California Instruments CS Series

Programmable high power AC current source

3–18 kVA

0–270 V

14.8–2000 A

≋	208	230	400
∼		230	

ETHERNET USB GPIB RS232

- **Precision Current Source**
  Ideally suited for current protection device testing
- **Single and Three Phase Modes**
  Built-in phase mode switch makes output configuration easy
- **3kVA to 18kVA Power Levels**
  Match power source & cost to application requirements
- **Arbitrary Waveform Generator**
  Test products using real world current profiles including harmonic currents
- **Built-In Power Analyzer**
  Performs voltage & current harmonic analysis & waveform acquisition
- **Standard IEEE-448, USB and RS232C**
  Remote control interface for ATE system integration
- **GUI Software Suite**
  Allows users to access the powerful features & functions of the instrument on a Windows™ system
- **Programmable Transients**
  Amplitude & time control with up to 1ms resolution

Introduction

The CS Series is an advanced AC current source that addresses increasing demands on manufacturers to test products using real-world current profiles. By combining true current trans-conductance amplifiers with an advanced digital controller and harmonic power analyzer, the CS Series current sources are capable of performing tests that traditionally have been difficult to accomplish.

The CS Series is completely microprocessor-controlled and can be operated from a simple front panel keypad. An analog knob located next to the backlit alphanumeric LCD display allows output current or frequency to be slewed up or down dynamically.

With precise current programming and regulation, high output current, multi-phase mode and built-in power analyzer measurement capabilities, the CS Series AC current sources address many AC current test applications. Additional features, like arbitrary waveform generation and transient generation make the CS Series the ideal source for demanding production test requirements.

All CS Series AC Sources are equipped with IEEE-488 (GPIB), USB and RS232C remote control interfaces and support SCPI command language programming. An Ethernet interface is optional (-LAN Option).

Applications

AC Current Sources are useful in a variety of applications where precision is required; including precise evaluation of circuit breakers, overload relays, bi-metal temperature sensors and heating elements. Another common application is non-destructive testing of fuses. The arbitrary waveform capability of the CS makes it possible to test these devices under real-world circumstances with harmonically rich current waveforms. Protection devices that are specified to withstand specific current levels for certain durations can be tested easily with the CS current source by programming specific current levels, frequencies, and durations using the transient programming system. Available transient modes are fixed, step, pulse, and list.
Other typical applications include:

- Life testing and continuity checking of harnesses and connectors.
- Electro-plating at frequencies other than 50 or 60 Hz.
- Calibration of current clamps, watt-hour meters, current probes
- Transformer and inductor testing

Current Control

The CS Series uses true current feedback control. This is considerably different from many commonly available AC power sources that use a voltage feedback scheme in combination with a constant current mode of operation. Such power sources adjust the output voltage to try and maintain the requested current level (Voltage controlled current). These voltage controlled

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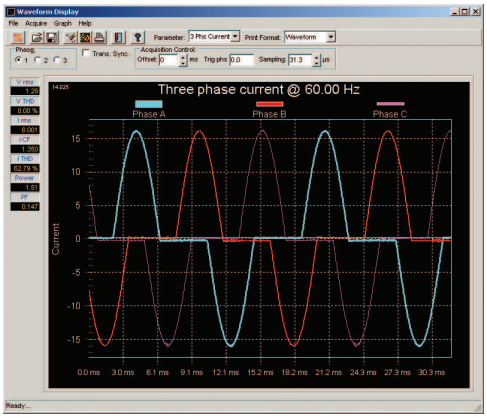
current sources have a finite response time to sudden impedance changes, which typically results in dynamic current over or undershoot as the load impedance changes. A current controlled current source does not suffer from the response lag and will always maintain the current at the specified level, regardless of transient load conditions. The maximum compliance voltage supported by the CS Series is 270 Vrms. A lower compliance voltage trip level can be programmed as needed.

Waveform Generation
The CS Series provides sine, clipped sine and square waveforms in addition to user defined arbitrary waveforms. Harmonic waveforms can be used to test for harmonic current susceptibility of a unit under test. With the help of the supplied Windows Instrument Control Software (GUI), defining harmonic waveforms is as easy as specifying the relative amplitude and phase angle for each of up to 50 harmonics. The user also has the ability to define arbitrary waveform data. Complex AC current anomalies can be simulated this way. The waveform data points generated are downloaded by the ICS to the AC source through IEEE-488, USB or RS232C bus. Up to 50 user-defined waveforms can be stored and given a descriptive name for easy recall. Downloaded waveforms are retained in non-volatile memory for recall over the bus or from the front panel.



Waveform Display, Three Phase

Transient Generation
To simulate complex current events, the CS Series offers a list of transient steps. These steps can be programmed from the front panel or downloaded over the interface using the software supplied. The ICS allows libraries of commonly used sequences 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 current transient generation allows the effect of rapid changes in current, frequency and current waveform shape on the unit under test to be analyzed. The combination of transients and user defined arbitrary waveforms creates a powerful test platform for AC powered products.

