



# Agilent E361XA 30W BENCH SERIES DC POWER SUPPLIES

## OPERATING AND SERVICE MANUAL FOR MODELS:

**Agilent E3610A, Serials KR83020046 and above**  
**Agilent E3611A, Serials KR83013830 and above**  
**Agilent E3612A, Serials KR83006181 and above**

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## SAFETY SUMMARY

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

### Before Applying Power

Verify that the product is set to match the available line voltage.

### Ground The Instrument.

This product is a Safety Class I 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. Any interruption of the protective(grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury. If the instrument is to be energized via an external autotransformer for voltage reduction, be certain that the autotransformer common terminal is connected to the neutral (earthed pole) of the ac power lines (supply mains).

### Do Not Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

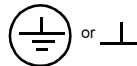
### KEEP AWAY FROM LIVE CIRCUITS.

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.

### 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.



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 CAUTION sign until the indicated conditions are fully understood and met.

## GENERAL INFORMATION

### Description

This operating and service manual covers three dual range Agilent power supplies, E3610A, E3611A, and E3612A. All models are compact, general purpose bench supplies that are particularly useful for powering developmental IC circuits, both linear and digital. Unless stated otherwise, all information in this manual applies equally to all three models. The desired output range is selected by the front panel RANGE push button. The output can be continuously adjusted for voltage and current throughout either output range.

The front panel VOLTAGE control can be used to establish the voltage limit when the supply is used as a constant current source and the CURRENT control can be used to establish the output current limit when the supply is used as a constant voltage source. The CC SET push button allows the current limit value to be conveniently set using the CURRENT control without shorting the output.

The front panel includes a digital voltmeter/ammeter. A 3 1/2 digit (E3611A 3 digit) voltage display and 3 digit current display accurately show the output voltage and current respectively. The output ratings for each model are shown in the Specifications Table.

## Specifications and Supplemental Characteristics

**INPUT:** 115 Vac  $\pm$  10%, 47-63 Hz, 0.8 A, 70 W  
 100 Vec  $\pm$  10%, 47-63 Hz, 0.8 A, 70 W  
 230 Vac  $\pm$  10%, 47-63 Hz, 0.4 A, 70 W

**OUTPUT:** E3610A: 0 to 8 V, 0 to 3 A or 0 to 15 V,  
 0 to 2 A  
 E3611A: 0 to 20 V, 0 to 1.5 A or 0 to 35 V,  
 0 to 0.85 A  
 E3612A: 0 to 60 V, 0 to 0.5 A or 0 to 120V,  
 to 0.25 A

**LOAD REGULATION:**

Constant Voltage - Less than 0.01% plus 2 mV for a full load to no load change in output current.

Constant Current - Less than 0.01% plus 1 mA for a zero to maximum change in output voltage.

**LINE REGULATION:**

Constant Voltage - Less than 0.01% plus 2 mV for any line voltage change within the input rating.

Constant Current - Less than 0.01% plus 1 mA for any line voltage change within the input rating.

**RIPPLE AND NOISE:**

Constant Voltage - Less than 200  $\mu$ V rms and 2 mV peak to peak(20 Hz - 20 MHz)

Constant Current - Less than 200  $\mu$ A rms and 1 mA peak to peak(20 Hz - 20 MHz)

**TEMPERATURE RANGE:** 0 to 40°C for full rated output.  
 Derate current 1% per degree C between 40°C-55°C

**\*TEMPERATURE COEFFICIENT:**

Constant Voltage - Less than 0.02% plus 1 mV per degree C.

Constant Current - Less than 0.02% plus 2 mA per degree C.

**TRANSIENT RESPONSE TIME:**

Less than 50 usec for output recovery to within 10 mV following a change in output current from full load to half load, or vice versa.

**ISOLATION:**  $\pm$  240 Vdc

**\*OUTPUT DRIFT:**

Constant Voltage - Less than 0.1% plus 5 mV total drift for 8 hours after an initial warm-up of 30 minutes.

Constant Current - Less than 0.1% plus 10 mA total drift for 8 hours after an initial warm-up of 30 minutes.

**METER ACCURACY:**  $\pm$ 0.5% + 2 counts at 25°C  $\pm$  5°C

**\*OVERLOAD PROTECTION:**

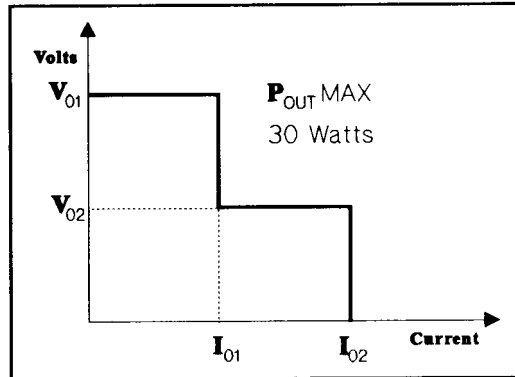
A continuously acting constant current circuit protects the power supply for all overloads including a direct short placed across the terminals. The constant voltage circuit limits the

output voltage in constant current operation.

**\*OUTPUT TERMINALS:**

Three output terminals are provided on the front panel. They are isolated from the chassis and either the positive or negative terminal may be connected to the ground terminal.

**\*OUTPUT CHARACTERISTICS**



**NOTE:** Output voltages higher than  $V_{02}$  are possible at low current when the high current range is selected.

E3610A:  $V_{01} = 15$  V  $V_{02} = 8$  V  $I_{01} = 2$  A  $I_{02} = 3$  A

E3611A:  $V_{01} = 35$  V  $V_{02} = 20$  V  $I_{01} = 0.85$  A  $I_{02} = 1.5$  A

E3612A:  $V_{01} = 120$  V  $V_{02} = 60$  V  $I_{01} = 0.25$  A  $I_{02} = 0.5$  A

**\*METER RESOLUTION**

Voltage:	E3610A	10 mV
	E3611A	100 mV
	E3612A	100 mV
Current:	E3610A	10 mA
	E3611A	10 mA
	E3612A	1 mA

**\*DOWN PROGRAMMING SPEED:** Maximum time for output voltage to change between 100% to 0.1% of maximum rated output voltage at NO LOAD condition.

E3610A: maximum 2.5 sec

E3611A: maximum 1.0 sec

E3612A: maximum 1.5 sec

**\*RESOLUTION:** Minimum output voltage or current change that can be obtained using panel controls.

E3610A: Voltage 10 mV Current 5 mA

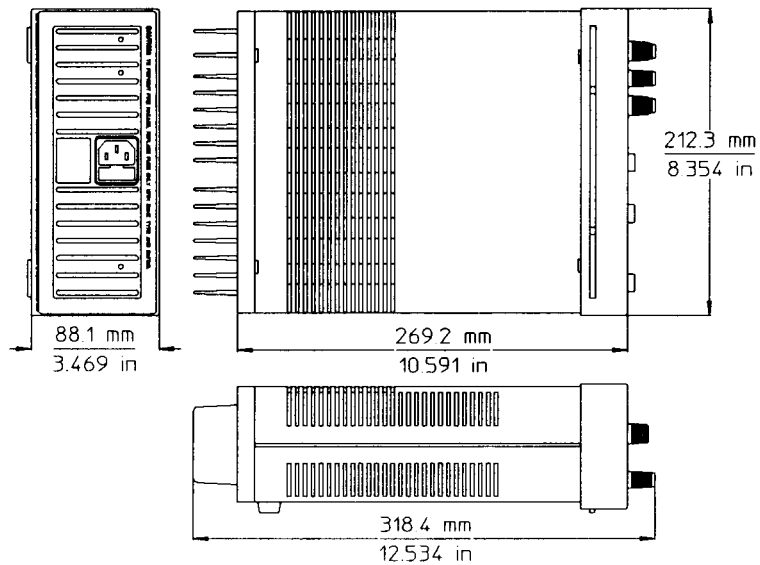
E3611A: Voltage 10 mV Current 5 mA

E3612A: Voltage 100 mV Current 0.5 mA

**COOLING:** Convection cooling is employed.

**WEIGHT:** 8.4 lbs/3.8 Kg net, 9.3 lbs/4.2 Kg shipping.

(NOTE) \* SUPPLEMENTAL CHARACTERISTICS



**Figure 1: OUTLINE DIAGRAM**

**Options**

The following factory installed options are available with this instrument.

