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# **i Series iX Series AC Power Source User Manual**



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User's Manual  
AC Power Source  
California Instruments

Models :

- 3001i
- 5001i
- 5001i-400
- 9003i
- 10001i
- 10001i-400
- 15001i
- 15001i-400
- 15003i
- 15003i-400
- 30003i
- 30003i-400
  
- 3001iX
- 5001iX
- 5001iX-400
- 9003iX
- 10001iX
- 10001iX-400
- 15001iX
- 15001iX-400
- 15003iX
- 15003iX-400
- 30003iX
- 30003iX-400

Rev AA, March 2011.

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# Important Safety Instructions

Before applying power to the system, verify that your product is configured properly for your particular application.

 <b>WARNING</b>	<b>Hazardous voltages may be present when covers are removed. Qualified personnel must use extreme caution when servicing this equipment. Circuit boards, test points, and output voltages also may be floating above (below) chassis ground.</b>
 <b>WARNING</b>	<b>The equipment used contains ESD sensitive ports. When installing equipment, follow ESD Safety Procedures. Electrostatic discharges might cause damage to the equipment.</b>

Only *qualified personnel* who deal with attendant hazards in power supplies, are allowed to perform installation and servicing.

Ensure that the AC power line ground is connected properly to the Power Rack input connector or chassis. Similarly, other power ground lines including those to application and maintenance equipment *must* be grounded properly for both personnel and equipment safety.

Always ensure that facility AC input power is de-energized prior to connecting or disconnecting any cable.

In normal operation, the operator does not have access to hazardous voltages within the chassis. However, depending on the user's application configuration, **HIGH VOLTAGES HAZARDOUS TO HUMAN SAFETY** may be normally generated on the output terminals. The customer/user must ensure that the output power lines are labeled properly as to the safety hazards and that any inadvertent contact with hazardous voltages is eliminated.

Guard against risks of electrical shock during open cover checks by not touching any portion of the electrical circuits. Even when power is off, capacitors may retain an electrical charge. Use safety glasses during open cover checks to avoid personal injury by any sudden component failure.

Neither AMETEK Programmable Power Inc., San Diego, California, USA, nor any of the subsidiary sales organizations can accept any responsibility for personnel, material or inconsequential injury, loss or damage that results from improper use of the equipment and accessories.

## SAFETY SYMBOLS



**WARNING**  
Risk of Electrical Shock



**CAUTION**  
Refer to Accompanying Documents



Off (Supply)



Direct Current (DC)



Standby (Supply)



Alternating Current (AC)



On (Supply)



Three-Phase Alternating Current



Protective Conductor Terminal



Earth (Ground) Terminal



Fuse



Chassis Ground

## Product Family: i Series, iX Series

### Warranty Period: One Year

#### WARRANTY TERMS

AMETEK Programmable Power, Inc. ("AMETEK"), provides this written warranty covering the Product stated above, and if the Buyer discovers and notifies AMETEK in writing of any defect in material or workmanship within the applicable warranty period stated above, then AMETEK may, at its option: repair or replace the Product; or issue a credit note for the defective Product; or provide the Buyer with replacement parts for the Product.

The Buyer will, at its expense, return the defective Product or parts thereof to AMETEK in accordance with the return procedure specified below. AMETEK will, at its expense, deliver the repaired or replaced Product or parts to the Buyer. Any warranty of AMETEK will not apply if the Buyer is in default under the Purchase Order Agreement or where the Product or any part thereof:

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- is damaged by modifications, alterations or attachments thereto which are not authorized by AMETEK;
- is installed or operated contrary to the instructions of AMETEK;
- is opened, modified or disassembled in any way without AMETEK's consent; or
- is used in combination with items, articles or materials not authorized by AMETEK.

The Buyer may not assert any claim that the Products are not in conformity with any warranty until the Buyer has made all payments to AMETEK provided for in the Purchase Order Agreement.

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Telephone: 800-733-5427, ext. 2295 or ext. 2463 (toll free North America)  
858-450-0085, ext. 2295 or ext. 2463 (direct)
  - **Outside the United States**, contact the nearest Authorized Service Center (ASC). A full listing can be found either through your local distributor or our website, [www.programmablepower.com](http://www.programmablepower.com), by clicking Support and going to the Service Centers tab.
2. When requesting an RMA, have the following information ready:
  - Model number
  - Serial number
  - Description of the problem

**NOTE:** Unauthorized returns will not be accepted and will be returned at the shipper's expense.

**NOTE:** A returned product found upon inspection by AMETEK, to be in specification is subject to an evaluation fee and applicable freight charges.



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## 1. Introduction

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This instruction manual contains information on the installation, operation, calibration and maintenance of all power systems that use the 3001i, 5001i, 3001iX, and 5001iX power sources with the programmable controller. Higher power configurations consisting of multiple units operated in parallel are also covered by this user manual. Such models are 10001iX, 10002iX, 15003iX and 30003iX.

### 1.1 General Description

---

The 3001i, 5001i, 3001iX, and 5001iX are high efficiency, lightweight AC power sources that provide a precise output with low distortion. Older generation i Series have two voltage ranges, either 0-135V or 0-270V. The iX Series and the newer generation i Series offer two sets of ranges, 0-135/0-270 and 0-150/0-300. Full power is available at the maximum output voltage for all ranges. Two or three 5001i/iX units can be connected in parallel as a single-phase system for 10 kVA or 15 kVA respectively. Three or six units can be connected as a three-phase system. They can be operated with AC or DC output. The iX Series also offers AC+DC output mode.

## 2. Specifications

All specifications are for a single i or iX series chassis and  $25 \pm 5^\circ\text{C}$  sine wave output with a resistive load unless noted otherwise.

### 2.1 Electrical

#### 2.1.1 Input

Parameter	3001i & ix	5001i & iX
Line Voltage:	208-240 $\pm 10\%$ VAC, single phase	208-240 $V_{LL} \pm 10\%$ , (Standard) 400-440 $V_{LL} \pm 10\%$ , (-400) 400-480 $V_{LL} \pm 10\%$ , (-400) 3 phase, 3 wire + ground
Line VA:	5000VA	8000VA
Line Current:	25 A RMS max. (Per Box)	23 A RMS max. at 208-240 VAC 12 A RMS max. at 400-440 VAC and 400-480 VAC (Per Box)
Line Frequency:	50-60 Hz $\pm 10\%$	
Efficiency:	80% (typical) depending on line and load	
Power Factor:	0.7 (typical)	0.9 (typical)
Inrush Current:	100 $A_{pk}$ for 100 $\mu\text{s}$	100 $A_{pk}$ for 100 $\mu\text{s}$ at 208-240V 50 $A_{pk}$ for 100 $\mu\text{s}$ at 400-440 VAC and 400-480 VAC
Hold-Up Time:	15 ms	
Isolation Voltage:	2200 VAC input to output 1350 VAC input to chassis	



## 2.1.2 Output

**(ALL SPECIFICATIONS ARE FOR AC AND DC UNLESS NOTED OTHERWISE)**

Output Parameter	i Series	iX Series
<b>Modes:</b>	AC, DC	AC, DC, AC+DC
<b>Voltage:</b>		
Ranges (L-N):		
AC Mode	Low: 0 - 135 VAC / High: 0 - 270 VAC 0 - 150 VAC / High: 0 - 300 VAC	
DC Mode	Low: 0 - 135 VDC / High: 0 - 270 VDC 0 - 150 VDC / High: 0 - 300 VDC	
AC+DC Mode iX Models only.	AC: Low: 0 - 150 V / High: 0 - 300 V DC Offset: Low 0 - 150 V / High: 0 - 250 V	
Programming Resolution:		
AC Mode	0.1 V	
DC Mode	0.1 V	
AC+DC Mode	AC: 0.1 V DC Offset: 0.01 V < 0.5 V 0.1 V 0.6 - 25 V 1 V > 25 V	
Voltage Accuracy:		
AC mode	±0.5% of range, 16 to 400 Hz.	±0.5% of range, 16 to 400 Hz.
DC mode	±0.5% of range	±0.5% of range
DC offset (AC+DC mode)		±5% of range ± 0.1 VDC.< 25VDC ±5% of range ± 1 VDC.> 25VDC
Voltage Distortion <sup>1</sup> : (linear load)	1% max THD at 50/60 Hz 2% max THD at 400 Hz	1% max THD at 50/60 Hz 2% max THD at 400 Hz
Load Regulation:	± 0.5% DC to 100 Hz ± 2.2% to 500 Hz (135 range) ± 0.6% to 500 Hz (270 range)	± 0.5% DC to 100 Hz. ± 2.2% to 500 Hz (135/150 range) ± 0.6% to 500 Hz (270/300 range)
Line Regulation:	0.1% for 10% input line change	0.1% for 10% input line change
Power: (per phase, either range, at full scale voltage)		
3001, 9003i/iX	3000 VA AC, 2100 W DC	3000 VA AC, 2100 W DC
5001, 15003i/iX	5000 VA AC, 3500 W DC	5000 VA AC, 3500 W DC
10001i/iX	10000 VA AC, 7000 W DC	10000 VA AC, 7000 W DC

<sup>1</sup> The distortion specification for the 3001i and iX is valid for an input voltage range of 197-264 V.

Output Parameter	i Series	iX Series
15001i/iX	15000 VA AC, 10500 W DC	15000 VA AC, 10500 W DC
Current, maximum rms amps per phase:		
3001i/iX	22.2, 135 VAC range 11.1, 270 VAC range	22.2, 135 VAC range 20.0, 150 VAC range 11.1, 270 VAC range 10.0, 300 VAC range
	15.5, 135 VDC range 7.77, 270 VDC range	15.5, 135 VDC range 14.0, 150 VDC range 7.77, 270 VDC range 7.00, 300 VDC range
Current, maximum rms amps per phase:		
5001, 15003i/iX per phase	37.0, 135 VAC range 18.5, 270 VAC range	37.0, 135 VAC range 33.3, 150 VAC range 18.5, 270 VAC range 16.7, 300 VAC range
	25.0, 135 VDC range 11.7, 270 VDC range	25.9, 135 VDC range 23.3, 150 VDC range 12.95, 270 VDC range 11.69, 300 VDC range
10001i/iX	74.0, 135 VAC range 37.0, 270 VAC range	74.0, 135 VAC range 66.7, 150 VAC range 37.0, 270 VAC range 33.3, 300 VAC range
	51.8, 135 VDC range 25.9, 270 VDC range	51.8, 135 VDC range 46.6, 150 VDC range 25.9, 270 VDC range 23.3, 300 VDC range

Output Parameter	i Series	iX Series
15001i/iX	111, 135 VAC range 55.5, 270 VAC range	111, 135 VAC range 100, 150 VAC range 55.5, 270 VAC range 50.0, 300 VAC range
	77.7, 135 VDC range 38.8, 270 VDC range	77.7, 135 VDC range 70.0, 150 VDC range 38.8, 270 VDC range 35.0, 300 VDC range
(Derated linearly from 50% of voltage to 10% of specified current at 5% of voltage range) Note: For the iX series, the current output in the AC & DC mode is equal to the current in the AC mode if the DC voltage is less than 20% of the fullscale voltage. It is equal to the DC current for DC voltages more than 20% of fullscale		

Output Parameter	i Series	iX Series
Current Limit	programmable 0 to 100% of range for all ranges	
Frequency Range:	16.00 - 81.91 Hz (0.01 Hz resolution) 81.0 - 500.0 Hz (0.1 Hz resolution)	
Frequency Accuracy:	±0.01% of programmed value	
DC Offset Voltage:	Less than 20 mV with linear load.	
Output Impedance		
Range:	n/a	R <sub>min</sub> to 1000 mΩ L <sub>min</sub> to 1000 μH
Resolution:	n/a	4 mΩ 4 μH
Accuracy:	n/a	± 2% F.S. at 796 μH and 400 mΩ
Output Noise: (20 kHz to 1 MHz)	400 mVrms max, 135 V range, 800 mVrms max, 270 V range	<250 mV rms (typ), <500 mV rms (max)
Peak Rep AC Current:		
3001i/iX 5001i/iX 9003i/iX 15003i/iX	110 A for 135 V range, 92 A for 270 V range	110 A for 135 V range, 100 A for 150 V range, 92 A for 270 V range, 83 A for 300 V range
10001i/iX	220 A for 135 V range, 184 A for 270 V range	220 A for 135 V range, 200 A for 150 V range, 184 A for 270 V range, 166 A for 300 V range
15001i/iX	330 A for 135 V range, 276 A for 270 V range	330 A for 135 V range, 300 A for 150 V range, 276 A for 270 V range, 249 A for 300 V range
Crest Factor:	Up to 5:1	Up to 5:1

### 2.1.3 Measurements (i series)

Parameter	Range	Accuracy ( ± )	Resolution
Frequency	16.00 - 99.99 Hz 100.0 - 500.0 Hz	0.02 Hz 0.2 Hz	0.01 Hz 0.1 Hz
Rms Voltage	0 - 300 Volts	0.5V	0.01 Volt
Rms Current	0 - 40 Amps	0.5A	0.001 Amp
Peak Current	0 - 119 Amps	0.5A	0.001 Amp
VA Power	0 - 6.000 kVA	0.2 kVA	0.001 kVA
Real Power	0 - 6.000 kW	0.05 kW	0.001 kW
Power Factor (>0.2kVA)	0 - 1.00	0.02	0.01
Current and Power Accuracy specifications are times ten for 10001i and 15001i. For 10001i and 15001i, resolution decreases by factor of 10, ranges for current and power increases by factor of ten.			

### 2.1.4 AC Measurements (iX series)

Parameter	Range	Accuracy ( ± )	Resolution
Frequency	16.00 - 500.0 Hz	0.01% + 0.01 Hz	0.01 to 81.91 Hz 0.1 to 500 Hz
RMS Voltage	0 - 300 Volts	0.05V + 0.02%, <100 Hz 0.1V + 0.02%, 100-500 Hz	0.01 Volt
RMS Current	0 - 40 Amps	0.05A + 0.02%, <100 Hz 0.1A + 0.02%, 100-500 Hz	0.001 Amp
Peak Current	0 - 119 Amps	0.05A + 0.02%, <100 Hz 0.1A + 0.02%, 100-500 Hz	0.001 Amp
VA Power	0 - 6.000 kVA	0.01kVA + 0.02%, <100 Hz 0.02kVa + 0.02%, 100-500 Hz	0.001 kVA
Real Power	0 - 6.000 kW	0.005kW + 0.02%, <100 Hz 0.01kW + 0.02%, 100-500 Hz	0.001 kW
Power Factor (>0.2kVA)	0 - 1.00		0.01

### 2.1.5 DC Measurements (iX series)

Parameter	Range	Accuracy ( ± )	Resolution
Voltage	0 – 300 Volts	0.1 Volts	0.01 Volt
Current	0 – 40 Amps	0.01 Amps	0.001 Amp
Power	0 – 6.000 kW	0.05 kW	0.001 kW
Current and Power Accuracy specifications are times two for 10001iX and times three for 15001iX. For 10001iX and 15001iX, resolution decreases by factor of 10, ranges for current and power increases by factor of three.			

### 2.1.6 Harmonic Measurements (iX series)

Parameter	Range	Accuracy ( ± )	Resolution
Frequency fundamental	16.00 - 500 Hz	0.01% + 0.01 Hz	0.01 Hz
Frequency harmonics	32.00 Hz - 19.5 kHz	2° typ.	0.5°
Voltage	Fundamental	0.25V	0.01V
	Harmonic 2 - 50	0.25V + 0.1% + 0.1%/kHz	0.01V
Current	Fundamental	0.05A	0.01A
	Harmonic 2 - 50	0.05A + 0.1% + 0.1%/kHz	0.01A
Accuracy specifications are times three for three phase mode. Harmonics frequency range in three phase mode is 32 Hz - 6.67 kHz. Resolution decreases by factor of 10 for 10001iX and 15001iX.			

### 2.1.7 System Specification

Parameter	Specification
External Modulation:	0 to 10%
Synchronization Input:	Isolated TTL input for external frequency control. Requires 5V at 5 ma for logic high.
Trigger Output:	400 $\mu$ s pulse for voltage or frequency change. Isolated output that requires a pull-up resistor, 22K $\Omega$ , to + 5 VDC.
Non volatile memory storage:	8 complete instrument setups and transient lists, 32 events per list.
Waveforms	Sine (i series) Sine, square, clipped, user defined (iX series)

Parameter	Specification
Transient	Voltage: drop, step, sag, surge, sweep
	Frequency: step, sag, surge, sweep
	Voltage and Frequency: step, sweep
IEEE-488 Interface:	SH1, AH1, T6, L3, SR1, RL2, DC1, DT1 IEEE 488.2 and SCPI Response time is 10 ms (typical)
RS232C Interface:	Bi-directional serial interface 9 pin D-shell connector Handshake: CTS, RTS Data bits: 7, 8 Stop bits: 1,2 Baud rate: 9600, 19200, 38400 IEEE 488.2 and SCPI
Current Limit Modes:	Two selectable modes of operation. Constant current and constant voltage with hold-off time and trip.
Function Strobe	Isolated open collector output available between pin 31 (High) and pin 14 (Low) of the System Interface connector (J22). Negative going pulse on any programmed voltage or frequency change. Function strobe output can be reassigned as trigger output when running list transients. This output requires a external DC supply and pull-up resistor.
Remote Inhibit	Also referred to as Remote On/Off. Digital input available on pin 36 and pin 27 (D-Common) of the System Interface connector (J22). The Remote inhibit input can be used to open the output relay. The output relay state is not latching so will return to the closed state when the input is removed.

### 2.1.8 Unit Protection

Input Overcurrent:	Circuit breaker with shunt trip control.
Input Overvoltage:	Automatic shunt trip of input circuit breaker.
Input Overvoltage Transients:	Surge protection to withstand EN50082-1 (IEC 801-4, 5) levels.
Output Overcurrent:	Adjustable level constant current mode with a maximum set point between 0% and 10% above programmed value.
Output Short Circuit:	Peak and rms current limit.
Overtemperature:	Automatic shutdown.

## 2.2 Mechanical

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Parameter	Specification
Dimensions:	19" (483 mm) wide x 7" (178 mm) high x 24" (610 mm) deep chassis size which is available in a rack mount or stand-alone configuration.
Unit Weight:	61 lb. (28 kg)
Material:	Aluminum chassis, panels and cover.
Finish:	Light textured painted external surfaces. Front and rear panels semi-gloss polyurethane color no. 26440 (medium gray) Top, bottom and sides semi-gloss polyurethane color no. 26622 (light gray).
Cooling:	Fan cooled with air intake on the sides and exhaust to the rear.
Internal Construction:	Modular sub assemblies.
Rear Panel Connections:	(see section 3 for description of connections) Input terminal block with cover Output terminal block with cover Remote voltage sense terminal block System interface (not for table top use, use only in rack enclosed systems) Clock and Lock (not for table top use, use only in rack enclosed systems) RS232 GPIB

## 2.3 Environmental

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Parameter	Specification
Operating Temp:	0 to +40 °C.
Storage Temp:	-40 to +85 °C.
Altitude:	<2000m
Relative Humidity:	80% maximum for temperatures up to 31°C decreasing linearly to 50% at 40°C.
Installation/Over voltage Category:	II
Pollution Degree:	2
Indoor Use Only	
Vibration:	Designed to meet NSTA 1A transportation levels.



Parameter	Specification
Shock:	Designed to meet NSTA 1A transportation levels.

## 2.4 Regulatory

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Electromagnetic Emissions and Immunity:	Designed to meet EN50081-2 and EN50082-2 European Emissions and Immunity standards as required for the “CE” mark.
Acoustic Noise:	65 dBA maximum at 0% to 50% load, 75 dBA maximum greater than 50% load to 100% load. Measured at one meter.
Safety:	Designed EN61010-1 European safety standards as required for the “CE” mark.

## 2.5 Front Panel Controls

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<b>Controls:</b>	
Shuttle knob:	Allows continuous change of all values including output calibration and range change.
Decimal keypad:	A conventional decimal keypad facilitates quick entry of numerical values such as voltage, current limit, etc. The large blue enter key will make the value you enter effective. Using the SET key allows the user to preset all parameter values and update them all at once by pressing the Enter key.
Up/down arrow keys:	A set of up and down arrow keys is used to move the cursor position in all menus. This allows quick selection of the desired function or parameter.
Function keys:	Measure key will display most measurement values. Program key will show all program parameters. Output on/off key for output relay control. Phase key will switch display to show program and measured values for each phase.
<b>Displays:</b>	
LCD graphics display:	A large high contrast LCD display with backlight provides easy to read guidance through all setup operations. An adjustable viewing angle makes it easy to read from all practical locations.
Status indicators:	Large and bright status indicators inform the user of important power source conditions. The Remote lamp informs the user that the unit is under remote control. The Overload lamp indicates that excessive current is being drawn at the output. The Over temperature lamp illuminates when internal heat sink temperatures are too high. The Hi Range indicator is lit any time the unit is switched to high output voltage range. The Output On/Off indicator is on when the power source output relays are closed.

