

## Ls Series II

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### Changes from Series I

The Series II versions of the Lx and Ls Series are backward compatible with the original Lx/Ls Series models. Series II models are different from the original Lx/Ls Series in the following areas:

- Standard USB interface has been added.
- Optional Ethernet LAN interface has been added. (Option -LAN).
- The front panel graphic design has been enhanced for a more pleasing look.
- The Output D and E terminal block is no longer installed on the standard Lx and Ls units unless the auxiliary output option -AX is installed. This makes the standard output terminal block more easily accessible.

No other functional differences exist between the Series I and Series II AC power sources. The RS232C interface is still available in addition to the USB interface.

The User Manual for Series I models is CI P/N 7004-960 and is available for [download](#). For Series II models, refer to user manual CI P/N 7004-980 also available for [download](#).

### General Description

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. 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.

### L Series Backward Compatibility

The Ls Series 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.

### 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 or MIL 704 test standards, make the Ls Series a good choice for avionics or defense applications.

All Ls Series AC sources are standard equipped with RS232C remote control interfaces. An optional GPIB interface is available as well.

### 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.

### Measurements

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

- Frequency

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

## 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).

## Configuration Options

The Ls Series is available in either three or one phase output configurations and offers 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 (-HV and -EHV)

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 (-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 models (e.g. 4500Ls-3).

### Waveform Generation (-ADV option)

The standard Ls Series provides sine wave output capability. For more demanding test applications, the advanced option package 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 Graphical User Interface (GUI) program, defining harmonic waveforms is as easy as specifying the relative amplitude and phase angle for each of up to 50 harmonics. The waveform data points are generated and downloaded by the GUI to the AC source through the standard RS232C or optional GPIB bus and are retained in non-volatile memory. Up to 50 waveforms can be stored and given a user defined name for easy recall.

### 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. The acquired voltage and current time-domain waveforms for each output phase can be displayed using the GUI program. Waveform displays on the PC. Available display modes include voltage and current combined, three phase voltage, three phase current and true power. The time-domain data is also available for transfer to a PC through the bus when using custom software.

## Windows Graphical User Interface

A Windows compatible Graphical User Interface (GUI) 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.

## Specifications

### Output

#### Power

Maximum power per phase:

Model:	Single Phase	Three Phase
3000Ls	3000 VA	1000 VA
4500Ls	4500 VA	1500 VA
6000Ls	5770 VA	1923 VA

#### Power Factor

0 to unity at full output VA

#### Voltage Ranges

Low : 0-135 Volt

High : 0-270 Volt

Contact factory for optional alternate voltage range pairs.

#### Voltage Resolution

100 mV

#### Load Regulation

Less than  $\pm 0.1\%$  FS

#### Line Regulation

Less than  $\pm 0.02\%$  for 10% line change

#### Programming Accuracy (25°C $\pm$ 5°C)

##### Voltage (rms):

$\pm(0.05\% + 0.25)$  V from 5.0 V to FS

##### Frequency:

$\pm 0.025\%$  45 Hz - 819.1 Hz

$\pm 0.07\%$  > 819.1 Hz

##### Phase:

$\pm 1^\circ$  45- 100 Hz

$\pm(1^\circ + 1^\circ/\text{kHz})$  100 Hz - 1 kHz

#### Frequency Range

45 Hz - 1000 Hz

#### Max RMS Current @ full power

	V Range	V high	V low
-3	3 Phs	7.4 A	14.8 A
-1	1 Phs	22.2 A	44.4 A

*Note: Constant power modes on 3000Ls and 4500Ls. Current available at reduced voltage for 3000Ls, 4500Ls and max voltage for 6000Ls..*

#### Max RMS Current @ FS Voltage

	V Range	V high	V low
3000Ls	3 Phs	3.7 A	7.4 A
	1 Phs	11.1 A	22.2 A
4500Ls	3 Phs	5.5 A	11.1 A
	1 Phs	16.7 A	33.3 A
6000Ls	3 Phs	7.4 A	14.8 A
	1 Phs	22.2 A	44.4 A

#### Current Limit

Programmable from 0 A to max. current for selected range.

