



## Ls Series Power Systems

### 3-18 kVA Programmable AC Power Source / Analyzer



#### Backward Compatible with L Series

*Function and bus compatible with the California Instruments L Series*

#### Three phase and Single phase modes

*Ideally suited for avionics and defense applications*

#### 3 KVA to 18 KVA Power Levels

*Match power source and cost to application requirements*

#### Transient Programming

*Test products for susceptibility to AC line disturbances*

#### Built-in Measurements

*Performs voltage, current and power measurements*

#### Advanced Features

*Options available to add arbitrary waveform generation, harmonic analysis, GPIB*

#### Interface

*Standard USB & RS232 interfaces with optional GPIB & LAN available*

#### CE Marked

*Safe, reliable and consistent operation*

#### Integrated System

The Ls Series is an improved version of the classic California Instruments L Series AC power sources. It provides many basic AC source capabilities at an economical cost. Additional capabilities such as arbitrary waveform generation and harmonic measurements can be added as options.

The Ls Series can be ordered in either single phase (-1) or three phase (-3) configurations. Power levels range from 3 kVA to 6 kVA in a single chassis. Multiple chassis can be combined for power levels up to 18 kVA..

#### Easy To Use Controls

The Ls Series is completely microprocessor controlled and can be operated from a simple front panel keypad. A pair of analog controls located next to the backlit alphanumeric LCD display allows output voltage and frequency to be slewed up or down dynamically. For more advanced operations, a series of menus is provided using a dual line high contrast LCD display. Optional full keypad is available.

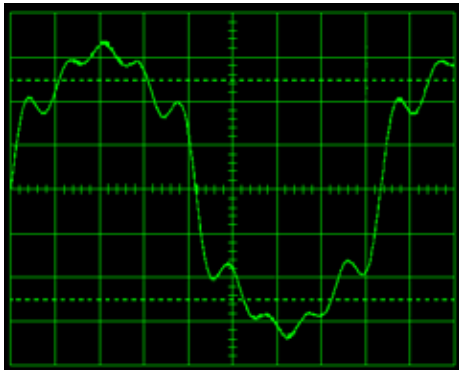
#### Applications

With precise output regulation and accuracy, high load drive current, multi or single phase mode and built-in measurement capabilities, Ls Series AC sources address many application areas for AC power testing. Additional features, like available DO 160, MIL 704, Boeing, or Airbus test standards, make the Ls Series a good choice for avionics or defense applications. All Ls Series AC sources are standard equipped with USB and RS232C remote control interfaces. An optional GPIB and Ethernet (LAN) interface is available as well.

#### Compatibility

Although the standard command language is SCPI, the Ls Series also offers functional and bus compatibility with the CI L Series AC power sources. Using the APE (Abbreviated Plain English) command syntax, the Ls Series can be used in existing test systems without the need to modify program code. The APE language is part of the -GPIB option which also adds the GPIB/ IEEE-488 interface.

## Ls Series - AC Transient Generation



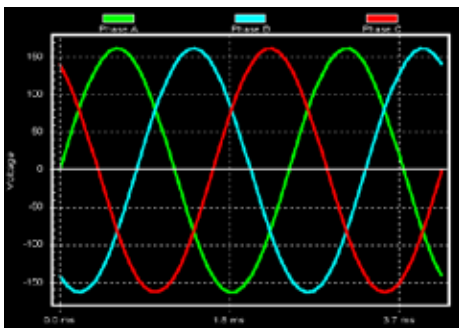
Voltage sweep transient causes output voltage to change at a programmed rate.

### Transient Programming

To simulate common line disturbance occurrences, the Ls Series offers a list of transient steps. These steps can be programmed from the front panel or downloaded over the interface using the GUI program supplied. The GUI allows libraries of commonly used line disturbances to be created on disk for quick recall. Once downloaded, the transient program can be executed from the PC or from the front panel.

AC transient generation allows the effect of rapid changes in voltage, frequency, phase angle and waveform shape on the unit under test to be analyzed.

