California Instruments FCS Series II

Overview

≋	208	380	400
	415	480	

ETHERNET USB GPIB RS232

- **High Performance**
  135/270 V, 156/312 V, or 200/400 V

- **Easy to Program**
  Uses front panel keyboard display with full decimal keypad for data entry

- **Single or Three Phase Operation**
  Ideally suited for avionics and defense applications

- **Arbitrary Waveform Capability**
  Test products for harmonics susceptibility

- **Power Analyzer**
  Performs voltage and load current harmonic analysis and waveform acquisition

- **Features multiple Connectivity**
  Connects via RS232, USB, and GBIB - remote control interface for ATE system integration included

Integrated System
The FCS Series II AC Power system is one of the most powerful systems in the industry, supporting high power levels with ease, at a reduced cost. The FCS Series II combines a flexible AC power source with a harmonic power analyzer that is capable of handling the most complex applications.

The FCS Series II uses a state-of-the-art Digital Signal Processor in conjunction with precision A/D converters. This provides more accuracy and resolution for test applications then is found in most dedicated harmonic power analyzers.

This system integrates digital multimeters, power harmonics analyzer, and current shunts, eliminating the need for multiple instruments; thus reducing cost and providing more flexibility than can be found with competing products.

Easy To Use Controls
The FCS Series II is microprocessor controlled and is operated using the front panel keypad that makes precise entries simple, and our powerful Instrument Control Software (GUI) which offers an even higher level of programability. An analog control allows output voltage and frequency to be slewed up or down dynamically. The control employs a dynamic rate change algorithm that combines the benfits of precise control over small parameter changes with quick sweeps through the entire range.

Applications
With precise output regulation and accuarcy, high load drive current, multi or single phase mode, and built-in power analyzer measurement

capabilities, the FCS Series II Power System addresses many application areas for AC power testing. Additional features like line arbitrary waveform generation, DO 160, MIL 704, and Airbus test standards make the FCS Series II a great choice for avionics and defense applications.

FCS Series II - Measurement and Analysis Standard Waveforms
The FCS Series II Series provides three standard waveforms that are always available for output. The standard waveforms are:

- Sinewave for normal AC applications.
- Squarewave for special applications.
- Clipped Sinewave - Simulates THD levels to test for harmonic distortion susceptibility.

In addition to these standard waveforms, user defined waveform can be downloaded over the bus.

Harmonic Waveform Generation
Using the latest DSP technology, the FCS Series II Series controller is capable of generating harmonic waveforms to test for harmonics susceptibility of a unit under test. The Instrument Control Software can be used to define harmonic waveforms by specifying amplitude and phase for up to 50 harmonics. The waveform data points are generated and downloaded by the Instrument Control Software to the AC source through either the Remote Interface bus and remain in nonvolatile memory. Up to 50 waveforms can be stored and given a user defined name for easy recall. The three phase FCS Series II configuration offers independent waveform generation on each phase allowing three phase anomalies to be programmed and also allows simulation of unbalanced line conditions.

Arbitrary Waveform Generation

Using the provided Instrument Control Software, the user also has the ability to define arbitrary AC waveforms. The arbitrary waveform method of data entry provides an alternative method of specifying AC anomalies by providing specific waveform data points. The Instrument Control Software includes a catalog of custom waveforms. Arbitrary waveform capability is a flexible way of simulating the effect of real-world AC power line conditions in both engineering and production environments.

FCS Series II Series - Configuration Options AC Transient Generation

The FCS Series II controllers have a powerful AC transient generation system that allows complex sequences of voltage, frequency and waveshapes to be generated. This further enhances the capability to simulate AC line conditions or disturbances. When combined with the multi phase arbitrary waveform capabilities, the AC output possibilities are truly exceptional. In three phase system configurations, transient generation is controlled independently yet time synchronized on all three phases. Accurate phase angle control and synchronized transient list execution provide unparalleled accuracy in positioning AC output events.

Transient programming is easily accomplished from the front panel or software where clearly laid out menu's guide the user through the transient definition process. This feature allows for transient execution, Start, Stop, Abort and Resume operations.

