the programming lines become open circuited during resistance programming (user's system becomes disconnected from J3), the power supply's output will tend to rise above rating. The supply will not be damaged if this occurs, but the user's load may be damaged. To protect the load, be sure that the overvoltage trip point is properly adjusted. The unit includes clamp circuits to prevent it from supplying more than about 120% of rated output voltage or current when the remote programming voltage is greater than 5Vdc or remote programming resistance is greater than 4K ohm. Do not intentionally operate the unit above 100% rated output. Limit your programming voltage to 5Vdc and programming resistance to 4K ohm to assure reliable operation.

Remote Voltage Programming (Figure A-6). Check switches Al and A2 on the rear panel, they must be in the correct positions for CV and CC resistance/ voltage programming (see Figure A-2). A voltage source variable from 0 to 5 volts, can be used to program the output voltage or current from 0 to full scale. The load on the programming source is less than 1mA. To program voltage, the voltage source should be connected from J3-25 (CV RES & VOLT PROG) to J3-22 (E COM). To program current, the voltage source should be connected from J3-24 (CC RES & VOLT PROG) to J3-22 (E. COMMON). If the programming lines become open circuited (user's system becomes disconnected from J3) during voltage programming, the Programming Protection circuit will reduce the power supply output to zero.

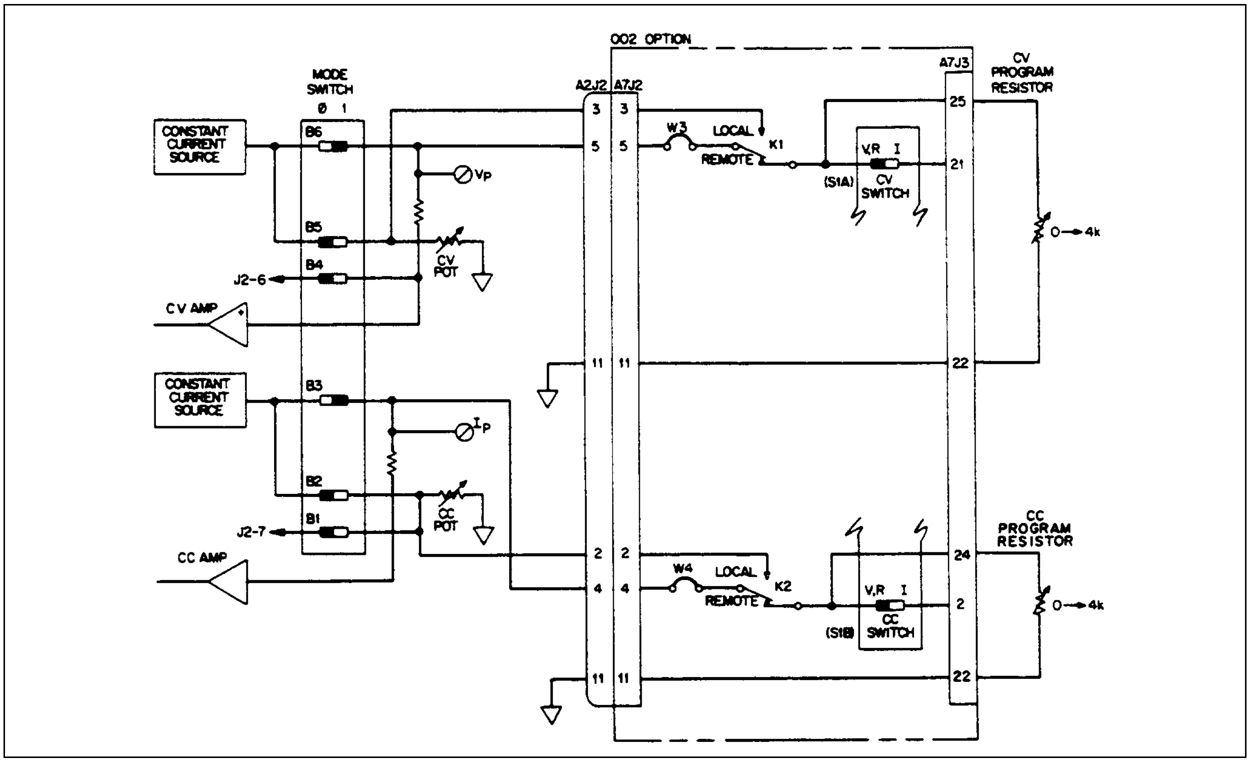


Figure A-5. Remote Resistance Programming

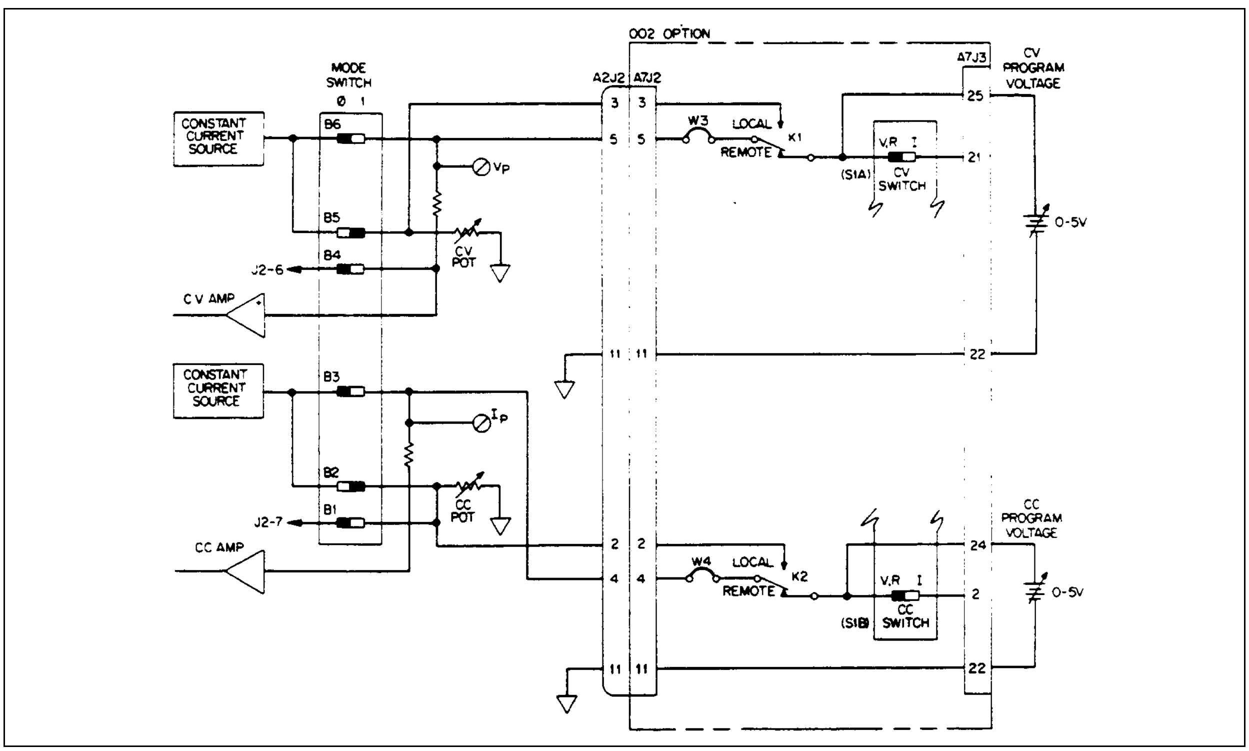


Figure A-6. Voltage Programming of Output Voltage and Current

Current Programming (Figure A-7). Check switches A1 and A2 on the rear panel, they must be in the correct positions for CV and CC current programming (see Figure A-2). A current sink variable from 0 to 2mA, can be used to program the output voltage or current from 0 to full scale (see Figure A-7). The following paragraph provides a brief circuit description, refer to schematic diagram.

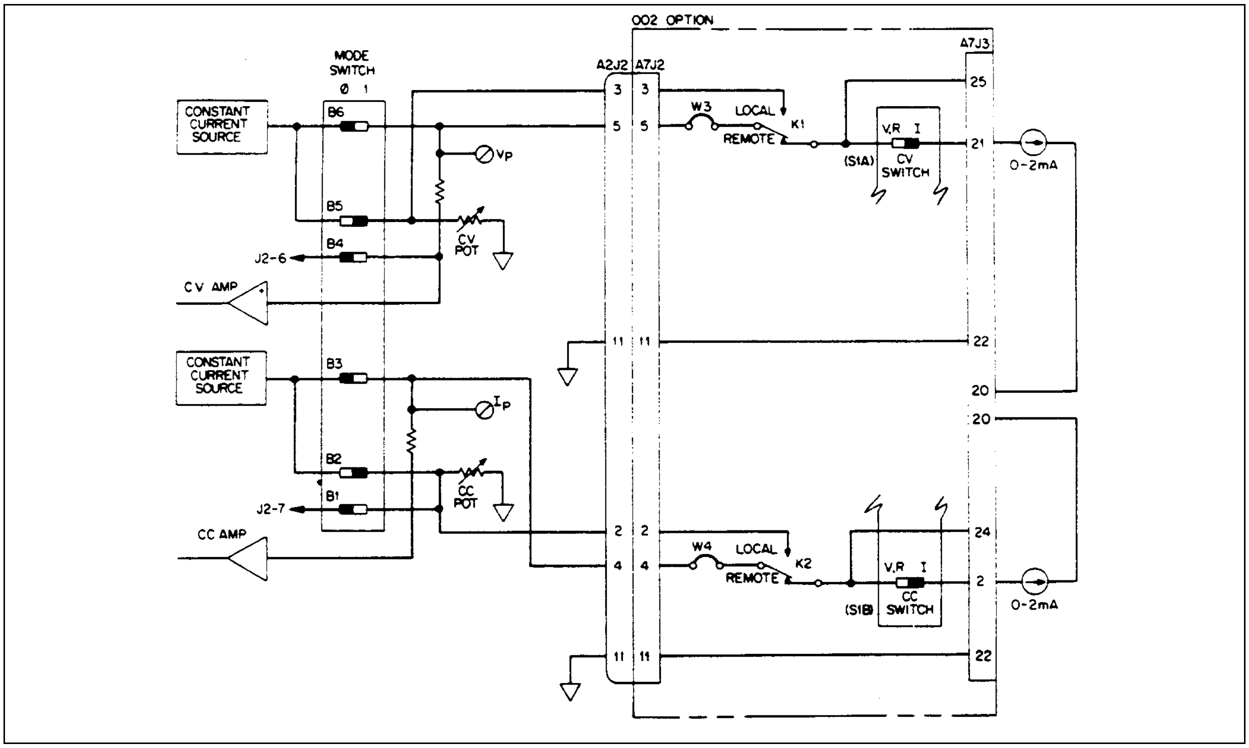


Figure A-7. Current Programming of Output Voltage and Current

To program voltage, the current sink can be connected from J3-21 (CV CURRENT PROG) to J3-20 (-15V). To program current, the current sink can be connected from J3-2 (CC CURRENT PROG) to J3-20 (-15V). Current sinks can either be connected to the power supply (-15 V) or to an external negative supply that is referenced to the L. COMMON of the power supply.