#### Peak Current

3000Ls: 6 x Irms at FS voltage.

4500Ls: 4 x Irms at FS voltage.

6000Ls: 3 x Irms at FS voltage.

#### Output Noise

-100 mVrms typical (20 kHz to 1 MHz)

#### Harmonic Distortion

< 1% (At full scale voltage, full resistive load.)

#### Voltage

### Input

#### Voltage

Models 3000Ls, 4500Ls, 9000Ls, 13500Ls:

Standard: 208-230  $\pm 10\%$  VAC, (L-L, 3 Phase)

Option -400: 360-440 VAC, (L-L, 3 Phase)

Models 6000Ls, 12000Ls, 18000Ls:

Standard: 208-230 + 10% VAC, (L-L, 3 Phase)

Notes:

1. Input range must be specified when ordering.

2 400 option not available on 6000Ls, 12000Ls or 18000Ls.

#### Line Current (rms per phase)

Model:	187 VLL	360 VLL
3000Ls;	19 A	10 A
3000Ls (1 $\emptyset$ );	32 A	n/a
4500Ls;	31 A	16 A
6000Ls (@208V);	38 A	n/a

#### Inrush Current (per phase)

@ 180-254 V	50 A peak
@ 360-440 V	83 A peak

#### Line Frequency

47 - 440 H

#### Efficiency

75 % typical

#### Power Factor

0.6 typical

#### Hold-up Time

At least 10 ms

300 V rms output to chassis

## Output Relay

Push button controlled and bus controlled output relay

## Measurements

Parameter	Range	Accuracy* ( $\pm$ )		Resolution
		1 $\emptyset$ mode	3 $\emptyset$ mode	
Frequency	45.00 - 81.91 Hz 82.0 - 819.1 Hz > 819 Hz	0.1% + 1 digit		0.01 Hz 0.1 Hz 1 Hz
Phase	45 - 100 Hz 100 - 1000 Hz	0.5° 2°		00.1° 1°
Voltage (AC)	0 - 300 V	0.05% + 250mV		10 mV
Current (AC rms)	0 - 50 A	0.1% + 150 mA	0.1% + 50 mA	1 mA
Real Power	0 - 5 kW	0.15% + 9 W	0.15% + 3 W	1 W
Apparent Power	0 - 5 kVA	0.15% + 9 VA	0.15% + 3 VA	1 VA
Power Factor	0.00 - 1.00	0.03	0.01	0.01

\* Accuracy specifications are in % of reading. Frequency measurement accuracy applies for output voltages of 20Vrms and higher.

## System

### Setup storage

16 complete instrument setups

### Transient lists storage

100 transient steps per list (SCPI mode) or 16 transient registers (APE mode).

### Trigger input

Triggers measurements or transient steps  
SMA connector: 10K pull-up

### Trigger output

SMA connector: HC TTL output.

## Remote Control

### Ethernet Interface

Local Area Network 10BaseT, 100BaseT, RJ45 connector.  
(Option -LAN)

### IEEE-488 Interface

IEEE-488 (GPIB) talker listener.

Subset:

AH1, DC1, DT1, L3, RL2, SH1, SR1, T6

### RS232C Interface

Bi-directional serial interface.

9 pin D-shell connector

Handshake: CTS, RTS

Data bits: 7 with parity,  
8 without parity

Stop bits: 2

Baud rate: 9600 to 115200

Supplied with RS232C cable

### Code and Format

SCPI

APE (option -GPIB)

## Physical

### Dimensions (per chassis)

Height: 10.5" (267 mm)

Width: 19" (483 mm)

Depth: 23.7" (602 mm)

Depth includes rear panel connectors and safety covers.

