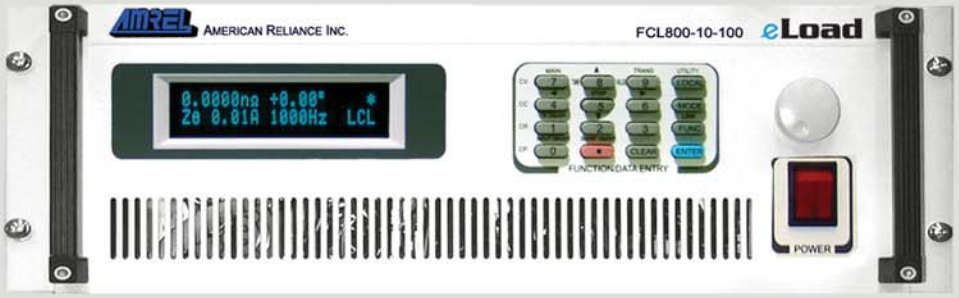
FCL800 FUEL CELL eLoad

A Fully Integrated Fuel Cell eLoad Solution by AMREL

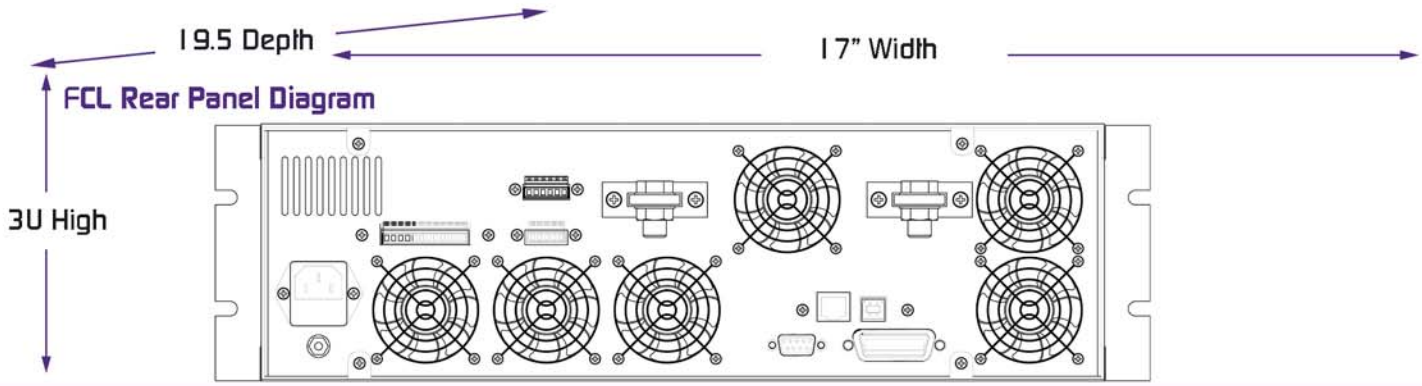
Features and Benefits

- Embedded FRA (Frequency Response Analyzer) without the hassles of external wiring
- Built-in Booster Power Supply to test down to 0Vdc at Full Operating Current
- Fully Integrated 800W/10Vdc/100Adc Air-cooled Electronic eLoad for seamless operation
- Impedance Measurement Software without the costs of purchasing additional software
- CC/CV/CR/CP Operating Modes to meet demanding application-specific requirements
- Dynamic Operation up to 20kHz provides accurate impedance measurements
- FRA uses digital sine correlation and adjustable sampling time to reject noise and harmonics
- Dynamic Profile Loading Via Voltage and Current Sweeps for polarization curves, durability, accelerated life-time tests, real-world application simulation and other dynamic test requirements
- Generate Polarization Curves down to 0Vdc and store key I-V data in CSV Format
- LabView & LabWindows Drivers, Virtual Panel & SCPI commands for simple ATE Integration
- The one-box solution for testing electrical specs, validating performance targets and evaluating the internal losses of Fuel Cells to optimize power output and cell performance