<u>Option</u>	<u>Description</u>
OE3	Input Power: 230 Vac +/-10%, 47-63 Hz, Single Phase
OE9	Input Power: 100 Vac +/-10%, 47-63 Hz, Single Phase

**Instrument Identification**

Agilent Technologies power supplies are identified by one serial number. The letter "MY" designates Malaysia as the country of manufacture, the first digit indicates the year (1 = 91, 2 = 92, etc), the second two digits indicate the week, and the last five digits of the serial number are a different sequential number assigned to each power supply.

If the serial number on your instrument does not agree with those on the title page of this manual, a yellow change sheet may be included if a design change has affected the contents of this manual.

**INSTALLATION**

**Inspection**

When you receive your power supply, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the carrier and the nearest Agilent Sales Office immediately. Warranty information is printed on the inside front cover of this manual. Save the shipping carton and packing materials in case the supply has to be returned to Agilent Technologies in the future. If you return the supply for service, attach a tag identifying the owner and model number. Also include a brief description of the problem.

The "Turn-On Checkout Procedure" in this manual can be used as an incoming inspection check to verify that the supply is operational. See the appendix for tests that verify the supply's specifications.

**Location And Cooling**

Figure 1 shows the outline shape and dimensions of the unit. It is shipped ready for bench operation after connection to an ac power source. The supply is air cooled. Sufficient space should be allotted so that a free flow of cooling air can reach the rear of the instrument when it is in operation. It should be used in an area where the ambient temperature does not exceed 40 degrees C. The current derates 1% per degree C between 40°C-55°C.

**Input Power Requirements**

Depending on the line voltage option ordered, the supply is ready to be operated from one of the power sources listed in the Specification Table. The input voltage range, and the input current and power at high line voltage and full load is listed for each option.

**Power Cord**

This instrument is equipped with a three conductor power cable. The third conductor is the ground conductor and when the cable is plugged into an appropriate receptacle, the instrument is grounded. The offset pin on the power cable three prong connector is the ground connection. In no event should this instrument be operated without an adequate cabinet ground connection.

The power supply was shipped with a power cord for the type of outlet used at your location. If the appropriate cord was not included, contact your nearest Agilent Sales Office to obtain the correct cord.

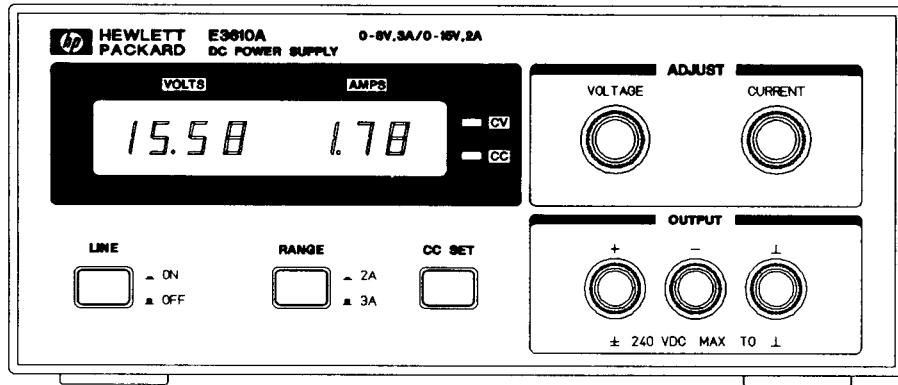


Figure 2: FRONT PANEL CONTROLS AND INDICATORS

## OPERATION

### Turn-On Checkout Procedure

The following checkout procedure describes the use of the front panel controls and indicators illustrated in Figure 2 and ensures that the supply is operational:

- Push LINE button to ON.
- Set RANGE push button to desired range.
- Turn VOLTAGE control fully counter clockwise to ensure that output decreases to 0 Vdc then fully clockwise to ensure that output voltage increases to the maximum output voltage.
- While depressing CC SET push button, turn the CURRENT control fully counter clockwise and then fully clockwise to ensure that the current limit value can be set from zero to maximum rated value.
- Connect load to output terminals.

## WARNING

### Shock Hazard

Disconnect ac power before making output terminal connections.

### Constant Voltage Operation

To set up a power supply for a constant voltage operation, proceed as follows:

- Turn on power supply and adjust 10-turn VOLTAGE control for desired output voltage (output terminals open). CV LED should light.
- While depressing CC SET push button, adjust 10-turn CURRENT control for maximum output current allowable (current limit). During actual operation, if a load change causes the current limit to be exceeded, the power supply will automatically crossover to constant current mode and output voltage will drop proportionately.

### Constant Current Operation

To set up a power supply for a constant current operation, proceed as follows:

- Turn CURRENT control fully counter clockwise to ensure that output decreases to 0 A, and then turn on power supply.
- Adjust VOLTAGE control (no load connected) for maximum output voltage allowable (voltage limit), as determined by load conditions. During actual operation, if a load change causes the voltage limit to be exceeded, the power supply will automatically cross-over to constant voltage operation at the preset voltage limit and output current will drop proportionately.
- Adjust CURRENT control for desired output current while depressing CC SET button (CC LED will not light until the supply is loaded)

### Connecting Loads

The output of the supply is isolated from earth ground. Either output terminal may be grounded or the output can be floated up to 240 volts off ground.

Each load should be connected to the power supply output terminals using separate pairs of connecting wires. This will minimize mutual coupling effects between loads and will retain full advantage of the low output impedance of the power supply. Each pair of connecting wires should be as short as possible and twisted or shielded to reduce noise pickup (If a shield is used, connect one end to the power supply ground terminal and leave the other end unconnected.)

### Operation Beyond Rated Output

The output controls can adjust the voltage or current to values above (up to 5%) the rated output as indicated on the front panel display. Although the supply can be operated in the 5% overrange region without being damaged, it can not be guaranteed to meet all of its performance specifications in this region.

### **Pulse Loading Considerations**

The power supply will automatically cross over from constant-voltage to constant-current operation in response to an increase (over the preset limit) in the output current. Although the preset limit may be set higher than the average output current, high peak currents (as occur in pulse loading) may exceed the preset current limit and cause crossover to occur. If this crossover limiting is not desired, set the preset limit for the peak requirement and not the average.

### **Capacitive Loads**

An internal capacitor, across the output terminals of the power supply, helps to supply high-current pulses of short duration during constant voltage operation. Any capacitance added externally will improve the pulse current capability,

but will decrease the safety provided by the current limiting circuit. A high-current pulse may damage load components before the average output current is large enough to cause the current limiting circuit to operate.

### **Reverse Current Loading**

Active loads connected to the power supply may actually deliver a reverse current to the power supply during a portion of its operating cycle. An external source can not be allowed to pump current into the supply without loss of regulation and possible damage to the output capacitor. To avoid these effects, it is necessary to preload the supply with a dummy load resistor so that the power supply delivers current through the entire operating cycle of the load devices.

