Associated Power Technologies
A DIVISION OF IKONIX USA

LS Series

Linear AC Power Source

Operation Manual for Models

LS500
LS1000

Ver. 1.12
PART #39097

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CE DECLARATION OF CONFORMITY

Manufacturer: Associated Power Technologies, Inc.

Address:	28105 North Keith Drive Lake Forest, IL 91765 USA
Product Name:	LS 500, LS 1000 Power Source
Model Number:	LS 500, LS 1000

Conforms to the following Standards:

Safety:	EN 61010-1:2010 IEC 61010-1:2010
EMC:	EN 61326-1:2006(EN 55011:1998/A2:2002 Class A, EN 61000-3-3:1995/A1:2001/A2:2005, IEC61000-4-2:1995/A2:2000, IEC 61000-4-3:2002, IEC61000-4-4:2004, IEC 61000-4-5:1995/A1:2000, IEC 61000-4-6:2003, IEC 61000-4-8:1993/A1:2000, IEC 61000-4-11:2004)

Supplementary Information

*The product herewith complies with the requirements of the **Low Voltage Directive 2014/35/EU**, the **EMC Directive 2014/30/EU**, and the **RoHS Directive 2011/65/EU** with respect to the following substances: Lead (Pb), Mercury (Hg), Cadmium (Cd), Hexavalent chromium (Cr (VI)), Polybrominated biphenyls (PBB), Polybrominated diphenyl ethers (PBDE), Deca-BDE included.*

Last two digits of the year in which the CE marking was affixed: 10

The technical file and other documentation are on file with Associated Research, Inc.

Joseph Guerriero, President
Associated Power Technologies, Inc.
Lake Forest, Illinois USA
July 20, 2017

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1. Introduction

1.1 Warranty

Associated Power Technologies, Inc. (APT), certifies that the instrument listed in this manual meets or exceeds published manufacturing specifications. This instrument was calibrated using standards that are traceable to the National Institute of Standards of Technology.

Your new instrument is warranted to be free from defects in workmanship and material for a period of 3 years from date of shipment. During the warranty period, you must return the instrument to Associated Power Technologies, Inc. or its branches for repair. Associated Power Technologies reserves the right to use its discretion on replacing the faulty parts or replacing the assembly or the whole unit.

APT will void your warranty under the following conditions:

- Operation of the instrumentation under non-normal conditions
- Any non-authorized modifications, tampering or physical damage
- Elimination of any connections in the earth grounding system or bypassing any safety systems
- Use of non-authorized parts in the repair of this instrument. Parts used must be parts that are recommended by APT as an acceptable specified part

This warranty does not cover accessories not of Associated Power Technologies, Inc. manufacture.

Except as provided herein, APT, makes no warranties to the purchaser of this instrument and all other warranties, expressed or implied (including, without limitation, merchantability or fitness for a particular purpose) are hereby excluded, disclaimed and waived.

APT recommends that your instrument be calibrated on a twelve month cycle. Instruments returned to APT annually for calibration fall under our extended warranty which can be extended up to five years. Each year the instrument is returned to APT in consecutive years the warranty is extended one additional year. This process can be repeated up to four years for a 5-Year Warranty.

Instruments returned for warranty repair within the first six months of the warranty period, will have the warranty extended for one year from the date of repair at no charge. Instruments received after the first six months can have the warranty extended for 3 months after its original expiration date at no charge or the warranty can be extended for a full year at the cost of an annual calibration.

1.2 Glossary of Terms

Alternating Current (AC) - current that reverses direction on a regular basis (usually 60 times per second in the United States). Measured in amps.

AC Power Source - An instrument that takes one AC voltage and frequency level and converts it into another AC voltage and frequency level.

Amplifier - a circuit that boosts an input signal from one level to another.

Apparent Power - The total power generated or consumed by a device due to real and reactive circuit components. Measured in VA (volt-amps).

Calibration - the process of comparing an unknown value with a reference standard and reporting the results. For example: Applied = 1.30V, Indicated = 1.26V (or Error= -0.04V). Calibration may include adjustment to correct any deviation from the value of the standard.

Crest Factor - The ratio of peak current (Apeak) to RMS current (Arms).

Complex Power – the vector sum of the real and reactive power components of a circuit. Measured in VA (volt-amps).

Direct Current (DC) - current that only flows in one direction. Direct current comes from a polarized source, meaning one terminal is always at a higher potential than the other. Measured in amps.

Frequency - The number of times a waveform completes a cycle in a period of time. Measured in hertz.

Inrush Current - A term used to describe the current needed to power a load upon start-up. Some loads require a large/inrush starting current in order to operate.

Linear Power Source - a power source that uses a simple amplifier to linearly increase the amplitude of the output waveform.

OC Fold - Over current fold back is a technology used in power sources that keeps output current constant by reducing the voltage in order to power loads that may have a high inrush current.

PFC - Power Factor Correction is a method by which an inductance is inserted into the input circuit of a power source to improve the power factor and overall efficiency of the system.

Phase Angle - the degree of measurement that corresponds to an AC waveform's amplitude. Measured from 0 – 360 degrees.

PLC - Programmable Logic Control is an automation method using relay or digital technology.

Power - A generic term used to describe electrical work being done. There are many types of power, including real power, reactive power, apparent power, and complex power.

Power factor - The ratio of real power (watts) to apparent power (VA). Based on a scale from 0 to 1 to determine how reactive and resistive a load is.

Reactive Power – the power absorbed by capacitive or inductive elements in a circuit. This power does no work. Measured in VAR (volt-amps reactive).

Real Power – the power that performs work in a circuit. Measured in watts.

Response Time - The time that is needed to regulate the voltage, current, frequency, and power output when a load is added to the power source.

Safety Agency Listing - A safety mark given to a product that has met stringent benchmarks as classified by the authorized agency.

Steady State Current - A term used to describe the current when the load is running nominally after the inrush current.

Switching Power Source - A power source that uses switching technology (integrated circuits and components) in order to generate the output waveform.

Total Harmonic Distortion (THD) - A percentage that is used to identify the degree of the noise/unclean signal in a power source's output waveform.

Transient - a momentary change (spike or dip) in a voltage or current waveform that can affect the performance of the DUT.

Verification - comparison of measured results against a specification, usually the manufacturer's published performance figures for the product (e.g. *Error = -0.04V, Spec = ±0.03V*, result: *"FAIL"*).

Voltage - The amount of force that is needed to move current from point to point. Measured in volts.

1.3. Safety Symbols

1.3.1 Product Marking Symbols

Product will be marked with this symbol when it is necessary to refer to the operation and service manual in order to prevent injury or equipment damage.

Product will be marked with this symbol when hazardous voltages may be present.

Product will be marked with this symbol at connections that require earth grounding.

1.3.2 Caution and Warning Symbols

Calls attention to a procedure, practice, or condition that could possibly cause bodily injury or death.

Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

1.4 Safety Precautions

- This product and its related documentation must be reviewed for familiarization with safety markings and instructions before operation.
- Before applying power verify that the instrument is set to the correct line voltage and the correct fuse is installed

To prevent accidental injury or death, these safety procedures must be strictly observed when handling and using the test instrument.

1.5 Service and Maintenance

User Service

To prevent electric shock do not remove the instrument cover. There are no user serviceable parts inside. Routine maintenance or cleaning of internal parts is not necessary. Any external cleaning should be done with a clean dry or slightly damp cloth. Avoid the use of cleaning agents or chemicals to prevent any foreign liquid from entering the cabinet through ventilation holes or damaging controls and switches.

Some chemicals may also damage plastic parts or lettering. Any replacement cables and high voltage components should be acquired directly from APT or its distributors.

Service Interval
The instrument must be returned at least once a year to an APT authorized service center for calibration and inspection of safety related components. APT will not be held liable for injuries suffered if the instrument is not properly maintained and its safety checked annually.

User Modifications
Unauthorized user modifications will void your warranty. APT will not be responsible for any injuries sustained due to unauthorized equipment modifications or use of parts not specified by APT. Instruments returned to APT with unsafe modifications will be returned to their original operating condition at the customer's expense.

2. Getting Started

This section contains information for the unpacking, inspection, preparation for use and storage of your APT product.