## Ls Series - Configuration Options



Three phase output mode.

The Ls Series is available in either three or one phase output configurations and offers standard voltage ranges of 135 Vrms and 270 Vrms. A wide range of options can be added to customize the Ls Series to meet your specific application requirements.

### Voltage Range Options

Output voltage range options are available to provide higher voltage outputs. In addition to the standard 135/270 V range pair, 156/312 Vrms (-HV option) and 200/400 Vrms (-EHV option) can be specified at the time of order. All voltage ranges are Line to Neutral. On three phase Ls Series models, maximum Line to Line voltages are 467 V (standard), 540 V (-HV option) and 692 V (-EHV option).

### Phase Mode

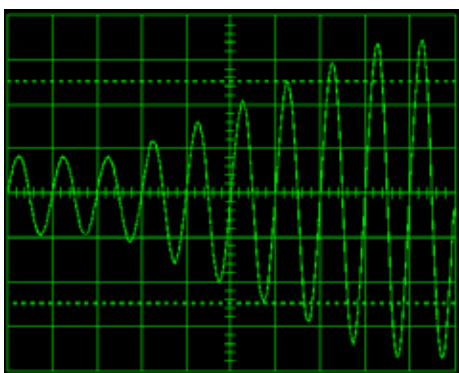
The -MODE option provides automatic switching between three phase and single phase output modes. In single phase mode, all output current is routed to the Phase A output terminal. The -MODE option is available for 3 phase Ls configurations.

### Waveform Generation

The standard Ls Series provides sine wave output capability. For more demanding test applications, the advanced option package (-ADV) adds the following waveform capabilities:

- Squarewave.
- Clipped Sinewave - Simulates THD levels to test for harmonic distortion susceptibility.
- Harmonic and Arbitrary (User defined) waveforms.

Using the provided Windows Interface Instrument Control Software (ICS), defining harmonic waveforms is as easy as specifying the relative amplitude and phase angle for each of up to the 50th harmonic. The waveform data points are generated and downloaded by the ICS to the AC source through the standard RS232C, USB or optional LAN or GPIB bus and are retained in non-volatile memory. Up to 50 waveforms can be stored and named for easy recall.



Harmonic waveform, Fund., 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> and 9<sup>th</sup>.

## Ls Series - Measurement and Analysis

The Ls Series measurement system is based on real-time digitization of the voltage and current waveforms using a 4K sample buffer. The digitized waveform data is processed by a Digital Signal Processor to extract conventional load values such as rms voltage, rms current, real and apparent power. With the addition of the advanced features option. (-ADV option), the same data can also be used to perform Fast Fourier Transformation (FFT) to extract the harmonic amplitude and phase angle of 50 harmonics, or display acquired voltage and current waveforms.



Standard measurements for all phases.

### Standard Measurements

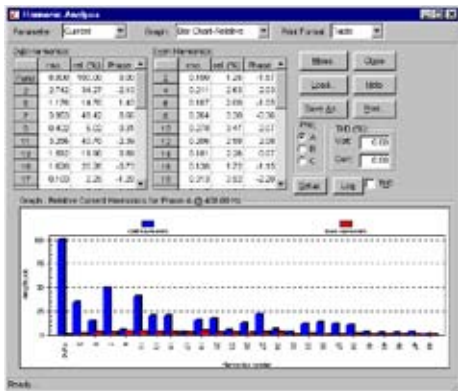
The following standard measurements are available from the front panel or via the bus:

- Frequency and Phase
- Voltage (rms)
- Current(rms) and Peak Current
- Crest Factor
- Real Power and Apparent Power
- Power Factor

### Advanced Measurement Functions (-ADV option)

Power analysis of EUT load characteristics is available by adding the -ADV option. Harmonics up to the 50th harmonic (for fundamental frequencies up to 250 Hz) and total harmonic distortion of both voltage and current is provided as well.

Harmonic analysis data can be displayed on the front panel display or on the PC using the GUI program. The GUI can also be used to save and print harmonics data in tabular, bar graph or time domain formats.