## APPENDIX

### SERVICE INFORMATION

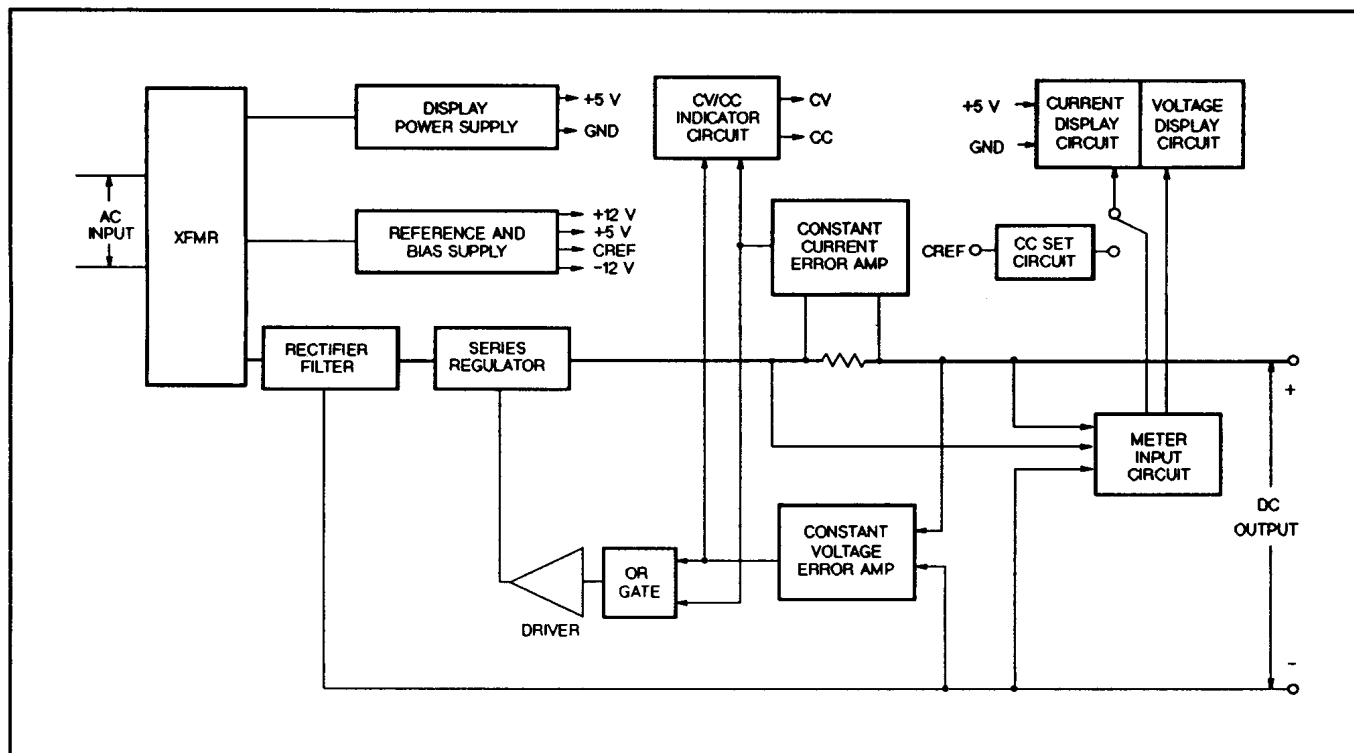


Figure A-1. Block Diagram

#### PRINCIPLES OF OPERATION

Throughout this discussion, refer to both the block diagram of Figure A-1 and the schematic diagram at the rear of the manual. The input AC line voltage is stepped down by the power transformer and applied to the rectifier and filter. The rectifier-filter converts the AC input to raw DC which is fed to the positive output terminal via parallel series regulator(Q1 and Q3) and current sampling resistor(R2). The regulator, part of the feedback loop, is made to alter its conduction to maintain a constant output voltage or current. The voltage developed across the current sampling resistor is the input to the constant current error amplifier. The constant voltage error amplifier obtains its input by sampling the output voltage of the supply.

Any changes in output voltage or current are detected, amplified by the error amplifier and driver and applied to the series regulator in the correct phase and amplitude to counteract the change in output voltage or current.

Two error amplifiers are included in a CV/CC supply, one for controlling output voltage, the other for controlling output current. Since the constant voltage amplifier tends to achieve zero output impedance and alters the output current whenever the load resistance changes, while the constant current amplifier causes the output impedance to be infinite and changes the output voltage in response to any load resistance change, it is obvious that the two amplifiers can not operate simultaneously. For any given value of load resistance, the power supply must act either as a constant voltage source or as a constant

current source - it can not be both; transfer between these two modes is accomplished at a value of load resistance equal to the ratio of the output voltage control setting to the output current control setting.

The reference and bias circuit provides stable reference voltages which are used by the constant voltage/current error amplifier circuits for comparison purpose. The digital meter circuit provides an indication of output voltage and current for constant voltage or constant current operating modes.

The display power circuit provides voltage which is used by A/D converter and LED drive.

Diode CR3 is connected across the output terminals in reverse polarity. It protects the output electrolytic capacitor and the series regulator transistor from the effects of a reverse voltage applied across the output terminals.

#### PERFORMANCE TEST

The following provides the test procedure in high current range for verifying the unit's compliance with the specifications and characteristics of Table in page 1-3. The same test procedure may be applied to low current range.

#### Test Equipment Required

The following Table lists the equipment required to perform the tests and adjustments. You can separately identify the equipment for performance tests, or calibration in the USE column of the Table.

**Table A-1. Test Equipment Required**

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Oscilloscope	Sensitivity: 1 mV Bandwidth: 20 MHz/100 MHz	P	Agilent 54602A
RMS Voltmeter	True rms, 10 MHz bandwidth	P	
Multimeter	Resolution: 0.1 mV Accuracy: 0.01%	P, A	Agilent 34401A
Electronic Load	Voltage Range : 240 Vdc Current Range : 10 Adc Open and short switches Transient on/off	P, A	Agilent 6063B
Load Resistor(For high current range)	2.6 ohm 50 W, 13.3 ohm 50 W, 120 ohm 50 W	P	
Current Sampling Resistor	0.1 ohm 0.1% 10 W, 1 ohm 1% 10 W	P, A	

\* P = Performance testing    A = Calibration adjustments.

### Constant Voltage(CV) Test

The measuring device must be connected as close to the output terminals as possible when measuring the output impedance, transient response, regulation, or ripple of the power supply in order to achieve valid measurements. A measurement made across the load includes the impedance of the leads to the load and such lead lengths can have an impedance several orders of magnitude greater than the supply output impedance, thus invalidating the measurement. For all CV tests set the output current at full rated output to assure CV operation.

### Load Effect(Load Regulation)

**Definition:** CV Load Effect is the change in dc output voltage when load resistance changes from open circuit to full load or from full load to open circuit.