2.1 Unpacking and Inspection

Your instrument was shipped in a protective shipping carton designed to protect the instrument through the shipping process. If the shipping carton is damaged, inspect the contents for visible damage such as dents, scratches, or broken display. If the instrument is damaged, notify the carrier and APT's customer support department. Please save the shipping carton and packing material for the carrier's inspection. Our customer support department will assist you in the repair or replacement of your instrument. Please do not return your product without first notifying us.

Safe Lifting and Carrying Instructions

Proper methods of lifting and carrying can help to protect against injury. Follow the recommendations below to ensure that instruments are handled in a safe manner.

- Determine if the instrument can be lifted by one individual or requires additional support.
- Make sure that your balance is centered and your feet are properly spaced, shoulder width apart behind the instrument.
- Bend at the knees and make sure your back is straight.
- Grip the instrument with your fingers and palms and do not lift unless your back is straight.
- Lift up with your legs, not your back.
- Keep the instrument close to your body while carrying.
- Lower the instrument by bending your knees. Keep you back straight.

2.2 Preparation For Use

Models 500 and 1000 require an input line voltage of 115/230 volts AC ± 10%, 47 – 500 Hz single phase. Please check the rear panel to be sure the proper switch setting is selected for your line voltage requirements before turning your instrument on.

CAUTION Do not switch the line voltage selector switch located on the rear panel while the instrument is plugged into an outlet. This may cause internal damage and represents a safety risk to the operator.

2.3 Input Power Considerations

The terminal strip located on the rear panel of LS1000 is designed to accept line, neutral, and a safety earth ground. Connections should be made using properly rated wire based on each application's input current specifications. Refer to the following figures for input/output current requirements:

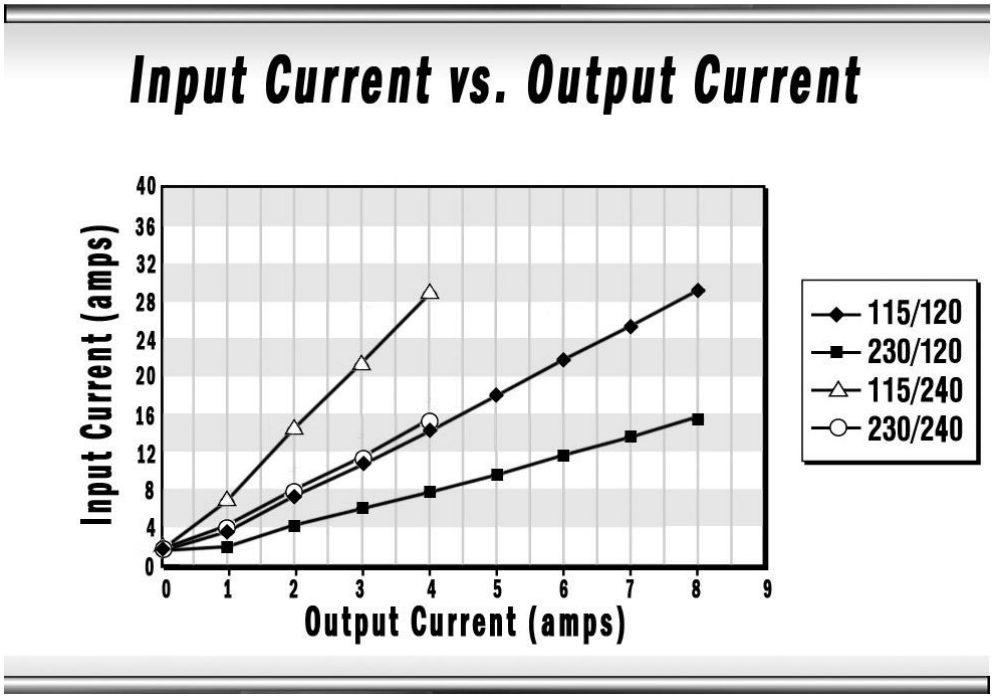


Figure 1

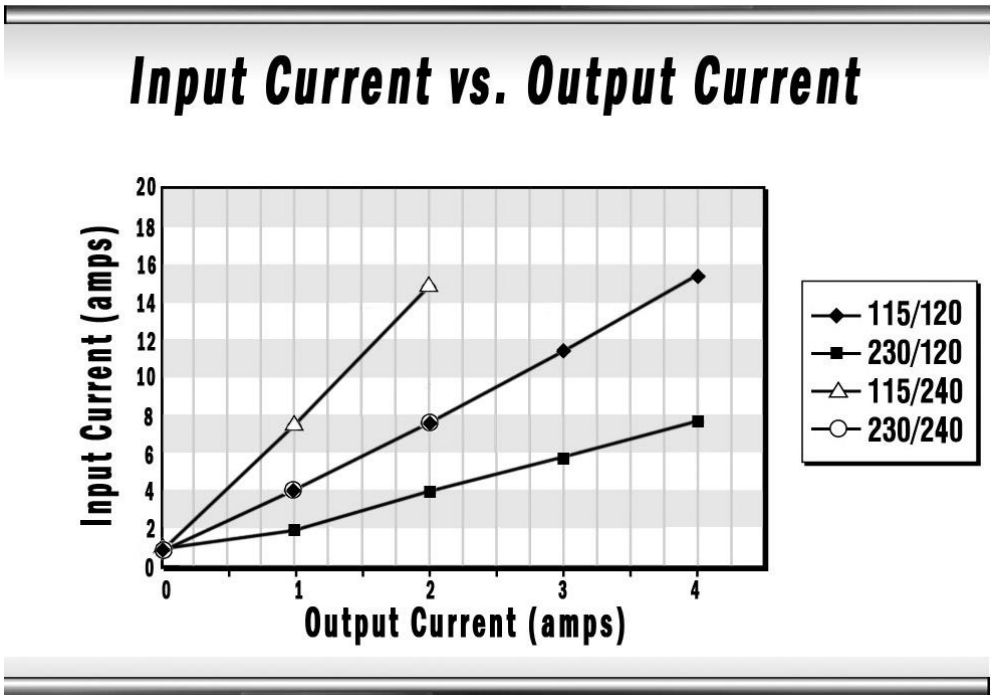

Input Current vs. Output Current
Input Current (amps)
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
Output Current (amps)
115/120
230/120
115/240
230/240

Figure 2

2.3.1 Selecting the Appropriate Wire Gauge

Below is the American Wire Gauge (AWG) table which may be used as a reference to determine the appropriate copper wire gauge based on the maximum rated current output of a 15, 20 and 30 Amp circuit breaker.

This table corresponds to posted NEC (National Electric Code) specifications for copper wire at an ambient temperature of 30 °C and is provided for reference only.

Conductor Size		Number of Current Carrying Conductors			
AWG	**mm2**	**2**	**3**	**4-6**	**7-24**
18	0.75	10	7	5.6	x
16	1.0	13	10	8.0	x
14	1.5	18	15	12.0	x
12	2.5	25	20	16.0	x
10	4.0	30	25	20.0	x
8	6.0	40	35	28.0	x
6	10.0	55	45	36.0	x
Conductor sizes do not represent exact dimensional equivalents.					

2.3.2 Installing the Power Line Cord

Once the proper wire gauge has been selected and a suitable input power cable has been assembled, it must be connected to the LS1000 input terminal block. The input terminal block is located on at the rear of the unit under a plastic shield. In order to access the screw terminals, two screws binding the shield to the terminal block must be removed. When mounting the lugs to the screw terminals, be sure that the wire comes from underneath the protective shield. The protective shield should be remounted once the line cord has been connected to the input terminal block

The mains plug is used as the disconnecting device and shall remain readily operable. The socket-outlet shall be installed. Near the equipment and shall be easily accessible.

The main plug shall only be inserted in a socket outlet with a protective ground (earth) contact. This protective ground **must not be defeated** by the use of an extension cord without a protective conductor.

