

AC Power Systems

Ls Series

Programmable AC Source

- **Backward Compatible with L Series AC Sources**
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
- **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.

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

All Ls Series AC sources are standard

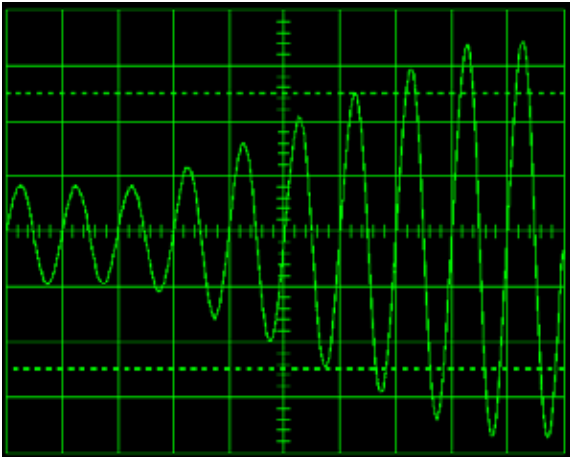
equipped with USB and RS232C remote control interfaces. An optional GPIB and Ethernet (LAN) interface is available as well.

L Series 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.

Ls Series - AC Transient Generation



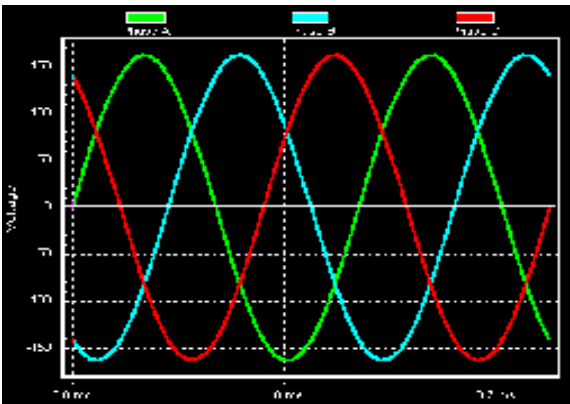
Voltage sweep transient causes output voltage to change at a programmed rate.

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 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

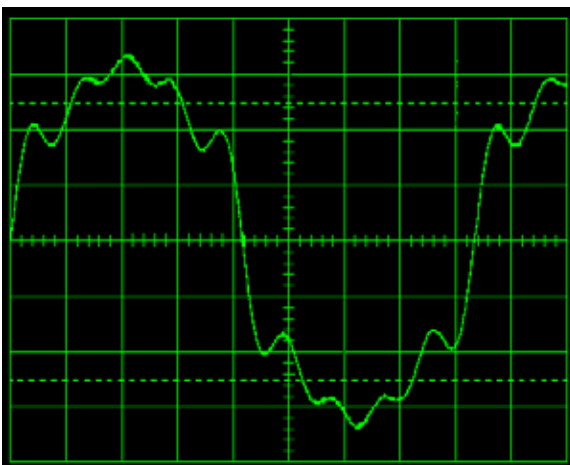
The -MODE option provides automatic switching between three phase and single phase output modes. In single phase mode, all output current is routed to the Phase A output terminal. The -MODE option is available for 3 phase Ls configurations.

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 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 named for easy recall.



Harmonic waveform, Fund., 3rd, 5th, 7th and 9th.

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:

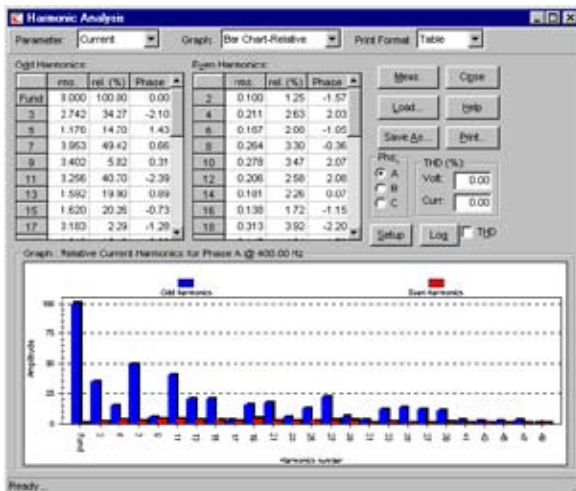
- Frequency and Phase
- Voltage (rms)
- Current(rms) and Peak Current
- Crest Factor
- Real Power and Apparent Power
- Power Factor

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.

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.



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).

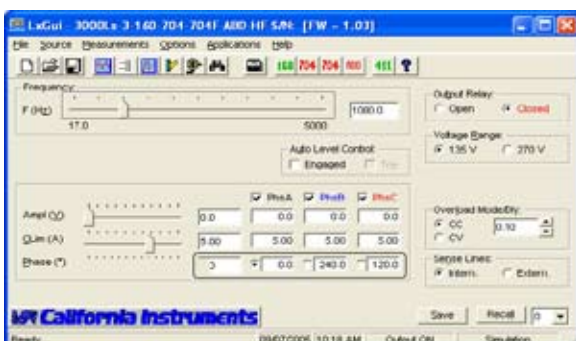
Windows Graphical User Interface

A Windows compatible 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.