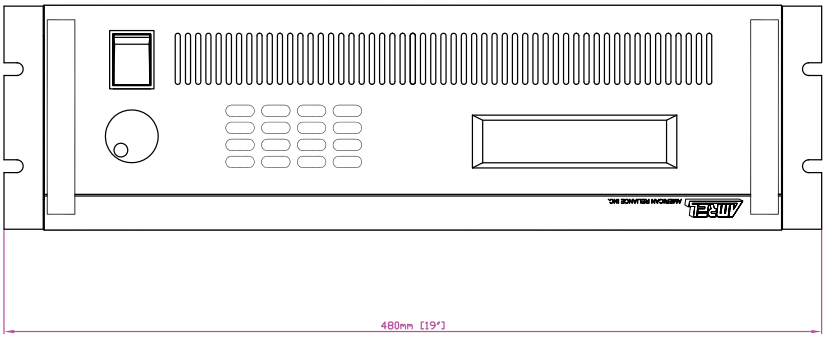
FCL Front Panel

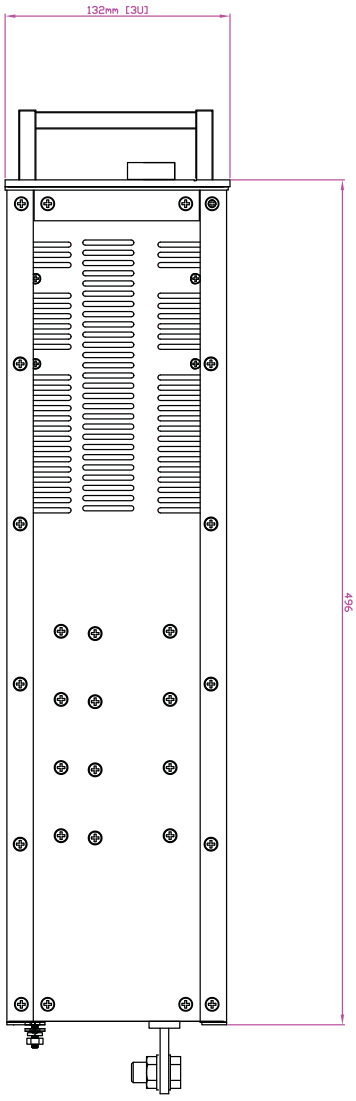


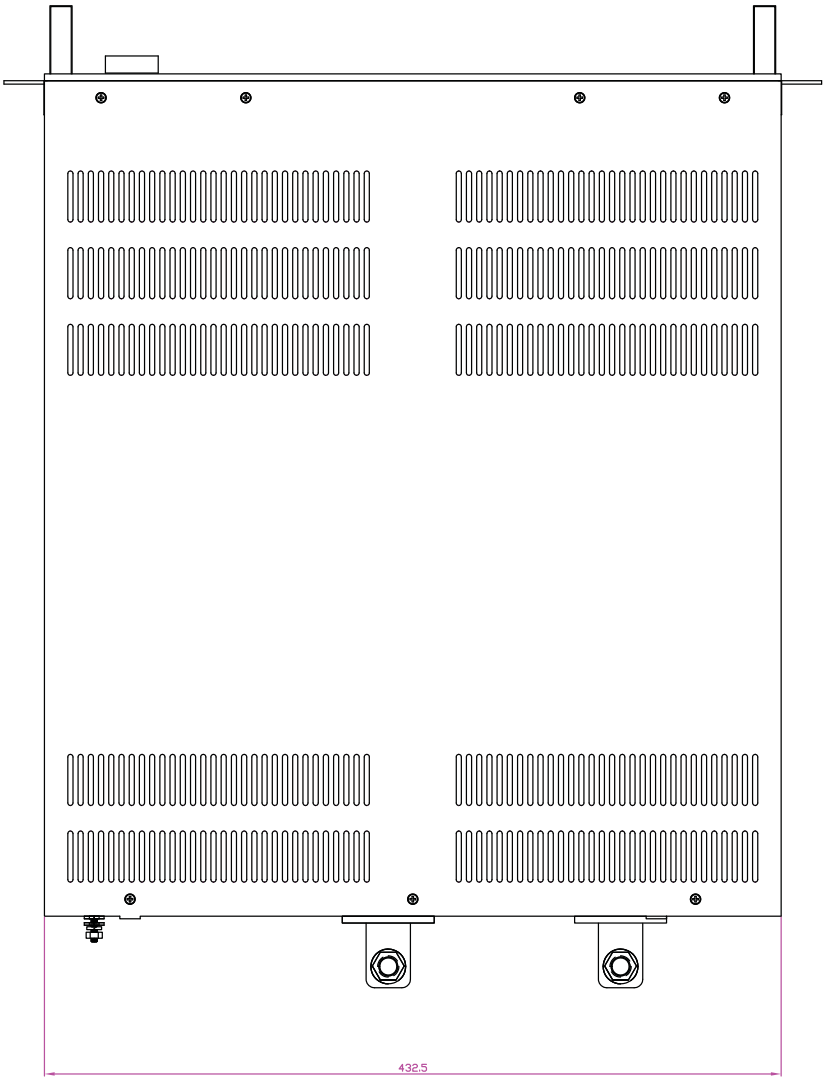
FCL Rear Panel Diagram

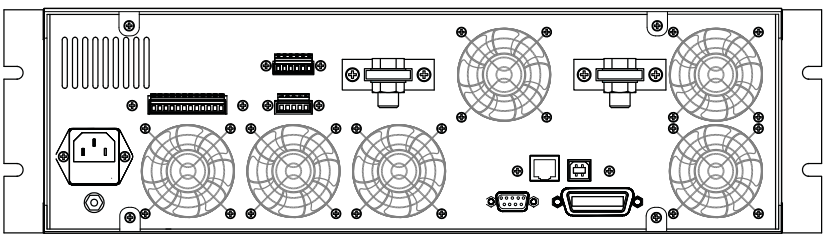


FCL 3-View Dimensional Diagram









FCL **800-10-100** | **800 W**

Constant Voltage Mode

CVH Range	0.000	~	10.00	V
CVM Range	0.000	~	5.000	V
CVL Range	0.000	~	1.000	V
Transient Time Range				
Fast Band(Default,Osc1)	0.150	~	15.36	ms
Slow Band(Osc2,Osc3)	0.150	~	153.6	ms
Temperature Coefficient	100 ppm / °C of Rated Voltage			
Program				
CV Resolution*2	1/16000 of Rated Voltage			
CVH Accuracy*2	0.05%	±	0.010	V
CVM Accuracy*2	0.05%	±	0.010	V
CVL Accuracy*2	0.05%	±	0.010	V
Display				
CVH Resolution	1/16000 of Rated Voltage			
CVH Accuracy	0.05%	±	0.010	V
CVM Accuracy	0.05%	±	0.010	V
CCL Accuracy	0.05%	±	0.010	V

Constant Current Mode

CCH Range	0.000	~	100.0	A
CCM Range	0.000	~	50.00	A
CCL Range	0.000	~	10.00	A
Transient Time Range				
Fast Band(Default,Osc1)	0.015	~	15.36	ms
Slow Band(Osc2,Osc3)	0.150	~	153.6	ms
Minimum Voltage(I_{Max})			0.000	V
Temperature Coefficient	100 ppm / °C of Rated Current			
Program				
CC Resolution*2	1/16000 of Rated Current			
CCH Accuracy*2	0.05%	±	0.100	A
CCM Accuracy*2	0.05%	±	0.100	A
CCL Accuracy*2	0.05%	±	0.100	A
Display				
CC Resolution	1/16000 of Rated Current			
CCH Accuracy	0.05%	±	0.100	A
CCM Accuracy	0.05%	±	0.100	A
CCL Accuracy	0.05%	±	0.100	A

Programmable Protection