Do not replace the power supply cord with an improperly rated cord. For North American: A UL listed and CSA labeled power cord must be used with the instrument in the United States and Canada. The power cord must include a NEMA5-15 style male plug, SVT or SJT cord sets, and be rated for at least 125VAC, 10A, number 16 gauge (or 125VAC, 15A, number 14 gauge) wire or larger, and the length of the cord does not exceed 2 m must

be used. For European: A certified power supply cord not lighter than light PVC sheathed flexible cord according to IEC 60227, designation H03 VV-F or H03 VVH2-F (for equipment mass not exceeding 3 kg), or H05 VV-F or H05 VVH2-F2 (for equipment mass exceeding 3 kg), and be rated for at least 3G 0.75 mm² (for rated current up to 10 A) or 3G 1.0mm² (for rated current over 10 A up to 16 A) wire or larger, and the length of the cord does not exceed 2 m must be used.

2.4 Environmental Conditions

Operating Environment
Temperatures: 5º - 40º C (41º - 104º F)
Relative humidity: 20% - 80%
Altitude: 2,000 meters (6,562 feet)

Do not block any ventilation openings to prevent over heating of the equipment. Keep the ventilation slits uncovered during operation. Failure to do so could cause the instrument to overheat and may damage internal components.

The instrument should also be protected against temperature extremes which may cause condensation within the instrument.

If the instrument is used in a matter not specified by the manufacturer, the protection provided by the instrument may be impaired.

Storage and Shipping Environment
This instrument may be stored or shipped in environments with the following limits:
Temperature……..-40º to +55º C (-40 to 131º F)
Altitude…….7,620 meters (25,000 feet)

2.5 Packaging

Please enclose the instrument with all options, accessories and test leads. Also, please mark the container “FRAGILE” to ensure proper handling. All returns must be accompanied by a return material authorization (RMA) number which is provided by the customer support department. All instruments shipped without a RMA number will result in additional fees for handling and storage.

APT will not be responsible for any repair costs associated with shipping damage as a result of improper packaging. The customer is responsible for providing adequate shipping insurance coverage while shipping an instrument in the event of loss or damage while in transit.

3. Specifications and Controls

3.1 Specifications

Model		LS500	LS1000
INPUT			
Phase		1Φ	
Voltage		115/230 VAC Selectable ± 10% Variation	
Frequency		50/60 Hz ± 5%	
Fuse		115VAC/15Amax, 8A x2(parallel) Slow-Blo 250VAC internal	115VAC/30Amax, 16A x2(parallel) Slow-Blo 250VAC internal
		230VAC/7.5Amax, 8A x2(series) Slow-Blo 250VAC internal	230VAC/15Amax, 16A x2(series) Slow-Blo 250VAC internal
OUTPUT			
Max. Power		500 VA	1 KVA
Voltage		0 - 300 VAC	
Frequency		45 - 500 Hz	
Max. Current (r.m.s)	0-150 V	4.2 A @ 120V	8.4 A @ 120V
	0-300 V	2.1 A @ 240V	4.2 A @ 240V
Phase		1Φ	
Total Harmonic Distortion (THD)		<0.5% @ 45-500Hz (Resistive Load)	
Crest Factor		≥ 4	
Line Regulation		± 0.1 V	
Load Regulation		±0.5% (Resistive Load)	
Response Time	Hardware	<100µs	
	Firmware	<1s	
SETTINGS			
Voltage	Low Range	0 - 150V	
	High Range	0 - 300V	
	Resolution	0.1V	
	Accuracy	±(1.5% of setting + 2 counts)	
Frequency	Range	45 - 500 Hz	
	Resolution	0.1 Hz at 45.0 - 99.9 Hz, 1 Hz at 100 - 1000 Hz	
	Accuracy	±0.02% of setting	
Current Hi-Limit	Low Range	OFF, 0.01 - 8.40 A	
	High Range	OFF, 0.01 - 4.20 A	
	Resolution	0.01 A	
	Accuracy	±(2.0% of setting + 3 counts)	
OC Fold Back		ON, OFF	

Model			LS500	LS1000
MEASUREMENT				
Voltage	Range		0.0 - 300.0 V	
	Resolution		0.1 V	
	Accuracy		±(1.5% of reading + 2 counts) (Option 04 1.5% of reading + 4 counts)	
Frequency	Range		0.0 - 500.0 Hz	
	Resolution		0.1 Hz	
	Accuracy		±0.1 Hz	
Current	Range	L	0.000 - 3.500A (2.0mA - 350.0 mA Option 5)	
		H	3.0 - 35.00 A	
	Resolution	L	0.001 A (0.1mA Option 5)	
		H	0.01 A	
	Accuracy		±(2.0% of reading + 3 counts) for high range ±(2.0% of reading + 5 counts) for low range (±{0.6% of reading + 5 counts} Option 5)	
Power	Range	L	0.0 - 350.0 W (0.20 - 3500 W Option 5)	
		H	300 - 4000 W	
	Resolution	L	0.1 W (0.01W Option 5)	
		H	1 W	
	Accuracy		±(5.0% of reading + 3 counts) for high range ±(5.0% of reading + 5 counts) for low range (±{0.6% of reading + 5 counts} Option 5)	
Power Factor	Range		0.000 - 1.000	
	Resolution		0.001	
	Accuracy		W/VA, Calculated value	
SYSTEM SETTINGS				
Power Up Settings	P-UP		On, Last, Off	
Voltage Limits	Hi/Lo Volt		0.0 - 300.0 V	
Frequency Limits	Hi/Lo Freq		45.0 - 500.0 Hz	
Over Current Foldback	Fold OC		On, Off	
Lock	Loc		On, Off	
GENERAL				
Safety Agency Listing			CE, cTUVus, RoHS2	
Inrush Current			4 times the current rating	
Enhanced Over Load Capacity			105% over current for 500 ms w/o protection	
Operation Key Feature			Up/Down Arrow Key	
Memory			3 Memories (M1, M2, M3), (7 Memories Option 4)	
PLC Remote Interface			Input: Test, Reset Recall Memories 1-3 (1-7 Option 4), Output: Fail, Test-in-Process	
Fan			Yes	
Front Output			Universal Receptacle	
Rear Output			Terminal Block (LS1000), Universal Receptacle (LS500)	
Displays			4 LED Displays	
Rack Mount Kit			Standard	
Protection Circuits			Over Current, Over Voltage, Over Temperature	
Calibration			Front panel software	
CE Mark			Yes	
Dimensions (W x H x D)	Inches		16.93 x 3.50 x 15.74 in.	16.93 x 3.50 x 22.05 in.

	Millimeters	430 x 89 x 400 mm	430 x 89 x 560 mm

Model		LS500	LS1000
Net Weight	Pounds	55 lbs.	80 lbs.
	Kilograms	25 kg	36 kg
OPTIONS			
Grounded Neutral	Option 2	Yes	
7 Memory Remote Recall	Option 4	Yes	
Low Power & Current Meter	Option 5	Yes	

Why use the term "Counts"?

Associated Power Technologies publishes some specifications using COUNTS which allows us to provide a better indication of the tester's capabilities across measurement ranges. A COUNT refers to the lowest resolution of the display for a given measurement range. For example, if the resolution for voltage is 1V then 2 counts = 2V.

3.2 Instrument Controls

3.2.1 Front Panel Controls

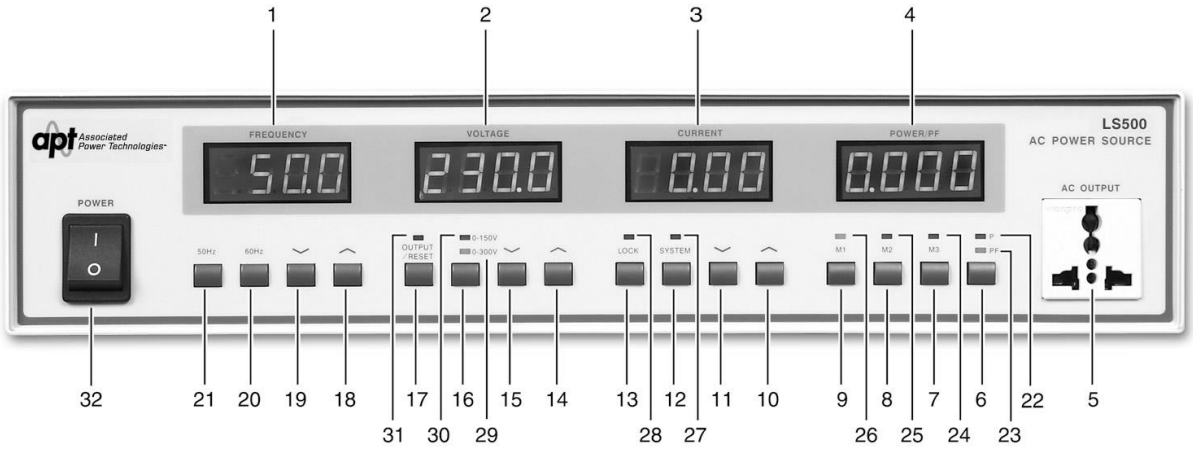


Figure 3

1. **Frequency Display:** Shows the output frequency during operation. Shows the parameter item when in the system setting mode. Shows the error condition if an error has occurred.