## 2.6 Special Features, Options and Accessories

Programmable Impedance.	Output impedance programming available on models 3001iX, 5001iX, 9003iX and 15003iX only.
Parallel Operation:	Up to three units can be paralleled in a single-phase configuration (with one master controller and one or two slave units). (10001iX and 15001iX).
Three Phase Output:	Three units (all with single-phase controllers) can be connected in a three-phase configuration using CLOCK and LOCK connections. Requires –LKM option in master and –LKS option in auxiliary units. Recommended is use of 9003iX, 15003iX or 30003iX three phase system however.
Rack Mount/Handles Version:	Available rack mounting kit with slides and handles. Handles also available as a separate option.
Controller:	Programmable controller front panel assembly.
Output Relay:	Standard output relay feature to isolate AC source from the load.
Output On/Off:	The output relay can be used to quickly disconnect the load. A green status indicator displays the status of the output relay.
Three-Phase Output 9003iX/15003ix	Three power sources with one controller in the Phase A power source. The one controller controls all three outputs.
15003iX – LKM/-LKS	Three power sources each with a controller for 3-phase output
- 704	Mil Std 704D & E test firmware.  Mil Std 704A, B, C, & F test software. Note: Requires use of CIGui32 Windows application software provided on CD ROM CIC496.
- 160	RTCA/DO-160C test firmware
- 411	IEC 1000-4-11 test firmware
- 413	IEC 1000-4-13 test firmware
-ABD	Airbus ABD0100.1.8 Test firmware. Note: Requires use of CIGui32 Windows application software provided on CD ROM CIC496.
- LNS	Line sync option to synchronize output frequency to input mains line frequency
-MODE-iX	Available for 9003iX and 15003iX configurations only. Switches output configurations between single-phase and three-phase mode of operation. Note that programmable impedance function on systems with –MODE-iX option is only available when in 3 phase mode.
- RMS	Rack mount slides
-OMNI-1-18i	Single phase lumped reference impedance network of IEC1000-3-3 Flicker test
-OMNI-1-37i	Single phase lumped reference impedance network of IEC1000-3-3 Flicker test – High current.
-OMNI-3-18i	Three phase lumped reference impedance network of IEC1000-3-

	3 Flicker test
-OMNI-3-37i	Three phase lumped reference impedance network of IEC1000-3-3 Flicker test – High current.
-TI	Function strobe break out box. Function strobe / Trigger Output connection break out box. Provides BNC output with internal 9Vdc pull up for connection to external equipment such as oscilloscope. Compatible with 3001i/iX and 5001i/iX. Refer to section 3.6.5.
-TIS	Function strobe break out box for systems. Function strobe / Trigger Output connection break out box. Provides BNC output with internal 9Vdc pull up for connection to external equipment such as oscilloscope. Compatible with multi-chassis i/iX Series configurations. Refer to section 3.6.5.

### 3. Unpacking and Installation

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#### 3.1 Unpacking

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Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. **DO NOT** return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.



**WARNING:** This power source weighs 61 lb (28kg). Obtain adequate help when moving or mounting the unit.

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#### 3.2 Power Requirements

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The 3001i/iX AC Power Source has been designed to operate from a single-phase 208 to 240 volt AC line. The 5001i/iX AC Power Source and its systems have been designed to operate from a three-phase AC line voltage. Three three-phase input models are available for inputs of 208-240 V<sub>LL</sub>, 400-440 V<sub>LL</sub> (option -400), or 400-480 V<sub>LL</sub> (option -400).



**CAUTION:** Do not connect 400-480V into the 208-240V unit, the result could be a severely damaged unit.

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Figure 3-1: The 5001iX Power Source



### 3.3 Mechanical Installation

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The 3001i/iX and 5001i/iX are completely self contained power sources. They may be used free standing on a bench top or rack mounted using the optional rack mount/handle kit. The units are fan cooled, drawing air in from the sides and exhausting at the rear. The sides of each unit must be kept clear of obstruction and a 6" clearance must be maintained to the rear. Special consideration of overall air flow characteristics and the resultant internal heat rise must be allowed for with systems installed inside enclosed cabinets to avoid self heating and over temperature problems.

### 3.4 Input Wiring – TB1

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The input terminal block, TB1, is located at the rear of the unit. Ground (earth) wire must be connected to the chassis of the AC power system. The mains source must have a current rating equal to or greater than the input circuit breaker and the input wiring must be sized to satisfy the applicable electrical codes. The input terminal block cover and strain relief must be installed in table top applications to maintain protection against hazardous voltages.



***CAUTION: Capacitors in the power source may hold a hazardous electrical charge even if the power source has been disconnected from the mains supply. Allow capacitors to discharge to a safe voltage before touching exposed pins of mains supply connectors.***

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### 3.5 Output Power Connections – TB2

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The output terminal block, TB2, is located at the rear of the unit. The external sense inputs allow the power system output voltages to be monitored directly at the load and must be connected either at TB2 or the load when the sense is programmed for external. The external sense input does not have to be connected when Internal Sense is programmed. The external sense wires are to be connected to TB3 on the rear panel and should be run as a twisted pair for short lengths. Sense leads over three (3) feet long should be run as a twisted shielded pair. Refer to Figures 3-2 through 3-12 for all connections.

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**Note: The output of the power source is isolated from the input line and floating from chassis ground. If needed, either side (HI or LO) may be grounded.**

---

The output power cables must be large enough to prevent a total voltage drop exceeding 1% of the rated output voltage between the power source and the load. Table 3-1 shows the AWG size of the cables that may be used. Cable lengths must not exceed twenty-five (25) feet. For lengths greater than 25 feet, calculate the voltage drop from the following formula:

$$2 \times \text{DISTANCE} \times \text{CABLE RESISTANCE PER FT.} \times \text{CURRENT} = \text{VOLT DROP}$$

*Table 3-1: Wire Sizes*

LOAD CURRENT	WIRE GAGE
22 AMPS	10 AWG
37 AMPS	8 AWG
74 AMPS	4 AWG
111 AMPS	2 AWG

### 3.6 Connectors - Rear Panel

A number of connectors are located along the top rear covers. These connectors are in a recessed area to protect them from shipment damage.

#### 3.6.1 System Interface, Clock and Lock Connectors



**WARNING:** The system interface connector and Clock and Lock connectors may be at hazardous voltages. These connections may not be used in table top applications. In table top applications the safety cover must be in place. These connections may only be used when the equipment is enclosed in a rack, only within one rack, only with California Instruments supplied cables, and only between California Instruments equipment.

J21 and J20 are the Clock and Lock connectors and are used to synchronize and control the phase shift between the three outputs when 3 units are operating as a three-phase system with the 15003iX - LK option.

The System Interface connector, J22, is used to connect the slave power sources to the Master power source (the one with the controller) in multiple box systems. The connector is also used for the external sync input, external modulation input and trigger output.

Table 3-2: System Interface Connector (J22)

J22	Description
1	Analog Common: analog signal common
2	MR B: Phase B master signal
3	Analog Common
4	CS B: Phase B current sum
5	CT Common: Current transformer common
6	OSC B: Phase B oscillator output
7	Analog Common
8	CL B: Phase B current limit reference
9	EXT MOD: External modulation input. A 10 volt input will modulate the output 10%. Original versions of iX power sources required a 100 volt input to modulate the output by 10%. If you experience problems using the external modulation input, contact California Instruments customer service.
10	OVR TEMP : A logic low output to indicate an over temperature condition.
11	CNF : Output relay state: Logic HI = open, LOW = closed.
12	FLT C: Phase C current limit fault control
13	FLT A: Phase A current limit fault control
14	F STB LO: Function Strobe / Trigger output Low signal. This is the emitter lead of an optically isolated NPN transistor. The internal power controller turns this transistor on to indicate a change of programmed values. See section 3.6.5 for details.
15	EX SYNC LO: External Sync Low signal. This is the ground return for the TTL external



J22	Description
	sync input. It connects to the cathode of an LED at the input of an optocoupler. Refer to J22-32.
16	AMP SHARE B
17	PARALLEL
18	CL ENA
19	MR C: Phase C master signal
20	MR A: Phase A master signal
21	CS C: Phase C current sum
22	CS A: Phase A current sum
23	OSC C: Phase C oscillator output
24	OSC A: Phase A oscillator output
25	CL C: Phase C current limit reference
26	CL A: Phase A current limit reference
27	D COM: Digital Common
28	RNG HI: Voltage range state: Logic HI = high range, LOW = low range
29	<input type="checkbox"/> : Overload
30	FLT B: Phase B current limit fault control
31	F STB HI: Function Strobe / Trigger output HI. A low-going pulse, >400 $\mu$ s, that indicates voltage or frequency change. Isolated output that requires a pull-up resistor, 22K $\Omega$ , to +5 VDC. Use J22 pin 14 (F STB LO) for common. See section 3.6.5 for details.
32	EX SYNC HI, External Sync input HI. This is an input that can be used to synchronize the outputs of the AC Power System. This input requires a logic high level of at least +4.5 VDC at 5 mA. The input should have a duty cycle 50 $\pm$ 30%. J22-15 is the common input. The External Sync input is optically isolated. It must be enabled from the SNC screen.
33	AMP SHARE C
34	AMP SHARE A
35	FLICKER / <input type="checkbox"/>
36	REMOTE ON: This is a logic input that can be used to remove the programmed output voltage. A logic low on this pin will cause the output voltages to be programmed to 0.0 volts and the output relays to open. A logic high will cause the programmed output voltage to be restored at the output terminals. A contact closure between this pin and J22-27 (D COM) will simulate a logic low state.

### 3.6.2 Remote Sense Connector TB3

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When selecting external sense mode, it is important that the remote sense connections are hooked up at the EUT or at the sense point. For single-phase systems, connect Phase A to phase A and neutral to neutral. For three-phase system configurations, connect all three phase.

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**NOTE: Do not reverse or swap sense connection phasing or damage to the unit may result.**

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All 3001iX and 5001iX AC Sources are shipped with the sense connections wired to the output terminals. This will prevent a voltage fault when the external sense mode is selected. On systems consisting of multiple 3001iX or 5001iX chassis, the end user has to connect the external sense inputs to allow the system to operate. Some system configuration do not support Internal sense mode in which case the sense connection must always be present at TB3.

*Table 3-3: Remote Sense Connector – TB3*

Pin	Description
A	Phase A sense
B	Phase B sense
C	Phase C sense
N	Neutral sense

### 3.6.3 RS232C Serial Interface Connector – J18

Table 3-4: RS232C Connector

Pin	
1	N/C
2	RxD, Receive data
3	TxD, Transmit data
4	DTR, Data Terminal Ready
5	Common
6	N/C
7	RTS, Request to Send
8	N/C
9	N/C

To connect the 5001iX to a PC's 9-pin DB9 serial port, a special RS232 cable is required. A 6 foot / 2 meter long cable (CI P/N 7000-263-1) is supplied in the iX Series ship-kit. The wiring diagram for this cable is shown below in case a longer cable has to be constructed. Alternatively, a generic straight thru DB9 male to DB9 female cable can be used to extend the supplied cable.

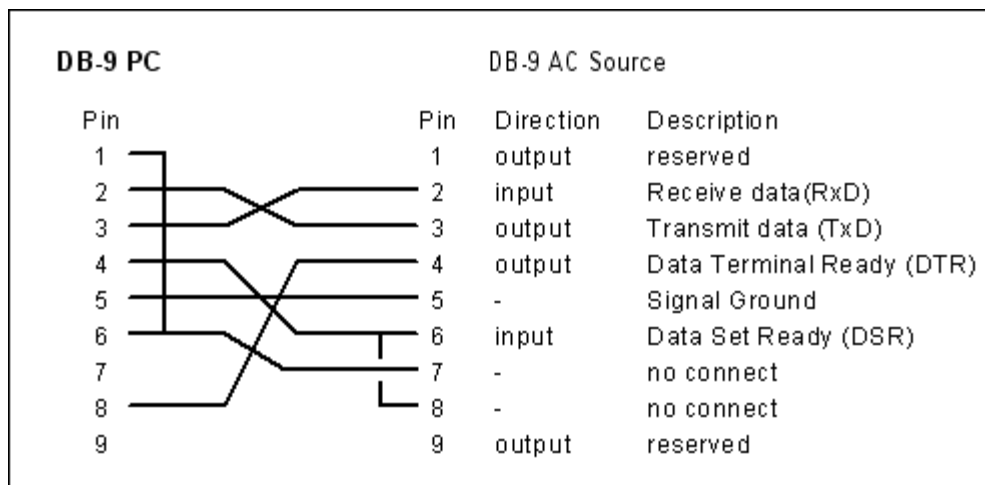


Figure 3-2: RS232C Cable for PC Connection wiring diagram.

### 3.6.4 I/O Option – J58

This connector is reserved for control of the EOS option. Do not connect anything else to this connector.

### 3.6.5 Function Strobe / Trigger Out – J22-31 / J22-14

A function strobe output is available on the System Interface connector. This open collector output may be used to trigger external equipment when voltage or frequency change occurs on the AC source.

This output generates a low-going pulse,  $> 400\mu\text{s}$  in duration, that indicates voltage or frequency change. Since this is an isolated output, an external DC supply and pull-up resistor,  $22\text{K}\Omega$ ,  $1/8\text{ W}$  is required. To create a TTL level output, a  $+5\text{V}$  or  $+3.3\text{V}$  DC supply is required. To create a signal for viewing on a scope, a higher DC voltage such as a  $9\text{V}$  battery may be used.

Connect the DC supply and pull-up resistor as shown.

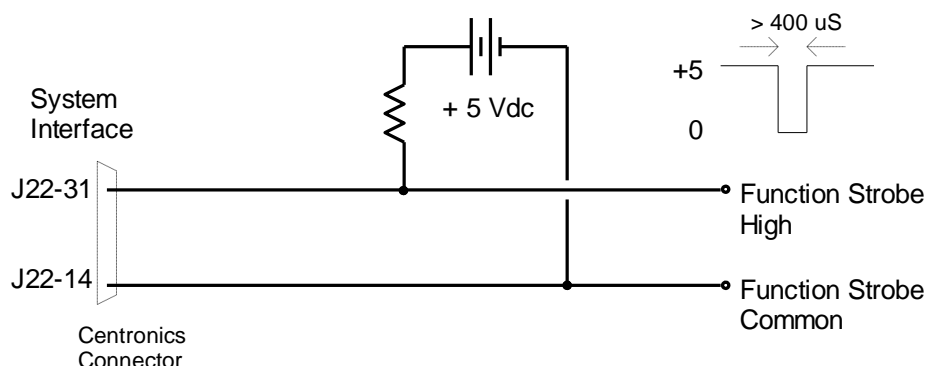


Figure 3-3: Function Strobe Connection.

When running list transients on the AC source, the LIST:TTLTrigger SCPI command may be used to reassign the operation of the Function Strobe output as a trigger output. An output pulse is generated for each logic “1” in the TTLTrigger list. See the iX/i Series Programming Manual P/N 7000-982 for details on the transient list system.

#### Trigger BNC Breakout Box

A convenient trigger BNC breakout box is available from California Instruments which facilitates connection to the Function Strobe / Trigger Output signal on the system interface connector. A  $9\text{V}$  DC battery is used to provide the required DC supply. This small box can be ordered through customer service or sales under P/N 7000-481-1 (for 3001i/iX and 5001i/iX) or P/N 7000-481-2 (for all multi-chassis i/iX systems).

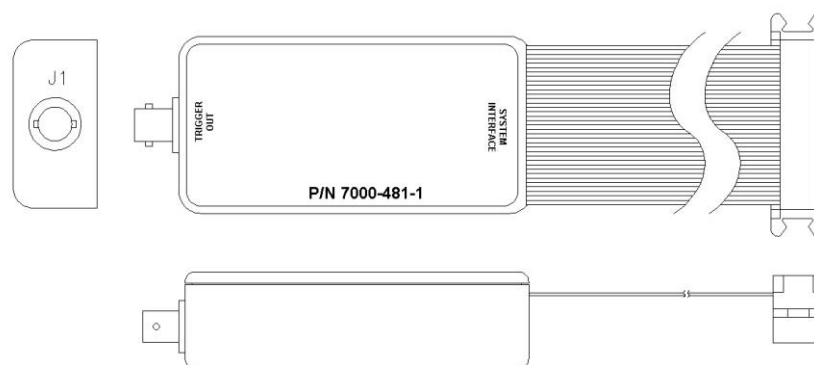


Figure 3-4: Function Strobe / Trigger Output Accessory.

### **3.6.6 Remote Inhibit – J22-36 / J22-27**

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The Remote Inhibit input J22 pin 36 can be used to open and close the output relay of the AC power source. This input overrides the state of the output relay programmed from the front panel or the bus. It may be used for safety interlock purposes.

A logic low on this pin will cause the output voltages to be programmed to 0.0 volts and the output relays to open. A logic high will cause the programmed output voltage to be restored at the output terminals. A contact closure between pin J22-36 and pin J22-27 (D COM) will simulate a logic low state.