Power(OPP)				
Range	1.100	~	880.0	W
Resolution			0.110	W
Accuracy	0.50%	±	2.200	W
Voltage(OVP)				
Range	0.007	~	10.50	V
Resolution			0.001	V
Accuracy	0.20%	±	0.013	V
Current(OCP)				
Range	0.066	~	105.0	A
Resolution			0.007	A
Accuracy	0.20%	±	0.131	A
Under Voltage Lockout(UVL)				
Mode	Input On / Continuous			
Range	0.008	~	10.00	V
Resolution			0.003	V
Accuracy	2.50%	±	0.013	V
Anti-Oscillation	Default / Osc1 / Osc2 / Osc3 / Disable			

Protection

Over Power Protection(OP)	880.0	±	16.76	W
Over Voltage Protection(OV)	10.50	±	0.200	V
Over Current Protection(OC)	110.0	±	1.048	A
Over Temperature Protection(OTP)	90.00	±	5.000	°C
Reverse Maximum Current(RCP)	110.0			A
Short Maximum Current			102.0	A
Remote Inhibit(RI)	Short			
Fault Indicator	SPDT Relay (30Vdc/0.5A or 125Vac/0.25A)			

Dielectric Strength

Primary Circuit To Chassis	1500 Vac for 1 min
Primary Circuit To Load Terminal	1500 Vac for 1 min
Load Terminal To Chassis	1500 Vdc for 1 min

Constant Power Mode

CPH Range	0.000	~	800.0	W
CPM Range	0.000	~	400.0	W
	@ Iin	≤	50.00	A
CPL Range	0.000	~	80.00	W
	@ Iin	≤	10.00	A
Transient Time Range	Same As CC Mode			
Temperature Coefficient	300 ppm / °C of Rated Power			
Program				
CP Resolution*2	1/16000 of Rated Power			
CPH Accuracy*2	1.00%	±	4.000	W
	@Iin	>	5.000	A
	& Vin	>	1.000	V
CPM Accuracy*2	1.00%	±	4.000	W
	@Iin	>	1.000	A
	& Vin	>	1.000	V
CPL Accuracy*2	1.00%	±	4.000	W
	@Iin	>	0.100	A
	& Vin	>	2.000	V