User defined transient sequences can be saved to nonvolatile memory on on the PC for instant recall and execution at a later time. The included GUI supports transient definitions using a spreadsheet-like data entry grid. A library of frequently used transient programs can be created on disk.

The FCS Series II 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 used to perform Fast Fourrier Transformation (FFT) to extract the harmonic amplitude and phase angle of 50 harmonics.
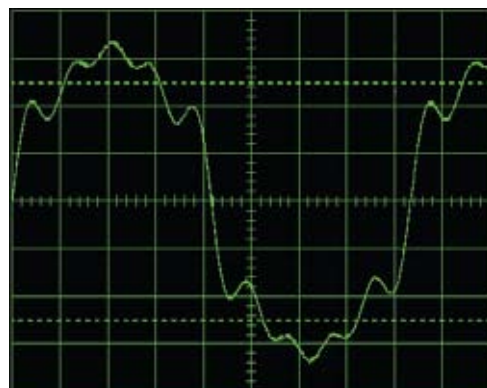
Harmonic waveform, Fund., 3rd, 5th, 7th and 9th.
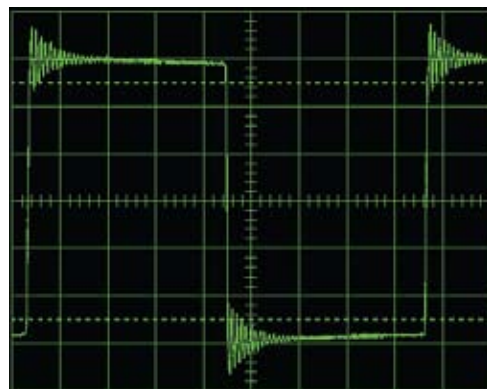
Simulation of severe ringing on the output of a UPS.
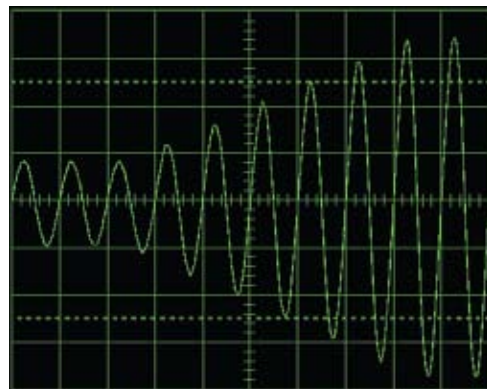
Voltage sweep transient causes output voltage to change at a programmed rate.

Standard Waveforms

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
- Neutral Current (rms)
- Real Power and Apparent Power
- Power Factor

Advanced Measurement Functions

In addition to standard load parameters, the FCS Series II Series is capable of measuring voltage and current amplitude and phase harmonics up to the 50th harmonic (for fundamental frequencies up to 250 Hz). Total harmonic distortion of both voltage and current is also available.

Harmonic analysis data can be displayed on the front panel display or on the PC using the GUI program. 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 be displayed using the GUI program. Waveform displays on the PC include voltage and current combined, three phase voltage, three phase current and true power. The time-domain data is available for transferr to a PC through IEEE-488, USB, RS232C, or Ethernet (option) when using custom software.

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).

Instrument Control Software

Windows® Instrument Control Software is included with the FCS Series II. This software provides easy access to the power source's capabilities without the need to develop any custom code. The following functions are available:

- Steady state output control (all parameters)
- Create, run, save, reload & print transient programs
- Generate & save harmonic waveforms
- Generate & save arbitrary waveforms
- Measure & log standard measurements
- Capture & display output voltage & current waveforms
- Measure, display, print & log harmonic voltage & current measurements
- Display bus traffic to & from the AC Source to help you develop your own test programs

1. Requires PC running Windows Vista™, Windows XP™, or Windows 2000™

Standard measurements for all phases.
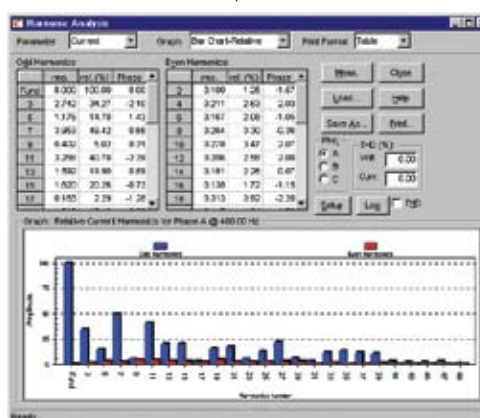
Relative Current Harmonics shown in table and chart.