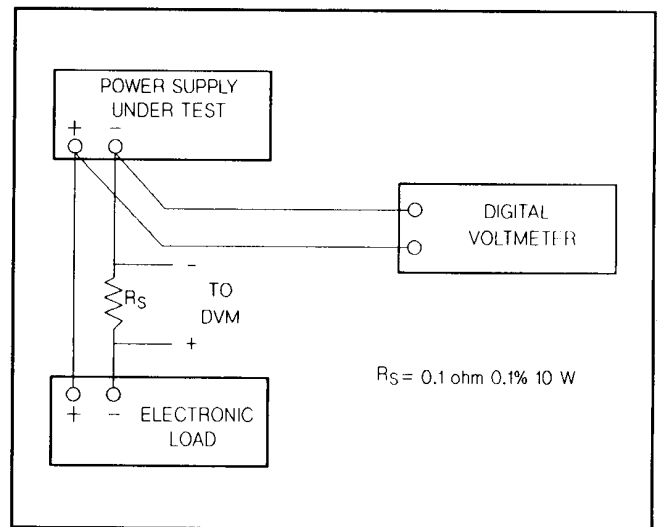
#### Test Parameters:

Measured Variable: Output Voltage

Expected Results: Less than 0.01% plus 2 mV

#### Test Procedure:

- Connect the test equipment as shown in Figure A-2. Operate the electronic load in constant current mode and set its current to the full rated value of the power supply (E3610A: 3.0 A, E3611A: 1.5 A, E3612A: 0.5 A).
- Turn the unit's power on and turn CURRENT control fully clockwise.
- Turn up output voltage to the full rated value (E3610A: 8.0 V, E3611A: 20 V, E3612A: 60 V) as read on the digital voltmeter.
- Record the output voltage at the digital voltmeter.
- Operate the electronic load in Open(Input Off) mode.
- When the reading settles, record the output voltage again. Check that the two recorded readings differ no more than 0.01% of output voltage plus 2 mV.



**Figure A-2. Basic Test Setup**

### Source Effect(Line Regulation)

**Definition:** Source effect is the change in dc output voltage when the ac input voltage changes from a minimum to maximum value( $\pm 10\%$  of nominal voltage).

#### Test Parameter:

Measured Variable: Output Voltage

Expected Results: Less than 0.01% plus 2 mV

#### Test Procedure:

- Connect the test equipment as shown in Figure A-2. Operate the electronic load in constant current mode and set its current



- to the full rated value of power supply.
- b. Connect the unit to the ac power line through a variable autotransformer which is set for low line voltage(104 Vac for 115 Vac).
- c. Turn the unit's power on and turn CURRENT control fully clockwise.
- d. Turn up output voltage to the full rated value as read on the digital voltmeter.
- e. Record the output voltage at the digital voltmeter.
- f. Adjust autotransformer to high line voltage(127 Vac for 115 Vac).
- g. When the reading settles, record the output voltage again. Check that the two recorded readings differ no more than 0.01% of output voltage plus 2 mV.

- d. Set the electronic load to transient operation mode between one half of unit's full rated value and unit's full rated value at a 1 KHz rate with 50% duty cycle.
- 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 A-3.
- g. Check that the pulse width of the transients at 10 mV from the base line is no more than 50 usec as shown.

### Load Transient Recovery Time

**Definition:** This is the time for the output voltage to return to within a specified bend around its voltage following a step change in load.

**Test Parameter:**  
 Measured Variable: Output Voltage Transients  
 Expected Results: Less than 50 usec (at 10 mV from base line)

- Test Procedure:**
- a. Connect the test equipment as shown in Figure A-2, but replace the DVM with the oscilloscope. Operate the electronic load in constant current mode.
  - b. Turn the unit's power on and turn CURRENT control fully clockwise.
  - c. Turn up output voltage to the full rated value.

### PARD(Ripple and Noise)

**Definition:** Periodic and random deviation(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 20 Hz to 20 MHz.

### PARD(RMS) Measurement

**Test Parameter:**  
 Measured Variable: Output Voltage(rms)  
 Expected Results: Less than 200 uV rms

- Test Procedure:**
- a. Connect the test equipment as shown in Figure A-4.
  - b. Turn the unit's power on and turn CURRENT control fully clockwise.
  - c. Turn up output voltage to the full rated value. Check that the unit's CV indicator remains lighted. Reduce VOLTAGE control if not lighted.
  - d. Check that the rms noise voltage at the true rms voltmeter is no more than 200 uV.

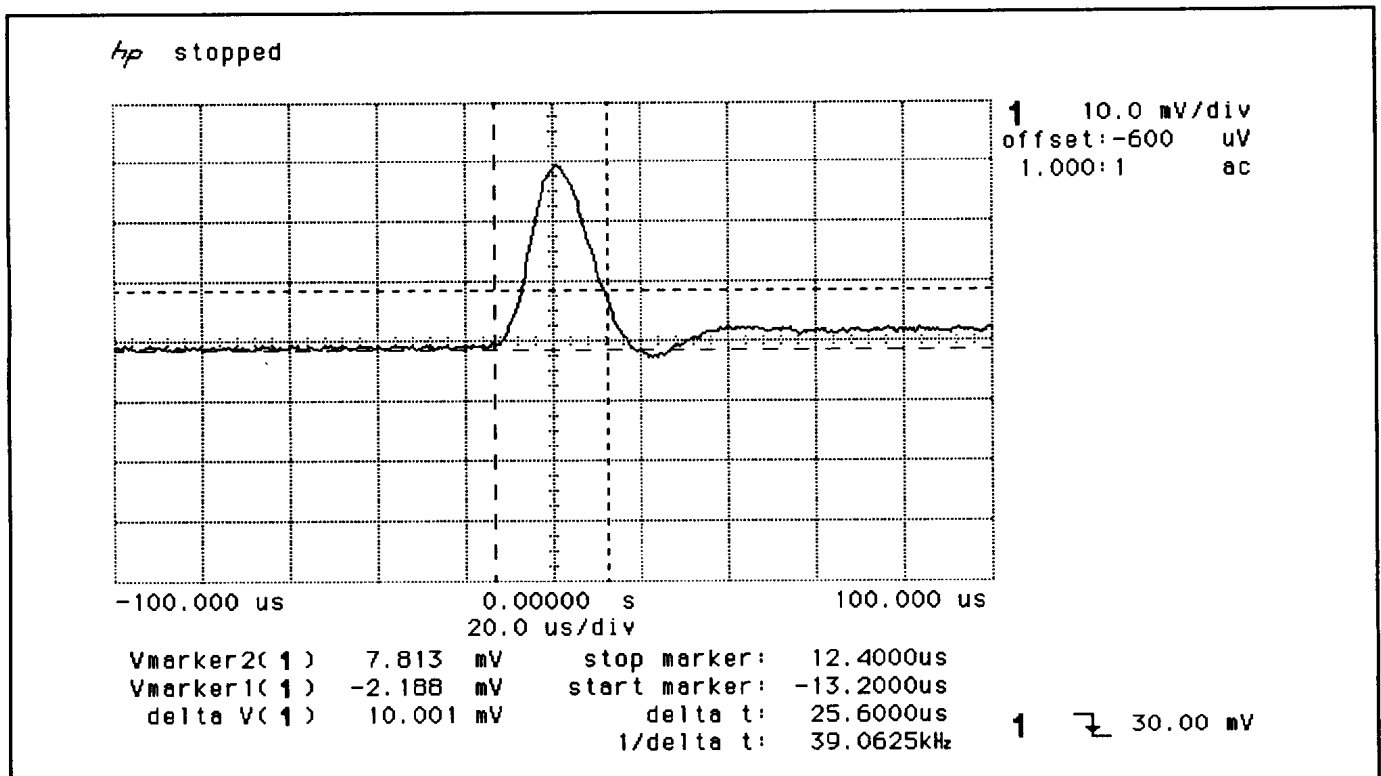


Figure A-3. Load Transient Recovery Waveform

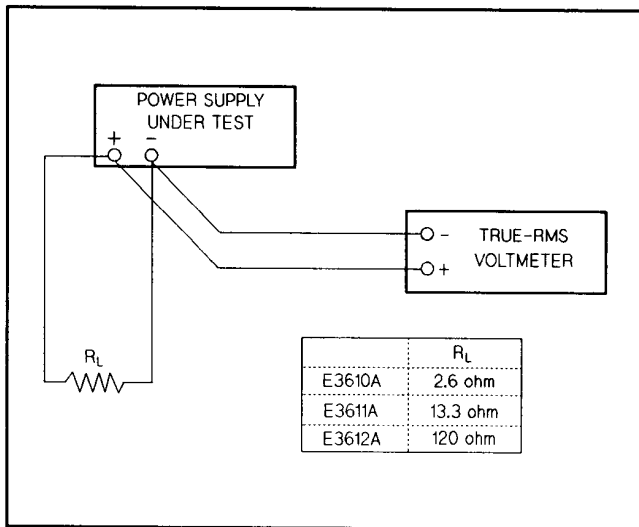


Figure A-4. RMS Measurement Test Setup

### PARD(Peak-to-Peak) Measurement

**Test Parameter:**

Measured Variable: Output voltage(peak-to-peak)

Expected Results: Less than 2 mV p-p

**Test Procedure:**

- Connect the test equipment as shown in Figure A-5.
- Turn the unit's power on and turn CURRENT control fully clockwise.
- Turn up output voltage to the full rated value. Check that the unit's CV Indicator remains lighted. Reduce VOLTAGE control if not lighted.
- Set the oscilloscope to AC mode and bandwidth to 20 MHz.
- Check that the peak-to-peak noise is no more than 2 mV.