Constant Resistance Mode

CRH Range	1.000	~	100.0	Ω
	@ Iin	≤	10.00	A
CRM Range	0.1000	~	25.00	Ω
CRL Range	0.0040	~	0.1000	Ω
Transient Time Range				
CRM / CRH	Same As CC Mode			
CRL	Same As CV Mode			
Temperature Coefficient				
CRM / H	300 ppm / °C of Minimum Resistance			
CRL	300 ppm / °C of Maximum Resistance			
Program				
CR Resolution*2	1/16000 Of Rated Value			
CRH Accuracy*2	1.00%	±	5.000	mS
	@Iin	>	0.100	A
	& Vin	>	2.000	V
CRM Accuracy*2	1.00%	±	20.00	mS
	@Iin	>	1.000	A
	& Vin	>	1.000	V
CRL Accuracy*2	1.00%	±	0.100	mΩ
	@Iin	>	10.00	A
	& Vin	>	0.010	V

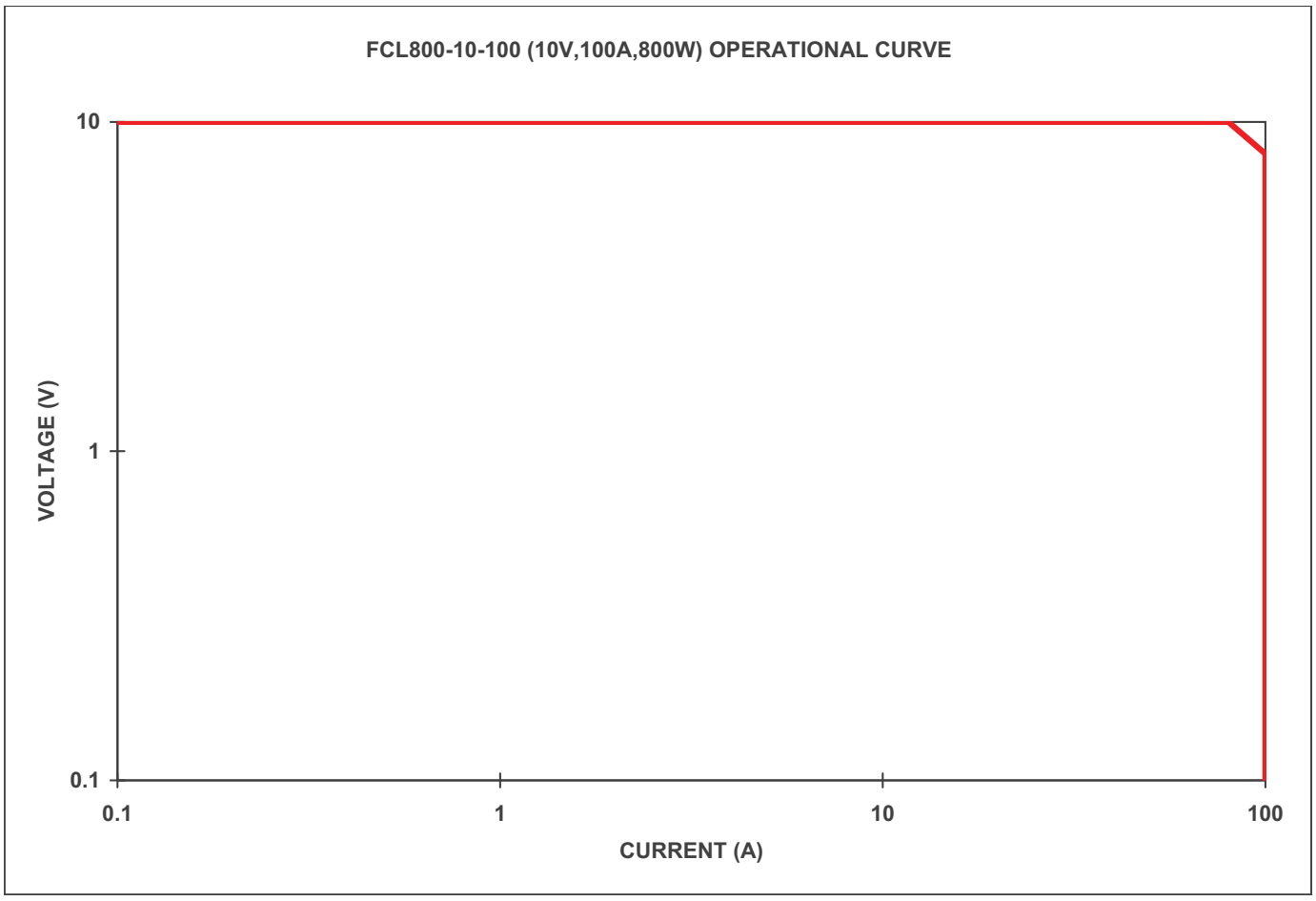
External Programming Mode

Analog Program	0~10 Volts Input yields			
	0~selected full scaled loading in all modes			
Accuracy	Same As Internal ± 0.1% Rating			
Input Impedance	400 kΩ	±	1 %	
BandWidth(-3dB)	Limited By Internal Transient Time			
Monitor output Signal	0~10 Volts output for 0~full scaled Value			
VMON Accuracy	0.10%	±	0.010	V
IMON Accuracy	0.10%	±	0.100	A
Transient Mode				
Frequency Range	0.100	~	20,000	Hz
Accuracy			0.1%	
Duty Range	1.000	~	100.0	%
Accuracy			0.1%	
Transient Time Accuracy	10.0%	±	50% of Minimum Time	
Remote Interface	GPIB / RS-232 / ETHERNET / USB			

General

Derating for higher temperatures	(-)1.67% Rated Power / °C
AC Input	95~240 Vac 48~62 Hz
Operating Temperature	5 °C ~ 40 °C
Dimension	19.5"(L)x17"(W)x5.25"(H)

*1 All Mode Specification measure by slow band and 25°C room temperature unless otherwise specified
*2 Transient Mode Specification must be x2
AMREL reserves the right to change limits,test conditions,and dimensions without notice


FCL800-10-100 (10V,100A,800W) OPERATIONAL CURVE
10
1
0.1
VOLTAGE (V)
0.1
1
10
100
CURRENT (A)

FCL **800-10-200** | **800 W**

Constant Voltage Mode

CVH Range	0.000	~	10.00	V
CVM Range	0.000	~	5.000	V
CVL Range	0.000	~	1.000	V
Transient Time Range				
Fast Band(Default,Osc1)	0.250	~	25.59	ms
Slow Band(Osc2,Osc3)	0.250	~	255.9	ms