Relative Current Harmonics shown in table and chart.

### Diagnostics Capability

The AC Source can perform a self test and report any errors. The self test will run until the first error is encountered and terminate. The response to the self test query command will either be the first error encountered or 0 if no error was found. (Self test passed).

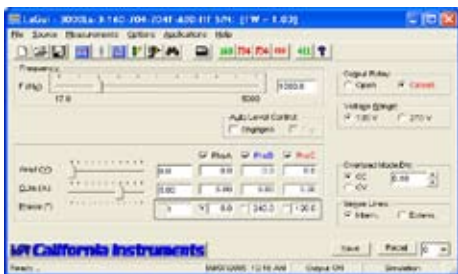
### Windows Graphical User Interface

A Windows compatible Instrument Control Software (ICS) offers a soft front panel interface for operation from a PC. The following functions are available through this GUI program:

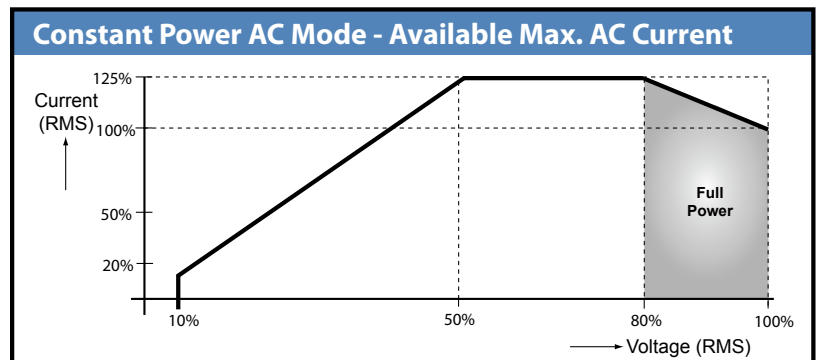
- Steady state output control (all parameters).
- Create, run, save and print transient programs.
- Measure and log standard measurements.

### With -ADV option:

- Generate and save harmonic waveforms.
- Generate and save arbitrary waveforms.
- Capture and display Voltage and Current waveforms.
- Measure, display, print and log harmonic voltage and current measurements.



Soft front panel control through Windows GUI.



## Ls Series - Measurement and Analysis

### Output

Maximum Power per phase:	3000Ls: 1 phase: 3000 VA, 3 phase: 1000 VA; 4500Ls: 1 phase 4500 VA, 3 phase 1500 VA; 6000Ls: 1 phase 6000 VA, 3 phase: 2000 VA		
Power factor:	0 to unity at full output VA		
Voltage Ranges:	Range:	V Low	V High
	AC	0-135 V	0-270 V
	VA Programming Resolution: 100 mV		
See -HV and EHV options for alternative voltage range pairs.			Load Regulation: < 0.1 % FS
Programming Accuracy (25°C ±5°C):	Voltage (rms): ± (0.05% + 0.25) V from 5.0 V to FS; Frequency: ± 0.025 45 Hz - 819.1 Hz, ± 0.7 % > 819.1 Hz; Phase: ± 1° 45-100 Hz, ± (1° + 1°/kHz) 100 Hz-1kHz		
Frequency Range:	45 Hz - 1000 Hz (see -HF option for higher output frequencies)		
Frequency Resolution:	0.01 Hz at < 81.9 Hz, 0.1 Hz at 82.0 to 819.1 Hz, 1 Hz <sup>2</sup> at > 819 Hz		

Max RMS Current:	V Range	V high	V low	< At Full Power	Model	3000Ls - 3 Ø	3000Ls - 1 Ø	4500Ls - 3 Ø	4500Ls - 1 Ø	6000Ls - 3 Ø	6000Ls - 1 Ø
	-3 3 Ø	7.4 A	14.8 A	At FS Voltage >	V Low	7.4 A	22.2 A	11.1 A	33.3 A	14.8 A	44.4 A
	-1 1 Ø	22.2 A	44.4 A		V High	3.7 A	11.1 A	5.5 A	16.7 A	7.4 A	22.2 A

Note: Constant power mode on 3000Ls and 4500Ls provides increased current at reduced voltage; 6000Ls provides maximum voltage.