Soft front panel control through Windows GUI.

FCS Series II : Specifications

Output

Output	
Maximum Power per phase	FCS18-1 (1 phase): 18 kVA; FCS18-3 (3 phase): 6 kVA
Power factor	0 to unity at full output VA

Voltage Ranges						
	Range:	V Low	V High	VA Programming Resolution	100 mV	
	AC	0-135 V	0-270 V	Load Regulation	< 0.1 % FS	
	See -HV and EHV options for alternative voltage range pairs.			Line Regulation	< 0.02 % for 10 % line change	

Programming Accuracy (25°C ±5°C	± (0.05% + 0.25 V) from 10V to FS. Specified at voltage sense point with ALC mode ON.
Frequency Range	45 Hz - 1200 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 at > 819 Hz

Max RMS Current			
	Range:	FCS18-1	FCS18-3
	0-135 V	133.2 Arms	44.4 Arms
	0-270 V	66.6 Arms	22.2 Arms
	Note: Constant power mode on the FCS Series II provides increased current at reduced voltage		

Current Limit	Programmable from 0 Amps to maximum current for selected range
Peak Current	135 V Range - Single Phase: 375 Apk, Three Phase: 125 Apk; 270 V Range - Single Phase: 187.5 Apk, Three Phase: 62.5 Apk
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

Line Voltage/Current (rms per phase)						
	Models	208 VAC (STD)	240 VAC (OPT)	380 VAC (OPT)	415 VAC (OPT)	480 VAC (OPT)
	Line Voltage	± 10%	± 10%	± 10%	± 10%	± 10%
	Line Current	65 Arms	56 Arms	36 Arms	33 Arms	28 Arms

Line VA	24 KVA at nominal input voltage
Line Frequency	47-63 Hz
Efficiency	85% (Typical) depending on line and load
Power Factor	0.85 (Typical)
Inrush Current	250 Apk max. (Note: Each FCS chassis requires its own AC service).
Hold-up Time	> 10 ms
Isolation Voltage	400 VAC RMS input to output; 1350 VAC input to chassis

Measurement

Voltage	Resolution 0.1 Volt, Accuracy 0.05% + 0.25%, Range 0 - 400 V
Current	Resolution 0.01 Amp, Accuracy 0.1% + 0.15A, Range 0 - 250 Amps
Power	Resolution 0.01 kW, Accuracy 1.0 % FS, Range 0 - 54 KW
Phase Angle	Resolution 0.1°, Accuracy ± 2°, Range 45 - 100.0 Hz
Power Factor	Range 0.00 to 1.00
Frequency	Resolution four decades, Accuracy ± 0,02 Hz to 99.99 Hz, ± 0.2 Hz to 500.0 Hz, ± 0.5 Hz to 999.9 Hz, ± 10 Hz to 1200 Hz
Apparent Power	Resolution 0.01 kVA, Accuracy 1.0 % FS, Range 0 - 54 KVA

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: Surge protection to withstand EN50082-1 (IEC 801-4, 5) levels.
Regulatory/RFI Suppresion	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.