Figure 3-5: Rear Panel View for the 3001i/3001iX

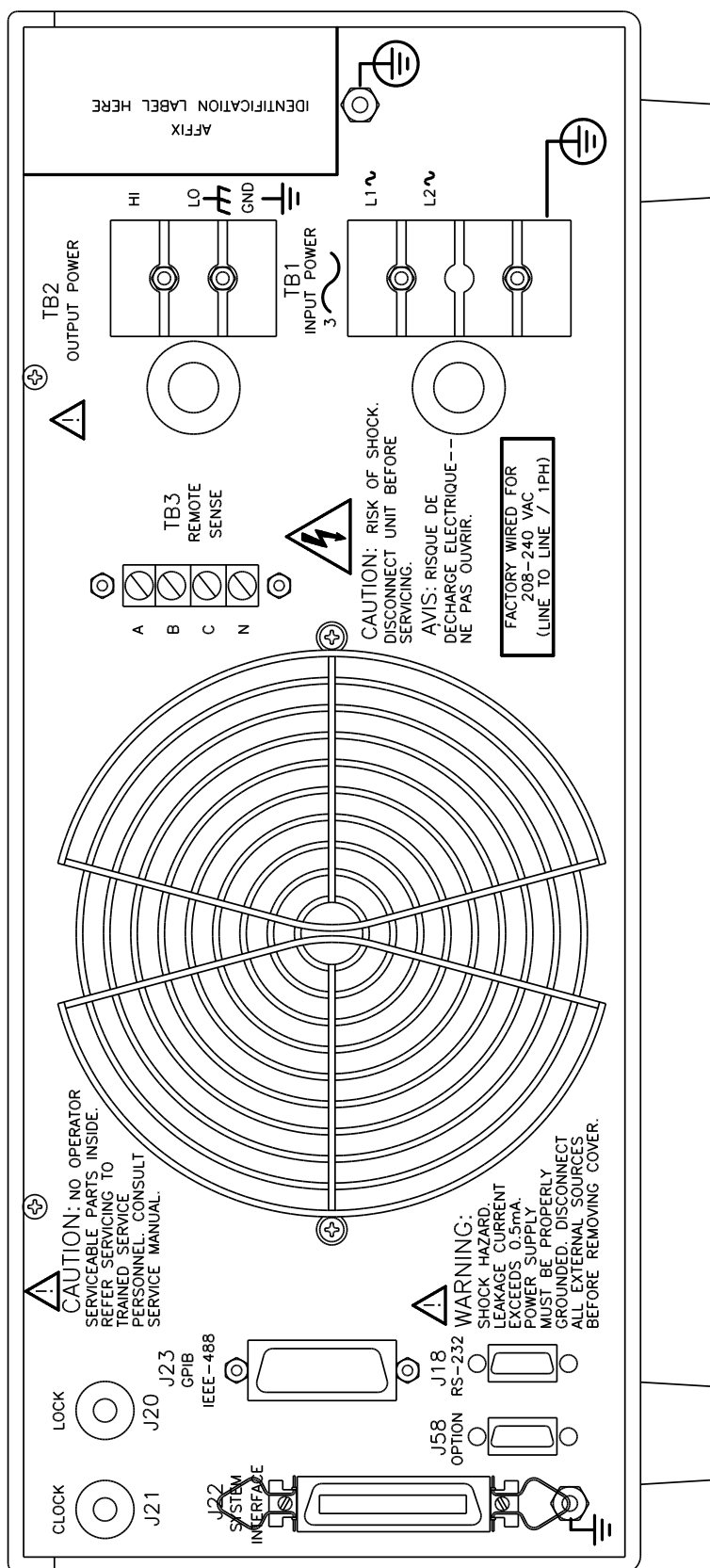
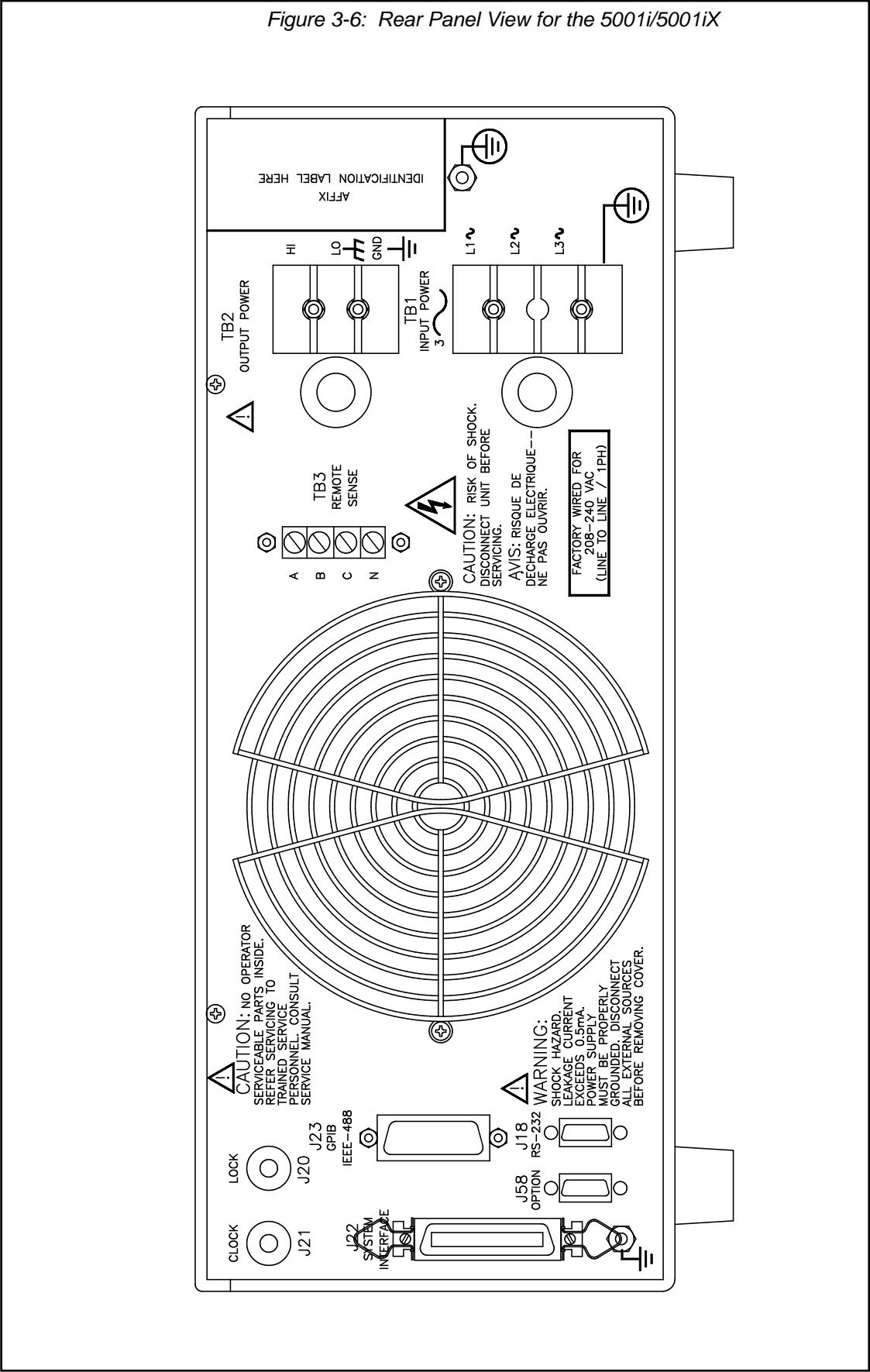


Figure 3-6: Rear Panel View for the 5001i/5001iX



### 3.7 Single-Phase and Three Phase Multiple Box System Configurations

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#### **Three Phase System:**

The three phase system will be configured ready for use when ordered as such from the factory. One unit, with the controller, will be identified as Phase A on the serial number tag. The other two units will be identified on their serial number tags as either Phase B or Phase C. The power sources **must** be installed in the system according to the phase markings on the serial number tags. There will be one master unit that will have a full controller and the slaves will have blank front panels except for the circuit breaker and indicator lights.

The three units must be interconnected using the system Interface cable. The three **LO** outputs must also be connected together before applying power.

If the units were purchased as single phase units and have not been configured for a three phase system please consult the factory.

#### **Single Phase System:**

In a single phase system consisting of two or three units there will be one master unit that will have a full controller and the slaves will have blank front panels except for the circuit breaker and indicator lights.

The units must all be connected with the system interface cable, **but not the clock and lock cables**. The HI outputs on all the terminal blocks should be connected together. The LO outputs should all be connected together and a heavy duty cable run to the load from the HI and LO outputs. See Table 3-1 for cable sizing.

The appropriate jumpers have been installed at the factory before shipment. If it becomes necessary to change the system to three phase output, please consult the factory.

### 3.8 Output Voltage Ranges

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The iX Series power sources have four voltage ranges: 0 to 135, 150, 270 or 300 volts. These ranges are organized in two pairs: 135/270 and 150/300. When operating on the 135 volt AC range, the current limit can be programmed to a maximum value of 37 amps for the 5001iX or 22.2 amps for the 3001iX.

The standard power source defaults to the 150/300 range pair. To change voltage range pairs perform the following steps:

1. Press the MENU key 2 times.
2. The cursor should point to UTILITY. Press the ENTER key to display the UTILITY 1 screen. In the UTILITY 1 screen select VOLT/CURR control by moving the cursor by pressing the  $\vee$  key.
3. Press ENTER.
4. In the VOLT/CURR control screen select VOLT PAIR = . Press the  $\pm$  key to change the range pair to 135/270. Pressing the  $\pm$  key again will program the 150/300 range pair.



### 3.9 Functional Test

---



**CAUTION:** *Work carefully when performing these tests, hazardous voltages are present on the input and output during this test.*

---

Refer to Figure 3-8 for the test set up.

1. Connect an oscilloscope, voltmeter and/or distortion analyzer to the AC source output at the output terminal block (TB2).
2. With the AC mains verified as being off, apply the correct three phase AC power input voltage connections to the AC source input terminals barrier (TB1). Apply the AC mains power and turn on the main circuit breaker on the AC source front panel.
3. Verify the front panel LCD display lights up with the initial start up screen showing the unit ID and serial number. A self check routine screen will follow and finally the system will display the main "Menu 1" screen with the cursor highlighting the "Program" selection.
4. Press "ENTER" and the unit will display the Program selection screen. Set the following output parameters: output voltage = 150 volts, frequency = 60 Hz, voltage range = 150 volts, and current limit = 20.0 amps (3001iX) or 33.3 amps (5001iX). Press "ENTER".
5. Enable the output by pressing the output "on/off" button below the front panel display screen. The green LED next to the button will light green when the output is on. The output should be a clean 150 volt AC sinewave having less than 1% distortion.
6. Apply full load to the output of the source and verify the output remains within 2% of the initial 150 volt value. The output should still be clean and the distortion should still be less than 1% at 60 Hz.
7. Using the PROGRAM screen set the output current limit value to 17 amps. The system should go into current limit. Return the current value to 20.0 amps (3001iX) or 33.3 amps (5001iX) and press the output on/off button to turn the output off. Disconnect the load.
8. Repeat steps 4 through 7 but set the output for the following: output voltage = 300 volts, output range = 300 volts, current limit = 10.0 amps (3001iX) or 16.7 amps (5001iX). For step 7, the current limit value can be set to 8 amps.

In the unlikely event the power source does not pass the functional test, refer to the calibration procedure in Section 6 or call California Instrument's customer satisfaction department for further assistance.

Figure 3-7: Connection For Single Power Source (5001iX/i, 3001iX/i)

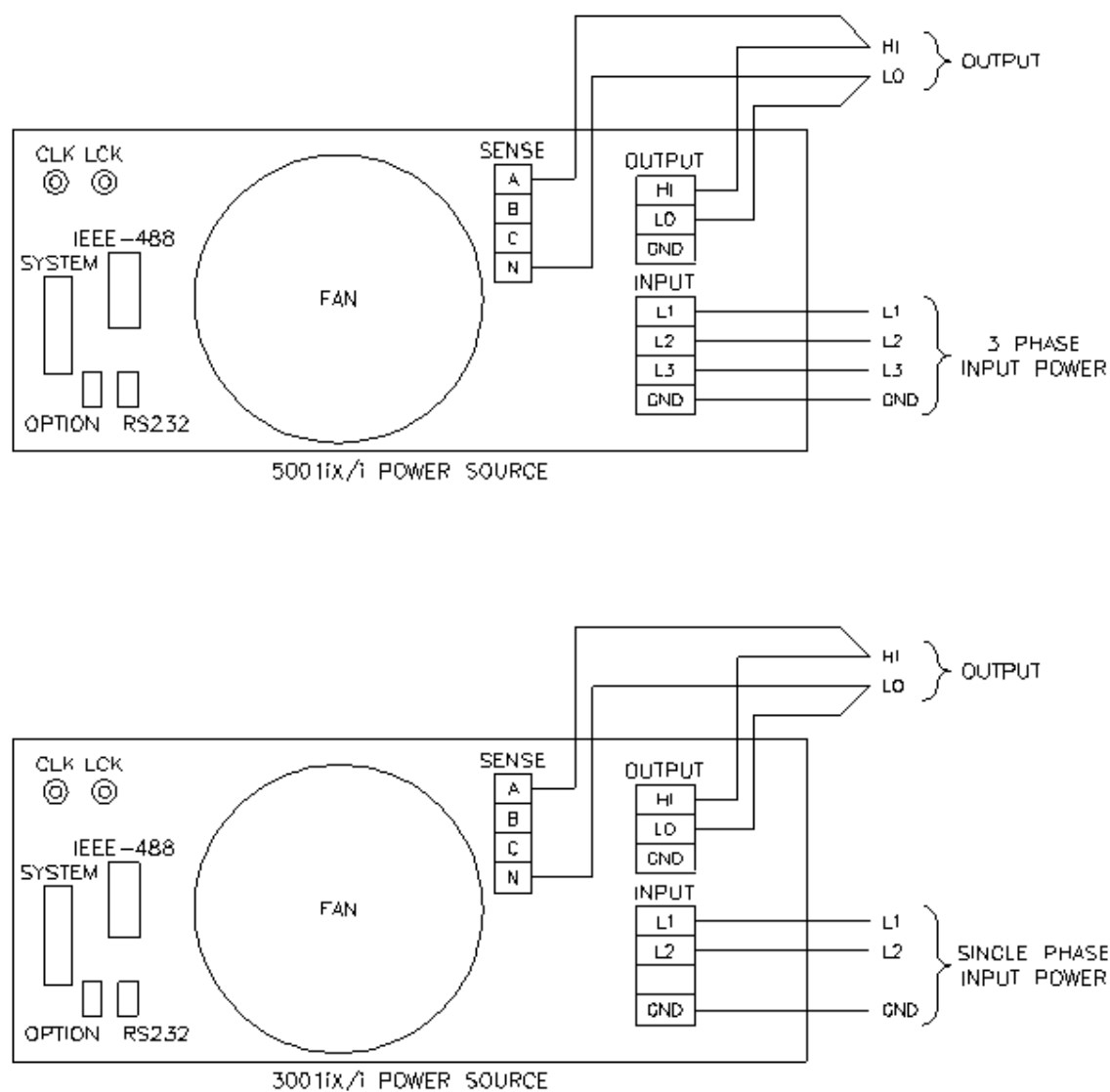


Figure 3-8: Functional Test Setup

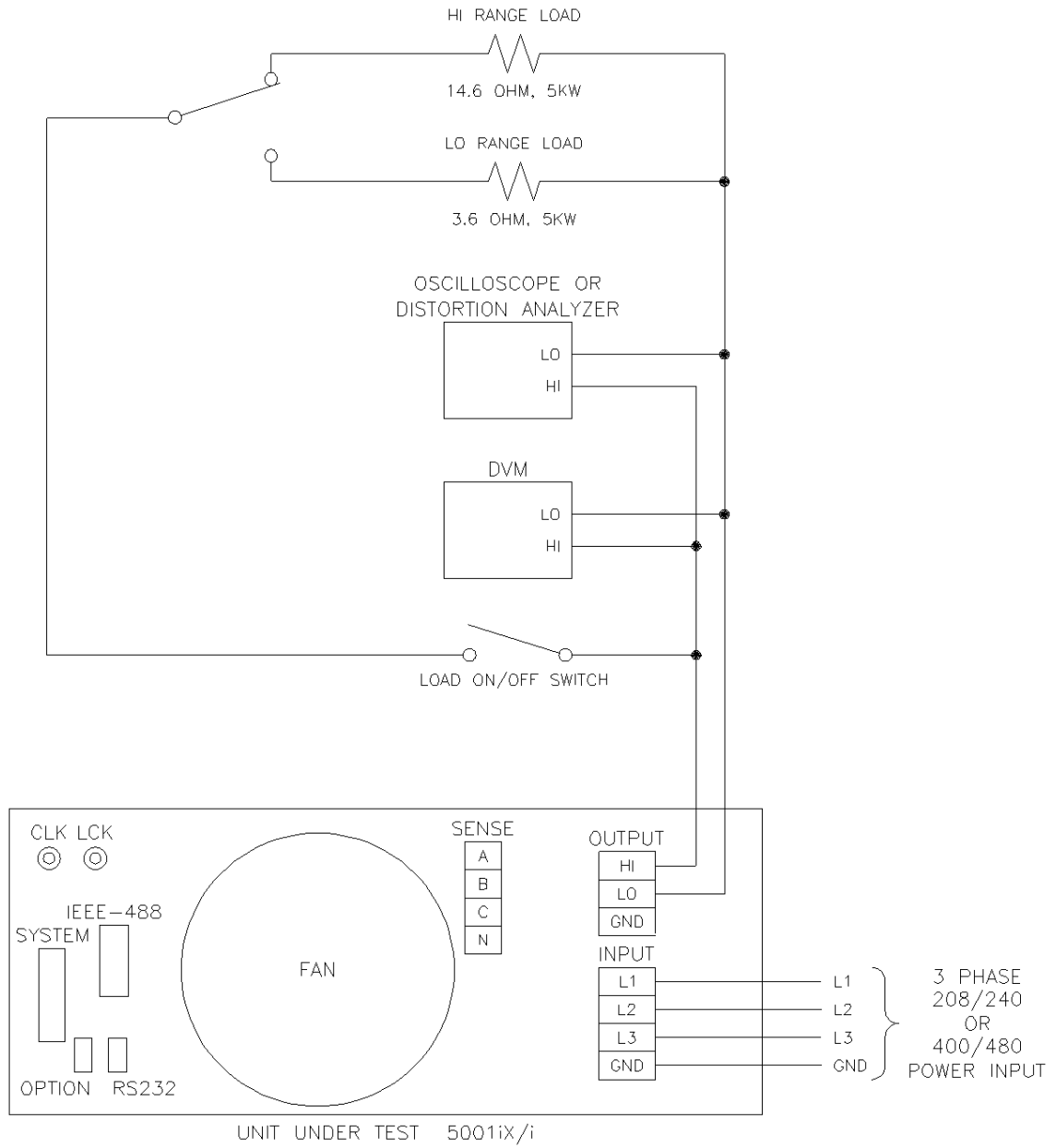


Figure 3-9: Single Phase 10000 VA System (10001iX/i)

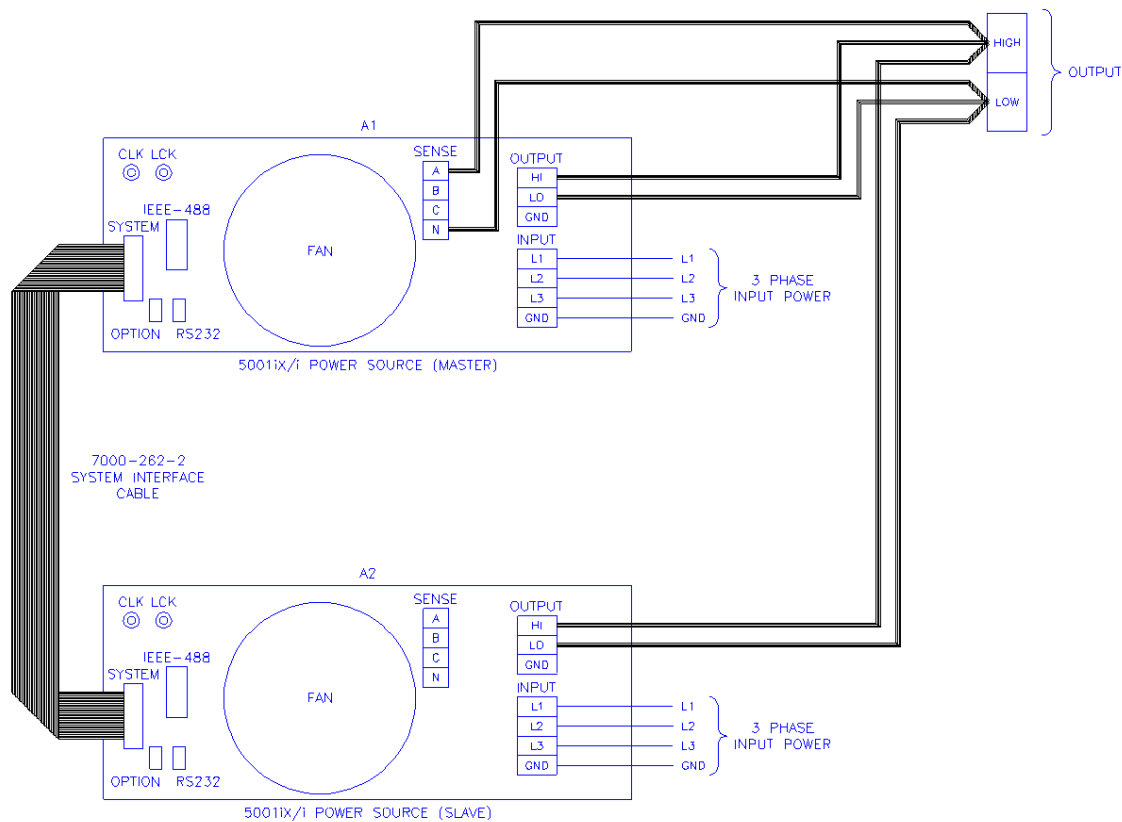


Figure 3-10: Three Phase 15000 VA System (15003iX/i-LK Three Controllers)