Current Limit:	Programmable from 0 Amps to maximum current for selected range		
Peak Current:	3000Ls: 6 X (I <sub>rms</sub> @ full scale voltage); 4500Ls: 4 X (I <sub>rms</sub> @ full scale voltage); 6000Ls: 3 X (I <sub>rms</sub> @ full scale voltage)		
Output Noise:	100mV rms typ. (20 kHz to 1 MHz)	Harmonic Distortion:	< 1% (at full scale voltage, full resistive load)
Isolation Voltage:	300 V rms output to chassis	Output Relay:	Push button controlled and bus controlled output relay

### Input

Voltage:	Models 3000Ls, 4500Ls, 9000Ls, 13500Ls: Standard: 208-230 ± 10% VAC, (L-L, 3 Phase); Option -400: 400 ± 10% VAC (L-L, 3 Phase); Models 6000Ls, 12000Ls, 18000Ls: Standard 208-230 + 10% VAC (L-L, 3 Phase) Notes: 1. Input must be specified when ordering. 2. -400 option not available on 6000Ls, 12000Ls, 18000Ls. 3. 3000Ls can be operated from 1 phase AC.					
Line Current (rms per phase):	Model	3000Ls	3000Ls (1Phase)	4500Ls	6000Ls (@ 280V)	Inrush Current @ 180-254 V: 50 A peak (Per phase): @ 360-440 V: 83 A peak  Line Frequency: 47-440 Hz
	187 VLL	19 A	32 A	31 A	38 A	
	360 VLL	10 A	n/a	16 A	n/a	

Efficiency:	75% typical	Power Factor:	0.6 typical	Hold-up Time:	At least 10 ms
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### Measurement

Parameter	Frequency	Phase	Voltage (AC)	Current (AC rms)	Real Power	Apparent Power	Power Factor
Range	45-81.91 Hz 82.0-819.1 Hz > 819 Hz	45-100 Hz 100-1000 Hz	0-400 V	0-50 A	0-6 kW	0-6 kVA	0.00-1.00
Accuracy* (±)	0.1% + 1 digit	0.5° 2°	0.5% + 250 mV	0.1% + 150 mA	0.15% + 9 W	0.15% + 9 VA	0.03
1 Ø mode (-1)				0.1% + 50 mA	0.15% + 3 W	0.15% + 3 VA	0.01
3 Ø mode (-3)							
Resolution*	0.01 Hz / 0.1 Hz / 1 Hz	0.1° / 1°	10 mV	1 mA	1 W	1 VA	0.01

\* Accuracy specifications are in % of reading and apply above 100 counts. For multi-chassis configurations, current, power range and accuracy specifications are times three. Power factor accuracy applies for PF > 0.5 and VA > 50% of max. Frequency measurement specification valid for output > 30 Vrms.

### System

Storage:	Setup: 16 complete instrument setups / Transient List: 100 transient steps per list (SCPI mode) or 16 transient registers (APE mode)
Trigger Input/Output:	Input: Triggers measurements or transient steps - SMA connector: 10K pull-up / Output: SMA Connector: HCTTL output

### Protection

Overload/Temp/Voltage:	Overload: Constant current or constant voltage mode; Over temperature: Automatic Shutdown; Over voltage: Automatic shutdown
Regulatory/RFI Suppression:	IEC1010, EN50081-2, EN50082-2, CE, EMC, and safety mark requirements / RIF Suppression: CISPR 11, Group1, Class A

Note: Specifications are subject to change without notice. Specifications are warranted over an ambient temperature range of 25±5°C. Unless otherwise noted, specifications are per phase for a sinewave with a resistive load and apply after a 30 minute warm-up period. For three phase configurations, all specifications are for L-N. Phase angle specifications are valid under balanced load conditions only.