Temperature Coefficient	100 ppm / °C of Rated Voltage			
Program				
CV Resolution*2	1/16000 of Rated Voltage			
CVH Accuracy*2	0.05%	±	0.010	V
CVM Accuracy*2	0.05%	±	0.010	V
CVL Accuracy*2	0.05%	±	0.010	V
Display				
CVH Resolution	1/16000 of Rated Voltage			
CVH Accuracy	0.05%	±	0.010	V
CVM Accuracy	0.05%	±	0.010	V
CCL Accuracy	0.05%	±	0.010	V

Constant Current Mode

CCH Range	0.000	~	200.0	A
CCM Range	0.000	~	100.0	A
CCL Range	0.000	~	20.00	A
Transient Time Range				
Fast Band(Default,Osc1)	0.025	~	25.59	ms
Slow Band(Osc2,Osc3)	0.250	~	255.9	ms
Minimum Voltage(I_{Max})			0.000	V
Temperature Coefficient	100 ppm / °C of Rated Current			
Program				
CC Resolution*2	1/16000 of Rated Current			
CCH Accuracy*2	0.05%	±	0.200	A
CCM Accuracy*2	0.05%	±	0.200	A
CCL Accuracy*2	0.05%	±	0.200	A
Display				
CC Resolution	1/16000 of Rated Current			
CCH Accuracy	0.05%	±	0.200	A
CCM Accuracy	0.05%	±	0.200	A
CCL Accuracy	0.05%	±	0.200	A

Programmable Protection

Power(OPP)				
Range	1.100	~	880.0	W
Resolution			0.110	W
Accuracy	0.50%	±	2.200	W
Voltage(OVP)				
Range	0.007	~	10.50	V
Resolution			0.001	V
Accuracy	0.20%	±	0.013	V
Current(OCP)				
Range	0.131	~	210.0	A
Resolution			0.013	A
Accuracy	0.20%	±	0.263	A
Under Voltage Lockout(UVL)				
Mode	Input On / Continuous			
Range	0.008	~	10.00	V
Resolution			0.003	V
Accuracy	2.50%	±	0.013	V
Anti-Oscillation	Default / Osc1 / Osc2 / Osc3 / Disable			

Protection

Over Power Protection(OP)	880.0	±	16.76	W
Over Voltage Protection(OV)	10.50	±	0.200	V
Over Current Protection(OC)	220.0	±	2.095	A
Over Temperature Protection(OTP)	90.00	±	5.000	°C
Reverse Maximum Current(RCP)	220.0			A
Short Maximum Current			204.0	A
Remote Inhibit(RI)	Short			
Fault Indicator	SPDT Relay (30Vdc/0.5A or 125Vac/0.25A)			

Dielectric Strength

Primary Circuit To Chassis	1500 Vac for 1 min
Primary Circuit To Load Terminal	1500 Vac for 1 min
Load Terminal To Chassis	1500 Vdc for 1 min