The 0 to 2mA current sink will cause the output signal of op-amps U17 and U18 to vary proportionally from 0 to 5 volts. These signals are then coupled through relays K1 and K2 and then on to the A2 Board's CV and CC circuits which, in-turn, will program the supply's output from 0 to full scale. If the programming lines become open circuited (user's system becomes disconnected from J3) during current programming, the Programming Protection circuit will bring the power supply output to zero.

Remote Monitoring

The 002 Option board provides a protected 0 to 5V output corresponding to a full scale voltage output. The voltage monitor output is available between pins J3-5 (V. Monitor) and J3-1 (D COMMON).

CAUTION Observe the caution described in Local Programming (Figure A-3) paragraph, page 96.

Output impedance is l0K ohm: the monitoring device input impedance should be at least 1M ohm to limit error to 1% + basic accuracy; 10M ohm to limit error to 0.1% + basic accuracy.

The I. MON signal from the mainframe is also brought out through the 002 Option board. A 0 to full scale current-monitor output is available between pins J3-3 (I. MON) and J3-1 (D COMMON). Output impedance is l0K ohms: the monitoring device input impedance should be at least 1M ohm to limit error to 1% + basic accuracy.

In some applications it may be desirable to install a noise-suppression capacitor on these monitor outputs to lessen the effects of noise induced in the monitor leads. The capacitors should be ceramic or tantalum type, from 0.1 to 1µF. The capacitor is installed directly across the monitor device input terminals .

Status Indicators

Six optically isolated lines provide open collector digital outputs which indicate certain modes and conditions of power supply operation. For proper supply operation of the opto-isolators, the user must supply the bias voltage, (ISOLATOR BIAS). This voltage can be from +4.75 V to + 16V depending upon the user's interface circuits, refer to the specifications Table A-1. Connect the bias voltage (+) between J3-37, (ISOLATOR BIAS) and J3-34 (ISOLATOR COMMON). The status indicator outputs are open collector (referenced to ISOLATOR common); therefore, it is necessary to connect a pull-up resistor from each output to ISOLATOR BIAS. When choosing the resistor value observe the current sink capabilities of these lines as described in the Specifications Table A-1.

Because of the relatively slow rise and fall times of opto-isolators, Schmitt-triggered devices should be used to interface these output lines to logic circuits.

The following signals are in active low-form:

a. $\overline{\text{CV MODE}}$, J3-36, indicates that the power supply is in constant voltage operation.

b. $\overline{\text{CC MODE}}$, J3-35, indicates that the power supply is in constant current operation.

c. $\overline{\text{OUTPUT UNREGULATED}}$, J3-18, indicates that the power supply is in neither constant voltage nor constant current operation and cannot be guaranteed to meet specifications.

d. $\overline{\text{OVERVOLTAGE}}$, J3-17, Indicates power supply shutdown because of: the voltage output exceeding the OV trip point set at the front panel; or, a system-initiated shutdown as described in multiple supply system shutdown section, page 103.

e. $\overline{\text{OVERTEMPERATURE}}$, J3-16, indicates power supply shutdown due to an excessive temperature rise on the FET or output diode heatsink.

The Low Bias AC DROPOUT signal, J3-19, is in active high form. This signal indicates: loss of primary power, momentary AC dropout. or "brownout" conditions where the AC line voltage drops below approximately 70% nominal.

Remote Control

For operation of the opto-isolators. the user must supply the bias voltage (CONTROL ISOLATOR BIAS). This voltage can be from + 4.75V to + 16V depending on the requirements of the driving circuits. The type of driving logic and bias voltage will determine the amplitude of the high and low logic levels, refer to the Specification Table A-1 under Remote Control.

Connect the bias voltage (+) to J3-10 CONTROL ISOLATOR BIAS, and reference the input signals to this bias supply's negative terminal.

Two optically isolated methods of remote control are available. They are described in the following paragraphs.

Remote Trip. A negative-going edge applied to terminal J3-30 ($\overline{\text{REMOTE TRIP}}$) will shut down the power supply, reducing the output voltage to near zero. For minimum pulse duration and timing considerations with respect to $\overline{\text{REMOTE RESET}}$, see Table A-1. The following paragraph provides a brief circuit description (see schematic diagram and Figure A-8).

A negative going edge at $\overline{\text{REMOTE TRIP}}$ coupled through opto-isolator (U9) causes one-shot U13B to set the TRIP/RESET latch (U5A) low. This sets terminal J1-13 ($\overline{\text{INHIBIT}}$) low, thus inhibiting the Pulse Width Modulator of the power supply. It also lights the unregulated indicator on the front panel and generates an unregulated signal from the opto-isolator U3.

The low signal generated by the Trip/Reset Latch is also coupled through opto-isolator U2 and appears at J3-17 as an $\overline{\text{OVERVOLTAGE}}$ status signal. This signal does not affect the state of the power supply's OVP circuit.

Remote Reset. A negative-going edge applied to terminal J3-29 ($\overline{\text{REMOTE RESET}}$) will return the supply to its initial state following a system-initiated shutdown or an OVP shutdown caused by a temporary over voltage condition. For minimum pulse duration and timing considerations with respect to $\overline{\text{REMOTE TRIP}}$ see Table A-1 under Remote Control. The following paragraphs provide a brief description of this circuit (see schematic diagram and Figure A-8).

A negative-going pulse applied to terminal J3-29 ($\overline{\text{REMOTE RESET}}$) is coupled through opto-isolator U10. One-Shot U13A then triggers and resets the TRIP/RESET latch output high. This sets terminal J1-13 ($\overline{\text{INHIBIT}}$) high, thus enabling the power supply's Pulse Width Modulator.

The $\overline{\text{REMOTE RESET}}$ signal will also reset the power supply OVP circuit in the event that an overvoltage condition has shut down the supply. When a $\overline{\text{REMOTE RESET}}$ signal is present, ONE SHOT U13A goes low, this will produce an OV CLEAR pulse at terminal J1-12. The $\overline{\text{OV CLEAR}}$ pulse will cause the output of A2U2 to go low thus, resetting the OV FLIP FLOP. When this occurs the output of A2U24D goes high and simultaneously causes the front panel OV LED to turn off and the OV signal (J1-6) to go high. The $\overline{\text{OVERVOLTAGE}}$ signal to U4B also goes high and enables the PWM of the power supply .

Note By observing the $\overline{\text{OVERVOLTAGE}}$ status indicator or the power supply's output while applying a reset pulse to $\overline{\text{REMOTE RESET}}$, the user can determine the cause of shutdown. If the output returns and $\overline{\text{OVERVOLTAGE}}$ goes high immediately, this indicates a controller-initiated shutdown. If the output takes about one second to return, this indicates that the output voltage had exceeded the OVP trip point. If the OVP circuit trips continually, check the load and/or the trip point setting.

Alternate Method of Remote Control. The $\overline{\text{REMOTE INHIBIT}}$ input, J3-31, provides an alternate method of remote shutdown. By maintaining a low logic level at this input, the supply's output will be inhibited until $\overline{\text{REMOTE INHIBIT}}$ is returned to its initial high state. The following paragraph provides a brief description of this circuit (see schematic diagram and Figure A-8).

A low logic level applied to terminal J3-31 ($\overline{\text{REMOTE INHIBIT}}$) is coupled through opto-isolator U8 and causes U4B to inhibit the power supply's (PWM) Pulse Width Modulator. If jumper W1 is used (see Figure A-8) while a $\overline{\text{REMOTE INHIBIT}}$ signal is applied, an $\overline{\text{OVERVOLTAGE}}$ signal will appear at terminal J3-17 $\overline{\text{OVERVOLTAGE}}$ thus, indicating the power supply shut down.