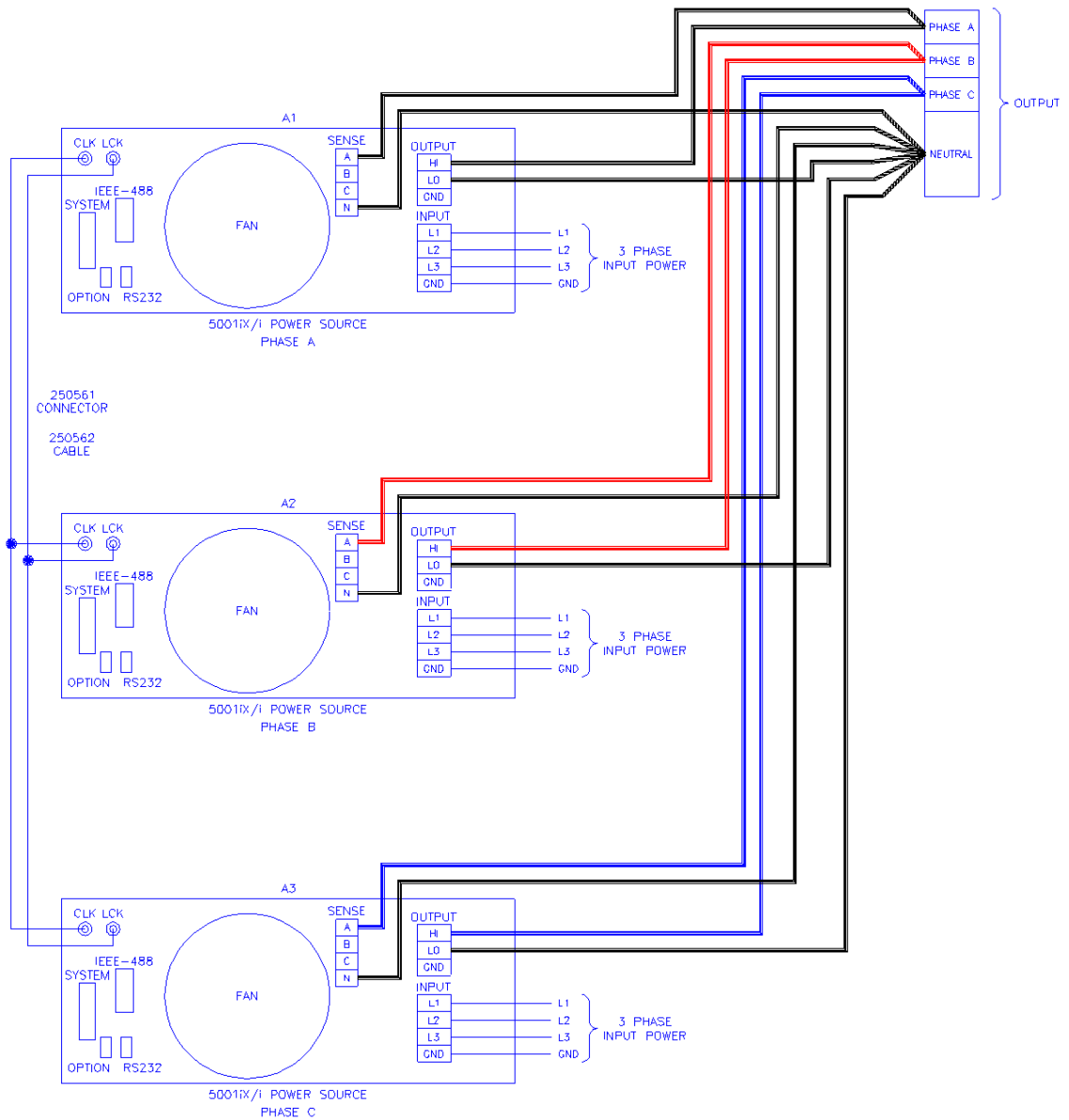


Figure 3-11: Single Phase 15000 VA System (15001iX/i)

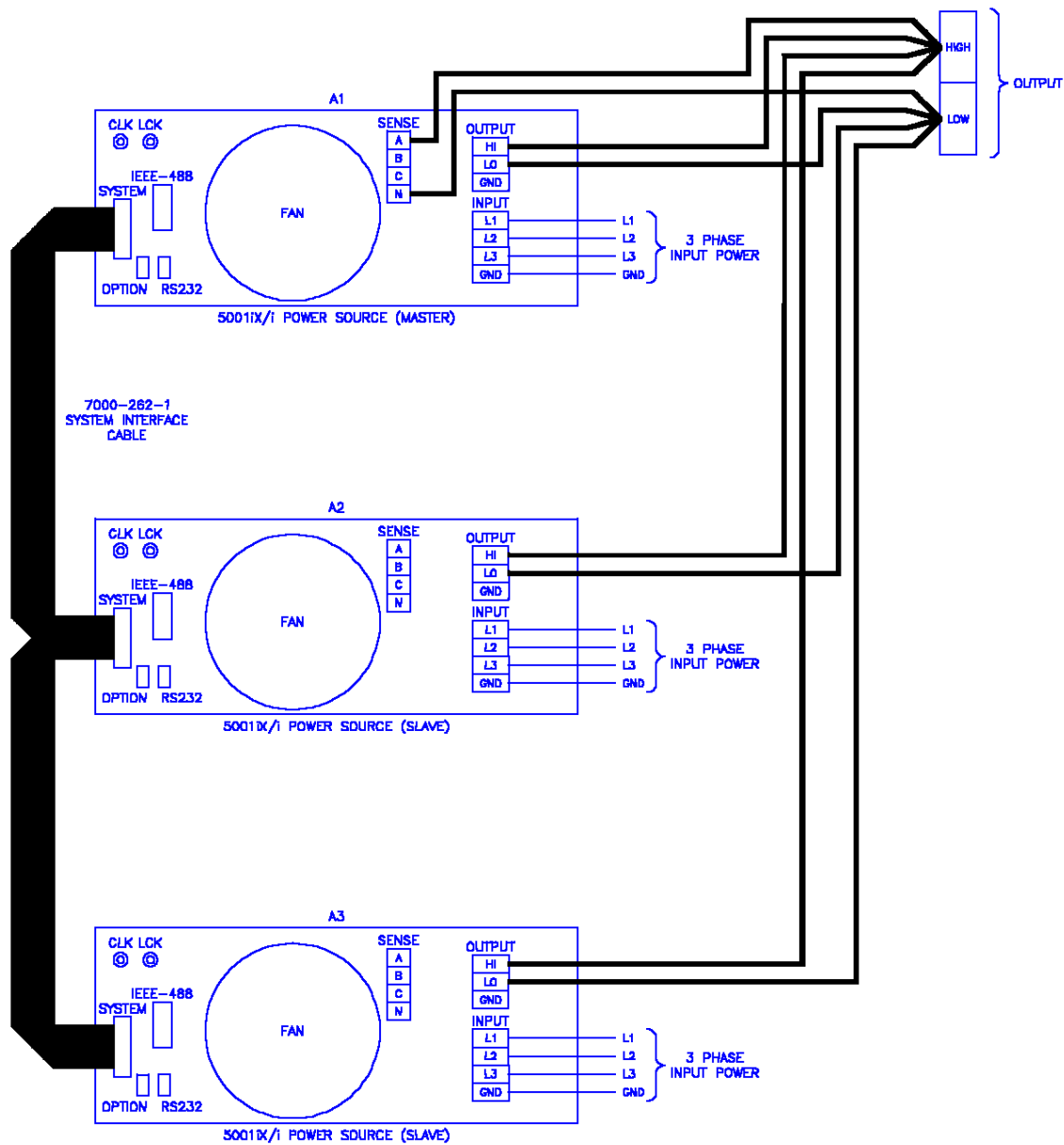


Figure 3-12: Three-Phase 15000 VA system (15003iX/i - One Controller)

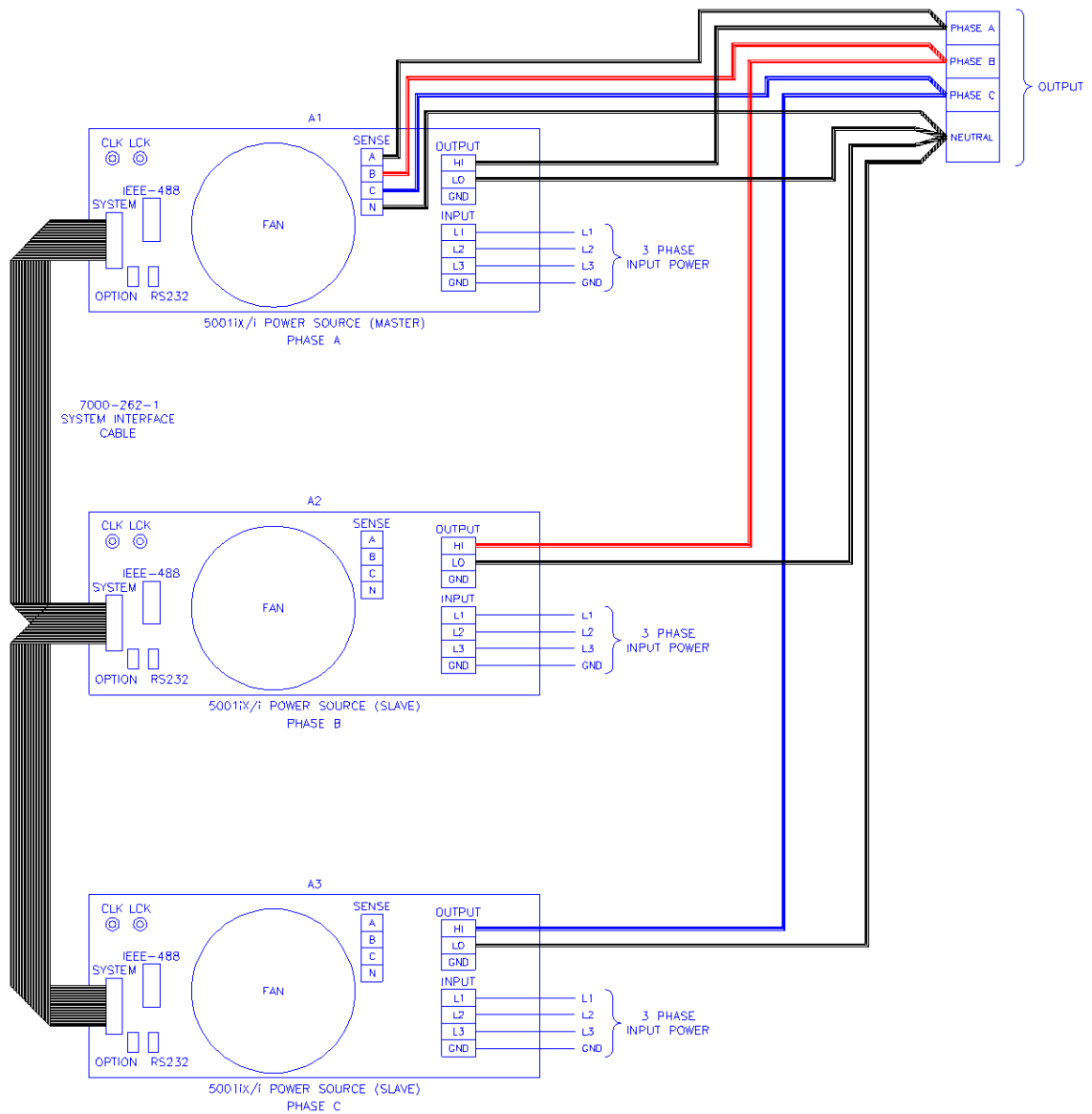


Figure 3-13: Connection With MODE Option

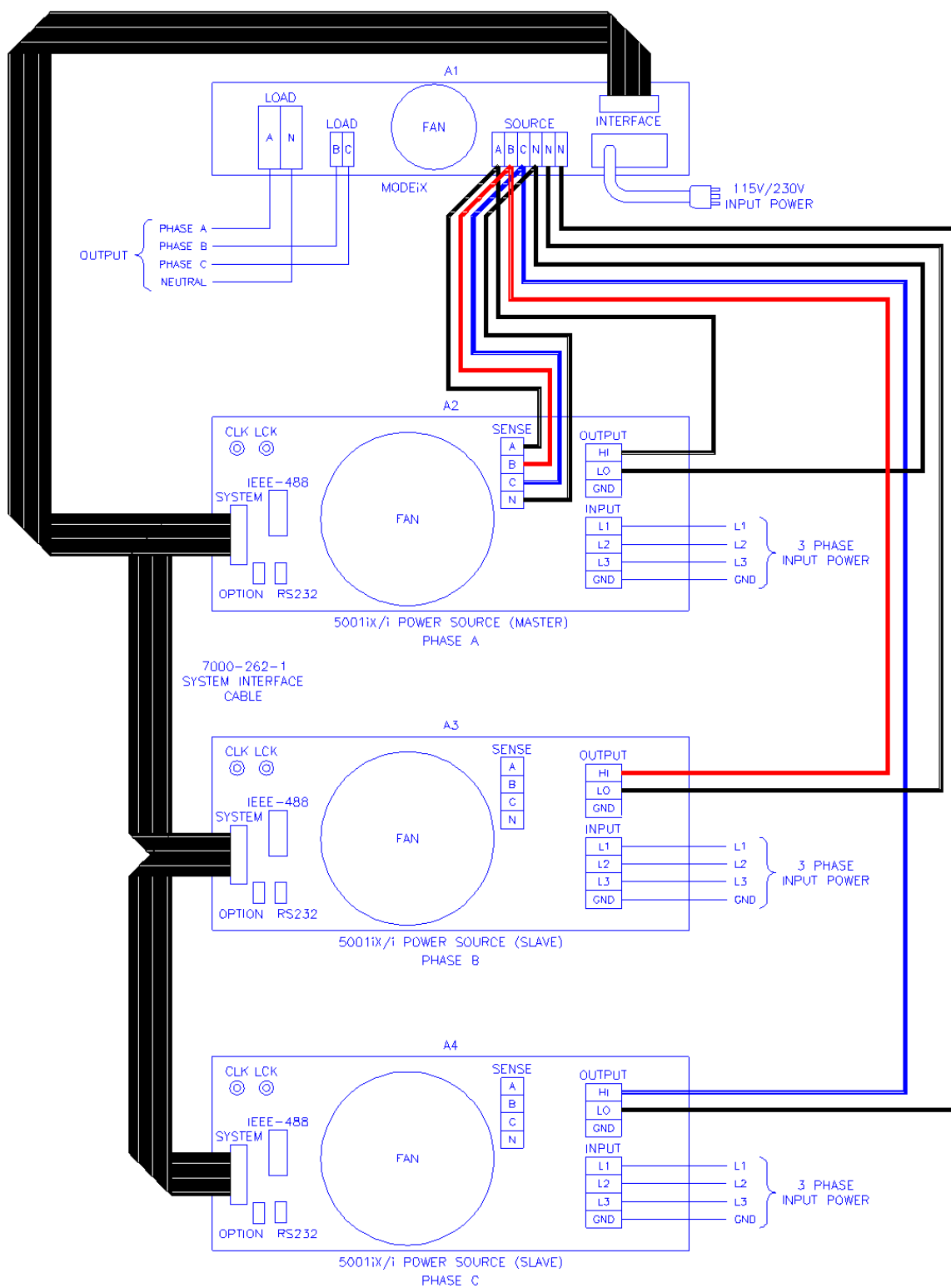




Figure 3-14: Two Phase 10000 VA System (10002i-LK Two Controllers)

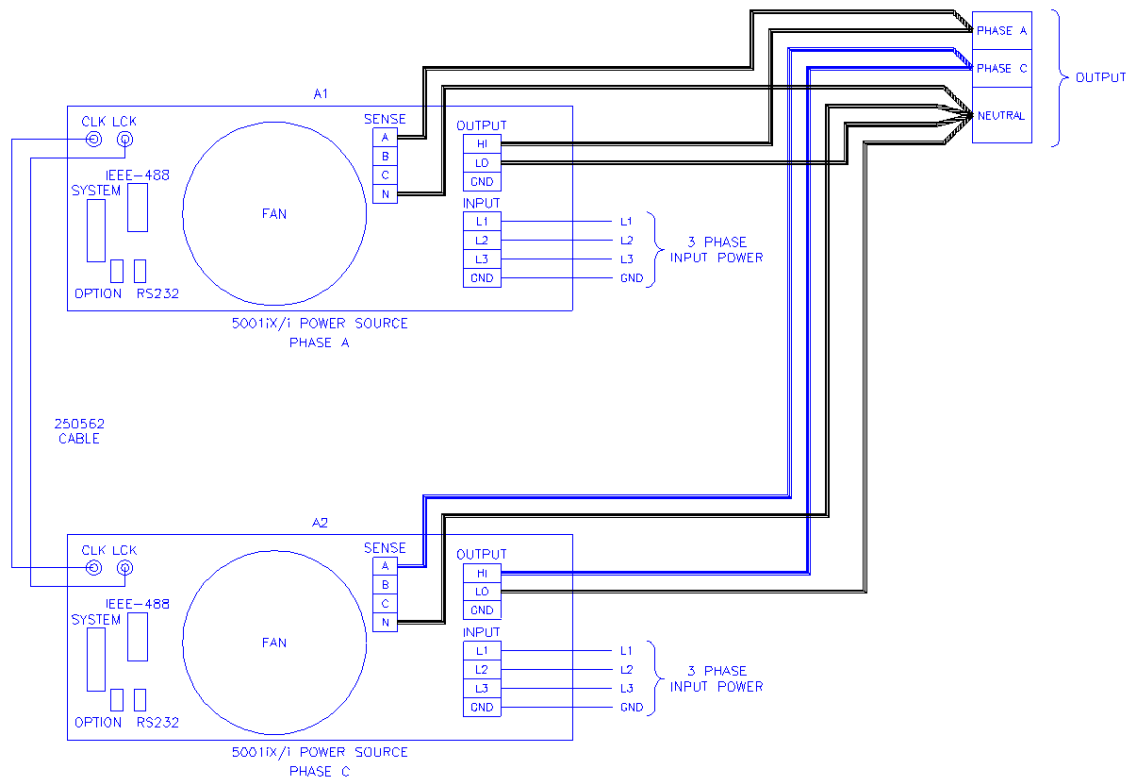
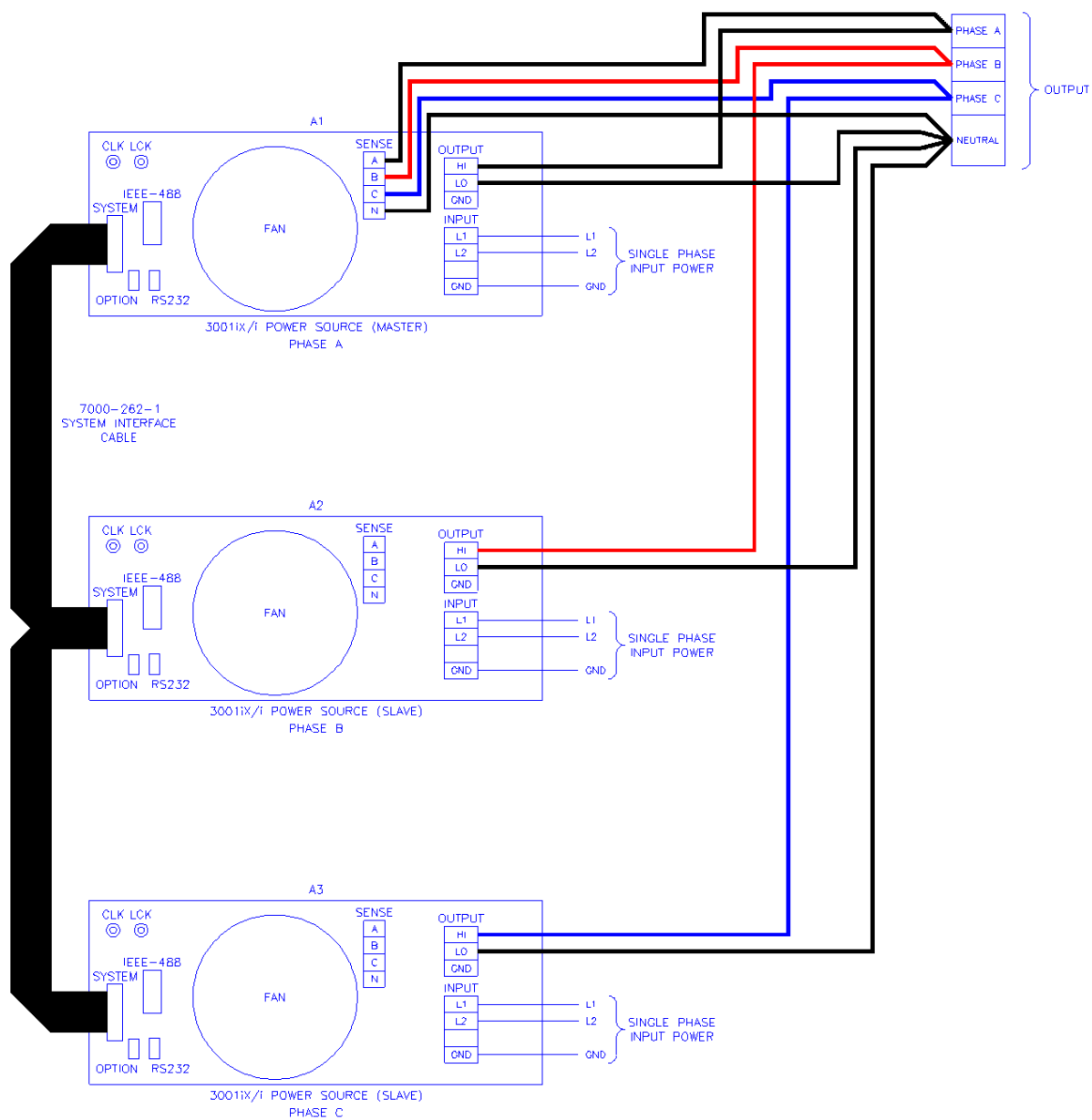


Figure 3-15: Three-Phase 9000 VA System (9003iX/i – One Controller)



## 4. Front Panel Operation

---

### 4.1 Tour of the Front Panel

---

The i and iX Series front panels are identical although some of the keys found on the front panel are only used by iX Series models. If your unit is an i Series, these keys will act as don't cares. This chapter provides information on operating the i and iX Series AC sources from the front panel keyboard.