All weights and dimension are per chassis.

### Weight (per chassis)

193 lbs / 87.7 Kg net.

280 lbs / 127.3 Kg shipping

### Vibration and Shock

Designed to meet NSTA project 1A transportation levels

### Air Intake/Exhaust

Forced air cooling, side air intake, rear exhaust

### Operating Temperature

0 to 35° C, full power.

### Storage Temperature

-40 to 85° C.

### Diagnostics

Built-in self test available over bus. (\*TST).

### Rear Panel Connectors

- Three phase AC Input terminal block with safety cover
- Three phase AC Output terminal block with safety cover
- IEEE-488 (GPIB) connector (Option -GPIB)
- 9 pin D-Shell RS232C connector
- Remote Inhibit (INH) and Discrete fault Indicator (DFI)
- Remote voltage sense terminal block
- Trigger In1 and Trigger Out1
- System Interface connectors
- Aux. Output (Option -AX)

(\*RS232 DB9 to DB9 cable supplied)

## Option Specifications

All specifications same as standard Ls models except where noted.

## -ADV Option

### Waveforms

Pre defined: Sine, Square, Clipped

User defined, 1024 addressable data points.

Storage: 50 user waveforms, non-volatile memory.

### Data Acquisition

Parameters: Voltage, Current time domain, per phase.

Resolution: 4096 data points, 10.4 usec (1 phase) or 31.25 usec (3 phase) sampling interval.

### Measurements - Harmonics

Parameter	Range	Accuracy* (±)	Resolution
Frequency			
Fundamental	45 - 250 Hz	0.1% + 1 digit	0.01 Hz
	0.09-12.5 kHz	0.5% + 1 digit	0.1 Hz
Voltage	Fundamental	0.05% + 250mV	10 mV
	Harmonics 2 - 50	0.1%+0.1%/KHz+250mV	10 mV
Current	Fundamental	50 mA	10 mA
	Harmonics 2 - 50	0.1% + 50 mA +0.1% /1 kHz	10 mA

\* Accuracy specifications are in % of reading for single unit in 3 phase mode.

## -HV Option

### Voltage Ranges

Low : 0-156 Volt

High : 0-312 Volt

### Max RMS Current @ full power

V Range   V high   V low

Mode: 3 Phs   6.4 A   12.8 A

Mode: 1 Phs   19.2 A   38.4 A

*Note: Constant power modes on 3000Ls and 4500Ls. Current available at reduced voltage for 3000Ls, 4500Ls and max voltage for 6000Ls.*

### Max RMS Current @ FS Voltage

V Range   V high   V low

3000Ls   3 Phs   3.2 A   6.4 A

1 Phs   9.6 A   19.2 A

4500Ls   3 Phs   4.8 A   9.6 A

1 Phs   14.4 A   28.8 A

6000Ls   3 Phs   6.4 A   12.8 A

1 Phs   19.2 A   38.4 A

### Frequency Range:

With -HF option:

3000Ls, 4500Ls, 6000Ls:

45 Hz - 5000 Hz

9000Ls, 12500Ls, 13500Ls, 18000Ls:

45 Hz - 2000 Hz

## -EHV Option

All specifications same as standard Ls models except where noted.

### Voltage Ranges

Low : 0-200 Volt

High : 0-400 Volt

### Max RMS Current @ full power

V Range   V high   V low

Mode: 3 Phs   5.0 A   10.0 A

Mode: 1 Phs 15.0 A 30.0 A

*Note: Constant power modes on 3000Ls and 4500Ls. Current available at reduced voltage for 3000Ls, 4500Ls and max voltage for 6000Ls.*

#### Max RMS Current @ FS Voltage

	V Range	V high	V low
3000Ls	3 Phs	2.5 A	5.0 A
	1 Phs	7.5 A	15.0 A
4500Ls	3 Phs	3.8 A	7.5 A
	1 Phs	11.3 A	22.5 A
6000Ls	3 Phs	5.0 A	10.0 A
	1 Phs	15.0 A	30.0 A