Soft front panel control through Windows GUI.

Specifications

Output¹

Power

Maximum power per phase:

Model:	Single Phase	Three Phase
3000Ls	3000 VA	1000 VA
4500Ls	4500 VA	1500 VA
6000Ls	6000 VA	2000 VA

Power Factor

0 to unity at full output VA

Voltage Ranges

Low : 0-135 Volt

High : 0-270 Volt

See -HV and -EHV options for alternate voltage range pairs.

Voltage Programming Resolution

100 mV

Load Regulation (ALC on)

< 0.1% FS

Line Regulation

< 0.02% for 10% line change

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

± 0.07% > 819.1 Hz

Phase:

± 1° 45- 100 Hz

±(1° + 1°/kHz) 100 Hz - 1 kHz

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 Hz² at > 819 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

Measurements

Parameter	Range	Accuracy* (±)		Resolution
		1 ø mode (-1)	3 ø mode (-3)	
Frequency	45 - 81.91 Hz	0.1% + 1 digit		0.01 Hz
	82.0 - 819.1 Hz			0.1 Hz
	> 819 Hz			1 Hz
Phase	45 - 100 Hz	0.5° 2°		0.1°
	100 - 1000 Hz			1°
Voltage (AC)	0-400 V	0.05% + 250 mV		10 mV
Current (AC rms)	0 - 50 A	0.1% + 150 mA	0.1% + 50 mA	1 mA
Real Power	0 - 6 kW	0.15% + 9 W	0.15% + 3 W	1 W
Apparent Power	0 - 6 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 and apply above 100 counts. For multi-chassis configurations, Current and 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.

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 (I_{rms} @ FS volt)

4500Ls: 4 x (I_{rms} @ FS volt)

6000Ls: 3 x (I_{rms} @ FS volt)

Output Noise

100mVrms 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 6000Lx, 12000Lx or 18000Lx.
3. 3000Lx can be operated from 1 phase AC.

Line Current (rms per phase)

Model:	187 VLL	360 VLL
3000Ls	19 A	10 A
3000Ls (1ø)	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 Hz

Efficiency: 75 % typical

Power Factor: 0.6 typical

Hold-up Time: At least 10 ms

Note: For three phase configurations, all specifications are for L-N. Phase angle specifications are valid under balanced load conditions only.

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

IEEE-488 Interface (-GPIB Option)

IEEE-488 (GPIB) talker listener.

Subset:

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

USB interface

Version: USB 1.1

Speed: 460 Kb/s max.

Ethernet interface (option)

Optional, specify -LAN option.
10BaseT, 100BaseT, RJ45

RS232C Interface

Bi-directional serial interface.

9 pin D-shell connector

Handshake: CTS, RTS

Databits: 7 with parity,
8 without parity

Stopbits: 2

Baud rate: 9600 to 115200

Supplied with RS232C cable

Code and Format

SCPI

APE (option -GPIB)

Protection

Over Load

Constant Current or Constant Voltage mode

Over Temperature

Automatic shutdown

Over Voltage

Automatic shutdown

Regulatory

IEC1010, EN50081-2, EN50082-2
CE EMC and Safety Mark requirements

RFI Suppression

CISPR 11, Group1, Class A

Physical

Dimensions (per chassis)

Height : 10.5" (267 mm)

Width : 19" (483 mm)

Depth¹ : 23.7" (602 mm)

¹ Depth includes rear panel connectors.

Weight (per chassis)

193 lbs / 87.7 Kg net.

280 lbs / 127.3 Kg shipping

All weights and dimension are per chassis. For /2 or /3 model configurations, multiply weight and height by number of chassis (2 or 3).

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 -ADV Specifications

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	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.

Option -HV Specifications

All specifications same as standard Ls models except where noted.

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, 12000Ls, 13500Ls, 18000Ls:

45 Hz - 2000 Hz

Option -EHV Specifications

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

Option -HF Specifications

All specifications same as standard Ls models except where noted.

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 ∅ mode	3 ∅ mode	
Frequency		See standard Lx		1 Hz
Phase	< 2000 Hz > 2000 Hz	See standard Lx 5°		1°
Voltage (AC)	0-300V < 1000 Hz > 1000 Hz	0.05% + 250mV 0.1% + 0.1%/KHz + 300 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.

Model ¹	Output Power	No of Output Phases		Nom. Input Voltage ²
		-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

-AX¹ Auxiliary outputs, 26 VAC, 5 VAC. Limits upper frequency to 800 Hz.
 -HV¹ 156/312 V output range.
 -EHV¹ 200/400 V output range.
 -HF¹ Extends upper frequency limit. See HF table.

-LF¹

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]

-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.
 -LKM¹ Clock and Lock Master
 -LKS^{1,2} Clock and Lock Auxiliary
 -LNS² Line Sync.
 -EXS² 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	-

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