2. **Voltage Display:** Shows the output voltage during operation. Shows the parameter item when in the system setting mode.

3. **Current Display:** Shows the Hi-limit of output current during operation. Shows the parameter condition and value when in the system setting mode.

4. **Power/PF Display:** Displays the output power (watts) or power factor.

5. **Universal AC Output Socket:** Output Socket (15A).

6. **P/PF Select Button:** Toggles display of output power or power factor.

7. **M3 Button:** Stores settings in memory or recalls memory M3.

8. **M2 Button:** Stores settings in memory or recalls memory M2.

9. **M1 Button:** Stores settings in memory or recalls memory M1.

10. **Current Up Key:** Increases the output current during operation or selects the system condition in the system setting mode.

11. **Current Down Key:** Decreases the output current during operation or selects the

system condition in the system setting mode.

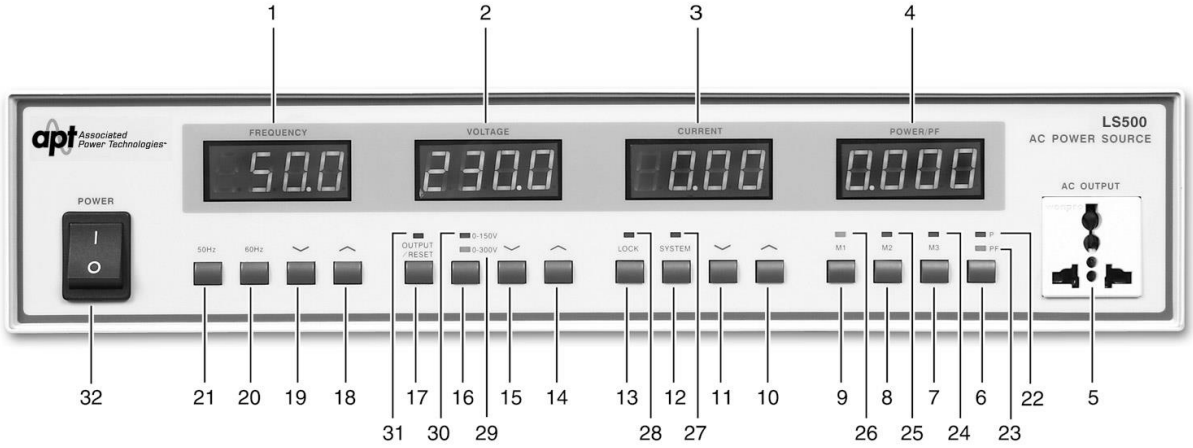


Figure 3

12. **SYSTEM Key:** Enters or exits the system setting mode.

13. **LOCK Key:** Disables all the keys on the front panel.

14. **Voltage Up Key:** Increases the output voltage during operation or selects the system item in system setting mode.

15. **Voltage Down Key:** Decreases the output voltage during operation or selects the system item in system setting mode.

16. **Range Key:** Toggles between the High (0-300V) and Low Voltage Ranges (0-150V).

17. **OUTPUT/RESET Key:** Turns the output ON and OFF. Resets the source if an error occurs.

18. **Frequency Up Key:** Increases the output frequency during operation.

19. **Frequency Down Key:** Decreases the output frequency during operation.

20. **60 Hz Frequency Key:** Press to set the output frequency to 60 Hz.

21. **50 Hz Frequency Key:** Press to set the output frequency to 50 Hz.

22. **Wattmeter Indicator:** When this LED is ON, the display shows the output power.

23. **Power Factor Indicator:** When the LED is ON, the display shows the output power factor.

24. M3 Indicator: When the LED is ON, the output is set according to M3.

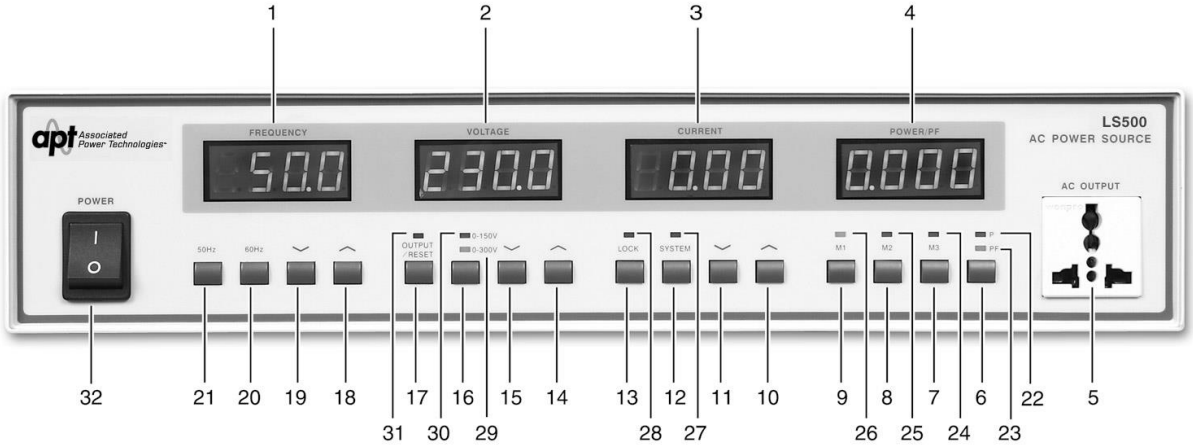


Figure 3

25. M2 Indicator: When the LED is ON, the output is set according to M2.

26. M1 Indicator: When the LED is ON, the output is set according to M1.

27. SYSTEM Indicator: When the LED is ON, the system setting menu is activated.

28. LOCK Indicator: When this LED is ON, all the keys are disabled.

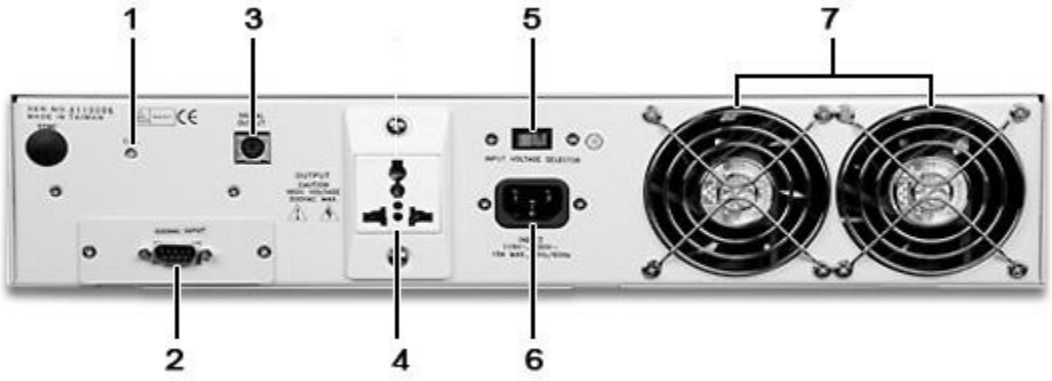
29. 0-300V Indicator: When the LED is ON the output is set to High range.

30. 0-150V Indicator: When the LED is ON, the output is set to Low range.

31. OUTPUT/RESET Indicator: When the LED is ON the source is operating normally. When the LED is OFF the output voltage is deactivated. When the LED is blinking the source has experienced an error.