#### Frequency Range:

With -HF option: 45 Hz - 2000 Hz

#### -HF Option

##### Frequency Range:

3000Ls, 4500Ls, 6000Ls

Standard, -HV: 45 Hz - 5000 Hz

-EHV: 45 Hz - 2000 Hz

All other models:

45 Hz - 2000 Hz

#### Output Noise

250 mVrms typical (20 kHz to 1 MHz)

#### Measurements

F < 2000 Hz: See standard Ls specifications.

F > 2000 Hz: See table.

Parameter	Range	Accuracy* (±)		Resolution
		1 ø mode	3 ø mode	
Frequency		See standard Ls		1 Hz
Phase	< 2000 Hz	See standard Ls		
	> 2000 Hz	5°		1°
Voltage (AC)	0 -300 V < 1000 Hz > 1000 Hz	0.05% + 250mV 0.1% + 0.1%/KHz + 300 mV		10 mV 10 mV
Current (AC rms)	0 - 50 A	0.5% + 150 mA	0.5% + 50 mA	1 mA
Real Power	0 - 5 kW	0.5% + 9 W	0.5% + 3 W	1 W
Apparent Power	0 - 5 kVA	0.5% + 9 VA	0.5% + 3 VA	1 VA
Power Factor	0.00 - 1.00	0.03	0.01	0.01

\* See standard measurement specifications for notes.

### Ordering Information

Model	Output Power	Phase Output	Input Voltage <sup>1</sup>
3000Ls	3 kVA	1/3	208-230V ±10 %
4500Ls	4.5 kVA	1/3	208-230V ±10 %
4500Ls-400	4.5 kVA	1/3	400V ±10%
6000Ls	6 kVA	1/3	208-230V ±10 %
9000Ls	9 kVA	1/3	208-230V ±10 %
9000Ls-400	9 kVA	1/3	400V ±10%
12000Ls	12 kVA	1/3	208-230V ±10 %



13500Ls	13.5 kVA	1/3	208-230V ±10 %
13500Ls-400	13.5 kVA	1/3	400V ±10%
18000Ls	18 kVA	1/3	208-230V ±10 %

*Note (1): 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.*

## Options

C prefix Cabinet System. Installed and pre-wired in 19" cabinet.

### Input Options

- 400 400 Volt Line-to-Line AC input.  
[Not available on 6000Ls model or 12000Ls and 18000Ls Systems]

### Output Options

- AX<sub>1</sub> Auxiliary outputs, 26 VAC, 5 VAC. Limits upper frequency to 800 Hz.
- HV<sub>1</sub> 135/270 V output range.
- EHV<sub>1</sub> 200/400 V output range.
- HF<sub>1</sub> Extends upper frequency limit. See HF table.

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

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

*Note 1: See option matrix*

### 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]
- 704 Mil-Std 704 Rev D and E test firmware. [AC only]
- 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<sub>1</sub> Clock and Lock Master
- LKS<sub>1,2</sub> Clock and Lock Auxiliary
- LNS<sub>2</sub> Line Sync.
- EXS<sub>2</sub> External Sync.

*Note 1: See option matrix*

*Note2 : -LKS, -LNS and -EXS are mutually exclusive and with Ext Trig function.*

### Cabinet Options

- RMS Rack-mount 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	x	x
LF	x	-	o	o	o	o	o	o

<b>HV</b>	o	o	-	o	o	o	o	o
<b>EHV</b>	x	o	x	-	o	o	o	o
<b>LKM</b>	x	o	o	o	-	x	o	o
<b>LKS</b>	x	o	o	o	x	-	x	o
<b>EXS</b>	o	o	o	o	o	x	-	o
<b>AX</b>	x	o	o	o	o	o	o	-