Constant Power Mode

CPH Range	0.000	~	800.0	W
CPM Range	0.000	~	400.0	W
	@ Iin	≤	100.0	A
CPL Range	0.000	~	80.00	W
	@ Iin	≤	20.00	A
Transient Time Range	Same As CC Mode			
Temperature Coefficient	300 ppm / °C of Rated Power			
Program				
CP Resolution*2	1/16000 of Rated Power			
CPH Accuracy*2	1.00%	±	4.000	W
	@Iin	>	10.00	A
	& Vin	>	1.000	V
CPM Accuracy*2	1.00%	±	4.000	W
	@Iin	>	2.000	A
	& Vin	>	1.000	V
CPL Accuracy*2	1.00%	±	4.000	W
	@Iin	>	0.200	A
	& Vin	>	2.000	V

Constant Resistance Mode

CRH Range	0.500	~	50.00	Ω
	@ Iin	≤	20.00	A
CRM Range	0.0500	~	12.50	Ω
CRL Range	0.0020	~	0.0500	Ω
Transient Time Range				
CRM / CRH	Same As CC Mode			
CRL	Same As CV Mode			
Temperature Coefficient				
CRM / H	300 ppm / °C of Minimum Resistance			
CRL	300 ppm / °C of Maximum Resistance			
Program				
CR Resolution*2	1/16000 Of Rated Value			
CRH Accuracy*2	1.00%	±	10.00	mS
	@Iin	>	0.200	A
	& Vin	>	2.000	V
CRM Accuracy*2	1.00%	±	40.00	mS
	@Iin	>	2.000	A
	& Vin	>	1.000	V
CRL Accuracy*2	1.00%	±	0.050	mΩ
	@Iin	>	20.00	A
	& Vin	>	0.010	V

External Programming Mode

Analog Program	0~10 Volts Input yields			
	0~selected full scaled loading in all modes			
Accuracy	Same As Internal ± 0.1% Rating			
Input Impedance	400 kΩ	±	1 %	
BandWidth(-3dB)	Limited By Internal Transient Time			
Monitor output Signal	0~10 Volts output for 0~full scaled Value			
VMON Accuracy	0.10%	±	0.010	V
IMON Accuracy	0.10%	±	0.200	A
Transient Mode				
Frequency Range	0.100	~	20,000	Hz
Accuracy			0.1%	
Duty Range	1.000	~	100.0	%
Accuracy			0.1%	
Transient Time Accuracy	10.0%	±	50% of Minimum Time	
Remote Interface	GPIB / RS-232 / ETHERNET / USB			

General

Derating for higher temperatures	(-)1.67% Rated Power / °C
AC Input	95~240 Vac 48~62 Hz
Operating Temperature	5 °C ~ 40 °C
Dimension	19.5"(L)x17"(W)x5.25"(H)