32. Power Switch: Turns the power source ON or OFF.

3.2.2 LS500 Rear Panel Controls



1. Calibration Key: Press and hold during power-up to enter Calibration Mode.

2. Remote Signal Input: 9-in D sub-miniature female connector for remote control of TEST, RESET, and MEMORY SELECTION functions (See Section 5. Connection of Remote I/O for more detailed information).

3. Remote Signal Output: 6-pin mini-DIN female connector for monitoring FAIL and PROCESSING output relay signals (see Section 5. for more detailed information).

4. Universal AC Output Socket: Universal Output Socket (15A).

5. Input Voltage Selection Switch: Configures the power source to accept 115 VAC or 230 VAC inputs.

6. Input Power Receptacle: Standard IEC 320 connector for connection to a standard NEMA style line power (mains) cord.

7. Thermal Fans: Used to cool the instrument.

3.2.3 LS1000 Rear Panel Controls

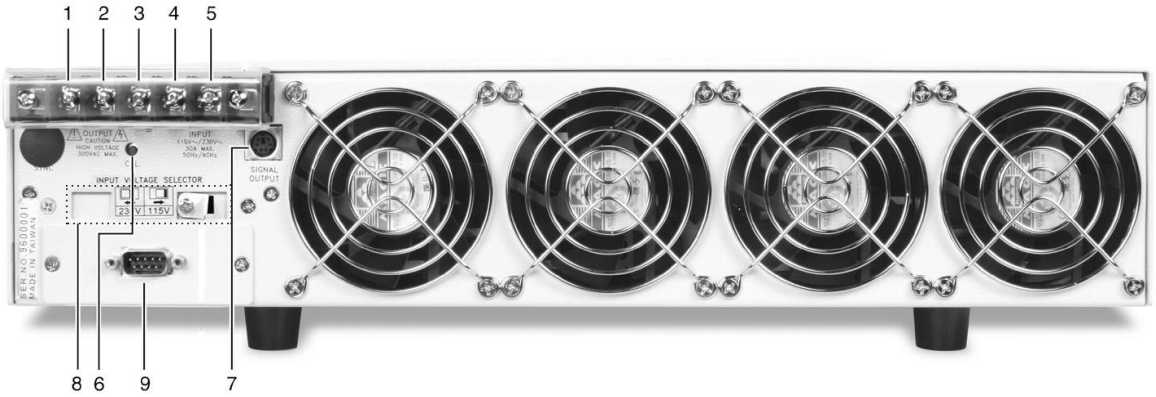


Figure 4

1. Line Output Terminal: High voltage output screw terminal.

2. Neutral Output Terminal: Neutral (return) screw terminal.

3. Ground Input Terminal: Earth ground (chassis) connection for line cord.

4. Line Input Terminal: High voltage input screw terminal for line cord.

5. Neutral Input Terminal: Neutral (return) screw terminal for line cord.

Note: the LS series includes a hard cover for the input/output terminal block when shipped from the factory.

6. Calibration Key: Press and hold during power-up to enter Calibration Mode.

7. Remote Signal Output: 6-pin mini-DIN female connector for monitoring FAIL and PROCESSING output relay signals (see Section 5. for more detailed information).

8. Input Voltage Selection Switch: Configures the power source to accept 115 VAC or 230 VAC inputs.

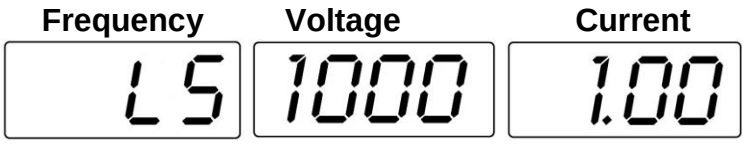
9. **Remote Signal Input**: 9-in D sub-miniature female connector for remote control of TEST, RESET, and MEMORY SELECTION functions (See Section 5. Connection of Remote I/O for more detailed information).

4. Programming Instructions

4.1 Instrument Operation

4.1.1 Powering on the Instrument

When the power source is powered up the Frequency, Voltage and Current Displays will indicate the model and firmware version.



4.1.2 Setting the Output Voltage

Press and hold the "^" or "v" keys to increment or decrement the voltage setting. The maximum allowable voltage setting is dependent on the range.

Low Range voltage: 0 – 150 volts
High Range voltage: 151 – 300 volts

The Voltage Display will blink once to signal that the new value has been accepted. Any invalid setting will not be accepted.

4.1.3 Setting the Output Frequency

The output frequency may be adjusted in one of two ways:

Press the "^" and "v" keys to adjust the frequency manually
Press the 50Hz and 60Hz keys to output utility standards frequencies

The Frequency Display will blink once to signal that the new value has been accepted. Any invalid setting will not be accepted.

4.1.4 Setting the Output Voltage Range

If the desired voltage is lower than 150 volts, press the RANGE key. The 0-150V LED will illuminate indicating the power source is in the low range. If the desired voltage is greater than 150 volts, press the RANGE key. The 0 – 300V LED will illuminate indicating the power source is in the high range. Any invalid setting will not be accepted.

Increasing the output voltage range from Low to High decreases the maximum output current capability of the power source.

4.1.5 Setting the Output Current

With the output disabled, press the "^" or "v" key to set the current limit. This current limit corresponds to the current hi limit or the over-current fold back limit, depending on which mode has been selected in the system setting mode. The Current Display will blink once to signal that the new value has been accepted. Any invalid current setting will not be accepted.

With the output enabled, press the "^" or "v" key to change the current limit. This current limit corresponds to the current high limit or the over-current fold back limit, depending on which mode has been selected in the system setting mode. The Current Display will blink once to signal that the new value has been accepted. Any invalid current setting will not be accepted.

4.1.6 Enabling the Output

Once all test parameters have been set or a memory location has been selected, press the OUTPUT/RESET button to turn the power source output ON. The OUTPUT/RESET LED will illuminate to signal that the output is ON and the decimal points on the various Display screens will blink. Press the OUTPUT/RESET button again to disable the output.

4.1.7 Using the Memory Keys

Current limit, and voltage and frequency settings may be stored in 3 different memory locations, along with the power meter configuration (display power or power factor). To store test parameters, press and hold the M1, M2 or M3 keys until the corresponding LED stops flashing. To recall each memory, press and release the M1, M2 or M3 keys.

4.1.8 Default Test Parameters

The power source has specific default test parameters that have been preconfigured upon shipment from the factory. The Default Parameters are as follows:

Test Parameter	Value
Frequency	60 Hz
Voltage	100 V
Current Hi-Lmt	OFF
Power/PF Display	Watt
Lock	OFF

4.2 System Setup

With the output in the OFF condition, press the SYSTEM key to enter the system setting mode. The SYSTEM indicator light will illuminate. The system setting screen cannot be entered when the output is ON. 8 system parameters may be configured and stored from the system setting mode (refer to following System Parameters table for more information): PLC Remote, Alarm, OC Fold Back, Voltage LO Limit, Voltage HI Limit, Frequency LO Limit, Frequency HI Limit, P-UP. The parameter item

currently selected will be shown in the Frequency and Voltage Displays. The Current Display will show the current parameter condition and value. To exit the system setting, press the SYSTEM key.

4.2.1 System Setup Keys

In the system setting mode, the keys on the front panel act in the following manner:

Current Up Key: Adjusts the system parameter
Current Down Key: Adjusts the system parameter
Voltage Up Key: Selects the system parameter
Voltage Down Key: Selects the system parameter

4.2.2 System Parameters

SYSTEM PARAMETERS			
Front Panel Displays			Explanation
FREQUENCY	VOLTAGE	CURRENT	
	PLC	OFF	Enables or disables the PLC Remote
		ON	
Alar	m	1-9	Alarm volume setting
	P-UP	OFF	Adjusts up
		ON	
		LAST	
Freq	HI	500.0	Maximum frequency setting limit
Freq	LO	45.0	Minimum frequency setting limit
Voltage	HI	300.0	Maximum voltage setting limit
Voltage	LO	0.0	Minimum voltage setting limit
OC	Fold	ON	Enables or disables the over current fold back
		OFF	

4.2.3 Setting the PLC Remote

Press the Voltage Up Down key until the voltage display reads PLC. Press the Current Up or Down key to enable or disable the PLC. When the PLC Remote parameter is active, the overall operation of the power source may be controlled through the PLC connector on the rear of the instrument. When enabled, all keys on the front panel will be disabled except the LOCK, SYSTEM and P/PF keys.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter.