Remote Control

IEEE-488 Interface	IEEE-488 (GPIB) talker listener. Subset: AH1, C0, DC1, DT1, L3, PP0, RL2, SH1, SR1, T6, IEEE-488.2 SCPI Syntax
USB Interface & Optional Ethernet	Version: USB 1.1; Speed: 460 Kb/s maximum
Ethernet Interface (Optional)	Specify -LAN option. 10BaseT, 100BaseT, RJ45
RS232C Interface	Bi-directional serial interface; 9-pin D-shell connector. Handshake: CTS, RTS. Databits: 7 w/ parity, 8 w/o parity. Stopbits: 2. Baud rate: 9600 to 115200. Supplied with RS232C cable / Code and Format: SCPI; APE (option -GPIB)

Physical Dimensions

Dimensions (per chassis)	Height: 45" (114.3 cm), Width: 30" (76.2 cm), Depth: 36" (+ 4" for J-box) = 40" (101.6 cm) (For /2 or /3 models multiply height by 2/3)
Weight	Chassis: Net: 900 lbs / 87.7 Kg, Shipping: 1100 lbs / 127.3 Kg (for /2 or /3 model configuarations multiply number of chassis).
Vibration and Shock	Designed to meet NSTA project 1A transportation level
Air Intake/Exhaust	Forced air cooling, front to rear air intake, rear exhaust, variable fan speed
Temperature	Operating: 0 to 35° C, full power / Storage: -40 to +85° C
Diagnostics	Built-in self test available over bus (*TST)
Rear Panel Connectors	*Three phase AC input and output terminal block with safety cover. *IEEE-488 (GPIB) connector, USB connector, RJ45 connector (with -LAN Option). *9-pin D-Shell RS232C connector (RS232 DB9 to DB9 cable supplied). *Remote Inhibit (INH) and Discrete Fault Indicator (DFI). *Remote voltage sense terminal block. *Trigger In1 and Trigger Out1. *System interface connectors. *Auxilary Output (Option -AX)

Option -ADV Specifications

Measurements - Harmonics				
	Parameter	Frequency Fundamental Harmonics	Voltage	Current
	Range	45-250 Hz / 0.09 - 12.5 kHz	Fundamental Harmonics 2 - 50	Fundamental Harmonics 2 - 50
	Accuracy* (±)	0.01% + 1 digit / 0.5% + 1 digit	750 mV 0.3% + 750 mV+0.3% /1 kHz	0.5 A / 0.3% + 150 mA +0.3% /1 kHz
	Resolution	0.01 Hz / 0.1 Hz	10 mV / 10 mV	10 mA / 10 mA

* Accuracy specifications are in a percent of reading for single unit in 3-phase mode.

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 (1ø) or 31.25 usec (3ø) sampling interval

Option -HV Specifications

Voltage/Frequency Ranges	Low: 0-156 Volt; High: 0-312 Volt

Max RMS Current at FSVoltage		
Range	FCS18-1	FCS18-3
0-156 V	115.3 Arms	38.4 Arms / ø
0-312 V	57.6 Arms	19.2 Arms / ø

Standard -EHV Specifications

Voltage/Frequency Ranges	Voltage: Low: 0-200 Volt; High: 0-400 Volt / Frequency: With -HF option: 45 Hz - 1000 Hz

Max RMS Current @ FS VA		
Range	FCS18-1	FCS18-3
0-200 V	90 Arms	30 Arms / ø
0-400 V	45 Arms	15 Arms / ø

FCS Series II : Ordering Information

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	-

FCS Series II Rear Panel

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

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

Output Options
-AX   Auxiliary outputs, 26 VAC, 5 VAC. Limits upper frequency to 800 Hz.

-HV   156/312 V output range.

-EHV   200/400 V output range.

-HF   Extends upper frequency limit. See HF table.

-LF   Limits output frequency to 500 Hz.

Controller Options
-160   RTCA/DO-160D, Change 2, EuroCAE-14D [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]

-704F   Mil Std 704 test firmware. Revisions A-F.

-ABD   Airbus Directive 0100.1.8 tests. [AC only]. Requires -ADV and use of Windows PC and included FCS Series II Instrument Control software.

-ADV   Advanced feature set. Adds arbitrary waveform generation and harmonic analysis of voltage and current.

-AMD   Airbus AMD24C Tests. Revision C.

-A350 Airbus Test Software

-B787 Boeing 787B3-0147 Tests.

-EXS   External Sync.

-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

-LKS1,2 Clock and Lock Auxiliary

-LNS2 Line Sync.

-EXS2 External Sync.

Cabinet Options

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