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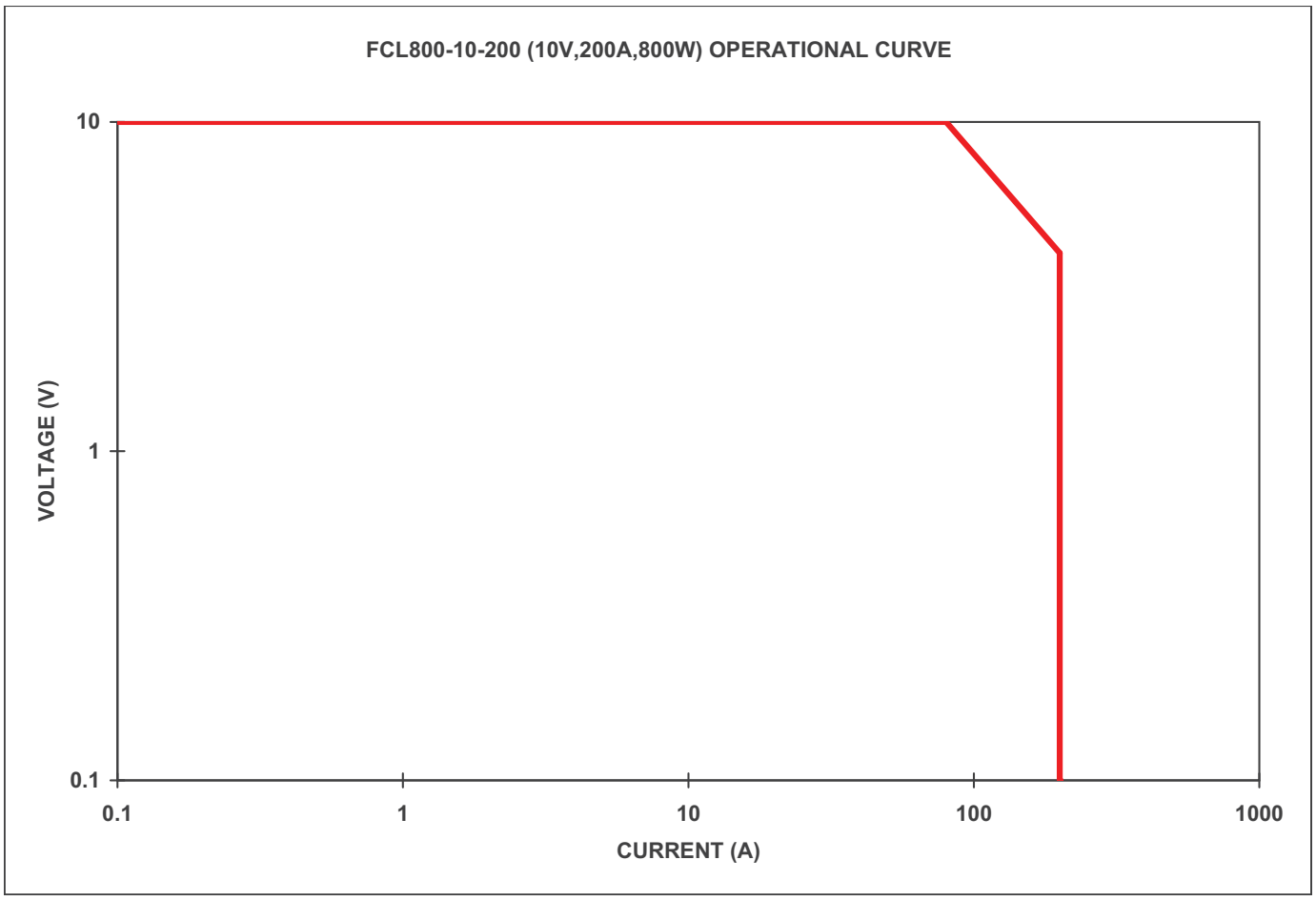
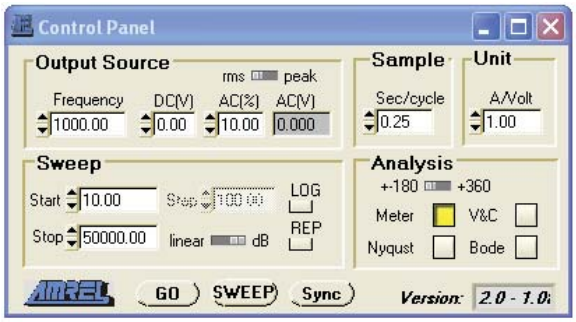
AMREL reserves the right to change limits,test conditions,and dimensions without notice


FCL800-10-200 (10V,200A,800W) OPERATIONAL CURVE
10
1
0.1
VOLTAGE (V)
0.1
1
10
100
1000
CURRENT (A)

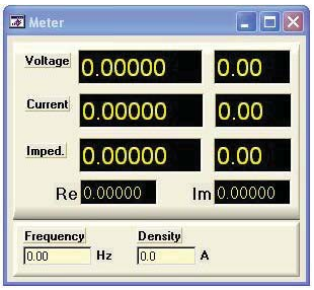
Frequency Response Analyzer Specifications

Technical Features:

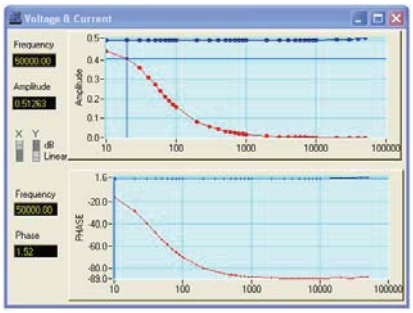
- Digital Sine Correlation to remove Harmonics for accurate measurements
- Programmable Integration (Sampling) Time will allow measurement of micro-ohm signals buried under noise without the need for auxiliary equipment
- Simultaneous V/I measurement to ensure exact impedance and phase information
- DDS Sine-wave generation, yielding frequency errors less than 0.02 Hz
- Floating Dual Independent Signal Analyzers provide single channel impedance measurements or both channels to measure transfer functions, transconductance, impedance, signal analysis (FRA) data and other important parameters in polar/rectangular format
- User-friendly features include: auto-gain, quick-set ac amplitude, signal overload (signal saturation) protection, and adjustable sample interval without the complicated calculations. The above features allow the user to start measuring impedance without hassles.
- Auto-Gain Control and flexible ranges for measuring small signals in noisy environments with 1μV sensitivity while maximizing resolution and precision to obtain an accurate measurement
- Universal ac + dc output signals critical for Impedance Measurement/AC Modulation applications in the battery/fuel cell/electronic components & devices R&D, Testing and Production sectors
- GPIB/RS-232 and Optional USB/Ethernet provide state-of-the-art connectivity while satisfying diverse throughput/network security requirements
- System-level Multi-channel Impedance Measurement can be achieved using the integrated MCU-1 capability and a switch matrix
- Impedance Measurement Application Program Included to save costs associated with existing expensive Impedance Measurement Software
- Comprehensive application program with premium features - Nyquist, Bode, V/I, real-time display of impedance measurements & operating conditions, frequency sweeps with adjustable amplitude in log/linear form & auto-save for logged data to establish AMREL's FRA as the ultimate diagnostic tool
- 0.1Hz Models Available