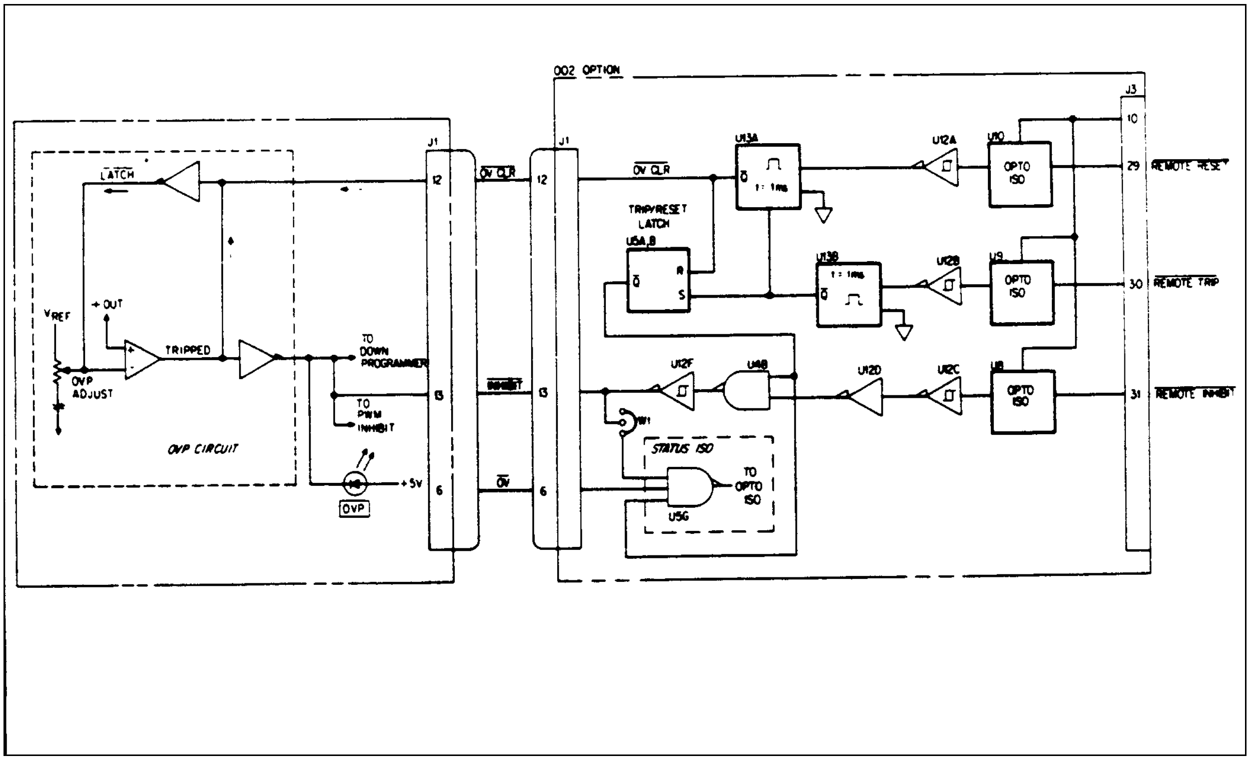


Figure A-8. Remote Control

Power-On Preset

This open collector output line J3-6, provides a logic low pulse ($\overline{\text{Power - On - Preset}}$) to the user that can be used to initialize or delay a system's operation until + 5 V Reg. supply has stabilized. The pulse is generated after primary power is turned on and also after resumption of power following momentary ac dropout or conditions in which line voltage drops below approximately 70% of the nominal. See Table A-l for $\overline{\text{Power - On - Preset}}$ signal specifications.

The $\overline{\text{Power - On - Preset}}$ circuit also ensures that terminal J3-17 ($\overline{\text{OVERVOLTAGE}}$) will be high when the supply is turned on. This protects against unwanted Multiple Supply System Shutdowns when using J3-17 ($\overline{\text{OVERVOLTAGE}}$) to remote trip additional power supplies.

The following paragraphs provide a brief description of the power-on preset circuit, refer to schematic diagram (Section 6).

Circuits on the Power Supply's A2 Control Board produce a power-clear signal, ($\overline{\text{PCLR}}$), when the supply is turned on. These circuits hold $\overline{\text{PCLR}}$ low until the unregulated input to the A2 Board's + 5Vdc bias supply is greater than about 11Vdc, an input voltage sufficient to assure + 5Vdc bias output.

This $\overline{\text{PCLR}}$ signal is coupled through terminal J1-15 to the 002 Option board's power-on preset circuit. When the power-on preset circuit receives the $\overline{\text{PCLR}}$ signal, transistors U14A and U14C turn off.

Turning U14A off causes a $\overline{\text{DROPOUT}}$ signal to appear at terminal J3-19 ($\overline{\text{DROPOUT}}$). Turning U14C off causes U14B and U14D to turn on. When U14B is on, it holds output J3-17 ($\overline{\text{OVERVOLTAGE}}$) high. Holding J3-17 high will prevents any unwanted Multiple Supply Shutdown's from occurring when the supply is wired for such an application. When

U10D is on, it causes J3-6 ($\overline{\text{Power - On - Preset}}$) to be low thus, if used, can initialize or delay a customer's system operation.

AC Dropout Buffer Circuit

This circuit couples, inverts and isolates the $\overline{\text{DROPOUT}}$ signal (received from the A2 Control Board) of status output terminal J3-19 ($\overline{\text{DROPOUT}}$). The dropout signal indicates loss of primary power, momentary AC dropout, or "brownout" conditions where the AC line voltage drops below approximately 70% normal. The following paragraph provides a brief description of the AC Dropout Buffer circuit. Refer to the Schematic Diagram

The AC Dropout Buffer Circuit receives a $\overline{\text{DROPOUT}}$ signal from the A2 Control Board. This causes the bias voltage supplied to the Dropout Buffer U14A to be pulled down through diode CR4 thus, turning U14A off. This in turn will cause opto-isolator U3 to turn off. Since external pull up resistors are used, terminal J3-19 (DROPOUT) will go high and remain high until the dropout signal from the A2 Control Board is removed.

Multiple Supply System Shutdown

When using more than one 002 Option equipped power supply in a system, it may be desirable to implement a system shutdown. In this configuration, an OVP trip or remote shutdown of a single unit will cause all of the supplies to shut down.

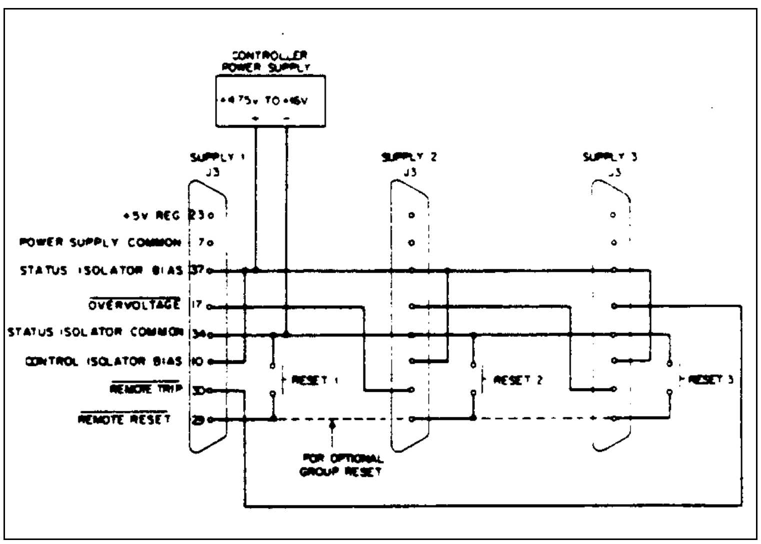


Figure A-9. System Shutdown using Controller Power Supply

Figure A-9 shows one method of system shutdown. The advantages of this method are that one common is used for all status and control lines (useful for controller-operated systems), and the capability of system reset. As shown in Figure A-9, one supply's $\overline{\text{OVERVOLTAGE}}$ line is connected to the next supply's $\overline{\text{REMOTE TRIP}}$ line, and so on in a continuous chain.

Note +5V REG/POWER SUPPLY common from Supply 1 can be used instead of the bias voltage from the controller. However, because of current limits of the + 5V REG, no more than four units can be connected together in this configuration. To prevent ground loops, do not parallel connect + 5V REG from more than one supply.

The note on page 101 tells how to determine if a shutdown was initiated through the remote trip line or by a supply's OVP.

This allows the controller to determine which supply initiated the shutdown. Following a multiple supply shutdown, each unit can be reset individually or all the REMOTE RESET lines can be tied together for a system reset.

If it is necessary to have all the supplies come up simultaneously after a system shutdown, follow this procedure:

a. First bring the $\overline{\text{REMOTE INHIBIT}}$ line low.

b. Provide a negative-going pulse to the $\overline{\text{REMOTE RESET}}$.

c. After at least one second, return $\overline{\text{REMOTE INHIBIT}}$ to a high level.

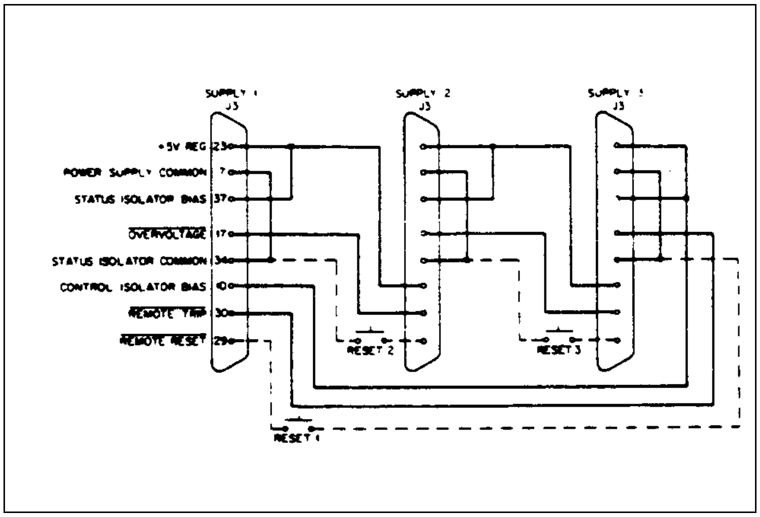


Figure A-10. System Shutdown Using Bias Supply Output

Figure A-10 shows a second method of system shutdown. This method is appropriate in systems which are not controller-operated and in which more than four supplies must be shutdown simultaneously. Because each supply derives its CONTROL ISOLATOR BIAS from the previous supply's + 5V REG, there is no limit to the number of supplies that can be shutdown. Each supply must be reset individually.