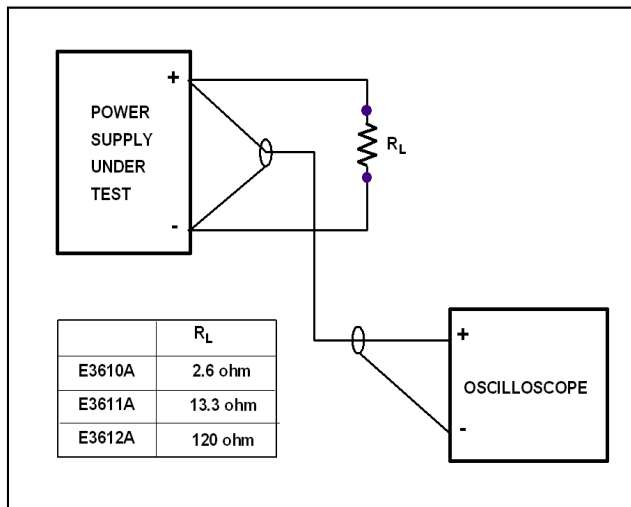


Figure A-5. Peak-to-Peak Measurement Test Setup

### Constant Current(CC) Tests

For output current measurements the current sampling resistor must be treated as a four terminal device. In the manner of a meter shunt,

the load current is fed to the extremes of the wire leading to the resistor while the sampling terminals are located as close as possible to the resistance portion itself. Generally, any current sampling resistor should be of the low noise, low temperature coefficient type and should be used at no more than 5% of its rated power so that its temperature rise will be minimized.

### Load Effect(Load Regulation)

**Definition:** CC Load Effect is the change in dc output current when load resistance changes from short circuit to full load or from full load to short circuit.

**Test Parameter:**

Measured Variable: Output Current

Expected Results: Less than 0.01% plus 1 mA

**Test Procedure:**

- Connect the DVM across  $R_S$  in Figure A-2. Operate the electronic load in constant voltage mode and set its voltage to the full rated value of power supply.
- Turn the unit's power on and turn VOLTAGE control fully clockwise.
- Turn up output current to the full rated value. Check that the AMPS display reads full rated values and CC indicator remains lighted. Reduce CURRENT control if not lighted.
- Record the voltage across  $R_S$  and convert it to current through dividing by  $R_S$ .
- Operate the electronic load in short(input short mode).
- When the reading settles, record voltage across  $R_S$  again. Check that the two recorded readings differ no more than 0.01% of output current plus 1 mA.

### Source Effect(Line Regulation)

**Definition:** Source Effect is the change in dc output current when the ac input voltage changes from the minimum to maximum value( $\pm 10\%$  of nominal voltage).

**Test Parameter:**

Measured Variable: Output Current

Expected Results: Less than 0.01% plus 1 mA

**Test Procedure:**

- Connect the DVM across  $R_S$  in Figure A-2. Operate the electronic load in constant voltage mode and set its voltage to the full rated value of power supply.
- Connect the unit to the ac power line through a variable autotransformer that set for low line voltage(104 Vac for 115 Vec).
- Turn the unit's power on and turn VOLTAGE control fully clockwise.
- Turn up output current to the full rated value. Check that the AMPS display reads full rated values and CC indicator remains lighted. Reduce CURRENT control if not lighted.
- Record output voltage across  $R_S$  and convert it to current through dividing by  $R_S$ .
- Adjust autotransformer to the high line voltage(127 Vac for 115 Vac).
- When the reading settles, record the voltage across  $R_S$  again. Check that the two recorded readings differ no more than 0.01% of output current plus 1 mA.

### PARD(Ripple and Noise)

**Definition:** Periodic and random deviation(PARD) in the unit's output ripple and noise combine to produce a residual ac current as well as

an ac voltage superimposed on the dc output. Constant Current PARD is specified as the root-mean-square(rms) output current in e frequency range of 20 Hz to 20 MHz with the unit in CC operation.

### PARD(RMS) Measurement

**Test Parameter:**

Measured Variable: Output Current(rms)

Expected Results: Less than 200 uA rms

**Test Procedure:**

- Connect the test equipment as shown in Figure A-6.
- Turn the unit's power on and turn the VOLTAGE control fully clockwise.
- Turn up output current to the full rated value. Check that the CC indicator remains lighted. Reduce CURRENT control if not lighted.
- Record rms voltage across  $R_s$  and convert it to current through dividing by  $R_s$ .
- Check that the rms noise current is no more than 200 uA.

### PARD(Peak-to-Peak) Measurement

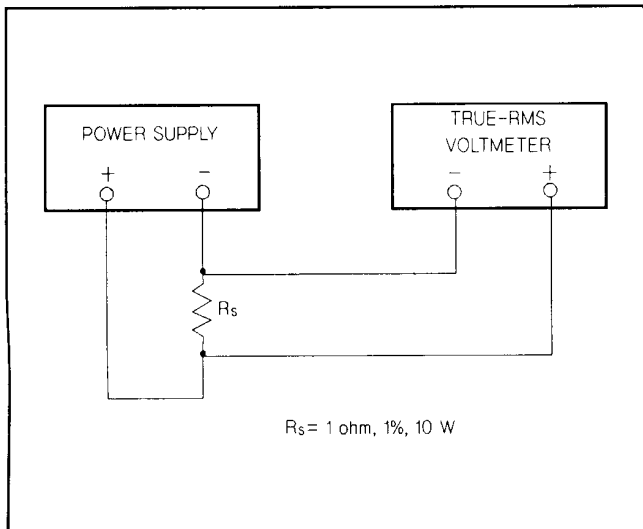
**Test Parameter:**

Measured Variable: Output Current(peak-to-peak)

Expected Results: Less than 1 mA p-p

**Test Procedure:**

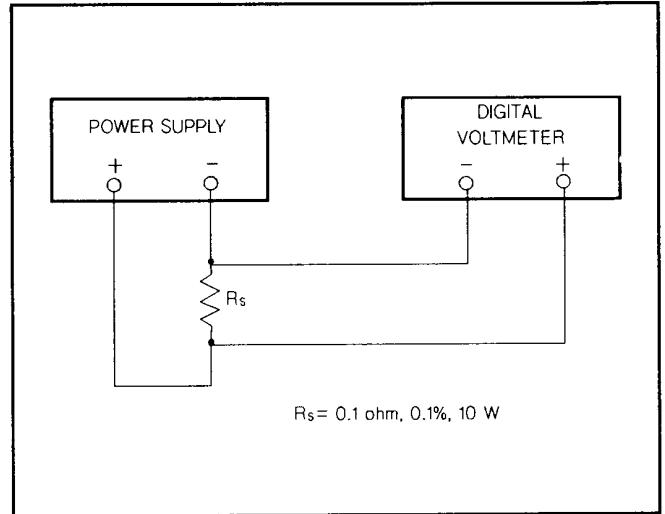
- Connect the test equipment as shown in Figure A-6, but replace the RMS voltmeter with oscilloscope.
- Set the oscilloscope to AC mode and bandwidth to 20 MHz.
- Turn the unit's power on and turn the VOLTAGE control fully clockwise.
- Turn up output current to the full rated value. Check that the CC indicator remains lighted. Reduce CURRENT control if not lighted.
- Record peak-to-peak voltage across  $R_s$  and convert it to current through dividing by  $R_s$ . Check that the peak-to-peak noise current is no more than 1 mA.