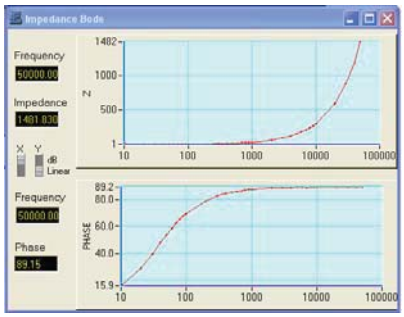
Control Panel



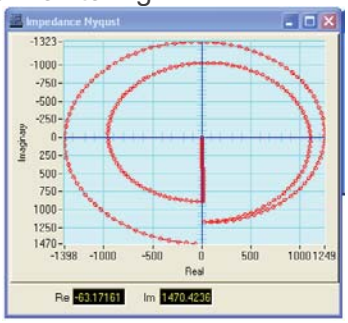
Real Time Monitoring



V/I Graph



Bode Plots



Nyquist Plots

Frequency Response Analyzer Specifications[1]:

Generator

Waveform: Sine Wave
Programmable Frequency Range: 1 Hz ~ 20 KHz
Frequency Resolution: 0.01Hz
Amplitude: Up to 20% of DC Bias Setting or 1Vrms
Amplitude Resolution: $5mV_{PP}$
Distortion: < 0.2%
Sweep Types: Frequency – logarithmic and linear
Amplitude – logarithmic and linear

Amplitude Accuracy:

Frequency Range	Amplitude Range	AC Amplitude Accuracy[2]
10Hz ~ 20kHz	0.05Vrms ~ 0.1999Vrms	± 2% * 0.1999Vrms
	0.2Vrms ~ 0.8Vrms	± 0.50% * 0.8Vrms
	Output Amplitude > 0.8	± 2% * 1Vrms

*1: Specifications are preliminary and is subject to change without prior notice
*2: Amplitude Accuracy are specified to % of Max Range Value

dc Bias

Range: 10mVdc ~ 10Vdc
Resolution: 10mV
Accuracy: 0.1% ± 50mVdc
Output Impedance: 50Ω
Maximum Output: 0V < Vdc + Vpk-pk(ac) ≤ 10V

Analyzers - Two independent analyzers operate in parallel.

Range: Auto
Sensitivity: 1µV
Dynamic Range: 90dB
Common Mode Rejection: >80dB @ 100Hz
Cross Channel Isolation: >90dB @ 10kHz
Coupling: ac (- 3dB @ 2Hz)
DC Blocking Voltage: 250Vdc Common Mode/500Vdc Differential Mode
Differential Input Impedance: > 200KΩ
Maximum Input: 1Vp-p (approx. 350mVrms)
ADC (Per Channel): 16 bit, 400K samples/second
Sample Interval: 10ms ~ 10s; Default Setting: 0.25s
Phase Accuracy: 1.0 degree
Magnitude Accuracy:

Amplitude			
160mV < Input ≤ 350mV	± 0.2% * 350mV	± 0.2% * 350mV	± 0.5% * 350mV
54mV < Input ≤ 160mV	± 0.2% * 160mV	± 0.2% * 160mV	± 0.5% * 160mV
27mV < Input ≤ 54mV	± 0.2% * 54mV	± 0.2% * 54mV	± 0.5% * 54mV
18mV < Input ≤ 27mV	± 0.2% * 27mV	± 0.2% * 27mV	± 0.5% * 27mV
11mV < Input ≤ 18mV	± 0.2% * 18mV	± 0.2% * 18mV	± 0.5% * 18mV
5.4mV < Input ≤ 11mV	± 0.2% * 11mV	± 0.2% * 11mV	± 0.5% * 11mV
3.6mV < Input ≤ 5.4mV	± 1.0% * 5.4mV	± 0.2% * 5.4mV	± 0.5% * 5.4mV
1µV < Input ≤ 3.6mV	± 1.0% * 3.6mV	± 1.0% * 3.6mV	± 1.0% * 3.6mV
Frequency	**10Hz ~ 999.99Hz**	**1kHz ~ 9999.99Hz**	**10kHz ~ 20kHz**