Before operating the AC source using the front panel, it helps to understand the operation of the front panel controls. Specifically, the operation of the knob, keyboard and the menu layout are covered in the next few paragraphs.

#### 4.1.1 Front Panel Controls and Indicators

---

The front panel can be divided in a small number of functional areas:

- Mains circuit breaker
- Status Indicator lights
- Shuttle knob
- LCD display
- FUNCTION keypad
- DATA ENTRY keypad

#### 4.1.2 Mains Circuit Breaker

---

The circuit breaker located on the bottom left side of the front panel disconnects the AC source from the three phase Line input. It will automatically trip when the input current rating of the unit is exceeded due to some component failure. The contrasting black color and large size throw bar make it easy to locate in case of an emergency.

#### 4.1.3 Status Indicator Lights

---

Four LED status indicators are located directly above the mains circuit breaker. These LED's correspond to the following conditions:

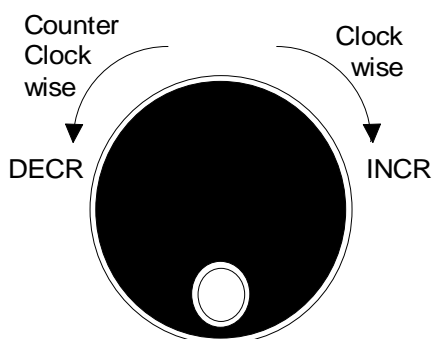
REMOTE	The REMOTE LED indicates that the unit is in remote control mode. If the IEEE-488 interface is used, this indicator will be lit whenever the REM line (REMOTE ENABLE) line is asserted by the IEEE controller. If the RS232C interface is used, the REMOTE state can be enabled by the controller using the SYST:REM command. Any time the REMOTE LED is lit, the front panel of the i Series unit is disabled. There is no LOCAL button that allows the user to regain control of the front panel. This prevents accidental change of settings in ATE applications.
OVERLOAD	The OVERLOAD LED indicates an output overload condition. This condition can be controlled by setting the current limit value in the PROGRAM menu. Removing the load using the OUTPUT ON/OFF button will recover from an overload condition.

OVER TEMPERATURE	The OVER TEMPERATURE LED indicates an overheating problem inside the unit. This is an abnormal condition, which will cause the unit to shut off. Check the air openings to make sure they are not blocked.
HI RANGE	The HI RANGE LED is on when the high voltage output range has been selected.

---

#### 4.1.4 The Shuttle Knob

---



*Figure 4-1: Shuttle Knob*

The shuttle knob is located to the right of the LCD screen and is used to change setup parameters. Note that it cannot be used to move the cursor position between menu fields. Use the UP and DOWN arrow keys in the FUNCTION keypad for this.

The shuttle knob can operate in one of two distinct modes of operation:

MODE	DESCRIPTION
IMMEDIATE mode	Any time the ENTER key is pressed, the i/iX Series returns to its normal mode of operation. In this mode, changes made with the shuttle knob or the data entry keypad will take immediate effect. The IMMEDIATE mode is useful for slewing output values such as voltage and frequency and observing the effect on the load.
SET mode	When the SET key located in the FUNCTION keypad is pressed, changes made with the shuttle to any output parameter will not take effect until the ENTER key is pressed. In this mode, any changes made to a setup menu will be blinking to indicate the pending change condition. This mode allows changes to be made to all output parameters and executing them all at once by pressing the ENTER key.

---

#### 4.1.5 FUNCTION Keypad

---

The function keypad provides access to all menus and measurement screens. The following keys are located in the FUNCTION keypad:

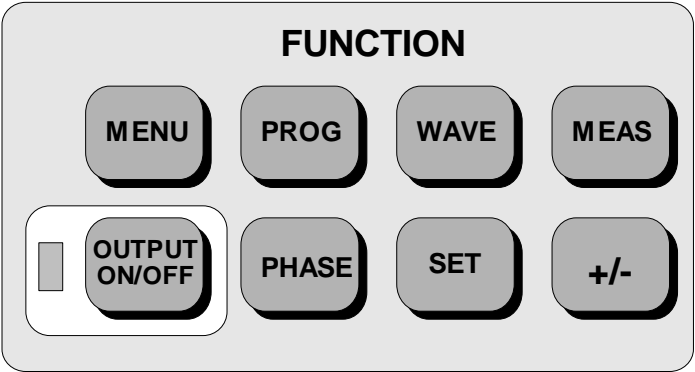


Figure 4-2: FUNCTION keypad

KEY	DESCRIPTION
MENU	The top level menu is accessed by pressing the MENU key. Three shortcut keys are used to provide direct access to the PROGRAM, WAVEFORM, and MEASUREMENT screens as these are among the most frequently used screens. Thus, instead of going through the main menu to reach the PROGRAM, WAVEFORM, and MEASUREMENT screens, they can be accessed directly by pressing the PROG, WAVE, and MEAS keys respectively. A map of the Main menus is provided on the next few pages. There are three top-level menus in the i/iX Series.
PROG	The PROG key is a shortcut to access the PROGRAM menu directly. The PROGRAM menu is one of the most frequently used menus. Thus, instead of going through the main menu to reach the PROGRAM menu, it can be accessed directly by pressing the PROG key.
WAVE	The WAVE key is a shortcut to access the WAVEFORM screen directly. The WAVEFORM screen is used to select a user defined arbitrary waveform. <b>(iX Series only)</b>
MEAS	The MEAS key is a shortcut to access the MEASUREMENT screen directly. The MEASUREMENT screen is one of the most frequently used screens. Thus, instead of going through the main menu to reach the MEASUREMENT screen, it can be accessed directly by pressing the MEAS key.
OUTPUT ON/OFF	The OUTPUT ON/OFF key toggles the output relay on or off. The state of the output relay is reflected by the green LED located directly to the left of the OUTPUT ON/OFF key. If the green LED is lit, the output relay is enabled (closed) and the programmed output voltage is present at the output terminals. If the green LED is off, the output relay is open and both the HIGH and LO terminal of the output terminal block are disconnected from the power source. In this mode, the output is floating. The ON/OFF button provides a convenient way to disconnect the load without having to remove any wires.

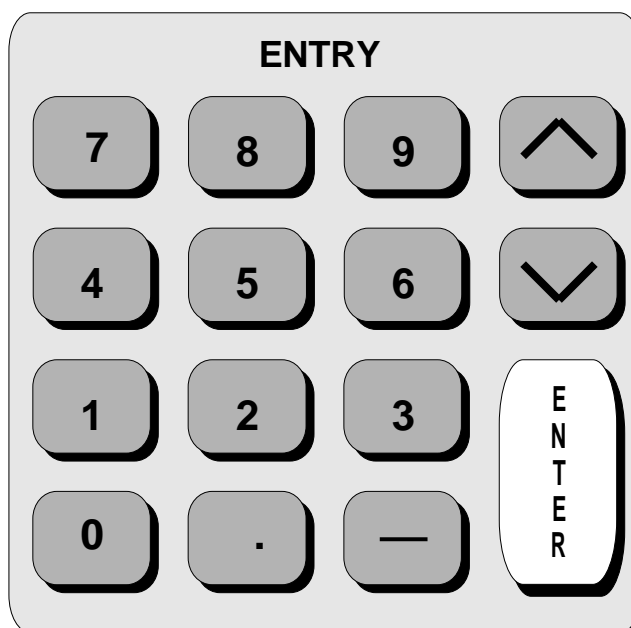
PHASE	<p>The PHASE key is used to select the phase on a three-phase 9003iX or 15003iX unit. Pressing the PHASE key will toggle phase A, B, C or ABC. Some screens may not support the ABC or show all phase information in which case this mode is skipped.</p> <p style="text-align: right;"><b>(iX Series with three phase controller only)</b></p>
SET	<p>The SET key is used to select the mode of operation of the shuttle. Refer to section 4.1.1 for details on its operation and the use of the SET key.</p>
+/-	<p>The +/- key can be used to toggle the sign for those parameters for which it is relevant. This is typically the output voltage when in DC mode of operation. For fields that have only two possible values such as the voltage range field, the +/- key can be used to toggle between these two values.</p>

---

#### 4.1.6 DECIMAL KEYPAD

---

The decimal keypad may be used to enter any numeric parameter required in any of the menu fields. Several fields accept input from either the keypad or the knob. Data entered from the keypad is normally accepted once the ENTER key is pressed unless the front panel mode is in the SET mode. The following keys are available on the decimal keypad:



*Figure 4-3: Entering value from decimal keypad*

CURSOR UP	<p>The UP key moves the cursor position upwards one position to the previous available cursor position. If the present cursor position is at the top of the right hand column, the cursor is moved to the bottom position of the left hand column. If the present cursor is at the top of the left hand column, the cursor is moved to the bottom of the right hand column. Figure 4-4 depicts the cursor movement through a two-column menu.</p>
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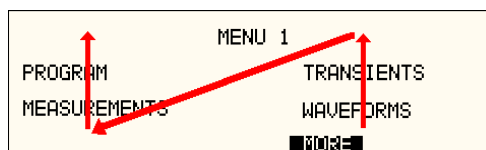


Figure 4-4: Cursor UP key movement

#### CURSOR DOWN

The DOWN key moves the cursor position downwards one position to the next available cursor position. If the present cursor position is at the bottom of the left hand column, the cursor is moved to the top position of the right hand column. If the present cursor is at the bottom of the right hand column, the cursor is moved to the top of the left hand column. Figure 4-5 depicts the cursor movement through a two column menu.

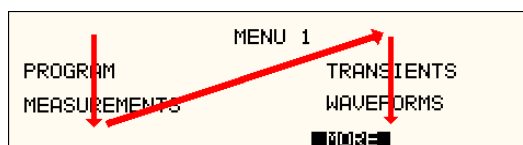


Figure 4-5: Cursor DOWN key movement

The decimal keypad can be used at any time in lieu of the shuttle knob to change output parameters. Direct data entry is often faster to effect large changes in values than using the shuttle knob. Note that pressing the ENTER key while in SET mode of operation will cause the AC source to revert back to IMMEDIATE mode. Thus, to change all parameters in SET mode, enter a value for each field and then proceed to the next field without pressing the ENTER key.

#### 0 through 9

The numeric keys provide all decimal number for entry of parameters.

#### DECIMAL POINT

The decimal point key is used to enter fractional parts of values for fields that have a resolution less than 1. The amount of resolution for each menu field is normally visible on the LCD. If more digits are entered after the decimal point than can be accepted by a field, the value is automatically rounded to the available resolution when the ENTER key is pressed.

#### BACKSPACE

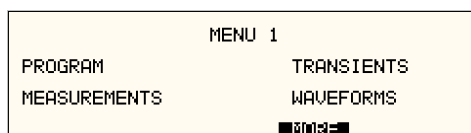
The BACKSPACE (←) key can be used to erase one digit at a time if you make a data entry error.

### 4.1.7 LCD Display

The LCD display of the i and iX Series AC power source provides information on instrument settings and also guides the user through the various menus. To ease reading of the displayed information, most screens are widely spaced. A sample of the main menu 1 screen that appears when the i Series AC source is powered up is shown in Figure 4-6. Due to the amount of space available on each screen, some menus have been split into parts. The MORE selection located at the bottom right hand side provides access to menu choices at the same level that did not fit on a single screen. Thus, to access MENU 2, the cursor should be placed on the 'MORE' selection followed by pressing the 'ENTER' key. Alternatively, the MENU key may be pressed to move to the MENU 2 screen.

The present cursor position is always shown with a inverse bar. The cursor is located on the 'MORE' selection in Figure 4-6. Pressing ENTER would cause MENU 2 to be displayed.

The cursor position can be moved by using the UP and DOWN keys located in the **DECIMAL** keypad.



*Figure 4-6: Main Menu 1 screen*

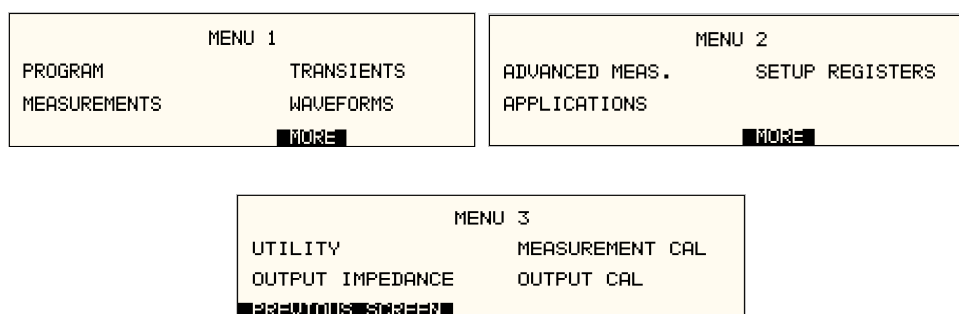
## 4.2 Menu Structure

---

The next few pages show a map of the available menus in the i/iX Series. There are three main level (level 1) menus from which all other menus can be reached. Frequently used (level 2) menus have a short cut key that provides direct access. Examples of such menus are Program, Measurements, and Waveform. In any case, there are never more than three levels of menus although some menus may be spread across more than one screen.

### 4.2.1 MAIN Menus

---



*Figure 4-7: Menu 1 through 3*

The top level menu is split in three parts, MENU 1 through MENU 3 to allow spacing between menu entries. MENU 2 and 3 can be reached from MENU 1 by selecting the MORE entry or by pressing the MENU key repeatedly, which will toggle from MENU 1 to 2 to 3 and back to 1. The division of menu choices between the two screens is graphically illustrated in 4.2.2 by the boxes in level 1. Each box represents one screen. Subsequent screens can be reached using the MORE entry.



The following top-level menu choices can be accessed from the MENU key:

<b>Entry</b>	<b>Description</b>
<b>MENU 1</b>	
PROGRAM	The PROGRAM menu allows output parameters the be changed.
MEASUREMENTS	The MEASUREMENTS screens are not menus in that no user entries are required.
TRANSIENTS	The TRANSIENTS menu allows output transients to be programmed.
WAVEFORMS	The WAVEFORMS menu allows different waveforms to be selected from the waveform library.
MORE	The MORE selection causes the second part of the MENU screen to be displayed. (MENU 2)
<b>MENU 2</b>	
ADVANCED MEAS.	The ADVANCED MEAS. screens are for display only. No user entries are required.
APPLICATIONS	The APPLICATIONS menu provides access to the optional firmware application programs that may be installed in the i/iX Series AC source.
SETUP REGISTERS	The SETUP REGISTERS menu allows complete instrument settings and transient list programs to be saved to nonvolatile memory.
MORE	The MORE selection causes the third part of the MENU screen to be displayed. (MENU 3)
<b>MENU 3</b>	
UTILITY	The UTILITY menu provides access to less commonly used setup screens such as those for the GPIB and RS232C interface settings, initial startup values, etc.
OUTPUT IMPEDANCE	The OUTPUT IMPEDANCE menu provides control of the AC source output impedance. (Available only on 3001iX, 5001iX, 9003iX and 15003iX models. On systems with –MODE-iX option, only available when in 3 phase mode.)
MEASUREMENT CAL	The MEASUREMENT CAL menu allows for calibration of the AC source measurement system.
OUTPUT CAL	The OUTPUT CAL menu allows for calibration of the AC source output.

Following the Menu overview pages is a detailed description of each menu and sub menu.

4.2.2 Overview of Menu 1

level 1

level 2

level 3

MENU 1

PROGRAM

PROGRAM1  
VOLTAGE  
FREQ  
VOLT RANGE  
CURR LIMIT  
MORE

PROGRAM2  
PHASE  
CLOCK MODE  
VOLT MODE  
DC OFFSET  
START 0

MEASUREMENTS

MEASUREMENTS1  
VOLTAGE  
CURRENT  
FREQ  
POWER  
MORE

MEASUREMENTS 2  
VA POWER  
PEAK CURR  
POWER FACT  
CREST FACT  
PEAK CURR RESET

MEASUREMENTS 3  
VOLT THD  
CURR THD  
INST PK CURR  
PHASE

HARMONICS/TRACE ANALYSIS  
FUNCTION  
VIEW  
DATA MODE  
SCALE  
TRIG MODE  
TRIG SOURCE  
TRIG PHASE  
TRIG DELAY  
START

TRANSIENTS

VOLT SURGE/SAG  
VOLT SWEEP/STEP  
FREQ SWEEP/STEP  
VOLT/FREQ SWEEP/STEP  
START/VIEW SEQUENCE  
PREVIOUS SCREEN

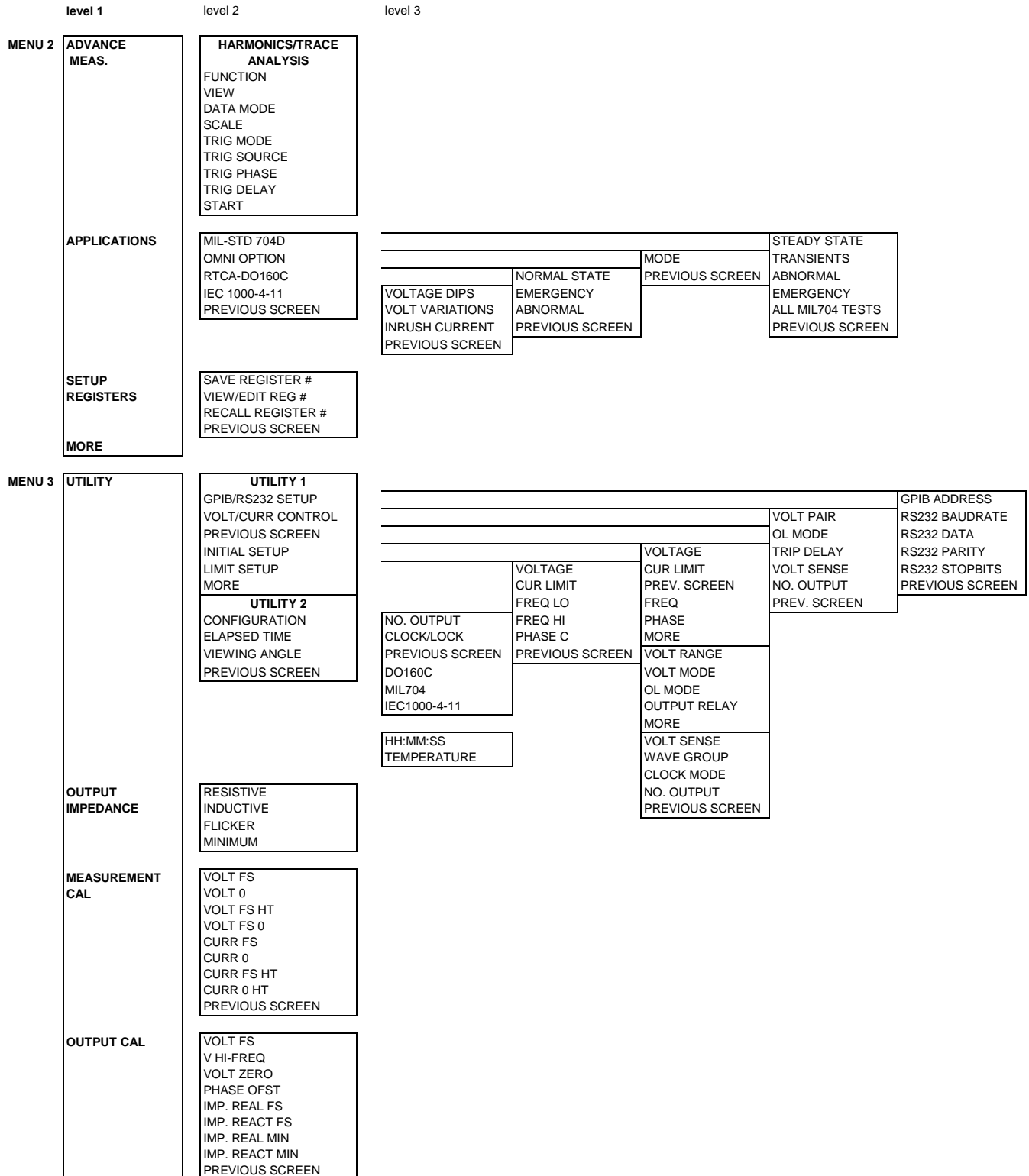
START 0  
GO TO VOLT  
DUR SCALE  
DURATION  
END VOLT  
END DELAY  
FUNCTION  
REPEAT  
EVENT#  
PREV. SCREEN

WAVEFORMS

CLIP LEVEL  
GROUP  
MODE  
SINE  
SQUARE  
CLIPPED  
USER WAVE  
..  
..  
USER WAVE

MORE

### 4.2.3 Overview of Menu 2 and 3



#### 4.2.4 PROGRAM Menu

PROGRAM 1	
VOLTAGE = 120.0VAC	VOLT RANGE = 135V
FREQ = 500.0Hz	CURR LIMIT = 11.20A
PREVIOUS SCREEN	MORE

PROGRAM 2	
PHASE = -178.9°	VOLT MODE = AC
CLOCK MODE = INT	DC OFFSET = 0.0V
PREVIOUS SCREEN	START @ = 90°

Figure 4-8: PROGRAM Menu

The PROGRAM menu is shown in Figure 4-8. It can be reached in one of two ways:

1. by selecting the PROGRAM entry in the MENU screen and pressing the ENTER key
2. by pressing the PROG key in the FUNCTION keypad

The PROGRAM menu is used to change output parameters. The most commonly used parameters are all located in PROGRAM 1. The PREVIOUS SCREEN entry, when selected, will return the user to the most recently selected menu. This is normally the MENU screen unless the PROGRAM menu was selected using the PROG key on the FUNCTION keypad. Less frequently used parameters are located in PROGRAM 2 which can be reached from the PROGRAM 1 screen using the MORE selection, or by pressing the PROGRAM key twice.