**Figure A-6. RMS Measurement Test setup**

### CALIBRATION PROCEDURE

To calibrate ammeter and full scale current, connect test equipments as shown in Figure A-7.



**Figure A-7. Calibration in High Current Range**

### Calibration in High Current Range

- Turn VOLTAGE and CURRENT control fully clockwise.
- Set RANGE push button to high current range.
- Turn on power supply and adjust R31 so that DVM indicates exactly as follows (5% over rated current):  
E3610A: 0.315 V    E3611A: 0.158 V    E3612A: 0.053 V
- Adjust R3 on the display board so that the displayed value on the front panel is equal to DVM value divided by  $R_s$ .
- While depressing CC SET push button, adjust R20 so that the displayed value on the front panel is equal to DVM value divided by  $R_s$ .

### Calibration in Low Current Range

- Set RANGE push button to low current range.
- Adjust R32 so that DVM indicates exactly as follows (5% over rated current).  
E3610A: 0.21 V    E3611A: 0.089 V    E3612A: 0.026 V

### Calibration of VOLTS Meter

- Disconnect the current shunt( $R_s$ ) and connect DVM across output of supply.
- Set RANGE push button to low current range at no load.
- Adjust VOLTAGE control till DVM indicates exactly as follows (full rated voltage):  
E3610A: 15 V    E3611A: 35 V    E3612A: 120 V
- Adjust R10 on the display board so that the value of the front panel display is the same as the value of DVM.

## E361XA REPLACEABLE PARTS LIST

Reference Designator	Agilent Part Number	Q'ty	Description	Mfr. Code	Mfr. Part Number
	E361XA		<b>E361XA POWER SUPPLY</b>		
	0403-0424	2	BUMPER FOOT-ADH MTG	28480	
	5041-8626	1	REAR CAP	28480	
	5041-8627	1	TOP COVER	28480	
	5041-8628	1	BOTTOM COVER	28480	
	0371-3806	1	KEY CAP-WH	28480	
	0371-8624	2	KEY CAP-FLINT GRAY	28480	
	5959-5304	1	OPERATION AND SERVICE MANUAL	28480	
E361XA STD/OE9	8120-1378	1	POWER CORD OPT903	28480	
E361XA OE3	8120-1689	1	POWER CORD OPT902	28480	
	9220-4867	1	PAD-PACKING,FRONT	28480	
	9220-4868	1	PAD-PACKING,REAR	28480	
	E361X-60001	1	<b>MAIN BOARD ASSY</b>		
	0340-0140	2	INSULATOR-XSTR MICA	28480	
	0340-0168	8	INSULATOR BUSHING	28480	
	0515-0926	2	SCR-MACH M4X0.7	28480	
	0515-1162	2	SCR-MACH M5X0.8	28480	
	0515-1711	4	SCR-MACH M3.5X0.6	28480	
	0535-0007	4	NUT-HEX DBL-CHAM M3.5X0.6	28480	
	1400-0307	6	CABLE TIE	28480	
E3610A Q1,3	1854-0611	2	XSTR NPN 2N6056 SI DARL TO-3	04713	2N6056
E3611A Q1,3	1854-0611	2	XSTR NPN 2N6056 SI DARL TO-3	04713	2N6056
E3612A Q1,3	1855-0536	2	XSTR MOSFET IRF440 N-CHAN TO-3	04713	IRF440
	2190-0585	4	WSHR-LK M3.5 ID	28480	
	2190-0586	2	WSHR-LK M4.0 ID	28480	
	2190-0587	2	WSHR-LK M5.0 ID	28480	
	3050-0894	2	WSHR-FL MTLCL 5.0	28480	
S1	3101-3115	1	SW-PB .5A 250AC	28480	
S2	3101-3231	1	SW-PB DPDT 6A 250V	28480	
S3	3101-3230	1	SW-PB DPST 6A 250V	28480	
E3610A STD T1	9100-5249	1	TRANSFORMER, E3610A 115V	28480	
E3610A OE9 T1	9100-5250	1	TRANSFORMER, E3610A 100V	28480	
E3610A OE3 T1	9100-5252	1	TRANSFORMER, E3610A 230V	28480	
E3611A STD T1	9100-5253	1	TRANSFORMER, E3611A 115V	28480	
E3611A OE9 T1	9100-5254	1	TRANSFORMER, E3611A 100V	28480	
E3611A OE3 T1	9100-5255	1	TRANSFORMER, E3611A 230V	28480	
E3612A STD T1	9100-5256	1	TRANSFORMER, E3612A 115V	28480	
E3612A OE9 T1	9100-5246	1	TRANSFORMER, E3612A 100V	28480	
E3612A OE3 T1	9100-5247	1	TRANSFORMER, E3612A 230V	28480	
	0890-1788	.240	SLEEVING FLEXIBLE	28480	
	5062-3403	1	WIRE-HARNASS ASSY-DISPLAY	28480	
	0470-0357	3	SILICONE RUBBER-RTV	28480	
	0890-1788	1	SLEEVING FLEXIBLE	28480	
	5062-3401	1	<b>HEAT SINK ASSY</b>		
	0360-0268	3	TERM-SOLDER LUG	28480	
	0515-0910	3	SCR-MACH M4X0.7	28480	
	1252-4214	1	CONNECTOR-AC POWER	28480	
E361XA STD/OE9 F4	2110-0702	1	FUSE 2A 250V NTD	28480	
E361XA OE3 F4	2110-0599	1	FUSE 250V 1A	28480	
	5022-1631	1	HEAT SINK-DIECASTING	28480	
	E361X-60002	1	<b>MAIN BOARD ASSY</b>		
C1	0160-7077	1	CAP 0.1UF 630V 10% POLY-MET	28480	
E3610A C2	0180-4352	1	CAP 1000UF 50V 20% AL-ELEC	28480	
E3611A C2	0180-4361	1	CAP 4700UF 100V 20% AL-ELEC	28480	
E3612A C2	0180-4351	1	CAP 1000UF 250V 20% AL-ELEC	28480	
E3610A C3	0180-4355	1	CAP 470UF 50V 20% AL-ELEC	28480	
E3611A C3	0180-3595	1	CAP 220UF 100V 20% AL-ELEC	28480	
E3612A C3	0180-3937	1	CAP 100UF 250V 20% AL-ELEC	28480	
E3612 C4,5	0160-0269	2	CAP 0.1UF 500V 20% CER	28480	
E3610A,11A C6	0160-7548	1	CAP 2200PF 50V 10% CER	28480	
E3612A C6	0160-4787	1	CAP 22PF 100V 5% CER	28480	
C7	0180-4085	1	CAP 330UF 35V 20% AL-ELEC	28480	
E3610A,11A C10	0180-3769	1	CAP 6.8UF 35V 10% TA	28480	
E3612A C10	0160-3585	1	CAP 1UF 250V 20% AL-ELEC	28480	
C11,16	0160-6225	2	CAP .33UF 250V 10% POLY-MET	28480	
C8,14,18	0160-7449	3	CAP.33UF 50V 10% PE	28480	
C9,15,19	0180-3970	3	CAP 1UF 50V 20% AL-ELEC	28480	
E3610A C12	0160-7456	1	CAP 180PF 50V 5% CER	28480	
E3611A C12	0160-7080	1	CAP 220PF 50V 5% CER	28480	
E3612A C12	0160-7082	1	CAP 120PF 50V 5% CER	28480	
C13	0180-4355	1	CAP 470UF 50V 20% AL-ELEC	28480	