Using either method of system shutdown, $\overline{\text{PCLR}}$ inhibits the $\overline{\text{OVERVOLTAGE}}$ indicator from going low and shutting down succeeding supplies upon initial sum-on. After the supplies have stabilized, $\overline{\text{PCLR}}$ returns to a high state.

Bias Supplies

The outputs of three current-limited bias supplies are available for user-supplied circuitry. These are + 15V @ 75mA at J3-4, -15V @ 75mA at J3-20, and +5 V @ 100mA at J3-23; all with respect to J3-7, L Common.

It may be desirable to install noise-suppression capacitors on the bias supply outputs near the load circuits. The capacitors should be ceramic or tantalum type, approximately 0.1µF to 10µF.

Maintenance

The following paragraphs provide procedures and setups to aid in checking and troubleshooting the 002 Option Board. This information, used in conjunction with the schematic drawing and the Operation section of this Appendix, will help in the isolation and repair of faulty circuits.

When testing the option, use of the test connector on page 95 will allow easier access to the J3 contacts.

Troubleshooting

Before attempting to troubleshoot the 002 Option Board, ensure that the fault is with the option itself and not with the main power supply. This can be accomplished by removing the top cover, inside cover and disconnecting the two ribbon cables from the A2 Control board and checking the operation of the main supply. Otherwise troubleshoot the option board as described in the following paragraphs.

Removal of the Option Board. To facilitate troubleshooting the 002 Option the board can be removed from the power supply and electrically connected via the ribbon cables from Service Kit's 06033-60005 or 5060-2665. To remove the circuit board proceed as follows:

a. Turn off power supply and disconnect line cord.

b. Disconnect option I/O cable from J3 on rear panel and remove the two screws that secure option board to rear panel.

c. Disconnect the ribbon cables from the A2 Control board.

d. Remove option board by lifting the board by the front edge and sliding the board toward the front of the power supply.

e. Reconnect the option board to the A2 Control board using the extended ribbon cables from the Service Kit, and pace the option board on an insulated surface next to the power supply.

f. Be careful that the option board lies securely on insulating material and does not touch any part of the main power supply.

Isolating Faulty Circuit. If it is apparent which function is not operating properly, proceed to the appropriate paragraph. If the problem involves more than one function, check the bias voltages from connectors J1 and J2 and the ± 11.8V on the option board.

Troubleshooting Resistance and Voltage Programming

a. Confirm that the problem is on the option board by disconnecting the ribbon cables from the A2 Control Board and attempting to program the supply via the rear panel terminal strip.

b. Check ± 15V and ± 11.8V supplies.

c. Check for a problem in the programming protection circuit. This circuit should draw about 2µA from the programming lines.

d. Check that W3 and W4 are installed and S1 is in proper position .

Troubleshooting Current Programming

a. Check ± 15V and ± 11.8V supplies.

b. Proceed to test set-up shown in Figure A-11 and/or A-12.

c. Put S1 in V, R position and see if varying the 0-20V voltage source produces a 0-5 volt DC level across R44 or R39. If not, check op-amps and associated circuitry.

d. Put S1 in I position and see if varying voltage source from 0 to 20 volts produces a 0-5VDC level at W3 or W4. If not check relay and programming protection circuit.

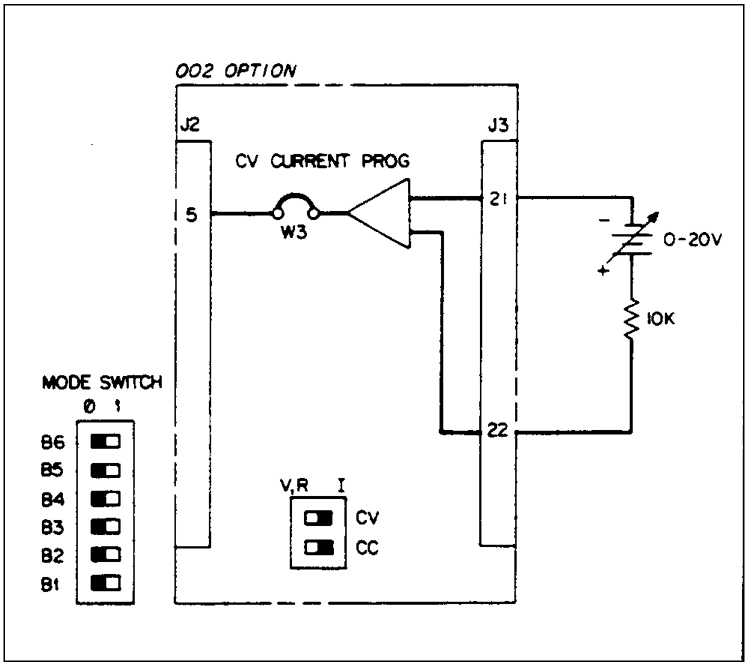


Figure A-11. Troubleshooting Current Programming of CV Mode

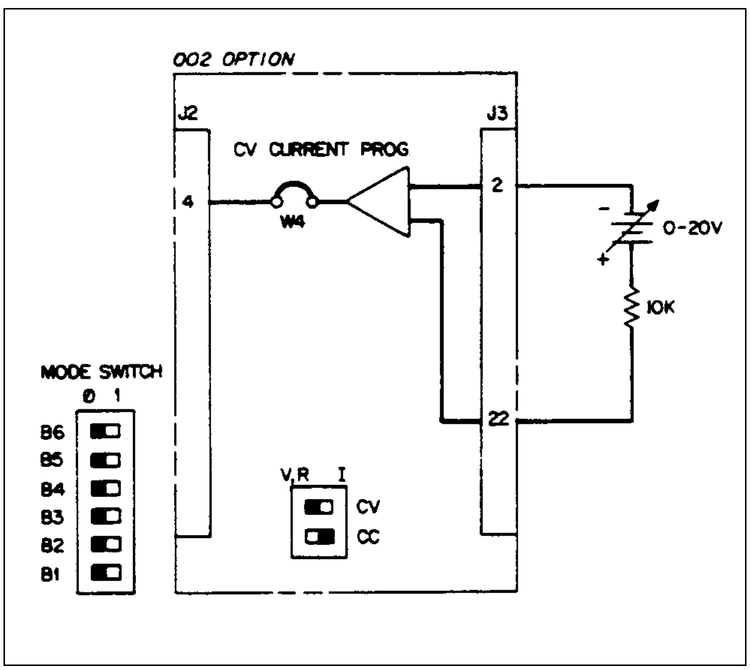


Figure A-12. Troubleshooting Current Programming of CC Mode

Troubleshooting Status Indicators. The test set-up shown in Figure A-13 can be used to check each of the six status indicators. This set-up will temporarily defeat the isolation of the status lines. Before attempting to troubleshoot a status indicator, check for + 5V Bias for proper operation of the opto-couplers.

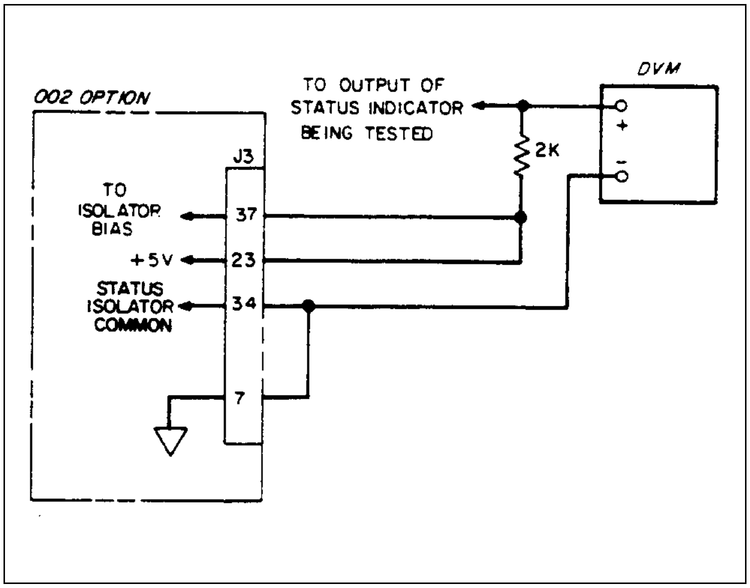


Figure A-13. Troubleshooting Status Indicators

To check CV Mode proceed as follows:

a. Using test set-up, Figure A-13, connect to end of 2KΩ resistor to J3-36.
b. Turn on power supply.
c. Using "Display Setting" set voltage and current or power supply for 1 volt and 1 amp.
d. DVM should read between 0 to 0.4 volts.
e. Turn off power supply and short to output terminals.
f. Turn on power supply.
g. DVM should read approximately 5Vdc.

To check CC Mode proceed as follows:

a. Using test set-up, Figure A-13, connect top end of 2KΩ resistor to J3-35.
b. Turn on power supply.
c. Using "Display Settings" set voltage for 1 volt and current for 1 Amp.
d. DVM should read = 5Vdc.
e. Turn off power supply and short the output terminals.
f. Turn on power supply.
g. DVM should read between 0 to 0.4Vdc.

To check OVERVOLTAGE proceed as follows:

a. Using test set-up, Figure A-13, connect top end of 2KΩ resistor to J3-17.
b. Turn "OVP Adjust" fully clockwise and voltage control fully counter clockwise.
c. Open power supply output terminals and turn on power.
d. DVM should read approximately 5Vdc.
e. Press 'Display Settings" and increase voltage control for 15Vdc output.
f. Turn OVP Adjust" counterclockwise until supply goes into overvoltage.
g. DVM should read between 0 and 0.4Vdc.
h. Turn "OVP Adjust" fully clockwise and turn off input power for 5 seconds.
i. Turn on input power and DVM should read approximately 5Vdc.