4.2.4 Setting the Alarm Volume

Press the Voltage Up or Down key until the frequency and voltage displays read

Alarm. Press the Current Up or Down key to adjust the volume of the alarm from 0-9.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter.

4.2.5 Setting the Power Up Status

Press the Voltage Up or Down key until the voltage display reads P-UP Press the Current Up or Down key to enable or disable this parameter. This parameter controls the output configuration during power up and can be changed to one of three conditions: ON, OFF, or LAST. If Power Up Status is set to OFF the output will be disabled when the unit is powered up. If Power Up Status is set to ON the output will be enabled when the unit is powered up. If Power Up Status is set to LAST the output will be enabled in the same condition as it was when power was turned off.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter

4.2.6 Setting the Frequency LO Limit

Press the Voltage Up or Down key until the frequency and voltage displays read Freq LO. Press the Current Up or Down key to adjust the frequency low limit from 45-500 Hz. The output frequency cannot be lowered to a value that falls below this limit during a test.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter

4.2.7 Setting the Frequency HI Limit

Press the Voltage Up or Down key until the frequency and voltage displays read Freq HI. Press the Down key to adjust the frequency high limit from 45-500 Hz. The output frequency cannot be raised to a value that exceeds this limit during a test.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter

4.2.8 Setting the Voltage LO Limit

Press the Voltage Up or Down key until the frequency and voltage displays read Voltage LO. Press the Down key to adjust the voltage low limit from 0-300 volts. The output voltage cannot be lowered to value that falls below this limit during a test.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter

4.2.9 Setting the Voltage HI Limit

Press the Voltage Up or Down key until the frequency and voltage displays read Voltage HI. Press the Down key to adjust the voltage high limit from 0-300 volts. The output voltage cannot be raised to a value that exceeds this limit during a test.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter

4.2.10 Setting the Over-current Fold Back

Press the Voltage Up or Down key until the frequency and voltage displays read OC Fold. Press the Down key to enable or disable the OC fold back feature. If OC Fold is set to ON, the instrument will automatically reduce the output voltage in order to maintain a constant current. When OC Fold is set to ON, the output current limit may be set in the same way as the high current limit. Please refer to section 4.1.5 Setting the Output Current.

Press the SYSTEM key again to accept the setting and exit the System Setting Mode or press the Voltage Up or Voltage Down key to move to the next parameter

4.2.11 Default System Parameters

PLC	OFF
Alarm	5
OC Fold back	OFF
Voltage LO Limit	0 V
Voltage HI Limit	300 V
Frequency LO Limit	45 Hz
Frequency HI Limit	500 Hz
P-UP	OFF

4.3 Error Messages

If for any reason an error occurs during testing the following actions will occur:

- The output will disable.
- The alarm will sound.
- The OUTPUT/RESET LED will start blinking.
- A corresponding error message will be displayed on the LED screens.

Pressing the OUTPUT/RESET key will reset the audible alarm and disable the OUTPUT/RESET LED. The error message will remain on the LED screens. Pressing the OUTPUT/RESET key a second time will clear the error message and the power source will revert to its idle state.

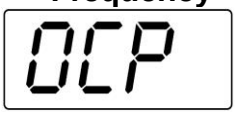
All error messages are the result of an abnormal condition and should be recorded. Check the cause of error to ensure the problem is eliminated before restarting the operation, or contact Associated Research, Inc.

OCP – Over Current Protection

If the output current exceeds 110% of maximum hardware current rating, the Frequency Display will indicate “OCP” and the alarm will sound. The

OUTPUT/RESET LED indicator will blink and the Voltage and Current Displays will show the overloaded voltage and current respectively.

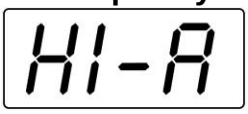
Frequency



HI-A – Hi Current Limit Exceeded

If the output current has exceeded the HI Limit, the Frequency Display will indicate “HI-A” and the alarm will sound. The OUTPUT/RESET LED indicator will blink and the Voltage and Current Displays will show the overloaded voltage and current respectively.

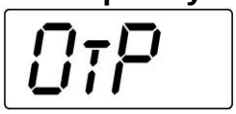
Frequency



OtP – Over Temperature Protection

If the heat sink of the instrument has exceeded 130 °C, the Frequency Display will indicate “OtP”. The alarm will sound, the OUTPUT/RESET LED indicator will blink and the Voltage and Current Displays will show the overloaded voltage and current respectively. This error may be cleared by pressing the OUTPUT/RESET key. It is a good idea to allow the power source to remain powered but with the output relay disabled so the fans have a chance to bring the internal temperature to an acceptable level.

Frequency



5. Connection of Remote I/O

One 9-pin D sub-miniature female connector is mounted on the rear panel that provides REMOTE-INPUT control and information. This connector mates with standard 9-pin D-sub-miniature connector provided by the user. The female (socket) connector on the power source mates to a male (plug) connector. For best performance, a shielded cable should be used. To avoid ground loops the shield should not be grounded at both ends of the cable.

One 6-pin mini-DIN female connector is mounted on the rear panel that provides the REMOTE-OUTPUT information. This connector mates with a standard 6-pin mini-DIN connector provided by the user. The female (socket) connector on the power source mates to a male (plug) connector.

Suggested AMP part numbers for interconnecting to the REMOTE-INPUT are shown below:

205204-4	PLUG SHELL WITH GROUND INDENTS
205203-3	RECEPTACLE SHELL
745254-7	CRIMP SNAP-IN PIN CONTACT (for plug)
745253-7	CRIMP SNAP-IN SOCKET CONTACT (for receptacle)
745171-1	SHIELDED CABLE CLAMP (for either plug or receptacle)
747784-3	JACKSCREW SET (2)

Suggested MOUSER part number for interconnecting to the REMOTE-OUTPUT is as follows:

171-2606	6 PIN MINI-DIN PLUG

5.1 Remote Signal Outputs

The 6-pin mini-DIN female connector provides output signals to remotely monitor FAIL, and PROCESSING conditions. These signals are provided by two normally open internal relays that switch on to indicate the current condition of the tester. These are normally open free contacts and will not provide any voltage or current. The ratings of the contacts are 1 A / 250 VAC (0.5 ADC). Below is a listing that indicates what conditions activate each pin. When a terminal becomes active, the relay closes thereby allowing the external voltage to operate an external device.

Pins 3 and 4 provide the FAIL signal.
Pins 5 and 6 provide the PROCESSING signal.

The following describes how the relays operate for each test condition:

PROCESSING - The relay contact closes the connection between pin 5 and pin 6 while the instrument is performing a test. The connection is opened at the end of the test.

FAIL - The relay contact closes the connection between pin 3 and pin 4 after detecting that the item under test failed any test. The connection is opened when the next test is initiated or the reset function activated.

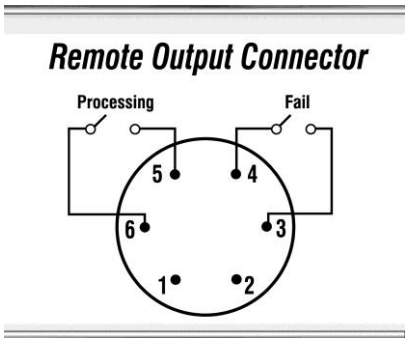


Figure 5

5.2 Remote Signal Inputs and Memory Access

Introduction
The 9-pin D sub-miniature female connector enables remote operation of the OUTPUT/RESET functions and allows the operator to toggle and select memory location 1, 2, and 3.

When the PLC Remote mode is ON, the power source will respond to simple switch or relay contacts closures. At this point the OUTPUT/RESET switch on the front panel cannot be used to enable the output, but can be used to return the power source to its idle state.