## Ordering Information

Model <sup>1</sup>	Output Power	No of Output Phases		Nom. Input Voltage <sup>2</sup>
		-1	-3	
3000Ls	3 kVA	1	3	208-230 V
3000Ls-400	3 kVA	1	3	400 V
4500Ls	4.5 kVA	1	3	208-230 V
4500Ls-400	4.5 kVA	1	3	400 V
6000Ls	6 kVA	1	3	208-230 V
9000Ls/2	9 kVA	1	3	208-230 V
9000Ls/2-400	9 kVA	1	3	400 V
12000Ls/2	12 kVA	1	3	208-230 V
13500Ls/3	13.5 kVA	1	3	208-230 V
13500Ls/3-400	13.5 kVA	1	3	400 V
18000Ls/3	18 kVA	1	3	208-230 V

Note 1: The /2 or /3 designation indicates number of chassis.

Note 2: All input voltage specifications are for Line to Line three phase, delta or wye. Model 3000Ls (208 V input) can be operated on 230 V L-N single phase if needed.

## Ordering Information

### Model

Refer to table shown for model numbers and configurations. Specify number of output phases (-1 or -3) as part of model number, eg 4500Ls-1 or 4500Ls-3.

### Supplied with

User / Programming Manual on CD-ROM, Software and RS232C serial cable.

### Options

#### Input Options

-400 400 ±10% Volt Line to Line AC input.  
[Not available on 6000Ls, 12000Ls and 18000Ls Models]

#### Output Options

-AX<sup>1</sup> Auxiliary outputs, 26 VAC, 5 VAC. Limits upper frequency to 800 Hz.  
-HV<sup>1</sup> 156/312 V output range.  
-EHV<sup>1</sup> 200/400 V output range.  
-HF<sup>1</sup> Extends upper frequency limit. See HF table.

HF Table	
Model	Max. Freq.
3000Ls	5000 Hz
4500Ls	
6000Ls	
9000Ls/2	2000 Hz
12000Ls/2	
13500Ls/3	
18000Ls/3	

-LF<sup>1</sup> Limits output frequency to 500 Hz.

### Keypad Options

-KPD Upgraded keypad control panel.



### Controller Options

-160 RTCA/DO-160D, Change 2, EuroCAE-14D and Airbus test firmware [Section 16, AC only. Refer to -160 option data sheet for details]  
-704 Mil-Std 704 rev D and E test firmware. [AC only, Refer to -704 option data sheet for details]

## Feature Comparison

- ABD Airbus Directive 0100.1.8 tests. [AC only]. Requires -ADV and use of Windows PC and included LxGui software.
- ADV Advanced feature set. Adds arbitrary waveform generation and harmonic analysis of voltage and current.
- GPIB GPIB interface and APE programming language.
- LAN Ethernet Interface.
- MB Multi-box. Adds controller to auxiliary chassis of multi-chassis systems.
- MODE Adds phase mode selections for -3 models.
- L22 Locking Knobs.
- LKM<sup>1</sup> Clock and Lock Master
- LKS<sup>1,2</sup> Clock and Lock Auxiliary
- LNS<sup>2</sup> Line Sync.
- EXS<sup>2</sup> External Sync.

### Cabinet Options

- RMS Rackmount Slides. Recommended for rack mount applications.
- C prefix Cabinet System. Installed and pre-wired in 19" cabinet.

### Option Matrix:

Note that some options are mutually exclusive as indicated in the table below. An 'o' means the options can be combined. An 'x' means they cannot.

	HF	LF	HV	EHV	LKM	LKS	EXS	AX
HF	-	x	o	o	x	x	o	x
LF	x	-	o	o	o	o	o	o
HV	o	o	-	x	o	o	o	o
EHV	o	o	x	-	o	o	o	o
LKM	x	o	o	o	-	x	o	o
LKS	x	o	o	o	x	-	x	o
EXS	o	o	o	o	o	x	-	o
AX	x	o	o	o	o	o	o	-

Note 1: See option matrix

Note 2: -LKS, -LNS and -EXS are mutually exclusive and with Ext Trig function.