The following choices are available in the PROGRAM menus:

Entry	Description
<b>PROGRAM 1</b>	
VOLTAGE	Programs the output voltage in rms. when in AC mode or absolute voltage when in DC mode. In DC mode, negative values can be entered.
FREQ	Programs the output frequency when in AC mode. If the unit is in DC mode, the value for FREQ will be set to DC and cannot be changed until AC mode is selected. When in AC mode, the frequency can be changed from 16 Hz to 500 Hz. Values entered that fall outside this range will generate a -200 RANGE ERROR and will not be accepted.
VOLT RANGE	Selects 135/150V or 270/300V voltage range. The actual range values may be different depending on the configuration. The value of this field can only be changed with the shuttle or the +/- key.  <b>Note</b> that the voltage range is coupled with the output relay state on all i/iX AC sources with firmware revision 2.39 or higher. If the output relay is closed (OUTPUT ON), the voltage range cannot be changed.
CURR LIMIT	Sets the current limit value for the current detection system. When the load current value exceeds the set current limit, a fault condition is generated. The actual response of the AC Source to a current limit fault is determined by the protection mode selected in the CONFIGURATION menu. (CC = Constant Current, CV = Constant Voltage).

**PROGRAM 2**

PHASE	Selects the phase angle between the external clock and the output of the AC source. If the clock source is internal, this parameter has no effect.
CLOCK MODE	Selects internal or external clock source. The i/iX Series uses an open air crystal timebase with an accuracy of 100 ppm. To improve output frequency stability and accuracy, an external clock generator may be used.
VOLT MODE	The iX Series offers three output modes, AC, DC and AC+DC. The VOLT MODE field can be used to toggle between these three output modes. Both the Knob and the +/- key may be used to toggle through these three selections. In DC mode, no frequency selection is possible and all maximum current and power ratings are divided by two. The i Series offers AC or DC modes.
DC OFFSET	When the AC+DC mode is selected, the VOLTAGE field in the PROGRAM 1 screen is used to set the AC portion of the output voltage. The DC OFFSET field in the PROGRAM 2 screen can be used to set the DC offset level. Either the knob or the decimal keypad may be used to set the DC offset level.
STARTØ	Selects the start phase angle for output changes made to either voltage or frequency. This allows changing the output at a specific phase angle. The output on key also uses this phase angle setting to program the output voltage up to the set level after the output relay is closed. The default value for this field is RANDOM.

## 4.2.5 MEASUREMENTS Screens

The i/iX Series uses a DSP based data acquisition system to provide extensive information regarding the output of the Source. This data acquisition system digitizes the voltage and current waveforms and calculates several parameters from this digitized data. The result of these calculations is displayed in a series of measurement data screens. The actual digitized waveforms can also be displayed by selecting the Harmonics/Trace Analysis screen. A total of four measurement screens are used to display all this information (iX series only).

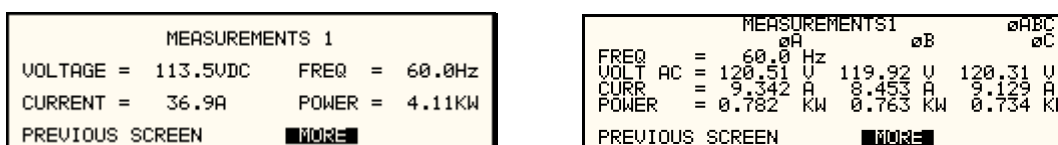


Figure 4-9: MEASUREMENTS Screen, single phase and three phase modes

The first three Measurement screens available on the iX Series are not menus in that no changes can be made anywhere. Instead, these three screens provide load parameter readouts. The fourth measurement screen provides access to the advanced measurements and does offer several user accessible fields (iX Series only). The measurement screens can be reached by successively pressing the MEAS key which will toggle to all four available screens.

In three phase configuration iX Series, measurements are available for each phase individually. To select the desired phase, use the PHASE key to toggle through phase A,B,C, or ABC. The ABC mode displays the data for all three phases simultaneously.

The following parameters are available in the first three measurement screens:

Entry	Description
<b>MEASUREMENT 1</b>	
VOLTAGE	When in AC or AC+DC mode, this value is the true rms output voltage measured at the voltage sense lines. In DC only mode, the voltage is the DC voltage including polarity.
CURRENT	When in AC or AC+DC mode, this value is the true rms output current drawn by the load. In DC only mode, the current is the DC current including polarity.
FREQ	When in AC or AC+DC mode, the output frequency is measured at the sense lines. When in DC only mode, this value always reads "DC".
POWER	In both AC and DC mode, this value is the real rms. power consumed by the load.
<b>MEASUREMENT 2</b>	
VA POWER	In AC or AC+DC mode, this value is the apparent rms. power consumed by the load. In DC mode, this value is always the same as the POWER readout.

PEAK CURR	This readout reflects the peak current value detected at the output. To measure inrush current for a unit under test, open the output relay and reset the peak current value using the PEAK CURR RESET entry. Then program the output voltage and frequency and turn on the output relay. The peak current measurement will continuously track the maximum current value detected until reset.
POWER FACTOR	This readout shows the power factor of the load.
CREST FACTOR	This readout displays the ratio between peak current and rms current.

### **MEASUREMENT 3**

**[iX Series only]**

VOLT THD	This readout displays the total voltage distortion for the selected phase.
CURR THD	This readout displays the total current distortion for the selected phase.
INST PK CURR	This readout reflects the instantaneous peak current value detected at the output. This value is updated continuously and does not require a reset operation like the PEAK CURR readout. The instantaneous peak current does not use a track and hold mechanism like the PEAK CURR measurement in the MEASUREMENT 2 screen. Instead, it tracks the peak current on a cycle by cycle basis. The INST PK CURR typically tracks the rms current and the crest factor.

### **Update Program Functions from Measurement Screen**

---

The Shuttle can be used to update program parameters such as voltage, frequency or current from the measurement screen. This can be achieved with the following sequence:

1. Select the program 1 screen using the PROG key.
2. Use the up and down key to select the desired function to update. (Selects parameter that will be changed by the shuttle once in the MEAS1 screen)
3. Select the measurement 1 screen by pressing the MEAS key.
4. The pointer symbol ( ► ) points to the programmed parameter (V,F or CL) that will be affected by turning the shuttle.

### HARMONICS/TRACE ANALYSIS Screen **[iX Series only]**

The fourth measurement screen is dedicated to the advanced measurements available on the iX Series only. This screen is not available on the i Series. The Harmonics/Trace Analysis measurement screen is a true menu screen offering several user accessible fields. These fields are used to select the desired acquisition trigger and display mode. The actual data is displayed whenever the ENTER key is pressed while the cursor is on the VIEW or START field. The following fields are available on this menu:

```

HARMONICS/TRACE ANALYSIS  @A
FUNCTION =VOLT      TRIG MODE =SINGLE
VIEW      =TABLE    TRIG SOURCE=IMM
DATA MODE=ABS      TRIG PHASE =0°
SCALE     =20ms     TRIG DELAY =0.0ms
PREVIOUS SCREEN  START
  
```

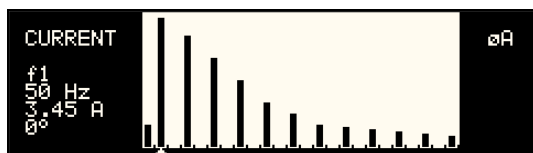
Figure 4-10: HARMONICS/TRACE ANALYSIS screen

Entry	Description
FUNCTION	Selects Voltage, Current or Both parameters for display.
VIEW	Available display modes are TABLE, BAR and TRACE.
	TABLE mode: displays the first 50 harmonics in a tabular text format.

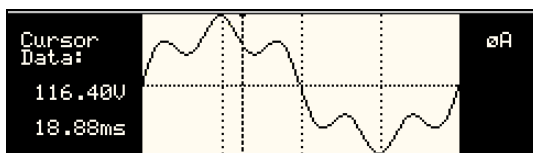
```

VOLT HARMONIC MEASUREMENTS  @A
HR#  AMPL.  PHASE  HR#  AMPL.  PHASE
0    0.00    0.0    1    151.42  0.0
2    0.33    46.9    3    116.17  351.4
4    0.57    90.1    5    85.24   29.6
6    0.59    131.0   7    54.72   67.0
8    0.45    171.4   9    24.55  100.6
  
```

BAR mode: displays the first 50 harmonics in a graphical bar chart display.



TRACE mode: displays the selected Function in a time domain (waveform) graphical display.





DATA MODE	<p>Selects absolute or relative harmonics display for TABLE and BAR view modes. In relative mode, all harmonics are shown in a percentage of the fundamental which is normalized at 100 %. In absolute mode, the harmonic amplitudes are shown in absolute volts or amperes.</p> <p>This mode does not apply to the TRACE view display mode and is ignored when this mode is selected.</p>
SCALE	<p>Sets the horizontal time axis for the TRACE view display mode. The field can range from 4 ms to 104 ms in single phase mode or 12 ms to 312 ms in three phase mode.</p> <p>This parameter is ignored when the TABLE or BAR view display mode is selected.</p>
TRIG MODE	<p>This field sets the trigger mode for the acquisition. Available options are SINGLE (single shot acquisition) or CONT (continuous acquisition). In SINGLE shot mode, the acquisition is triggered once each time the START field is selected and the ENTER key is pressed. The selected trigger source is used to determine the trigger point. Once the acquisition has been triggered, the data are displayed and do not change until the next acquisition is triggered. This mode is most appropriate for single shot events such as start up currents.</p> <p>In the CONT mode, acquisitions occur repeatedly and the data is updated on screen after each trigger occurs. This provides a continuous update of the data and is most appropriate for repetitive signals.</p>
TRIG SOURCE	<p>The trigger source selects the event that will trigger a measurement acquisition. Available options for this field are IMM (immediate), PHASE A or SET VOLT. The IMM trigger source causes the acquisition to trigger immediately when the ENTER key is pressed on the START field. Essentially, this is an asynchronous trigger event. The acquisition will always be triggered in this mode and data is available immediately.</p> <p>The PHASE A source will cause the acquisition to trigger on the occurrence of a set phase angle for the voltage on phase A. The trigger source is always phase A when in this mode, regardless of the phase selection shown in the top right corner of the display. When the acquisition is started, the acquisition system waits for the specified phase angle to occur before triggering the acquisition. This mode allows exact positioning of the acquisition data window with respect to the voltage waveform.</p> <p>The SET VOLT mode causes the acquisition to trigger at the specified voltage. This mode also programs the selected phase or all three phases when the measurement is started from the START field. As such, this trigger source selection also programs the output voltage to the selected rms level.</p>
TRIG PHASE / SET VOLT	<p>This field changes purpose, depending on the trigger source selected immediately above it. If the trigger source equals IMM or PHASE A, this field can be used to program the trigger phase angle (TRIG PHASE). In IMM mode, the value of this field is ignored.</p>

If the trigger source is set to SET VOLT, this field can be used to specify the rms voltage to program the output to and trigger the measurement on. The voltage value set here should not exceed the maximum voltage range selected or the rms capability for the waveshape selected on the phase or phases programmed.

#### TRIG DELAY

The trigger delay field allows the trigger point to be positioned anywhere in the acquisition window. A negative value will provide pre-trigger information on data leading up to the trigger event. The pre-trigger delay can not exceed the length of the acquisition buffer (104 ms in single phase mode, 312 ms in three phase mode). A positive trigger delay positions the data window after the trigger event. Positive trigger delays can exceed the length of the acquisition buffer in which case the trigger event itself will not be in the buffer any more. The maximum value of the trigger delay is 1000 ms. The default trigger delay value is 0.0 ms which puts the trigger event at the beginning of the acquisition window.

#### START

The START field is used to start a new acquisition run. To start an acquisition, place the cursor on the START field and press the ENTER key. Once the ENTER key is pressed, the display toggles to the data display mode selected in the VIEW field as soon as the selected trigger event occurs. To return to the HARMONICS/TRACE ANALYSIS menu, press the ENTER key while in the data display mode.

To change display modes without triggering a new acquisition, make the desired changes in the menu and move the cursor to the VIEW field. Once on the VIEW field, press the ENTER key. This will not trigger a new acquisition which means the original data is retained.

#### 4.2.6 TRANSIENTS Menu

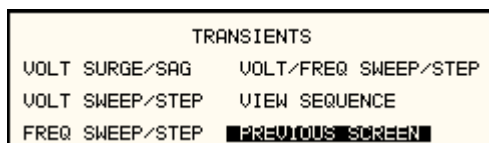


Figure 4-11: TRANSIENTS menu

The transient menu provides access to the transient list data. Both the i and the iX Series have a transient list of up to 32 data points. This is represented by 32 transient step numbers from 1 through 32. From the Transient menu, the desired transient step type can be selected. Based on the user's choice, the relevant transient type sub menu will be shown. The START/EDIT SEQUENCE sub menu allows the user to review and change any transient step or execute the transient list. When executing a transient list, transient steps are executed in an ascending numerical order. Steps that are not defined are skipped.

The following entries can be found in the TRANSIENTS menu:

Entry	Description
VOLT SURGE/SAG	Voltage surges and sags are temporary changes in amplitude. The output voltage will change from its present value to a user specified value for a specified duration. (Sag if the value is lower, surge if the value is higher.) After this period has expired, the output voltage returns to a user specified end value. This value may or may not be the same as the value present prior to the start of the sag or surge.
VOLT SWEEP/STEP	Voltage sweeps cause the output voltage to change from the present value to a user specified end value at a specified rate of change. A voltage step on the other hand is an instantaneous change in output voltage. The new value will be held for the duration period specified by the user. The final output voltage value of a sweep and a step transient step should be different than the value at the start of the transient step or no change in output value will occur.
FREQ SWEEP/STEP	This transient type is similar to a voltage sweep/step except it affects the frequency. Refer to the previous paragraph.
VOLT/FREQ SWEEP/STEP	This transient type combines the previous two types into a single step. The effect is that of changing the output voltage and frequency simultaneously.  Note: While this transient is programmed as a single transient step, two list entries are required to store this information. As such, every VOLT/FREQ SWEEP/STEP used will consume two list entries at a time.
START/VIEW SEQUENCE	This entry allows the user to switch to the transient execution menu. This menu provides a list of all available transient list steps and their sequence numbers. From this menu, transient list execution can be started.  The same menu can be used to view or edit any available transient list step or erase a step using the backspace key.

#### 4.2.6.1 VOLT SURGE/SAG sub menu

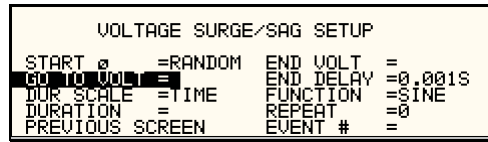


Figure 4-12: VOLTAGE SURGE/SAG SETUP screen

The Voltage surge and sag screen shown in Figure 4-12 can be reached from the transient screen as follows:

1. Scroll to the VOLT SURGE/SAG entry using the up and down cursor keys.
2. Press the ENTER key to bring up the VOLT SURGE/SAG screen.

The VOLT SURGE/SAG screen has several data fields. All data fields that are blank to the right of the equal sign must be filled or an error message will occur when trying to leave this screen. The EVENT # is the last data field to be filled. Entering the event data field will cause the display to return to the TRANSIENT screen where a new selection can be made.

The VOLT/SURGE/SAG screen has the following fields:

START ∅	This field will show the start phase angle of the voltage transient in degrees. Only one start phase angle per transient sequence is allowed. The start phase angle must be in the first transient event in the list. The start phase angle is not valid for DC transients. If no start phase angle is required, this field can be set to RANDOM by pressing the BACKSPACE (<-) key on the decimal keypad.
GO TO VOLT	This field will set the voltage level during the transient duration in volts
DUR SCALE	Duration scale default is time in seconds. Use the Shuttle knob to select CYCLES if desired. Note that durations expressed in cycles may cause rounding errors if the period of the selected frequency setting is not an integer number of mss. Thus, for 50 Hz applications, no rounding errors occur but for 60 Hz, the 16.66 ms period will cause a rounding error when converted. The Duration scale selection affects both the DURATION and END DELAY parameters.
DURATION	Duration is the time the output voltage level will dwell at the GO TO VOLT level. The DUR SCALE defines the time scale of this parameter in CYCLES or SECONDS
END VOLT	This is the output voltage level at the end of the transient EVENT and after a time specified by the DURATION
END DELAY	This is the time delay the voltage level will stay at the END VOLT level before it proceeds with the next transient event or completes the transient.
FUNCTION	[iX Series only] This field can be used to select the waveshape to be used during this step of the transient sequence. Each step can use a different waveshape from the available library of 50 user defined waveforms or the three standard waveforms. The output waveshape changes upon entry into each step and remains in effect for the duration of the step. The default waveshape is always the SINE (sinewave).

REPEAT	This is the number of times the SURGE/SAG transient event will repeat before it will proceed to the next event or exit the transient program. Note that the number of times the transient event is generated is equal to the REPEAT + 1. Leave this value at zero if only one execution of this event in the list is required.
EVENT #	This must be the last item in the transient edit screen. All data fields must be entered before inserting the EVENT #. The EVENT # takes a value from 1 to 99. The EVENT # defines the order of execution of the transient events in a multiple event transient. It is a good practice to enter spaced EVENT #'s to allow insertion of an EVENT later if needed. (For example, space them by 5.) Entry of a sequence EVENT # number will cause the display to return to the TRANSIENT screen.

#### 4.2.6.2 VOLTAGE SWEEP/STEP sub menu

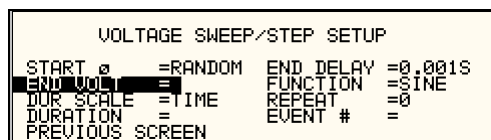


Figure 4-13: VOLTAGE SWEEP/STEP SETUP screen

The Voltage sweep and step screen shown in Figure 4-13 can be reached from the transient screen as follows:

1. Scroll to the VOLT SWEEP/STEP entry using the up and down keys.
2. Press the ENTER key to bring up the VOLTAGE SWEEP/STEP screen.

The VOLTAGE SWEEP/STEP screen has several data fields. All data fields that are blank to the right of the equal sign must be filled or an error message will occur when trying to leave this screen. The EVENT # is the last data field to be filled. Entering the event data field will cause the display to return to the TRANSIENT screen where a new selection can be made.