Below is the pin configuration of Remote Input:

1. TEST	Connect between PIN 3 and PIN 5
2. RESET	Connect between PIN 2 and PIN 5
3. Memory Input Control	
a. Memory 1 (M1)	Connect between PIN 8 and PIN 5
b. Memory 2 (M2)	Connect between PIN 9 and PIN 5
c. Memory 3 (M3)	Connect PIN 8 and PIN 9 with a series diode (D4148 or equivalent) at each pin and the joint point is connected to PIN 5. PIN 5 is the Common of the input signals (COM).

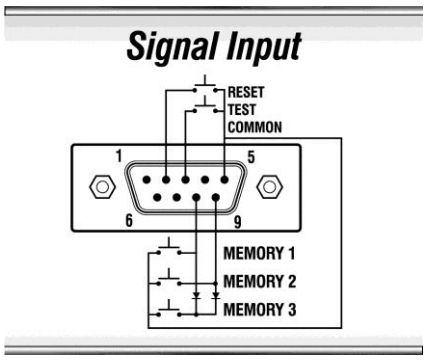
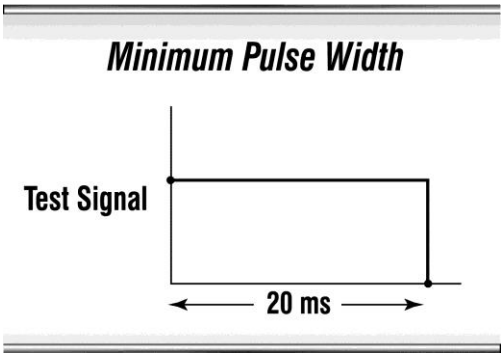


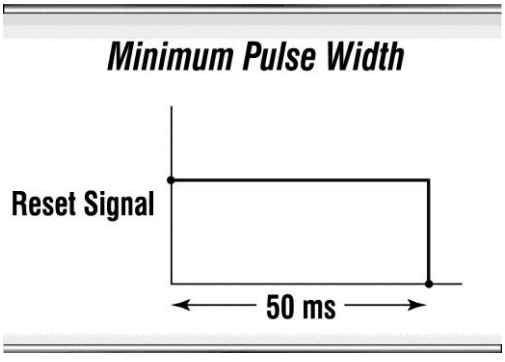
Figure 6

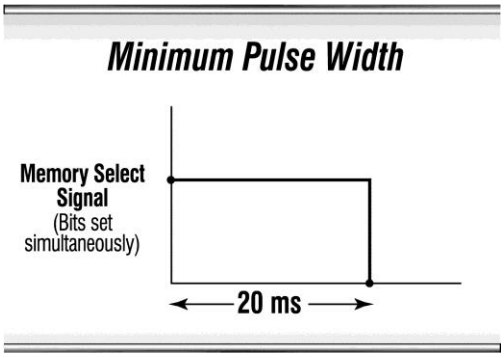
- THE OUTPUT OF THE POWER SOURCE IS CONTROLLED EXTERNALLY WHEN USING THE PLC REMOTE.
- ACTIVATING MEMORY PROGRAM FUNCTIONS THROUGH THE REMOTE CONNECTOR SELECTS THE PROGRAM AND ENABLES THE OUTPUT WHICH IS PREPROGRAMMED INTO THAT MEMORY.
- DO NOT CONNECT VOLTAGE OR CURRENT TO THE SIGNAL INPUTS, THIS COULD RESULT IN DAMAGE TO THE CONTROL CIRCUITRY.

Timing Information

A minimum pulse width or contact closure of 20 ms is required to guarantee activation of the OUTPUT/RESET relay to start a test. A minimum pulse width or contact closure of 50 ms is required to disable the OUTPUT/RESET relay while a test is running. The memory select bits should be set simultaneously and remain set for a minimum of 20 ms to guarantee that the correct memory will be selected. However, the memory select bits may be set in sequential manner, provided that the time delay between each bit is less than 4 ms. When the desired bit pattern has been established it should remain set for a minimum of 20 ms to guarantee that the correct memory will be selected.






Minimum Pulse Width
Memory Select Signal
(Bits set simultaneously)
20 ms

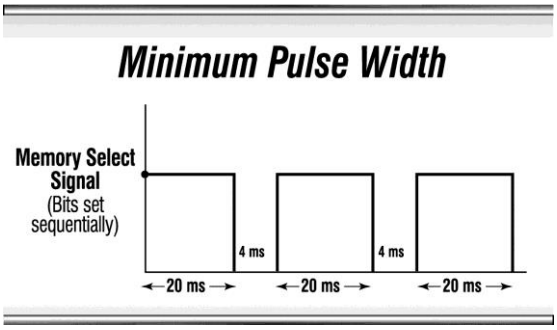

Minimum Pulse Width
Memory Select Signal
(Bits set sequentially)
4 ms
4 ms
20 ms
20 ms
20 ms

Figure 7

6. Options

Introduction
This section contains a list and descriptions of available factory installed options at the time of this printing. The list of options contains an option code number that can be referenced on the data plate on the rear panel of the unit.

Option Label
On the rear panel of the instrument, you will find a label that contains the option code.

For example, your options code would appear as follows:
Fitted with option 01……..OPT: 01
Fitted with option 01 and 02…….OPT: 0102

LS Series Options

02 Grounded Neutral
This option allows for a grounded return on the neutral output. It is ideal for looking to reduce overall leakage current that can result from the instrument itself in normal applications. This option is ideal for the medical industry.

04 7 Remote Memories Select
The 7 Remote Memory Select option increases the number of programmable memory locations from 3 to 7. These locations can be toggled manually or accessed via the PLC input. To store test parameters in a memory location, press and hold the correct combination of the M1, M2, and M3 keys until the corresponding LED's stop flashing. To recall each memory, press and release the appropriate keys. The following table lists the key combinations for each memory location.

Memory Location	Key
1	M1
2	M2
3	M3
4	M1 + M2
5	M2 + M3
6	M1 + M3
7	M1 + M2 + M3

The following binary truth table shows the different combinations of relay closures and their corresponding memory programs for accessing memory locations via the PLC input. It may be necessary to logically "OR" the relay contacts to prevent incorrect program selection due to timing errors. For more information please review section 5.

7 REMOTE MEMORIES SELECT TRUTH TABLE			
M3	**M2**	**M1**	**MEMORY PROGRAM #**
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7
1= Momentary Contact closure between BIT and COMMON			
0= No Contact closure between BIT and COMMON			

WARNING ACTIVATING MEMORY LOCATIONS THROUGH THE REMOTE CONNECTOR STARTS THE TEST THAT IS PREPROGRAMMED INTO THAT MEMORY LOCATION.

WARNING DO NOT CONNECT VOLTAGE OR CURRENT TO THE SIGNAL INPUTS. THIS COULD RESULT IN DAMAGE TO THE CONTROL CIRCUITRY.

05 Low Power & Current Meter

The Low Power & Current option adds a low current and low power range and increases the resolution of the current and power measurement. The option adds a 2.0mA-350.0mA current range and a 0.00-35.00W power range to the existing ranges of the instrument. In addition to the new ranges, the existing ranges have been rescaled and the instrument now displays in milliamps instead of amps. The following specifications have been changed for this option:

Current Measurement	Range 1: 2.0mA - 350.0mA Resolution: 0.1mA Accuracy: ± (2.0% of reading + 2 counts) Range 2: 300mA - 3500mA Resolution: 1mA Accuracy: ± (2.0% of reading + 2 counts) Range 3: 3000mA - 9999mA Resolution: 10mA Accuracy: ± (2.0% of reading + 2 counts)
Power Measurement	Range 1: 0.00 – 35.00W Resolution: 0.01W Accuracy: ± (5.0% of reading + 5 counts) O/P V>50V PF ≥0.05 Range 2: 30.0W - 350.0W Resolution: 0.1W Accuracy: ± (5.0% of reading + 3 counts) PF ≥0.05 Range 3: 300 - 4000W Resolution: 1W Accuracy: ± (5.0% of reading + 3 counts) PF ≥0.05

Calibration Low Power & Current Meter (With Option 05 only)

- Follow the standard calibration as described in Section 7 Calibration Procedure with the exception of the new A-OP and P-OP ranges. It should be noted that the calibration is now entered in mA instead of amps. The standard loads described in the manual will still work for A-LO, A-HI, P-LO, and P-HI ranges.
- Calibrate the A-OP and P-OP ranges using the 333Ω, 30 watt resistor. The A-OP and P-OP ranges are calibrated at 100volts similar to the standard calibrated ranges.
- Complete the calibration process as described in Section 7 Calibration Procedure in this manual.