To check OUTPUT UNREGULATED proceed as follows:

a. Using test set-up, Figure A-13, connect to end of 2KΩ to J3-18.
b. Connect output terminals of power supply to an electronic load capable of exceed the power supplies output power rating by 50%.

c. Turn on power supply.
d. DVM should read approximately 5Vdc.
e. Set voltage and current controls of power supply to maximum.
f. Decrease resistance of electronic load until "UNREGULATED" LED on front panel lights.
a. DVM should now read between 0 to 0.4Vdc.

To check LOW BIAS or AC Dropout proceed as follows:
a. Using test set-up, Figure A-13, connect top end of 2KΩ resistor to J3-19.
b. Substitute an oscilloscope in place of DVM. Set vertical deflection for 1 volt/div on the DC input.
c. Turn power on and observe oscilloscope trace. Voltage should increase to 5V at power-on and drop to between 0 to 0.4Vac approximately 3 sec.
d. Turn power off. Voltage should go to about 5Vdc before decaying back to 0V.

Note In this test, the Low BIAS or AC Dropout signal decays to 0V only because of loss of power to the + 5V REG Bias Supply used in the test set-up. If in doubt, use an external + 5V supply for this test.

To check $\overline{\text{OVERTEMPERATURE}}$ proceed as follows:
a. Turn off power supply and disconnect line cord.
b. Wait at least two minutes for input capacitors to discharge .
c. Remove top cover and inside cover.
d. Using test set-up, Figure A-13, connect top end of 2KΩ resistor to J3-16.
e. Turn on power supply.
f. DVM should read approximately 5Vdc.
g. Turn off power and wait two minutes.
h. Remove the A4 FET Assembly from the unit.
i. Turn on power supply. DVM should read between 0 to 0.4Vdc.

Note The FET heatsinks are connected to the primary circuit and hazardous voltage (up to between 300 to 400V) exists between the heatsinks and the heatsink and the chassis. These potentials remain for up to 2 minutes if the power supply is turned off. Do not touch the heatsinks or any components on the heatsink assemblies while the power supply is turned on or for at least two minutes after primary power is removed. Do not place any of the heatsink assemblies on extender boards.

Troubleshooting Remote Shutdown. The following procedures check the Remote Shutdown features of 002 Option. Troubleshooting can be accomplished by using a logic probe and referring to the schematic and the circuit description on page 104. Before attempting to troubleshoot the Remote Shutdown section of the option, check for + 5Vdc internal bias. This voltage must be present for proper operation of these circuits

To check the $\overline{\text{REMOTE TRIP}}$ and $\overline{\text{REMOTE RESET}}$ proceed as follows:
a. Connect +5V (J3-23) to Control Isolator bias (J3-l0).
b. Turn unit on and short $\overline{\text{REMOTE TRIP}}$ (J3-30) to + 5V common (J3-7) momentarily. Output should go into unregulated condition with output off.
c. Short REMOTE RESET (J3-29) to + 5V common (J3-7) momentarily and OUTPUT should return to its initial state.

To check $\overline{\text{REMOTE INHIBIT}}$ proceed as follows:
a. Table A-3. Replacement Connect +5V (J3-23) to control isolator bias (J3-10).
b. Turn unit on and short $\overline{\text{REMOTE INHIBIT}}$ (J3-31) to + 5V common (J3-7). Output should go to an unregulated output off condition.
c. Remove short between $\overline{\text{REMOTE INHIBIT}}$ (J3-31) and + 5V common (J3-7) and output should return to its initial state.

Table A-3. Replacement Parts

REF. DESIG.	MODEL NO,	PART NO.	DESCRIPTION
A7	**All**	**5060-2854**	**Opt. 002 Interface Board**
C1,2	All	0180-0230	fxd elect. 1µF 20% 50V
C3	All	0180-2825	fxd elect. 22µF 50V
C4	All	0160-4835	fxd cer. 0.1µF 10% 50V
C5	All	0160-4554	fxd cer. 0.0µF 20% 50V
C6	All	0160-4835	fxd cer. 0.1µF l0% 50V
C7	All	0160-4554	fxd cer. 0.0µF 20% 50V
C8,9	All	0180-0230	fxd elect. 1µF 20% 50V
C10	All	0180-2825	fxd elect. 22µF 50V
C11	All	0160-4801	fxd cer. 100pf 5% l00V
C12,13	All	0160-5422	fxd cer. 0.047µF 20% 50V
C14	All	0160-4801	fxd cer. 100pfF 5% l00V
C15	All	0160-5422	fxd cer. 0.047µF 20% 50V
C16	All	0160-5422	fxd cer. 0.047µF 20% 50V
C17,18	All	0180-0230	fxd elect. 1µF 20% 50V
C19	All	0180-2825	fxd elect. 22µF 50V
C20-22	6010	0160-0128	fxd cer. 2.2µF 20% 50V
C20-22	6011A, 6012B	0160-0122	fxd cer. 2.2µF 20% 50V
CR1-4	All	1901-0050	switching 80V 200ma
CR5-10	All	1901-0327	pwr. rect. 300V 40A
CR11-14	All	1901-0033	gen. prp. 180V 200ma
CR15	All	1901-0327	zener 9.09V 10% PD=1.5W
CR16,17	All		NOT USED
CR18,19	All	1901-0050	switching 80V 200ma
CR20	All	1901-0033	gen. prp. 180V 200ma
CR21,22	All	1901-0050	switching 80V 200ma
CR23	All	1901-0033	gen. prp. 180V 200ma
CR24,25	All	1901-0050	switching 80V 200ma
CR26-29	All	1901-0033	gen. prp. 180V 200ma
CR30	All	1901-0327	zener 9.09V 10% PD=1.5W
K1,2	All	0490-1418	relay 250ma 28V,5V –coil 3VA
L1-3	All	9170-1223	core shielding bead
Q1,2	All	1854-0823	NPN SI PD=300mW FT=200MHZ
R1-3	All	0683-2015	fxd. film 200 5% 1/4W
R4	All	0683-3925	fxd. film 3.9K 5% 1/4W
R5	All	0683-2035	fxd. film 20K 5% 1/4W
R6	All	0683-3035	fxd. film 30K 5% 1/4W
R7	All	0683-6225	fxd. film 6.2K 5% 1/4W
R8,9	All	0683-2035	fxd. film 20K 5% 1/4W
R10	All	0683-1035	fxd. film 10K 5% 1/4W
R11	All	0683-5125	fxd. film 5.1K 5% 1/4W
R12	All	0757-0984	fxd. film 10 1% 1/2W
R13	All	0683-1615	fxd. film 160 5% 1/4W
R14	All	0683-4715	fxd. film 410 5% 1/4W
R15,16	All	0683-1235	fxd. film 12K 5% 1/4W
R17	All	0686-1525	fxd. film 1.5K 5% 1/4W
R18	All	0683-1535	fxd. film 15K 5% 1/4W
R19	All	0683-4715	fxd. film 470 5% 1/4W
R20,21	All	0683-1235	fxd. film 12K 5% 1/4W

Table A-3. Replacement Parts

REF. DESIG.	MODEL NO,	PART NO.	DESCRIPTION
R22	All	0686-1525	fxd. film 1.5K 5% 1/4W
R23	All	0683-1535	fxd. film 15K 5% 1/4W
R24	All	0683-4715	fxd. film 470 5% 1/4W
R25,26	All	0683-1235	fxd. film 12K 5% 1/4W
R27	All	0686-1525	fxd. film 1.5K 5% 1/4W
R28	All	0683-1535	fxd. film 15K 5% 1/4W
R29,30	All	0698-4479	fxd. film 14K 1% 1/8W
R31	All	0686-5125	fxd. comp. 5.lK 5% 1/2W
R32	All	0683-5125	fxd. film 5.1K 5% 1/4W
R33	All	0686-5125	fxd. comp. 5.1K 5% 1/4W
R34	All	0683-5125	fxd. film 5.1K 5% 1/4W
R35	All	0757-0986	fxd. film 12.1K 1% 1/2W
R36	All	0757-0269	fxd. film 270 1% 1/8W
R37	All	0683-4715	fxd. film 470 5% 1/4W
R38	All	0683-1035	fxd. film 10K 5% 1/4W
R39	All	0698-6631	fxd. film 2.5K .1% 1/8W
R40	All	0683-4715	fxd. film 470 5% 1/4W
R41	All	0813-0001	fxd. ww. 1K 5% 3W
R42	All	0683-4715	fxd. film 470 5% 1/4W
R43	All	0683-l035	fxd. film 10K 5% 1/4W
R44	All	0698-6631	fxd. film 2.5K .1% 1/8W
R45	All	0683-4715	fxd. film 470 5% 1/4W
R46	All	0813-0001	fxd. ww. 1K 5% 3W
R47	All	0683-1525	fxd. film 1.5K 5% 1/4W
R48	All	0683-3325	fxd. film 3.3K 5% 1/4W
R49	All	0683-2225	fxd. film 2.2K 5% 1/4W
R50,51	All	0683-3355	fxd. film 3.3M 5% 1/4W
R52,53	All	0683-1055	fxd. film 1M 5% 1/4W
R54	All	0757-0441	fxd. film 8.25K 1% 1/8W
R55	All	0757-0986	fxd. film 12.lK 1% 1/2W
R56	All	0757-0269	fxd. film 270 1% 1/8W
R57	All	0698-3226	fxd film 6.49K 1% 1/8W
S1	All	3101-2715	Switch-Slide 2-lA .1A 50V
U1-3	All	1990-0732	Opto-Isolator IF=20mA max.
U4	All	1820-1197	IC NAND gate TTL LS quad
U5	All	1820-1202	IC NAND gate TTL LS
U6	6010A, 6011A	5060-2942	IC Voltage Reg. heatsink assy.
U6	6012B	1826-0393	IC Voltage Reg.
U7	6010A, 6011A	5060-2945	IC Voltage Reg. heat sink assy.
U7	6012B	1826-0551	IC Voltage Reg.
U8-10	All	1990-0494	Opto-Isolator IF=20mA max.
U11	All	1820-1491	IC Buffer TTL LS, hex
U12	All	1820-1416	IC Schmitt-Trig. TTL LS, hex
U13	All	1820-l437	IC Multi. Vib. TTL LS
U14	All	1858-0023	Trans. Array 16-pin
U15	6010A, 6011A	5060-2943	IC Voltage Reg. heatsink assy.
U15	6012B	1826-0527	IC Voltage Reg.
U16	6010A, 6011A	5060-2950	IC Voltage Reg. heatsink assy.
U16	6012B	1826-0277	IC Voltage Reg.
U17,18	All	1826-0493	IC Op Amp Low-bias-High-Impd.