The VOLTAGE SWEEP/STEP screen has the following fields:

START	This field will show the start phase angle of the voltage transient in degrees. Only one start phase angle per transient sequence is allowed. The start phase angle must be in the first transient event in the list. The start phase angle is not valid for DC transient.
END VOLT	This is the output voltage level at the end of the transient event in volts.
DUR SCALE	Duration scale default is time in seconds. Use the Shuttle knob to select CYCLES if desired. Note that durations expressed in cycles may cause rounding errors if the period of the selected frequency setting is not an integer number of mss. Thus, for 50 Hz applications, no rounding errors occur but for 60 Hz, the 16.66 ms period will cause a rounding error when converted. The Duration scale selection affects both the DURATION and END DELAY parameters.
DURATION	Duration is the time it will take for the output voltage to reach the END VOLT level. As such, "Duration" will define the slew rate of the output voltage for the event. A duration of 0 seconds will cause the output voltage to reach the end voltage immediately. The DUR SCALE defines the time parameter CYCLES or SECONDS
END DELAY	This is the time delay the voltage level will stay at END VOLT before it proceeds with the next transient event or completes the transient.
FUNCTION	[iX Series only] This field can be used to select the waveshape to be used during this step of the transient sequence. Each step can use a different waveshape from the available library of 50 user defined waveforms or the three standard waveforms. The output waveshape changes upon entry into each step and remains in effect for the duration of the step. The default waveshape is always the SINE (sinewave).

REPEAT	This is the number of times the VOLTAGE SWEEP/STEP transient event will repeat before it will proceed to the next event or exit the transient program. Note that the number of times the transient event is generated is equal to the REPEAT + 1. Leave this value at zero if only one execution of this event in the list is required.
EVENT #	This must be the last item in the transient edit screen. All data fields must be entered before inserting the EVENT #. The EVENT # takes a value from 1 to 99. The EVENT # defines the order of execution of the transient events in a multiple event transient. It is a good practice to enter spaced EVENT #'s to allow insertion of an EVENT later if needed. (For example, space them by 5.) Entry of a sequence EVENT # number will cause the display to return to the TRANSIENT screen.

#### 4.2.6.3 FREQUENCY SWEEP/STEP sub menu

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FREQUENCY SWEEP/STEP SETUP	
DURATION	=0.001S
END FREQ	=
END DELAY	=0.001S
FUNCTION	=SINE
REPEAT	=0
EVENT #	=
PREVIOUS SCREEN	

Figure 4-14: FREQUENCY SWEEP/STEP SETUP screen

The Voltage sweep and step screen shown in Figure 4-14 can be reached from the transient screen as follows:

1. Scroll to the FREQ SWEEP/STEP entry using the up and down cursor keys.
2. Press the ENTER key to bring up the FREQ SWEEP/STEP screen.

The FREQ SWEEP/STEP screen has several data fields. All data fields that are blank to the right of the equal sign must be filled or an error message will occur when trying to leave this screen. The EVENT # is the last data field to be filled. Entering the event data field will cause the display to return to the TRANSIENT screen where a new selection can be made.

The FREQ SWEEP/STEP screen has the following fields:

DURATION	Duration is amount of the time the output frequency will take to reach the END FREQ level. Duration will define the slew rate of the output frequency for the event. A duration of 0 seconds will cause the output frequency to reach the end frequency immediately.
END FREQ	This is the output frequency at the end of the transient event in Hz.
END DELAY	This is the time delay the frequency will stay at END FREQ before it proceeds with the next transient event or completes the transient.
FUNCTION	[iX Series only] This field can be used to select the waveshape to be used during this step of the transient sequence. Each step can use a different waveshape from the available library of 50 user defined waveforms or the three standard waveforms. The output waveshape changes upon entry into each step and remains in effect for the duration of the step. The default waveshape is always the SINE (sinewave).
REPEAT	This is the number of times the FREQUENCY SWEEP/STEP transient will repeat before it will proceed to the next event or exit the transient. The number of times the transient event is generated is equal to the REPEAT + 1. Leave this value at zero if only one execution of this event in the list is required.
EVENT #	This must be the last item in the transient edit screen. All data fields must be entered before inserting the EVENT #. The EVENT # takes value from 1 to 99. The EVENT # defines the order of execution of the transient events in a multiple event transient. It is a good practice to enter spaced EVENT #'s to allow insertion of an EVENT later if needed. (For example, space them by 5.) Entry of a sequence EVENT # number will cause the display to return to the TRANSIENT screen.



#### 4.2.6.4 VOLTAGE/FREQUENCY SWEEP/STEP sub menu

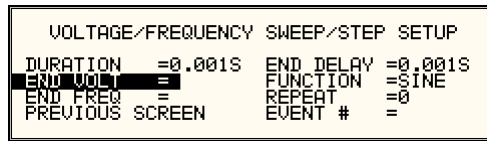


Figure 4-15: VOLTAGE/FREQUENCY SWEEP/STEP SETUP screen

The Volt/freq sweep/step screen shown in Figure 4-15 can be reached from the transient screen as follows:

1. Scroll to the VOLT/FREQ SWEEP/STEP entry using the up and down cursor keys.
2. Press the ENTER key to bring up the VOLT/FREQ SWEEP/STEP screen.

The VOLT/FREQ SWEEP/STEP screen has several data fields. All data fields that are blank to the right of the equal sign must be filled or an error message will occur when trying to leave this screen. The EVENT # is the last data field to be filled. Entering the event data field will cause the display to return to the TRANSIENT screen where a new selection can be made.

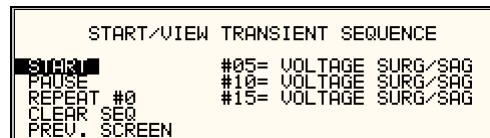
The VOLT/FREQ SWEEP/STEP screen has the following fields:

DURATION	Duration is the amount of time the output voltage and frequency will take to reach the END FREQ and END VOLT levels. Duration will define the slew rate of the output voltage and frequency for the event. A duration of 0 seconds will cause the output voltage and frequency to reach their end value immediately.
END FREQ	This is the output frequency at the end of the transient event in Hz.
END VOLT	This is the output voltage at the end of the transient event in volts.
END DELAY	This is the time delay the output frequency and voltage will stay at END FREQ and END VOLT before proceeding with the next transient event or completing the transient.
FUNCTION	[iX Series only] This field can be used to select the waveshape to be used during this step of the transient sequence. Each step can use a different waveshape from the available library of 50 user defined waveforms or the three standard waveforms. The output waveshape changes upon entry into each step and remains in effect for the duration of the step. The default waveshape is always the SINE (sinewave).
REPEAT	This is the number of times the VOLTAGE/FREQUENCY SWEEP/STEP transient will repeat before it will proceed to the next event or exit the transient. The number of times the transient event is generated is equal to the REPEAT + 1. Leave this value at zero if only one execution of this event in the list is required.

**EVENT #** This must be the last item in the transient edit screen. All data fields must be entered before inserting the EVENT #. The EVENT # takes value from 1 to 99. The EVENT # defines the order of execution of the transient events in a multiple event transient. It is a good practice to enter spaced EVENT #'s to allow insertion of an EVENT later if needed. (For example, space them by 5.) Entry of a sequence EVENT # number will cause the display to return to the TRANSIENT screen.

#### **4.2.6.5 START/VIEW TRANSIENT SEQUENCE sub menu**

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*Figure 4-16: START/VIEW TRANSIENT SEQUENCE screen*

The START/VIEW TRANSIENT SEQUENCE screen is used to control transient execution. It also provides an overview of available transient list events. This list appears in the order they were assigned event numbers. Editing an existing event can be accomplished from this screen by positioning the cursor on the event to be edited and pressing the ENTER key. This method can also be used to review the parameters of a previously entered event.

The START/VIEW TRANSIENT SEQUENCE screen has the following fields:

<b>START / ABORT</b>	The START field is used to start a transient execution. When the cursor is positioned on the START field and the ENTER key is pressed, transient execution starts. The output relay must be closed or an error message will appear and the transient will not start.  Once a transient is in progress, this field changes to ABORT and can be used to abort a transient in progress. If the transient completes execution, the field reverts back to START.
<b>PAUSE / RESUME</b>	The PAUSE field may be used to suspend execution of a transient list in progress. If the cursor is on the PAUSE field and the ENTER key is pressed, the transient is suspended and this field changes to RESUME. Pressing the ENTER key again will cause the transient list to resume execution from the point where it was suspended.
<b>REPEAT #</b>	This field determines the number of times a transient list is repeated. The default value is zero which means the programmed list runs only once. The range for this field is from 0 through 99999. This repeat function should not be confused with the REPEAT function available for individual events. The event specific repeat value will cause only that event to be repeated, not the entire list.
<b>CLEAR SEQ</b>	Moving the cursor to this field and pressing the ENTER key will cause the entire programmed transient list to be erased. Be careful not to press ENTER accidentally while on this field as you will lose the programmed transient list. Note that a list may be stored as part of the front panel setup in the nonvolatile memory registers.

4.2.7 WAVEFORMS Menu [iX Series only]

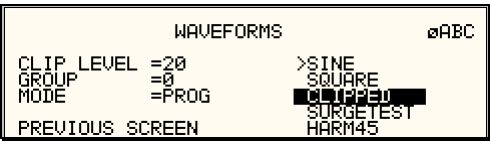


Figure 4-17: WAVEFORMS menu

The WAVEFORMS menu is available on the iX Series only. If your unit is an i Series, pressing the WAVE key on the front panel function keypad has no effect. The WAVEFORMS menu allows selection of the waveshape for each phase individually or all phases at once. For three phase versions of the iX Series, the mode is determined by the phase coupling. If only a single phase is selected in the top right corner of the display (øA, øB or øC), the selected waveshape will be applied to that phase. If all phases are selected (phase coupling), the selected waveform will apply to all three phases.

For single phase versions of the iX Series, the phase coupling is always set to phase A, so pressing the PHASE button has no effect.

The following fields are available in the WAVEFORMS menu:

- CLIP LEVEL

This parameter determines the amount of total harmonic distortion of the built-in CLIPPED sinewave waveform. The range is 0 % through 20 % THD.

Note that changing the distortion level of the CLIPPED sinewave while the CLIPPED sinewave is used on the output of one or more phases, forces the output of the AC Source to be dropped momentarily. To avoid this, make sure none of the phases is using the CLIPPED sinewave function when changing the clip level.
- GROUP

The group field displays the currently selected waveform group. The iX Series provides four groups of 50 user defined waveforms each for a total of 200 waveforms. Only one group can be active at a time however. This field only displays the selected waveform group. It cannot be used to change the actual group selected. Group selection must occur at power up and is done from the INITIAL SETUP 3 screen. See section 4.2.11.3 for details.
- MODE

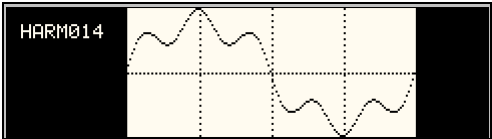
The mode field determines the operation mode of the WAVEFORMS display screen. Available options for this field are:

PROG:

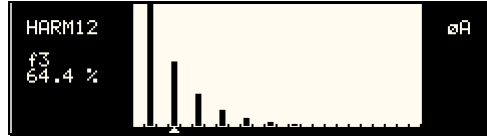
This mode is used to change the programmed waveshape function on the selected phase. This is also the default mode of operation.

VIEW(T):

This mode can be used to display any of the available user defined waveforms in a time domain display. Previewing a waveform can be useful if you are unsure about the nature of the waveform that was stored.



**VIEW(F):** This mode can be used to display any of the available user defined waveforms in a frequency domain display. Waveform data is shown by harmonic amplitude and phase relative to the fundamental frequency. Previewing a waveform can be useful if you are unsure about the nature of the waveform that was stored.



#### SINE

The SINE is a standard waveform that is always available. It does not consume any of the user defined waveform registers and is always displayed in the waveform list. A right arrow indicates the waveform is presently selected for the phase. If the cursor is moved to this field, the ENTER key will execute the selected MODE. If the mode is set to PROG, pressing ENTER while the cursor is on the SINE entry will select the sinewave for the phase shown in the top right corner of the display.

Note that the VIEW modes are not available for any of the three standard waveforms.

#### SQUARE

The SQUARE is a standard waveform that is always available. It does not consume any of the user defined waveform registers and is always displayed in the waveform list. A right arrow indicates the waveform is presently selected for the phase. If the cursor is moved to this field, the ENTER key will execute the selected MODE. If the mode is set to PROG, pressing ENTER while the cursor is on the SQUARE entry will select the square wave for the phase shown in the top right corner of the display.

Note that the VIEW modes are not available for any of the three standard waveforms.

#### CLIPPED

The CLIPPED is a standard waveform that is always available. It does not consume any of the user defined waveform registers and is always displayed in the waveform list. A right arrow indicates the waveform is presently selected for the phase. If the cursor is moved to this field, the ENTER key will execute the selected MODE. If the mode is set to PROG, pressing ENTER while the cursor is on the CLIPPED entry will select the clipped sinewave for the phase shown in the top right corner of the display. The amount of clipping is determined by the CLIP LEVEL field.

Note that the VIEW modes are not available for any of the three standard waveforms.

#### USER DEFINED

A list of user defined waveforms appears immediately below the three standard waveforms. If no user defined waveforms were downloaded to the iX Series AC source, this list will be blank. User defined waveforms can be given a symbolic name of up to twelve characters. The use of any of the three standard waveform names (SINE, SQUARE and CLIPPED) should be avoided as it will be rejected by the iX controller.

A right arrow indicates the waveform is presently selected for the phase. If the cursor is moved to this field, the ENTER key will execute the selected MODE. If the mode is set to PROG, pressing ENTER while the cursor is on the user defined entry will select the custom waveform for the phase shown in the top right corner of the display.

If the MODE is set to either VIEW option, the waveform data under the cursor will be displayed when the ENTER key is pressed. Press the ENTER key again to return to the WAVEFORMS menu.

**4.2.8 ADVANCE MEAS. Menu [iX Series only]**

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This entry in the MENU 2 screen displays the HARMONICS/TRACE ANALYSIS screen which is covered in section 4. This field can be used in lieu of the MEAS key to directly bring up the advanced measurements screens.

**4.2.9 APPLICATIONS Menu**

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*Figure 4-18: APPLICATIONS menu*

The APPLICATIONS menu provides access to the optional application specific pre-programmed test sequences. Since these test sequences are optional, this menu may have no choices if none of the options are installed. The following entries may be found in the APPLICATIONS menu:

Entry	Description
MIL-STD 704	Test sequence for MIL standard 704 AC and DC tests.
OMNI OPTION	This entry selects the OMNI control menu. The OMNI option provides a lumped reference impedance for use in IEC 1000-3-3 Flicker test applications. The iX Series also provides programmable impedance, so, in most cases, the OMNI option is not required. For the i Series, the OMNI impedance is available as an option. If the OMNI option is installed, this screen allows the impedance to be ENGAGED or BYPASSED.
RTCA/DO-160	Test sequence for RTCA DO160 commercial aviation AC and DC tests.
IEC-1000-4-11	Test sequences for IEC 1000-4-11 Voltage Dips and Variations test standard.
IEC-1000-4-13	Test sequence for IEC 1000-4-13 Harmonics and Interharmonics test standard.

#### 4.2.10 SETUP REGISTERS Menu

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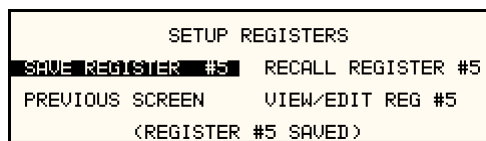


Figure 4-19: *SETUP REGISTERS* menu

The SETUP REGISTERS menu allows the user to store and recall complete instrument setups, including transient program lists. A total of 8 non volatile setup registers is available, numbered sequentially from 0 through 7.

The following entries can be found in the SETUP REGISTERS menu:

Entry	Description
SAVE REGISTER	Save present instrument setup to a register number selected by the user. The numeric data entry keypad should be used to enter a number between 0 and 7. Once the ENTER key is pressed, all settings are saved. A message will appear at the bottom of the screen to confirm the save operation.
RECALL REGISTER	Recall instrument setup from a register number selected by the user. The numeric data entry keypad should be used to enter a number between 0 and 7. Once the ENTER key is pressed, all settings are recalled. A message will appear at the bottom of the screen to confirm the recall operation.
VIEW/EDIT REGISTER	The View/Edit entry can be used to display the contents of a setup register before it is recalled. After the user enters a register number to view or edit and presses the ENTER key, the PROGRAM screen will appear. All parameters that will be changed by recalling the register will be blinking. If ENTER is pressed again, the register will be recalled and the new values take effect. To edit the register content, change all parameters that need to be changed. Pressing ENTER will save the new values and make them active.

### 4.2.11 UTILITY Menus

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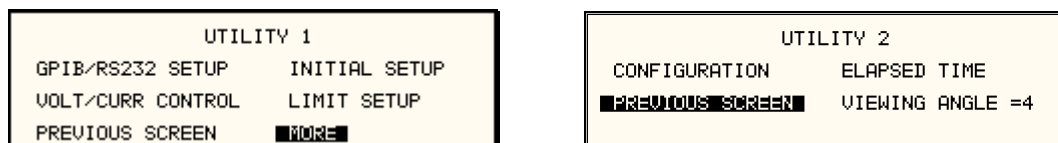


Figure 4-20: UTILITY menu

The UTILITY menu provides access to less frequently used setup items. There is no connection between the various entries in the UTILITY menu other than there is no other logical place to put them. The following entries can be found in the UTILITY menu:

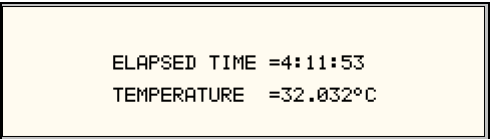
Entry	Description
<b>UTILITY 1</b>	
GPIB/RS232 SETUP	This entry provides access to the setup parameters for either the IEEE-488 bus or the RS232C bus. All parameters are saved in non-volatile memory so there is rarely a need to change these values.
VOLT/CURR CONTROL	<p>The voltage and current control menu can be used to select the voltage range pair, the current limit method, the voltage sense source, and the number of output phases (only in three phase systems with Mode-iX option).</p> <p>The standard available voltage range pairs are 135/270 and 150/300. The 135/270 pair gives higher current capability, and the 150/300 gives higher voltage capability.</p> <p>The two current limit choices are Constant Voltage and Constant Current. Constant Voltage mode will maintain the set voltage at the output until the load current exceeds the current limit setting at which time the voltage will be dropped to zero. This effectively shuts off the AC source output in case of an overload condition. This mode has user programmable trip delay which is located in the same menu.</p> <p>Constant Current mode will maintain the load current at the maximum level set by the current limit value, even if the maximum power level is exceeded. This is done by reducing the voltage as needed. As such, the voltage will be reduced from the set level down to zero depending on the load requirement. This mode is useful for starting up motor or capacitor loads that may require a high inrush current. This mode also has a user programmable trip delay.</p> <p>Voltage sensing for regulation and measurement can be selected for internal or external. External voltage sensing can compensate for voltage drops caused by load cable impedance. To achieve the best output regulation select external sense and connect the voltage sense wires at the load.</p> <p>The number of outputs in a multibox system with the Mode-iX option can be switched between one for 15000 VA single phase, and three for 5000 VA per phase, three phase. If the Mode-iX option is not installed, the number of outputs is fixed.</p>



INITIAL SETUP	The initial setup menu can be used to determine the AC source settings at power up. CAUTION: The initial setup can be used to power up the AC source with the output on and a high voltage present at the output. For normal situations, this is not recommended due to the potential danger to operators. It is recommended that the initial voltage be set low and/or the output relay be programmed to OFF for most situations.
LIMIT SETUP	The Limit menu shows the frequency, voltage and current limit capabilities of the AC source. Any attempt to program the output beyond these limits will result in a “-222 Data Out of Range error”. Note that these limits are hardware determined and cannot be changed by the user. They are shown for reference only.