Measurements
The CS 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. The same data is also used to perform Fast Fourier Transformation (FFT) to extract the harmonic amplitude and phase angle of 50 harmonics.

Standard Measurements
The following standard measurements are available from the front panel or via the bus: Frequency, Phase, Voltage (rms), Current (rms), Peak Voltage, Voltage Crest Factor, Real Power, Apparent Power, Power Factor

Advanced Measurement Functions
In addition to standard load parameters, the CS Series is capable of measuring voltage and current amplitude and phase harmonics. Total harmonic distortion of both voltage and current is also available. Advanced measurement results like harmonic content of voltage and current for all three phases are available over the bus. The GUI can 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 also be displayed using the software. Waveform displays on the PC 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.

Windows Graphical User Interface
The GUI offers a soft front panel interface for operation from a PC running Windows Vista™, Windows XP™, or Windows 2000™. The following functions are available through this software:

- Steady state output control (all parameters).
- Create, run, save and print transient programs.
- Generate and save harmonic waveforms.
- Generate and save arbitrary waveforms.
- Measure and log standard measurements.
- Capture and display Voltage and Current waveforms.
- Measure, display, print and log harmonic voltage and current measurements.

Output Power	
Maximum Power Per Phase	3000CS: Single Phase = 3000 VA, Three Phase = 1000 VA. 4500CS: Single Phase = 4500 VA, Three Phase = 1500 VA
Multi-Chassis Maximum Power Per Phase	9000CS/2: Single Phase = 9000 VA, Three Phase = 3000 VA. 13500CS/3: Single Phase = 13500 VA, Three Phase = 4500 VA. 18000CS/4: Single Phase = 18000 VA, Three Phase = 6000 VA.
Current	
Maximum Available Current	3000CS: Single Phase = 44.44 A, Three Phase = 14.81 A. 4500CS: Single Phase = 44.44 A, Three Phase = 14.81 A
Multi-Chassis Maximum Available Current	9000CS/2: Single Phase = 88.88 A, Three Phase = 29.62 A. 13500CS/3: Single Phase = 133.33 A, Three Phase = 44.44 A. 18000CS/4: Single Phase = 177.7 A, Three Phase = 59.24 A
Programming Resolution	0.01 A
Programming Accuracy	Three Phase Mode: ± (0.1% + 0.05 A) from .5A to full scale. Single Phase Mode: ± (0.1% + 0.15 A) from .5A to full scale.
Distortion THD (full scale current, resistive load conditions)	< 1.2% [60-500 Hz], < 2% [500-1000 Hz], < 2.5% [1000-2000 Hz]
Load Regulation	0.1% full scale
Line Regulation	0.02% for 10% input line change
Output Noise	(20 kHz to 1 MHz, full current output): Three Phase Mode: < 13 mARMS, Single Phase Mode: < 40 mARMS
Temperature Coefficient	± 0.01% of range / °C
Stability	± 0.01 A over 24 hours
DC Offset Current	0.0 A
Output Coupling	Transformer coupled
Output Impedance	>100KOhm
Voltage Limit Programming	Range: 3000CS: 0 to 270 Vrms @ 7.41 A, 0 to 67.5 Vrms @ 14.81 A. 4500CS: 0 to 270 Vrms @ 11.11 A, 0 to 101.3 Vrms @ 14.81 A Programming Resolution: 0.1 Vrms
Frequency	Range: 45 Hz - 2000 Hz. Resolution: 0.01 Hz [<81.91 Hz], 0.1 Hz [> 82.0 to 819.1 Hz], 1 Hz [> 819 Hz]. Accuracy: ± 0.025%. Temperature Coefficient: ± 5 ppm of value / °C. Stability: ± 15ppm of value/year
Phase	Range: Phase B/C relative to phase A 0.0 to 360.0°. Resolution: (0.1° < 819.1 Hz), (0.5° > 819.1 Hz). Accuracy: < 1° [45 Hz-1000 Hz], <1° + 1°/kHz [>1000 Hz]
Protection	
Input Current	Input circuit breaker. Breaker protects the equipment only and is not a branch protection device. AC input connection should be made using a suitable branch protection device per local electrical code
Input Voltage Transients	Surge protection to withstand EN50082-1 (IEC 801-4, 5) levels
Output Over Voltage	Adjustable level constant voltage mode with programmable set point
Open Circuit & Over Temperature	Automatic Shutdown
Input	
Line Voltage	(Three Phase, 3-wire + ground - PE) 3000CS, 4500CS, 9000CS/2, 13500CS/3, 18000CS/4: Standard: 208-230 VL-L ± 10%, -400: 400 VLL ± 10%. Note: Each CS chassis requires its own AC service. 3000CS may be operated from 208-230 V L-N single phase AC input between B & C on TB3 for 3000CS
Line VA	3000CS: 5900 VA / 4100 W. 4500CS: 8900 VA / 5900 W (x2 for 9000CS/2, x3 for 13500CS/3, X4 for 18000CS/4)
Line Current (per phase)	3000CS: Standard: 19 Arms @ 187 VL-L, 3 phase AC input or 32 Arms @ 187 VLN single phase AC input. 4500CS: Standard 31 Arms @ 187 VL-L, - 400: 16 Arms @ 360 VL-L. Currents shown are for single chassis models. Currents are per chassis for multi-chassis configurations
Line Frequency & Efficiency	Line Frequency: 47-440 Hz; Efficiency: 75% (typical) depending on line and load
Power Factor	0.65 (typical)
System	
Storage	Setup Storage: 16 complete instrument setups; User Waveform Storage: 50 User-defined arbitrary waveforms of 1024 points each; Transient Lists Storage: Up to 100 transient steps per list.
Remote Control Interfaces	IEEE-488 (GPIB), USB, RS232C, Ethernet (Optional-LAN)

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.