Table A-3. Replacement Parts

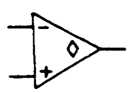
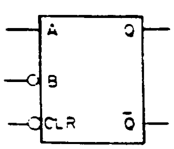
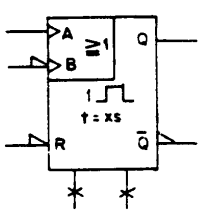
REF. DESIG.	MODEL NO,	PART NO.	DESCRIPTION
U19	6010A, 6011A	5060-2942	IC Voltage Reg. heatsink assy.
U19	6012B	1826-0393	IC Voltage Reg.
U20	6010A, 6011A	5060-2946	IC Voltage Reg. heatsink assy.
U20	6012B	1826-0607	IC Voltage Reg.
VR1-8	All	1902-0556	zener 20V 5% PD=1W IR=5µA
VR9	All	1902-3185	zener 12.4V 5% PD=.4W
VR10	All	1902-0556	zener 20V 5% PD=1W IR=5µA
VR11	All	1902-3256	zener 23.7V 5% PD=.4W
VR12	All	1902-0779	zener 11.8V 5% PD=.4W
VR13	All	1902-3180	zener 11.8V 2% PD=.4W
VR14	All	1902-3110	zener 5.9V 2% PD=.4W
VR15	All	1902-0575	zener 6.5V 2% PD=.4W
VR16	All	1902-0556	zener 20V 5% PD=.4W IR=5µA
VR17	All	1902-3256	zener 23.7V 5% PD=.4W
Z1	All	1810-0276	network res. 1.5K x 9
		Mechanical	
	All	06023-00025	plate (ref. A7J3)
A7J3	All	1251-6075	connector 37-pin
	6010A	1205-0282	heatsink (ref. U6, 7, 15, 16, 19, 20)
W1	All	1258-0189	jumper
W2	All	NOT USED	
W3,4	All	7175-0057	jumper, solid tinned copper
W5,6	All	8120-4356	ribbon cable, 16 cond.
	All	1251-8417	post type header (ref. J1, J2)
	All	0360-1300	solder pin

Logic Symbols and Definitions

High = more positive
Low = less positive

Indicator and Qualifier Symbols

≥	OR function
	Polarity indicator, shown outside logic symbol. Any marked input or output is active low; any unmarked input or output is active high.
	(Dynamic indicator) Any market input is edge-triggered, ie, active during transition between states. Any unmarked input is level sensitive.
	(Schmitt trigger) indicates that hysteresis exists in device.
	(Non-logic indicator) Any marked input or output does not carry logic information.
	Open-collector or open emitter output.
	Monostable (one-shot) multivibrator.
t = xSec	Indicates pulse width usually determined by external RC network.
G	Gate input (a number following G indicates which inputs are gated).
C	Control input (clock).
R	Reset (clear).
S	Set.

OLD SYMBOL	NEW SYMBOL	NOTES
		
		Output requires external components to achieve logic state.
		A positive-going transition at A or a negative-going transition at B triggers the one-shot. External timing components connect to non-logic inputs.
		Output changes state rapidly regardless of input rate of change.

SCHEMATIC DIAGRAM NOTES

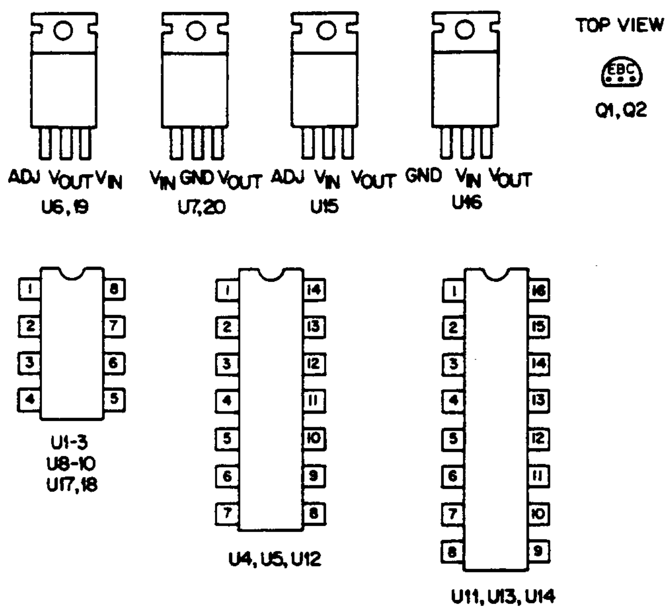
1. ALL RESISTORS ARE IN OHMS, ± 5%, 1/4W, UNLESS OTHERWISE INDICATED.

2. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE INDICATED.

3. WHITE SILKSCREENED DOTS ON P. C. BOARDS INDICATE ONE OF THE FOLLOWING.

   A. PIN 1 OF AN I. C. (EXCEPT FOR U18 SEE NOTE 4).
   B. POSITIVE END OF A POLARIZED CAPACITOR.
   C. CATHODE OF A DIODE OR THE EMITTER OF A TRANSISTOR.

4. PIN LOCATIONS FOR SEMICONDUCTORS ARE SHOWN BELOW:



5. ON VOLTAGE REGULATOR DEVICES:
   REF SUPPLY BIAS FOR REGULATORS INTERNAL REFERENCE.
   REF = OUTPUT FROM REGULATORS INTERNAL REFERENCE.
   BOOST OUTPUT = CONTROL FOR EXTERNAL PASS TRANSISTOR.
   CS = CURRENT SENSE.
   CL = CURRENT LIMIT.
   INV = INVERTING INPUT TO REGULATORS ERROR AMPLIFIER.
   NI = NON-INVERTING INPUT TO REGULATORS ERROR AMPLIFIER.
   COMP = FREQUENCY COMPENSATION.

Schematic Notes

1. W1 in normally open position.
2. W3 & W4 jumpered.
3. Relays K1, K2 normally closed.
4. S1A and S1B are located at the rear panel.