## E361XA REPLACEABLE PARTS LIST

Reference Designator	Agilent Part Number	Q'ty	Description	Mfr. Code	Mfr. Part Number
C17	0180-3990	1	CAP 4700UF 25V 20% AL-ELEC	28480	
C20	0160-6071	1	CAP 18PF 100V 5% CER	28480	
E3612A C22,23	0160-4832	2	CAP 0.1UF 50V 20% CER	28480	
E3610A R1	0811-1806	1	RES 2K 5% 3W PWI	28480	
E3611A R1	0811-2188	1	RES 5K 5% 3W PWI	28480	
E3612A R1	0699-3105	1	RES 45K 5% 2W MO	28480	
E3610A R2	0811-3478	1	RES .1 1% 5W PWN	28480	
E3611A R2	0811-3839	1	RES .2 1% 5W PWN	28480	
E3612A R2	0811-3861	1	RES 1.78 1% 5W PWN	28480	
R3	0699-2882	1	RES 1.2K 1% .5W TF	28480	
R4,25	0698-4254	2	RES 1K 5% .125W TF	28480	
R5	0698-4002	1	RES 5K 1% .125W TF	28480	
E3610A,11A R6	0699-3266	1	RES 1.5M 5% .125W TF	28480	
E3612A R6	8150-4920	1	JUMPER WIRE 22AWG 1X2	28480	
E3610A,11A R8	0698-4254	1	RES 1K 5% .125W TF	28480	
E3612A R8	0698-4002	1	RES 5K 1% .125W TF	28480	
E3610A,11A R10	0698-3430	1	RES 21.5 1% .125W TF	28480	
E3612A R10,38,39	0757-0398	3	RES 75 1% .125W TF	28480	
E3611A,12A R11,12	0757-0442	2	RES 10K 1% .125W TF	28480	
E3610A R12	8150-4920	1	JUMPER WIRE, 22AWG 1X22	28480	
E3610,11A R13	0813-0001	1	RES 1K 5% 3W PWI	28480	
E3612A R13	0811-2188	1	RES 5K 5% 3W PWI	28480	
R14	0698-4254	1	RES 1K 5% .125W TF	28480	
E3610A R15	0698-4307	1	RES 14.3K 1% .125W TF	28480	
E3611A R15	0757-0290	1	RES 6.19K 1% .125W TF	28480	
E3612A R15	0811-3873	1	RES 3.65K 1% 3W PWN	28480	
R16,26	0698-4278	2	RES 10K 5% .125W TF	28480	
R17	0699-1063	1	RES 900K 1% .125W TF	28480	
E3610A R18	0698-8020	1	RES 100K 1% .125W TF	28480	
E3611A,12A R18	0757-0288	1	RES 9.09K 1% .125W TF	28480	
R20	2100-4306	1	RES-TMMR 50K 10% 25T	28480	
E3610A,11A R22,23	0698-6250	2	RES 2.5K 1% .125W TF	28480	
E3612A R22,23	0757-0440	2	RES 7.5K 1% .125W TF	28480	
R24	0698-4009	1	RES 50K 1% .125W TF	28480	
E3610A R27	0698-8812	1	RES 1 1% .125W TF	28480	
E3611A R27	0699-3200	1	RES 6.8 1% .125W TF	28480	
E3612A R27	8150-4920	1	JUMPER WIRE 22AWG 1X22	28480	
E3610A,11A R28	0757-0439	1	RES 6.81K 1% .125W TF	28480	
E3612A R28	0757-0290	1	RES 6.19K 1% .125W TF	28480	
R29,30	0761-0021	2	RES 1K 5% 1W MO	28480	
R31,32	2100-4305	2	RES-TMMR 10K 10% 25T	28480	
E3610A R33	0698-4440	1	RES 3.40K 1% .125W TF	28480	
E3611A R33	0698-0063	1	RES 5.23K 1% .125W TF	28480	
E3612A R33	0698-4471	1	RES 7.15K 1% .125W TF	28480	
E3610A R34	0698-8957	1	RES 500K 1% .125W TF	28480	
E3611A R34	0698-8825	1	RES 681K 1% .125W TF	28480	
E3610A R35,36	0811-3864	2	RES .6 5% 5W PWN	28480	
E3611A R35,36	0811-3874	2	RES 1.2 5% 5W PWN	28480	
E3612A R35,36	0811-3886	2	RES 10 1% 3W PWN	28480	
R40	0698-4531	1	RES 267K 1% .125W TF	28480	
R41	0698-3155	1	RES 4.64K 1% .125W TF	28480	
E3612A R43	0757-0465	1	RES 100K 1% .125W TF	28480	
E3612A R44,45	0698-3160	2	RES 31.6K 1% .125W TF	28480	
E3610A R46	0811-1799	1	RES 390 5% 3W PWI	28480	
E3611A R46	0813-0001	1	RES 1K 5% 3W PWI	28480	
F1,2	2110-0665	2	FUSE 1A 125V	28480	
F3	0699-2715	1	FUSIBLE RES 1 OHM 5% .5W	28480	
U1	1826-0961	1	IC LF411CN-OP AMP	27014	LF411CN
U2	1826-0147	1	IC V RGLTR FXD 11.5/12.5 TO-220	04713	MC7812CT
U3	1826-1297	1	IC LM336BZ5.0-V RGLTR TO-92	27014	LM336BZ
U4	1826-1075	1	IC LF442CN-OP AMP DUAL 8 DIP-P	27014	LF442CN
U5	1826-0412	1	IC 393 8-DIP-P PKG	27014	LM393CN
U6	1826-0221	1	IC MC7912CT-V RGLTR TO-220	04713	MC7912CT
U7	1826-0144	1	IC MC7805CT-V RGLTR TO-220	04713	MC7805CT
Q2	1853-0590	1	XSTR PNP SI 2N4036	04713	
E3612A Q4,5	1854-0477	2	XSTR NPN 2N2222A SI TO-18	04713	2N2222A
CR2	1906-0255	1	DIODE-FW BRDG 600V 6A	28480	KBPC606
CR3	1901-0848	1	DIODE-PWR RECT 400V 3A	04713	MR854
CR4,5	1901-0461	2	DIODE-GEN PRP 10V .2A	27014	1N4148
CR6,7,10,11	1901-0033	4	DIODE-GEN PRP 180V .2A	27014	1N645
CR8	1901-0327	1	DIODE-PWR RECT 200V 1A	28480	
CR9,13	1906-0284	2	DIODE-FW BRDG 100V 1A	28480	
	0360-2359	10	TERMINAL-TEST POINT	28480	