Measurement

Measurements - Standard (AC Measurements)

Parameter	Frequency	Phase	Voltage (AC)	Current (AC rms)	Real Power	Apparent Power	Power Factor
Range	5.00-81.91 Hz 82.0-819.1 Hz > 819 kHz	0-360°	0 - 400	0 - 50 A	0.5 kW	0.5 kVA	0.00 - 1.00
Accuracy* (±)	0.1% + 1 digit	0.5° < 500 Hz 2° > 500 Hz	0.05% + 0.25 V	0.1% + 0.15 A 0.1% + 0.05 A	1ø Mode: 0.15% + 9W 3ø Mode: 0.15% + 3W	1ø Mode: 0.15% + 9 VA 3ø Mode: 0.15% + 3 VA	1ø Mode: 0.03 3ø Mode: 0.01
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 valid above 100 counts. For multi-chassis configurations, Current and Power range and accuracy specifications are per chassis. Frequency measurement accuracy applies to output voltages of 1 Arms or higher

Measurements - Harmonics

Parameter	Frequency Fundamental	Voltage	Current
Range	45-81.91 Hz / 82.0-819.1 Hz / >819 Hz	Fundamental Harmonics 2 - 50	Fundamental Harmonics 2 - 50
Accuracy* (±)	0.1% + 1 digit	0.05% + 0.25 V / 0.1% + 0.1%/kHz + 0.25 V	0.5 A / 0.1% + 0.05 A + 0.1% /1 kHz
Resolution	0.01 Hz / 0.1 Hz / 1 Hz	10 mV / 10 mV	10 mA / 10 mA

* Accuracy specifications are in percent of reading for single unit and three phase mode

Physical Dimensions

Dimensions	Height: 10.5" (267 mm), Width: 19.0" (483 mm), Depth: 23.0" (584 mm) All dimensions are per chassis. For /2, /3, or /4 model configurations, multiply height by 2, 3, or 4 for total height. Width includes integrated front panel rackmount ears
Weight	Chassis: Net: 193 lbs / 87.7 Kg, Shipping: 280 lbs / 127.3 Kg
Vibration and Shock	Designed to meet NSTA project 1A transportation levels. Units are shipped in wooden crate with forklift slots
Air Intake/Exhaust	Forced air cooling, side air intake, rear exhaust
Temperature	Operating Temperature: 0 to 35° C, full power; Storage Temperature: -40 to 85° C

Model: Refer to table shown for model numbers and configurations.

Input Options

-400 400 ±10% Volt Line to Line AC input

Output Options

-AX[1] Auxiliary outputs, 26 VAC, 5 VAC. Limits upper frequency to 800 Hz.

-LF[1] Limits output frequency to 500 Hz

Note 1: See option matrix

Controller Options

-HF High Frequency - up to 5 kHz (except with multi-box configurations 2 kHz)

-MB Multi-box. Adds controller to auxiliary chassis of multi-chassis systems

-L22 Locking Knob.

-LAN Ethernet Interface

-LKM[1] Clock and Lock Master

-LKS[1,2] Clock and Lock Auxiliary

-LNS[2] Line Sync.

-EXS[2] External Sync

Note 1: See option matrix

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

Cabinet Options

-RMS Rackmount Slides. Recommended for rack mount applications

C1-C5 prefix: Cabinet System. Number indicates cabinet height. Installed and pre-wired in 19" cabinet. Consult factory for available cabinet sizes

Standard controller versions with single voltage range

Model	Output Power	Phase Output	Input Voltage[1]
3000CS	3 kVA	1/3	208-230V
4500CS	4.5 kVA	1/3	208-230V
4500CS-400	4.5 kVA	1/3	400V
9000CS/2	9 kVA	1/3	208-230V
9000CS/2-400	9 kVA	1/3	400V
13500CS/3	13.5 kVA	1/3	208-230V
13500CS/3-400	13.5 kVA	1/3	400V
18000CS/4	18 kVA	1/3	208-230V
18000CS/4-400	18 kVA	1/3	400V

Note (1): All input voltage specifications are for Line-to Line three phase, delta or wye. Model 3000CS (208 V input) can be operated on 230 V L-N single-phase.

	LF	LKM	LKS	EXS	AX
LF	–	O	O	O	O
LKM	O	–	X	O	O
LKS	O	X	–	X	O
EXS	O	O	X	–	O
AX	O	O	O	O	–

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.

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