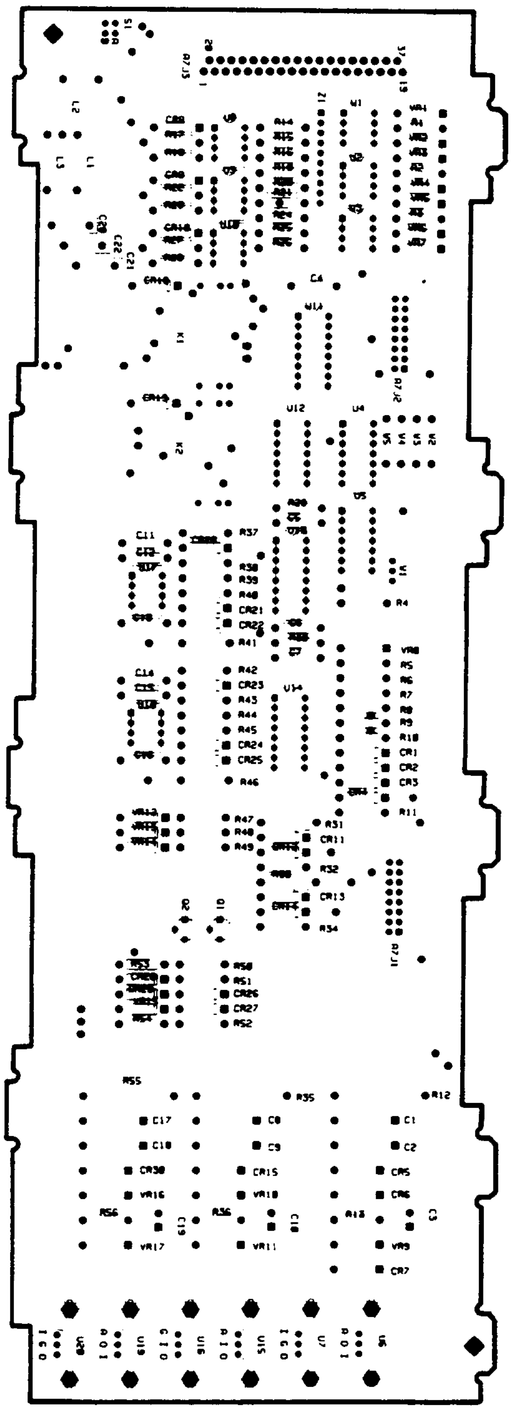


Figure A-15. Option 002 Board, Component Location

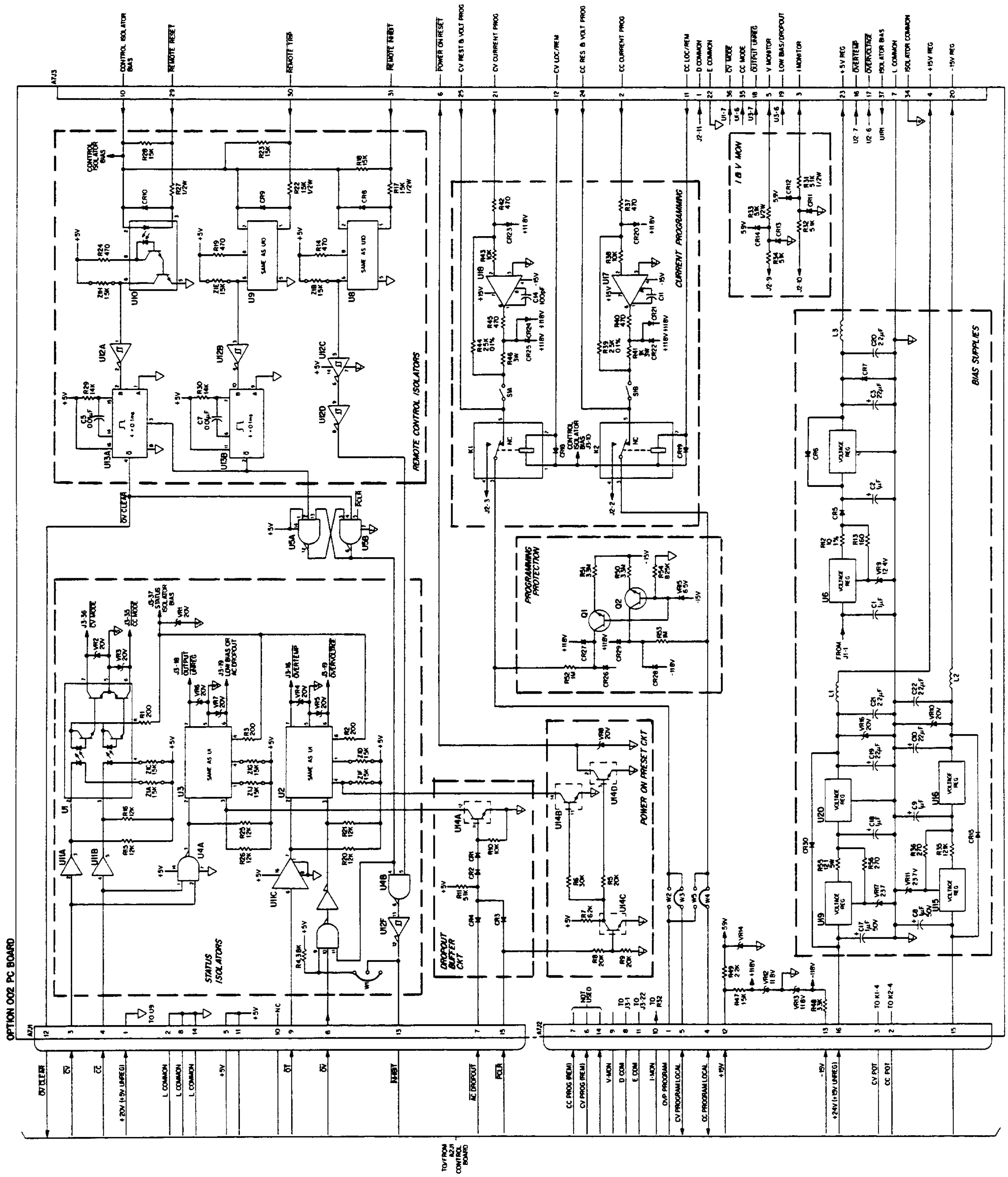


Figure A-16. Option 002 Board, Schematic Diagram

Backdating

Manual backdating describes changes that must be made to this manual for power supplies whose serial numbers are lower than those listed in the title page to this manual.

Look in the following table and locate your Agilent Model. Then look at each serial number listed for this group. If the serial number of your power supply is prior to any of the serial number(s) listed, perform the change indicated in the Change column. Note that several changes can apply to your supply. You may also be instructed to update your power supply if certain components are being replaced during repair.

Model 6010A Serial Numbers		Change
PREFIX	NUMBER	
US3711	0101-0170	1
3711A	01800-01929	1
3544A	01605-01799	1,2
3420A	01400-01604	1-3
3306A	01240-01399	1-4
3214A	01170-01239	1-5
3211A	01150-01169	1-6
3140A	01060-01149	1-6
3105A	00960-01059	1-7
3038A	00900-00959	1-8
2846A	00545-00899	1-9
2824A	00465-00544	1-10
2718A	00285-00464	1-11
2707A	00245-00268	1-12
2536A	00101-00244	1-13

Model 6011A Serial Numbers		Change
PREFIX	NUMBER	
US3546	0101-0155	1
3546A	01838-01962	1
3419A	01588-01837	1,2
3313A	01518-01587	1-3
3303A	01498-01517	1-4
3212A	01398-01497	1-5
3142A	01348-01397	1-5
3139A	01338-01347	1-6
3102A	01278-01337	1-7
3037A	01218-01277	1-8
2850A	00856-01217	1-9
2719A	00466-00855	1-10
2709A	00436-00465	1-11
2614A	00296-00435	1-12
2603A	00286-00295	1-13
2520A	00211-00285	1-14
2438A	00161-00210	1-15
2423A	00101-00160	1-16

Model 6012B Serial Numbers PREFIX	NUMBER	Change
US3543	0101-0335	1
3543A	04801-05360	1
3415A	04311-04800	1,2
3319A	04091-04310	1-3
3303A	04061-04090	1-4
3232A	03981-04060	1-5
3212A	03481-03980	1-6
3139A	03661-03840	1-6
3104A	03411-03660	1-7
3037A	03271-03410	1-8
2846A	02711-03270	1-9
2723A	01911-02710	1-10
2709A	01891-01910	1-11
2703A	01771-01890	1-12
2616A	01151-01770	1-13
2614A	01131-01150	1-14
2606A	01011-01130	1-15
2524A	00586-01010	1-16
2519A	00511-00585	1-17
2517A	00436-00510	1-18
2439A	00211-00435	1-19
2428A	00101-00210	1-20

Model 6015A Serial Numbers PREFIX	NUMBER	Change
US3705	0101-0145	1
3705A	00444-00518	1
3543A	00344-00443	1,2
3424A	00244-00343	1-3
3402A	00229-00243	1-4
3310A	00219-00228	1-4
3310A	00179-00218	1-5
3243A	00174-00178	1-6
3215A	00144-00173	1-7
3142A	00124-00143	1-8
3103A	00109-00123	1-9
3044A	00101-00108	1-10

CHANGE 1

All — In the parts list for the A1 Main Board Assembly change R45 to 82.5K, 1% 1/8W, p/n 0757-0463.

CHANGE 2

6010A, 6015A — In the parts list for the A5 Diode Board Assembly change CR4, 5 to p/n 1901-1182. Change Q1 to p/n 1855-0486. Under A5 Mechanical change the heatsink for Q1 to p/n 1205-0398, change heatsink for CR4 to p/n 06030-00004, change heatsink for CR5 to p/n 06030-00003.

6011A, 6012B — In the parts list for the A4 FET Board Assembly change CR1, CR4 to p/n 1901-1137.

CHANGE 3

6010A, 6015A — In the parts list for the A4 FET Board Assembly change CR1and CR4 to p/n 1901-1137.

6011A, 6012B — In the parts list for the A1 Main Board Assembly change K1 to p/n 0490-1457 and K2 to p/n 0490-1341. Change R47 and R48 to 150 5% 1W, p/n 0761-0035.

CHANGE 4

6010A, 6015A — In the parts list for the A1 Main Board Assembly change K1 to p/n 0490-1457 and K2 to p/n 0490-1341. Change R47 and R48 to 150 5% 1W, p/n 0761-0035.

6011A, 6012B — In the parts list for the A1 Main Board Assembly make the following changes:
Add:
C3, C7 1400µF, p/n 0180-3460

R6, 1.3K, p/n 0811-1803
U2, U4, Rectifier, p/n 1906-0006
Delete:
C27, C34, 0.01µF 400V, p/n 0160-6805
CR6-CR13, power rectifier 400V, p/n 1901-0731
R24, 200 5% 1/2W, p/n 0686-2015
R43, R44, 2.61K 1% 1/8W, p/n 0698-0085
R45, 82.5K 1% 1/8W, p/n 0757-0463
R46, 681 1% 1/8W, p/n 0757-0419
R47, R48 150 5% 1W, p/n 0761-0035
R49, 100 1% 1/8W, p/n 1902-0955
Q2, FET N-channel, p/n 1855-0665
VR1, diode zener 7.5V 5%, p/n 1902-0955
U6, opto-isolator, p/n 1990-1074
Change:
A1 board to p/n 06011-60021
C1, C2, C4-C6, C8 to p/n 0180-3460
C10 to p/n 0180-0426
DS1 to p/n 1990-0325
K1 to p/n 0490-1457
K2 to p/n 0490-1341
R5 to p/n 0686-3015
R7 to p/n 0686-1005
R8 to p/n 0686-3335
R41 to p/n 0811-1869
CR1 to p/n 1901-0028

Under AC Input Filter, change to p/n 06011-60025. Subtract 100 from all of the reference designators. C101 thus becomes C1. Also delete W101-W103, p/n 1251-5613.

Under Chassis Electrical change L4 to p/n.06011-80093. Also add C27 0.01µF 10% 400W, p/n 0160-0381and R24 200 5% 1/2W, p/n 0686-2015.

CHANGE 5

6010A

In the parts list for the A1 Main Board Assembly make the following changes:
Add:
C3, C7 1400µF, p/n 0180-3460
R6, 1.3K, p/n 0811-1803
U2, U4, Rectifier, p/n 1906-0006
Delete:
C27, C34, 0.01µF 400V, p/n 0160-6805
CR6-CR13, power rectifier 400V, p/n 1901-0731
R24, 200 5% 1/2W, p/n 0686-2015
R43, R44, 2.61K 1% 1/8W, p/n 0698-0085
R45, 82.5K 1% 1/8W, p/n 0757-0463
R46, 681 1% 1/8W, p/n 0757-0419
R47, R48 150 5% 1W, p/n 0761-0035
R49, 100 1% 1/8W, p/n 1902-0955
Q2, FET N-channel, p/n 1855-0665
VR1, diode zener 7.5V 5%, p/n 1902-0955
U6, opto-isolator, p/n 1990-1074
Change:
A1 board to p/n 06030-60021

C1, C2, C4-C6, C8 to p/n 0180-3460
C10 to p/n 0180-0426
DS1 to p/n 1990-0325
K1 to p/n 0490-1457
K2 to p/n 0490-1341
R5 to p/n 0686-3015
R7 to p/n 0686-1005
R8 to p/n 0686-3335
R41 to p/n 0811-1869
CR1 to p/n 1901-0028

Under AC Input Filter, change p/n to 06011-60025 Subtract 100 from all of the reference designators. C101 thus becomes C1. Also delete W101-W103, p/n 1251-5613.