## E361XA REPLACEABLE PARTS LIST

Reference Designator	Agilent Part Number	Q'ty	Description	Mfr. Code	Mfr. Part Number
	0515-0911	1	SCREW-MACH M3X0.5	28480	
	0515-0918	3	SCREW-MACH M3.5X0.6	28480	
E3610A,11A	1205-0595	3	HEAT SINK PLSTC	28480	
J1	1251-7406	1	CONNECTOR-POST TYPE 10P	28480	
	2190-0584	1	WSHR-LK M3.0 ID	28480	
	2190-0585	3	WSHR-LK M3.5 ID	28480	
E3610A,11A	5002-0202	1	HEAT SINK-BRIDGE DIODE	28480	
L1	9170-0894	1	CORE-SHLD BEAD	28480	
E3612A JP1	8150-4920	1	JUMPER WIRE 22AWG 1X22	28480	
E3610A,11A JP2	8150-4920	1	JUMPER WIRE 22AWG 1X22	28480	
	E361X-60003	1	<b>FRONT PANEL ASSY</b>		
R19	2100-4503	1	RES-VAR 10K 5% 10-TURN CERMET	28480	
E3610A,11A R37	2100-4308	1	RES-VAR 50K 5% 10-TURN WW	28480	
E3612A R37	2100-4307	1	RES-VAR 100K 5% 10-TURN WW	28480	
	5002-0203	1	LUG-GROUND	28480	
	5021-8104	1	PLATE WINDOW	28480	
	5041-8625	1	FRONT FRAME	28480	
E3610A	E3610-80005	1	LABEL FRONT PANEL	28480	
E3611A	E3611-80005	1	LABEL FRONT PANEL	28480	
E3612A	E3612-80005	1	LABEL FRONT PANEL	28480	
	8151-0013	.025	COPPER WIRE 22 AWG 1X22	28480	
	E3631-20011	1	BINDING POST,RED	28480	
	E3631-20012	1	BINDING POST,BLACK	28480	
	E3631-20013	1	BINDING POST,GREEN	28480	
	5041-8621	1	KNOB	28480	
	2950-0144	3	NUT-HEX-DBL-CHAM	28480	
E3610A	E3610-60005	1	<b>DISPLAY BOARD ASSY, E3610 10P</b>	28480	
E3611A	E3611-60005	1	<b>DISPLAY BOARD ASSY, E3611 10P</b>	28480	
E3612A	E3612-60005	1	<b>DISPLAY BOARD ASSY, E3612 10P</b>	28480	

Component	Model		
	E3610A	E3611A	E3612A
C2	1000UF 50V +-20% AL-ELECTLT	4700UF 100V +-20% AL-ELECTLT	1000UF 250V +-20% AL-ELECTLT
C4,5			0.1UF 500V +-20% CER
C3	470UF 50V +-20% AL-ELECTLT	220UF 100V +-20% AL-ELECTLT	100UF 250V +-20% AL-ELECTLT
C6	2200PF 50V +-10% CER	2200PF 50V +-10% CER	22PF 100V +-5% CER
C12	180PF 50V +-5% CER	220PF 50V +-5% CER	120PF 50V +-5% CER
C22,23			0.1UF 50V +-20% CER
R1	2K +-5% 3W PWI	5K +-5% 3W PWI	45K +-5% 2W MO
R2	0.1 +-1% 5W PWN	0.2 +-1% 5W PWN	1.78 +-1% 5W PWN
R6	1.5M +-5% .125W TF	1.5M +-5% .125W TF	JUMPER WIRE
R8	1K +-5% .125W TF	1K +-5% .125W TF	5K +-5% .125W TF
R10	21.5 +-1% .125W TF	21.5 +-1% .125W TF	75 +-1% .125W TF
R11		10K +-1% .125W TF	10K +-1% .125W TF
R12	JUMPER WIRE	10K +-1% .125W TF	10K +-1% .125W TF
R13	1K +-5% 3W PWI	1K +-5% 3W PWI	5K +-5% 3W PWI
R15	14.3K +-1% .125W TF	6.19K +-1% .125W TF	3.65K +-1% 3W PWN
R18	100K +-1% .125W TF	9.09K +-1% .125W TF	9.09K +-1% .125W TF
R22,23	2.5K +-1% .125W TF	2.5K +-1% .125W TF	7.5K +-1% .125W TF
R27	1 +-1% .125W TF	6.8 +-1% .125W TF	JUMPER WIRE
R28	6.81K +-1% .125W TF	6.81K +-1% .125W TF	6.19K +-1% .125W TF
R33	3.4K +-1% .125W TF	5.23K +-1% .125W TF	7.15K +-1% .125W TF
R34	500K +-1% .125W TF	681K +-1% .125W TF	
R35,36	0.6 +-5% 5W PWN	1.2 +-5% 5W PWN	10 +-5% 3W PWN
R37	50K +-5% 10-TURN WW	50K +-5% 10-TURN WW	100K +-5% 10-TURN WW
R38,39			75 +-1% .125W TF
R43			100K +-1% .125W TF
R44,45			31.6K +-1% .125W TF
R46	390 +-5% 3W PWI	1K +-5% 3W PWI	
Q4,5			XSTR NPN 2N2222A SI TO-18
JP1			JUMPER WIRE
JP2	JUMPER WIRE	JUMPER WIRE	

\* COMPONENT VALUE TABLE

NOTES:

- 1.The value of all component \*marked are shown in the above component value table.
- 2.All resistors are .125W, +-5%, and ohms, unless otherwise specified.
- 3.All capacitors are microfarads, unless otherwise specified.
- 4.S1A CC SET switch shown is OFF position.
- 5.S2B RANGE selector switch shown is high current range.
- 6.Voltages between TP2 and TP4 in low current range are as follows.

E3610A 25V +- 10%  
E3611A 47V +- 10%  
E3612A 152V +- 10%



## CERTIFICATION

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

## WARRANTY

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

For warranty service, with the exception of warranty options, this product must be returned to a service facility designated by Agilent. Return to Englewood Colorado Service Center for repair in United States(1-800-258-5165). Customer shall prepay shipping charges by (and shall pay all duty and taxes) for products returned to Agilent for warranty service. Except for the products returned to Customer from another country, Agilent shall pay for return of products to Customer.

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

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

The warranty period begins on the date of delivery or on the date of installation if installed by Agilent.

## LIMITATION OF WARRANTY

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

*For consumer transactions in Australia and New Zealand:*

The warranty terms contained in this statement, except to the extent lawfully permitted, do not exclude, restrict or modify and are in addition to the mandatory rights applicable to the sale of this product to you.

## EXCLUSIVE REMEDIES

TO THE EXTENT ALLOWED BY LOCAL LAW, THE REMEDIES PROVIDED HEREIN ARE THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. AGILENT SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

## ASSISTANCE

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



## DECLARATION OF CONFORMITY

according to ISO/IEC Guide 22 and EN 45014

**Manufacturer's Name:** Agilent Technologies, Inc.

**Manufacturer's Address:** 345-15, Kasan-dong, Kumchon-ku,  
Seoul 153-023 Korea

**declares, that the products**

Product Name: DC Power Supply

Model Numbers: E3610A, E3611A, and E3612A

Product Options: All Options

**conforms to the following Product Specifications:**

Safety: IEC 1010-1:1990+A1:1992 / EN 61010-1:1993

EMC: CISPR 11:1990 / EN 55011:1991 - Group 1 Class A<sup>1)</sup>  
EN 50082-1:1992

IEC 801-2 : 1991 - 4KV CD, 8KV AD

IEC 801-3 : 1984 - 3V/m

IEC 801-4 : 1988 - 1kV Power Lines  
0.5kV Signal Lines

**Supplementary Information:** The product herewith comply with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carry the "CE" mark accordingly.

<sup>1)</sup>The products was tested in a typical configuration with Agilent Technologies Test System.

Seoul, Korea      November 1, 1999



Quality Manager

European Contact for regulatory topics only: Hewlett-Packard GmbH, HQ-TRE, Herrenberger Strabe 110-140,  
D-71034 Böblingen (FAX: +49-7031-143143).