7. Calibration Procedure

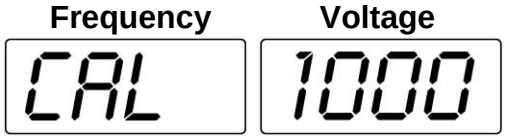
All Associated Power Technologies, Inc. instruments have been calibrated at the factory prior to delivery. The recommended verification cycle for all APT instruments is every 12 months. Verification must me performed prior to making any adjustments or corrections. If the item under test fails the verification, a calibration should be performed.

7.1 Required Calibration Equipment

- 20 AAC True RMS Ammeter.
- 0 - 500 VAC True RMS Voltmeter.
- 12.5Ω/800W Resistor (series resistors can be used to achieve the desired value)
- 33.3Ω/300W Resistor (series resistors can be used to achieve the desired value)
- 333Ω/30W Resistor (series resistors can be used to achieve the desired value)
- 9Ω/900W Resistor (series resistors can be used to achieve the desired value)

7.2 Calibration Procedure

Press and hold the CAL key (located on the back of the power source) while powering up the instrument. After two seconds, the power source will indicate the model number and firmware version: it is now in calibration mode. Press the “^” or “v” key to select the calibration menu.



7.2.1 Low Range Voltage Calibration

Press the “^” or “v” key from the Frequency Display until “V-LO" is displayed. Connect the calibrated true RMS voltmeter across the output and press the OUTPUT/RESET key. This will activate the low range offset voltage while outputting 150 VAC. Using the voltage value from the RMS Voltmeter, press the “^“or “v“ key from the Current Display to change the displayed value to the value that corresponds to the voltmeter. After the appropriate value is reached, press the LOCK key to save the data. The low range voltage calibration is now complete.

7.2.2 High Range Voltage Calibration

Press “^” or “v” key from the Frequency Display until “V-HI" is displayed. Connect the calibrated true RMS voltmeter across the output and press the OUTPUT/RESET key. This will activate the high range offset voltage while outputting 300 VAC. Using the voltage value from the RMS voltmeter, press the “^” or “v” key from the Current Display to change the displayed value to the value that corresponds to the voltmeter. After the appropriate value is reached, press the LOCK key to save the data. The high range voltage calibration is now complete.

7.2.3 Low Range Current Meter Calibration (Option 05 Only)

Press the “^” or “v” key from the Frequency Display until “A-OP" is displayed. Connect a variable resistor (333Ω/30W) and a calibrated true RMS ammeter in series with the output and press the OUTPUT/RESET key. This will activate the low range offset current while outputting 100 VAC. Adjust the load to get a reading of 3.000 mA from the ammeter. Using the current value from the RMS ammeter, press the “^” or “v” key from the Current Display to change the displayed value to the value that corresponds to the ammeter. After the appropriate value is reached, press the LOCK key to save the data. The low range current calibration is now complete.

7.2.4 Low Range Current Calibration

Press the “^” or “v” key from the Frequency Display until “A-LO" is displayed. Connect a variable resistor (33.3Ω/300W) and a calibrated true RMS ammeter in series with the output and press the OUTPUT/RESET key. This will activate the low range offset current while outputting 100 VAC. Adjust the load to get a reading of 3.000 A from the ammeter. Using the current value from the RMS ammeter, press the “^” or “v” key from the Current Display to change the displayed value to the value that corresponds to the ammeter. After the appropriate value is reached, press the LOCK key to save the data. The low range current calibration is now complete.

7.2.5 High Range Current Calibration

Press the “^” or “v” key from the Frequency Display until “A-HI" is displayed. Connect a variable resistor (12.5Ω/800W) and a calibrated true RMS ammeter in series with the output and press OUTPUT/RESET key. This will activate the high range offset current while outputting 100 VAC. Adjust the load to get a reading of 8.00 A from the ammeter. Using the current value from the RMS ammeter, press “^” or “v” key from the Current Display to change the displayed value to the value that corresponds to the ammeter. After the appropriate value is reached, press the LOCK key to save the data. The high range current calibration is now complete.

Frequency	Voltage	Current	Power
A-HI	100.0	8.00	CAL

7.2.6 Low Range Power Meter Calibration (Option 05 Only)

Press “^” or “v” key from the Frequency Display until “P-OP" is displayed. Connect a variable resistor (333Ω/30W) and a calibrated true RMS power meter in series with the output and press the OUTPUT/RESET key. This will activate the low range offset power while outputting 100 VAC. Adjust the load to get a reading of 30 W from the power meter. Using the power value from the RMS power meter, press the “^” or “v” key from the Current Display to change the displayed value to the value that corresponds to the power meter. After the appropriate value is reached, press the LOCK key to save the data. The low range power calibration is now complete.

Frequency	Voltage	Current	Power
P-OP	100.0	30.00	CAL

7.2.7 Low Range Power Calibration

Press “^” or “v” key from the Frequency Display until “P-LO" is displayed. Connect a variable resistor (33.3Ω/300W) and a calibrated true RMS power meter in series with the output and press the OUTPUT/RESET key. This will activate the low range offset power while outputting 100 VAC. Adjust the load to get a reading of 300 W from the power meter. Using the power value from the RMS power meter, press the “^” or “v” key from the Current Display to change the displayed value to the value that corresponds to the power meter. After the appropriate value is reached, press the LOCK key to save the data. The low range power calibration is now complete.

Frequency	Voltage	Current	Power
P-LO	100.0	300.0	CAL

7.2.8 High Range Power Calibration

The Frequency Display until “P-HI” is displayed. Connect a variable resistor (9Ω/900W) and a calibrated true RMS power meter in series with the output and press the OUTPUT/RESET key. This will activate the high range offset power while outputting 100 VAC. Adjust the load to get a reading of 900W from the power meter. Using the power value from the RMS power meter, press the “^” or “v” key from the Current Display to change the displayed value to the value that corresponds to the power meter. After the appropriate value is reached, press the LOCK key to save the data. The high range power calibration is now complete.

7.2.9 Calibration Completion

Once calibration is completed, turn OFF the instrument. Each calibration item above can be performed independently of the others. If the full calibration procedure has to be terminated for any reason, press the P/PF key to exit the calibration mode.

8. Replacement Parts List

Rev: C 5/16/12 ECO 5555

Part Number	Qty.	Ref. Designator	Description
Supplied Accessories			
38174	4	-	Screw for Rack Mount Handle
38794	2	-	2U Rack Mount Handle
38793	2	-	2U Rack Mount Bracket
Panel Components			
38021	10	-	Diode LED Red Square
38882	1	-	Universal Receptacle (front panel)
39259[2]	1	-	Universal Receptacle 7.5kv (rear)
38109	1	-	Power Switch 2P 10A/250V
38070[2]	1	-	Rear Input Power Receptacle
38121	1	-	Panel Bezel Plastic 2U x 17in
38274	16	-	Button Keypad Rect. 9.8 x 8.0mm
38751	1	-	Front Panel
38752	6	-	Plastic Foot
38759[1]	1	-	Terminal Block
38760[1]	1	-	Terminal Block Cover
38797[1]	1	-	Shorting Bar Terminal Block
PCB Assemblies			
38739	1 (2)[1]	AMP6700	Amplifier Board
38740	1	CON6700	Main Control Board
38741	1	DSP6800	Display Board
38742	1	OPT6700	Output Control Board
38743	1	PWR6700	Input Voltage Select Board
38744	1 (2)[1]	REC6700	DC Filter Board
38779	1	REM6700	Remote Input Board
Internal Components			
38756	1	T-67100-T11-A	Input Transformer
38757[1]	1	T-6710-T12-A	Input Transformer
39037	2	-	Fuse 20A Slow Blow 30mm
38758	1	T-6710-T2-A	Output Transformer
39257[2]	1	T-6705-T2-A	Output Transformer
38262	1	-	IC W78E516B

[1]LS1000 only
[2]LS500 only