Under Chassis Electrical change L4 to p/n 06011-80093. Also add C27 0.01µF 10% 400W, p/n 0160-0381 and R24 200 5% 1/2W, p/n 0686-2015.

6011A In the parts list for the A1 Main Board Assembly make the following changes:
Change C23, C28 to 0.047µF, p/n 0160-5895
Add C21,C24, 0.047µF, p/n 0160-5895
Add R21, R22, 1 5% 1/4W, p/n 0699-0208

6012B In the parts list for the A1 Main Board Assembly make the following changes:
Change C20, C22 to 0.047µF, p/n 0160-5895
Add C21,C23, 0.047µF, p/n 0160-5895
Add R20, R23, 1 5% 1/4W, p/n 0699-0208

6015A In the parts list for the A2 Control Board Assembly change R40 to 95K 1% p/n 0699-1211 and 1.21M 1% p/n 0699-0088 assembled in parallel. Change R41 to 200K 0.1%, p/n 0699-6376.

CHANGE 6

6010A In the Diode board A5 parts list and schematic diagram delete L3.

6011A, 6012B In the parts list for the A1 Main Board Assembly change U1 to p/n 1906-0218.

6015A In the parts list for the A1 Main Board Assembly make the following changes:
Add:
C3, C7 1400µF, p/n 0180-3460
R6, 1.3K, p/n 0811-1803
U2, U4, Rectifier, p/n 1906-0006
Delete:
C27, C34, 0.01µF 400V, p/n 0160-6805
CR6-CR13, power rectifier 400V, p/n 1901-0731
R24, 200 5% 1/2W, p/n 0686-2015
R43, R44, 2.61K 1% 1/8W, p/n 0698-0085
R45, 82.5K 1% 1/8W, p/n 0757-0463
R46, 681 1% 1/8W, p/n 0757-0419
R47, R48 150 5% 1W, p/n 0761-0035
R49, 100 1% 1/8W, p/n 1902-0955
Q2, FET N-channel, p/n 1855-0665
VR1, diode zener 7.5V 5%, p/n 1902-0955
U6, opto-isolator, p/n 1990-1074
Change:
A1 board to p/n 06030-60021

C1, C2, C4-C6, C8 to p/n 0180-3460
C10 to p/n 0180-0426
DS1 to p/n 1990-0325
K1 to p/n 0490-1457
K2 to p/n 0490-1341
R5 to p/n 0686-3015
R7 to p/n 0686-1005
R8 to p/n 0686-3335
R41 to p/n 0811-1869
CR1 to p/n 1901-0028

Under AC Input Filter, change to p/n 06011-60028. Subtract 100 from all of the reference designators. C101 thus becomes C1. Also delete W101-W103, p/n 1251-5613.

Under Chassis Electrical change L4 to p/n 06011-80093. Also add C27 0.01µF 10% 400W, p/n 0160-0381 and R24 200 5% 1/2W, p/n 0686-2015.

CHANGE 7

6010A — In the parts list for the A1 Main Board Assembly change U1 to p/n 1906-0218. In the parts list for the A5 Diode Board, change L1 to p/n 06011-80094.

6011A, 6012B — In the parts list for the A5 Diode Board, change L1 to p/n 06011-80094.

6015A — In the parts list for the A1 Main Board Assembly change C11, C12 to p/n 0160-6392. Change R12, R13 to 2.2 5% 1/4W p/n 0699-0188.

CHANGE 8

6010A, 6012B — In the parts list for the A1 Main Board Assembly change T3 to p/n 5080-1982. Delete the following mechanical attaching parts:
Screw, p/n 0515-0964
lock washer p/n 2190-0586
flat washer, p/n 3050-0893

6011A — In the parts list for the A1 Main Board Assembly delete T3 and the following mechanical attaching parts:
Screw, p/n 0515-0964
lock washer p/n 2190-0586
flat washer, p/n 3050-0893

6015A — In the parts list for the A5 Diode Board, delete L3.

CHANGE 9

6010A, 6011A, 6012B — In the parts list for the Mechanical Chassis change the following parts:

	From:	To:
Internal cover	06032-00024	06032-00005
Chassis	06032-00025	06032-00016
Cover-top	5001-6739	06032-00020
Cover-bottom	5001-6738	06032-00019
Cover-plate	06023-00026	06023-00010

In the option 002 replaceable parts list change cover plate from p/n 06023-00025 to p/n 06023-00013. Add cover-plate p/n 06023-00010.

6015A In the parts list for the A1 Main Board Assembly change U1 to p/n 1906-0218. In the parts list for the A5 Diode Board, change L1 to p/n 06011-80094.

CHANGE 10

6010A, 6011A, 6012B In the parts list for the Mechanical Chassis change the following parts:

	From:	To:
Top cover	06032-00020	06032-00002
Bottom cover	06032-00019	06032-00003
Top trim	5041-8802	5040-7202
Side trim	5001-0539	5001-0439
Front frame	5021-8403	5021-5803
Feet	5041-8801	5040-7201
Strap handle	5062-3703	5060-8903
Handle ret. back	5041-8820	5041-6820
Handle ret. front	5041-8819	5041-6819
Lettered panel	06010-00009	06010-00008

6015A In the parts list for the A1 Main Board Assembly delete T3 and the following mechanical attaching parts:
Screw, p/n 0515-0964
lock washer p/n 2190-0586
flat washer, p/n 3050-0893
clamp, p/n 06671-400002
bracket, p/n 06671-400003

CHANGE 11

6010A In the Diode board A5 parts list and schematic diagram delete CR6.

6011A In the Diode board A5 parts list and schematic diagram change R17 from 2.87K 1%, p/n 0698-3151 to 4.87K 1%, p/n 0698-4444.

6012B In the Diode board A5 parts list and schematic diagram change R2 from 2.87K 1%, p/n 0698-3151 to 4.87K 1%, p/n 0698-4444.

CHANGE 12

6010A In the Diode board A5 parts list and schematic diagram change R2 from 2.87K 1% p/n 0698-3151 to 4.87K 1%, p/n 0698-4444.

6011A In the option 002 (Appendix A) parts list and schematic diagram delete R57 and solder pin p/n 0360-1300.

6012B In the Diode board A5 parts list and schematic diagram change CR4 to p/n 1901-0887. Delete heatsink (ref. Q2) p/n 06032-0018, heatsink bracket 06032-00017 and replace with inner heatsink (ref. Q2) p/n 06032-00006 and outer heatsink (ref. Q2) p/n 06032-00018.

CHANGE 13

6010A	In the option 002 (Appendix A) parts list and schematic diagram delete R57 and solder pin p/n 0360-1300.
6011A	In the parts list for the A1 Main Board Assembly change C17, C18 to 1000µF 50V, p/n 0180-3019. Change C10 to 22µF 250V, p/n 0180-0426.
6012B	In the option 002 (Appendix A) parts list and schematic diagram delete R57 and solder pin p/n 0360-1300.

CHANGE 14

6011A	In the parts list for the A2 Control Board Assembly add R130, 1M 1% 1/8W, p/n 0698-8827. Delete C85. In the Chassis, Mechanical, delete AC output cover with strain relief, p/n 5060-3237. Add AC output cover, p/n 5040-1627, and strain relief, p/n 5040-1625. In the parts list for the A1 Main Board Assembly delete C33 and R25.
6012B	In the parts list for the A1 Main Board Assembly change C17, C18 to 1000µF 50V, p/n 0180-3019. Change C10 to 22µF 250V, p/n 0180-0426.

CHANGE 15

6011A	In the parts list for the A5 Diode Board Assembly change CR1 and CR5 to 1901-1127. In the parts list for the A1 Main Board Assembly change XA4, XA5 to 1251-7891. Under A4 and A5 Mechanical parts list change P1 to 1251-8696. In the parts list for A6 AC Input Filter delete capacitor C9. In the parts list for CHASSIS MECHANICAL, change front frame casting to p/n 5021-8803; chassis to p/n 06032-00001; front sub-panel to p/n 06032-00009; and handle retainer (front) to 5040-7219.
6012B	In the parts list for the A1 Main Board Assembly delete C30 and R25.

CHANGE 16

6011A — In the parts list for the A3 Front Panel Board delete DS1-8 and replace with the following:

DS1	1990-0681
DS2-4	1990-0540
DS5	1990-0681
DS6-8	1990-0540

6012B — In the parts list for the A2 Control Board Assembly add R130, 1M 1% 1/8W, p/n 0698-8827. Delete C85.

CHANGE 17

6012B	In the parts list for the A1 Main Board Assembly change XA4, XA5 to 1251-7891. Under A4 and A5 Mechanical parts list change P1 to 1251-8696.

CHANGE 18

6012B In the parts list for A6 AC Input Filter delete capacitor C9.

CHANGE 19

6012B In the parts list for CHASSIS MECHANICAL, change front frame casting to p/n 021-8803; chassis to p/n 06032-00001; front sub-panel to p/n 06032-00009; handle retainer (front) to 5040-7219 and handle retainer to p/n 5040-7220.

CHANGE 20

6012B In the parts list for the A3 Front Panel Board delete DS1-8 and replace with the following:

DS1	1990-0681
DS2-4	1990-0540
DS5	1990-0681
DS6-8	1990-0540