**UTILITY 2**

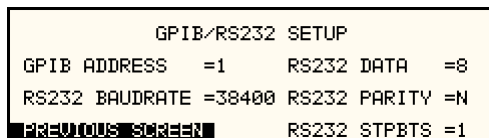
CONFIGURATION	The Configuration menu shows the installed options. This screen is for reference only and no fields can be changed by the user.
ELAPSED TIME	<p>The elapsed time screen, when selected from the UTILITY menu, will appear for about 3 seconds. The elapsed time shown is the cumulative amount of time the power source has been on from its initial build. This value is read only and cannot be changed by the user.</p> <p>The same screen also displays the internal AC source ambient temperature in degrees C.</p>



VIEWING ANGLE	The viewing angle can be used to change the contrast ratio of the LCD display. The range of the viewing angle parameter is from -10 to +10. Setting the right viewing angle is matter of personal taste. Set this parameter to a value that is most comfortable for the user.
---------------	---

#### 4.2.11.1 GPIB/RS232 SETUP menu

---



```

      GPIB/RS232 SETUP
GPIB ADDRESS  =1      RS232 DATA  =8
RS232 BAUDRATE =38400 RS232 PARITY =N
PREVIOUS SCREEN      RS232 STPBITS =1

```

*Figure 4-21: GPIB/RS232 SETUP menu*

The GPIB/RS232 SETUP menu may be used to change the interface parameter settings for both the IEEE-488 interface and the RS232 serial interface. The following parameters can be set from this menu:

GPIB ADDRESS	Sets the IEEE-488 address used by the AC source. The address value can be set from 0 through 31. Address 0 is often reserved for the IEEE-488 controller. The factory setting is address 1. Once changed, the IEEE-488 address is retained in nonvolatile memory.
RS232 BAUDRATE	This field can be used to set the RS232 baudrate to either 9600, 19200 or 38400 baud. The baudrate set on the AC source must match the one programmed for the communications port of the controller.
RS232 DATA	This field is used to set the number of databits to either 7 or 8. Factory setting is 8 bits. This value must match the number of data bits set on the communications port of the controller.
RS232 PARITY	This field is used to set the parity. Available options are Even (E), Odd (O) or no parity (N). Factory setting is No parity. This value must match the parity set on the communications port of the controller.
RS232 STPBITS	<p>This field is used to set the number of stop bits used on the serial port. Available options are 1 or 2 bits. Factory setting is 1 stop bit. This value must match the parity set on the communications port of the controller.</p> <p>The number of start bits is always fixed to 1 bit.</p>

#### 4.2.11.2 VOLTAGE/CURRENT CONTROL SETUP menu

---

```
VOLTAGE/CURRENT CONTROL SETUP
VOLT PAIR =150/300  TRIP DELAY =0.10S
OL MODE   =CC      VOLT SENSE =INT
PREVIOUS SCREEN  NO. OUTPUT =THREE
```

Figure 4-22: VOLTAGE/CURRENT CONTROL SETUP menu

The VOLTAGE/CURRENT CONTROL SETUP menu may be used to set output voltage and current control parameters. These parameters are not frequently changed in the normal operation of the AC source and are thus located on the UTILITY rather than the PROGRAM menu.

The following options are available in this menu:

VOLT PAIR	<p>[iX Series only] The iX Series can be operated in either a 135/270 voltage range pair or a 150/300 voltage range pair. The amount of current available in the 135/270 range pair setting is about 10% higher. Unless the extra voltage range is needed, the maximum current can be attained in the 135/270 volt mode. This field allows the selection of the most optimal voltage and current combination for the application at hand.</p>
OL MODE	<p>This field is used to select constant current (CC) or constant voltage (CV) mode. The constant current mode will limit the maximum amount of current drawn by the load to the set value. The voltage will be reduced as needed after the trip delay time to maintain the level of programmed current.</p> <p>The constant voltage mode will maintain the set voltage as long as the current drawn by the load does not exceed the current limit programmed. If the current limit is exceeded, the output will be shut off after the trip delay time.</p>
TRIP DELAY	<p>The trip delay field may be used to set the amount of time to hold off the current limit trip point. The minimum amount of time is 100 ms or 0.1 sec. The maximum amount of time is 5.00 sec.</p>
VOLT SENSE	<p>This field selects the internal or external sense line inputs. Internal sense does not require the external sense lines to be connected as sensing occurs at the output relay of the AC source. For best results, connect the external sense lines and select the EXT sense mode in this field. This will compensate for voltage drop in the cables to the load. The measurements are also taken at the sense points, so the external sense mode should be used for best measurement results.</p>
NO. OUTPUT	<p>This field is only accessible if the phase mode option is installed. It allows the number of output phases to be toggled between single and three phase mode. In single phase mode, all power is available on phase A. The Mode-iX option is available to route all power to a single output terminal pair.</p>

### 4.2.11.3 INITIAL SETUP menu

INITIAL SETUP 1		INITIAL SETUP 2	
VOLTAGE = 5.00AC	FREQ = 123.0Hz	VOLT RANGE =150V	OL MODE =CC
CURR LIMIT = 2.0A	PHASE = 0.0°	VOLT MODE =AC	OUTPUT RELAY =OFF
PREVIOUS SCREEN	MORE	PREVIOUS SCREEN	MORE

INITIAL SETUP 3	
VOLT SENSE =INT	CLOCK MODE =EXT
WAVE GROUP =0	NO. OUTPUT =LAST
PREVIOUS SCREEN	

Figure 4-23: INITIAL SETUP menus

Any time the AC source is powered up, the output will reflect the values stored as the INITIAL setup values. This allows the unit to be powered up in a known state at all times. The INITIAL values can be set in the INITIAL SETUP menus.

The initial setup can be used to power up the AC source with the output on and a high voltage present at the output. For normal situations, this is not recommended due to the potential danger to the operator. It is recommended that the initial voltage be set low and/or the output relay be programmed to OFF for most situations.

The following fields are provided in the INITIAL SETUP menus:

Entry	Description
<b>INITIAL SETUP 1</b>	
VOLTAGE	Sets the power-on AC voltage for AC and AC+DC modes or the DC voltage for DC mode.
CURR LIMIT	Sets the power-on current limit value.
FREQ	Sets the power-on frequency value.
PHASE	Sets the power-on frequency for phase A with respect to an external sync signal. If the internal oscillator is used (default) this setting has no effect.
<b>INITIAL SETUP 2</b>	
VOLT RANGE	Sets the power-on voltage range value. The available choices are determined by the VOLT PAIR selected in the VOLTAGE/CURRENT CONTROL SETUP menu.
VOLT MODE	Sets the power-on voltage mode. Available settings are AC mode, DC mode or AC+DC mode [ <i>iX Series only</i> ].
OL MODE	Sets the power-on overload mode. Available settings are Constant Current (CC) or Constant Voltage (CV) mode.
OUTPUT RELAY	Sets the power-on state of the output relay. Available settings are ON or OFF.

**INITIAL SETUP 3**

VOLT SENSE	Sets the power-on state of the voltage sense mode. Available settings are Internal (INT) or External (EXT).
WAVE GROUP	<i>[iX Series only]</i> Sets the user defined waveform group that will be loaded at power on. Available groups are 0, 1, 2 and 3. Each group can contain up to 50 user defined waveforms. A waveform group can only be loaded at power up. To change groups, you must change this field to the desired new group and cycle the power to the AC source or issue a *RST command over one bus.
CLOCK MODE	Sets the clock source used at power up. Available settings are Stand Alone (STAND), MASTER, and SLAVE.
NO. OUTPUT	<i>[iX Series only]</i> Sets the phase mode at power up. Available options are determined by the presence of the phase mode option. If the phase mode option is installed, available options are single phase mode (ONE), three phase mode (THREE) or last used phase mode (LAST). If the phase mode option is not installed, this field is either fixed to ONE or THREE.

#### 4.2.11.4 LIMIT SETUP screen

---

LIMIT SETUP	
VOLTAGE =300.0V	FREQ LO =16.00Hz
CUR LIMIT =111A	FREQ HI =500.0Hz
PREVIOUS SCREEN	PHASE C =120°

*Figure 4-24:LIMIT SETUP menu*

The limit setup screen is not a menu but only serves to inform the user of the hardware capabilities of the AC source. The cursor can be moved to any of the fields in this screen but none of these fields can be changed. The following information is provided on this screen:

Entry	Description
VOLTAGE	Maximum AC rms or DC voltage available in the high voltage range.
CUR LIMIT	Maximum AC rms current limit available in the low voltage range.
FREQ LO	Lowest possible fundamental frequency that can be programmed.
FREQ HI	Highest possible fundamental frequency that can be programmed.
PHASE C	Phase angle of phase C with respect to phase A in three phase mode. If the AC source is a single phase model, this field will shown 0°. If the AC source is a split phase model, this field will shown 180°.

**4.2.11.5 CONFIGURATION SETUP screen**

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The configuration setup screen is not a menu but only serves to inform the user of the software options installed in the AC source. The cursor can be moved to any of the fields in this screen but none of these fields can be changed. The following information is provided on this screen:

<b>Entry</b>	<b>Description</b>
NO. OUTPUT	<p>[iX Series only] Displays the phase mode option. SELECT indicates the phase mode option is installed and the user can select between single and three phase modes of operation. The phase mode option is only available on the 15003iX model.</p> <p>FIXED indicates the phase mode option is not installed and only single phase or three phase mode of operation is possible.</p>
ADVANCE	<p>[iX Series only] For iX Series models, this field is always set to ON to indicate the advanced capabilities for waveform generation and measurement analysis are present. On i Series AC sources, this field is always set to N/A (not available).</p>
DO160D	<p>Indicates the presence of the RTCA DO160D test option. If this option is installed, this field will show ON. If this option is not installed, this field will show N/A (not available).</p>
MIL704D	<p>Indicates the presence of the MIL/STD-704D test option. If this option is installed, this field will show ON. If this option is not installed, this field will show N/A (not available).</p>
IEC1000-4-11	<p>Indicates the presence of the IEC 1000-4-11 test option. If this option is installed, this field will show ON. If this option is not installed, this field will show N/A (not available).</p>
IEC1000-4-13	<p>Indicates the presence of the IEC 1000-4-13 test option. If this option is installed, this field will show ON. If this option is not installed, this field will show N/A (not available).</p>

4.2.12 OUTPUT IMPEDANCE Menu [iX Series only]

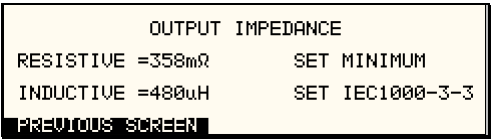


Figure 4-25: OUTPUT IMPEDANCE menu

The iX Series offers programmable output impedance on selected models. This allows the user to simulate line impedance conditions by programming resistive and inductive elements of the AC source's output impedance.

Models on which this function is available are:

3001iX, 5001iX, 9003iX, 15003iX.

**Note: On 9003iX-MODE and 15003iX-MODE systems, programmable impedance function is only available in 3 phase mode of operation.**

Alternative, one of the available OMNI lumped reference impedance options may be used to increase the AC source output impedance for applications such as IEC 61000-3-3 Flicker testing.

The OUTPUT IMPEDANCE menu can be accessed from MENU 3. The following fields are available in this menu:

Entry	Description
RESISTIVE	Sets the resistive component of the output impedance. This value can be set from 17 mΩ to 1000 mΩ.  (The lower limits for the resistive and inductive components may vary on different AC source models and are set as part of the source calibration.)
INDUCTIVE	Sets the inductive component of the output impedance. This value can be set from 230 μH to 1000 μH.  (The lower limits for the resistive and inductive components may vary on different AC source models and are set as part of the source calibration.)
SET MINIMUM	Selecting this field and pressing the ENTER key sets both impedance components to their minimum values.
SET IEC1000-3-3	Selecting this field and pressing the ENTER key sets the output impedance to the IEC 725 reference impedance values required for IEC 1000-3-3 flicker testing.



4.2.13 MEASUREMENT CAL FACTORS Menu

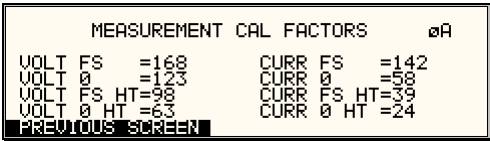


Figure 4-26: MEASUREMENT CAL FACTORS menu

The MEASUREMENT CAL FACTORS menu provides access to the measurement calibration parameters. For three phase configurations, the PHASE keys toggle between the three calibration screens for each phase. These parameters are password protected and can only be changed after the calibration password has been entered. Refer to the calibration section in this manual for details on performing a calibration.

The following calibration factors are available from this menu:

Entry	Description
VOLT FS	Full scale voltage measurement calibration factor.
VOLT 0	Zero offset voltage measurement calibration factor.
VOLT FS HT	Temperature compensated full scale voltage measurement calibration factor.
VOLT 0 HT	Temperature compensated zero offset voltage measurement calibration factor.
CURR FS	Full scale current measurement calibration factor.
CURR 0	Zero offset current measurement calibration factor.
CURR FS HT	Temperature compensated full scale current measurement calibration factor.
CURR 0 HT	Temperature compensated zero offset current measurement calibration factor.

#### 4.2.14 OUTPUT CAL FACTORS Menu

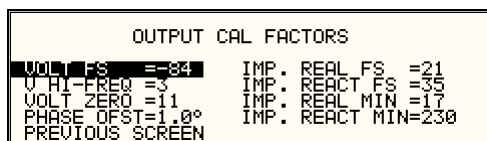


Figure 4-27: OUTPUT CAL FACTORS menu

The OUTPUT CAL FACTORS menu provides access to the output calibration parameters. These parameters are password protected and can only be changed after the calibration password has been entered. For three phase configurations, the PHASE keys toggle between the three calibration screens for each phase. Refer to the calibration section in this manual for details on performing a calibration.

The following calibration factors are available from this menu:

Entry	Description
VOLT FS	Full scale voltage output calibration factor.
V HI-FREQ	High frequency full scale voltage output calibration factor.
VOLT ZERO	Zero offset voltage calibration factor.
PHASE OFST	Phase offset calibration factor. Compensates for phase shift caused by AC amplifier.
IMP. REAL FS	Full scale resistive output impedance calibration factor.
IMP. REACT FS	Full scale inductive output impedance calibration factor.
IMP. REAL MIN	Minimum resistive AC source output impedance. The AC source has an output impedance greater than zero. This value determines the minimum resistive component of the AC source output impedance.
IMP. REACT MIN	Minimum reactive AC source output impedance. The AC source has an output impedance greater than zero. This value determines the minimum inductive component of the AC source output impedance.

## 4.3 Output Programming

### 4.3.1 Set the Output

Output parameters are all set from the PROGRAM screen.

1. Use the MENU key and select the PROGRAM entry.
2. Press the ENTER key to bring up the PROGRAM menu.

or

2. Use the PROG key to directly bring up the PROGRAM menu.

There are two methods for programming output parameters:

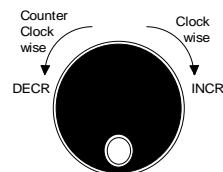
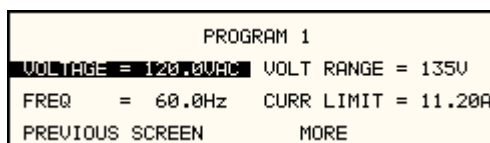
IMMEDIATE mode

SET mode

### 4.3.2 Slewing Output Values with the Knob in IMMEDIATE Mode

The default mode of operation is an immediate mode in which changes to output parameters made with the knob or the entry keypad are immediately reflected at the output.

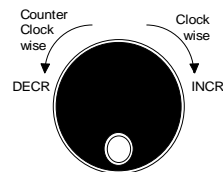
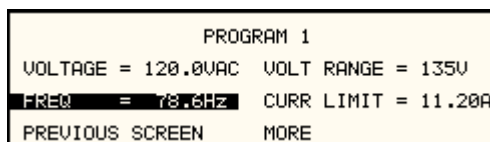
To change the output voltage:



1. Place the cursor on the VOLTAGE entry
2. Rotate the knob clockwise to increase the value, counterclockwise to decrease the value

These changes take effect immediately.

To change the output frequency:



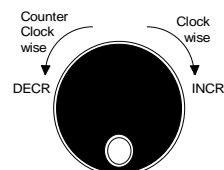
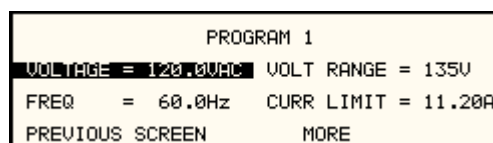
1. Place the cursor on the FREQ entry
2. Rotate the knob clockwise to increase the value, counterclockwise to decrease the value

These changes take effect immediately.

### 4.3.3 Change Output Values with the Knob in SET Mode

The SET mode of operation is a mode in which changes to output parameters made with the knob or the entry keypad do not affect the output until the ENTER key is pressed. The AC source is put in this SET mode by pressing the SET key.

To change the output voltage:



1. Press the SET key
2. Place the cursor on the VOLTAGE entry
3. Rotate the knob clockwise to increase the value, counterclockwise to decrease the value
4. The VOLTAGE field will be blinking to indicate a change in settings but the output remains unchanged.
5. Place the cursor on the FREQ entry
6. Rotate the knob clockwise to increase the value, counterclockwise to decrease the value
7. The FREQ field will be blinking to indicate a change in settings but the output remains unchanged.
8. Press the ENTER key.

Both new voltage and frequency output values are now present at the output. The unit has returned to immediate mode of operation until the SET key is pressed again.

## 4.4 Waveform Management *[iX Series only]*

The iX Series employs independent arbitrary waveform generators for each phase. This allows the user to create custom waveforms. In addition, the iX offers three standard waveforms that are always available. This chapter covers issues that relate to defining, downloading and managing custom waveforms.

### 4.4.1 Standard Waveforms

For many AC applications, a sinewave shape is used. The sinewave is one of the standard waveforms provided on the iX Series. The standard sinewave is always available and is the default waveform at power-on. In addition to the sinewave, two more standard waveforms are available, square and clipped.

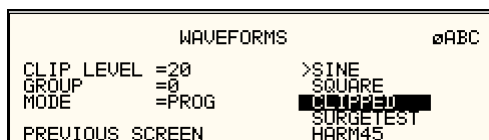


Figure 4-28: Selecting a waveform

The square wave provides a high frequency content waveform with relative fast rise and fall times. Due to AC amplifier bandwidth limitations, the frequency content of the standard square wave has been kept within the amplifier's capabilities. As the fundamental frequency is increased, the relative contribution of higher harmonics is reduced.

The clipped sinewave may be used to simulate voltage distortion levels to the unit under test. The total harmonic distortion level may be programmed in percent using the CLIP LEVEL field of the WAVEFORMS menu. Changing the distortion level of the CLIP waveform forces the AC source to regenerate the CLIPPED sinewave's datapoints and reload the waveform register with the newly requested data. This process requires the output to be dropped briefly. To avoid interrupting the voltage output to the unit under test, select a different waveform such as the standard sinewave first, change the clip level and change the waveform back to the CLIPPED sinewave. This will avoid any output interruption.

4.4.2 Phase Selection

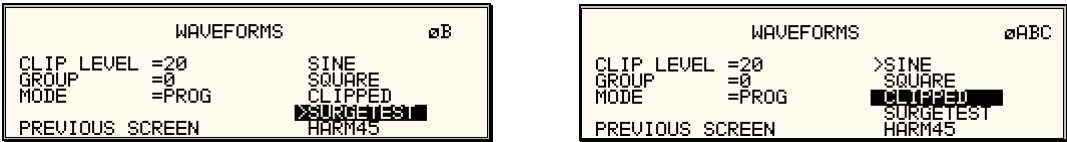


Figure 4-29: Selecting waveforms for single phase or all phases

If the 9003iX or 15003iX, different waveforms may be selected for each phase. The number of custom waveforms from which to select remains 50 but each phase can be assigned a different custom or standard waveform. The specific output phase for which the waveshape is programmed is selected with the PHASE key on the front panel. The selected phase is always shown in the top right hand corner of the WAVEFORMS display.

To select the same wave shape for all three phases in a three phase configuration, press the PHASE key until the øABC annunciator appears in the top right corner of the WAVEFORMS menu. Waveform selections made in this mode will apply to all three phases.

4.4.3 Creating Custom Waveforms

The iX Series provides four groups of 50 custom defined waveforms each for a total of 200 waveforms in addition to the 3 standard waveforms. Of these four groups, one may be active at a time. The active group is selected in the INITIAL SETUP menu.

Custom waveforms cannot be created from the front panel of the iX Series. Rather, they have to be downloaded through the IEEE-488 or RS232C interface. A Windows based program is included with the iX Series that allows waveforms to be created and downloaded easily. This Graphical User Interface program allows waveforms to be created by specifying harmonic amplitudes and phase angles with respect to the fundamental. It also offers an arbitrary waveform data entry mode that allows individual data points to be specified.

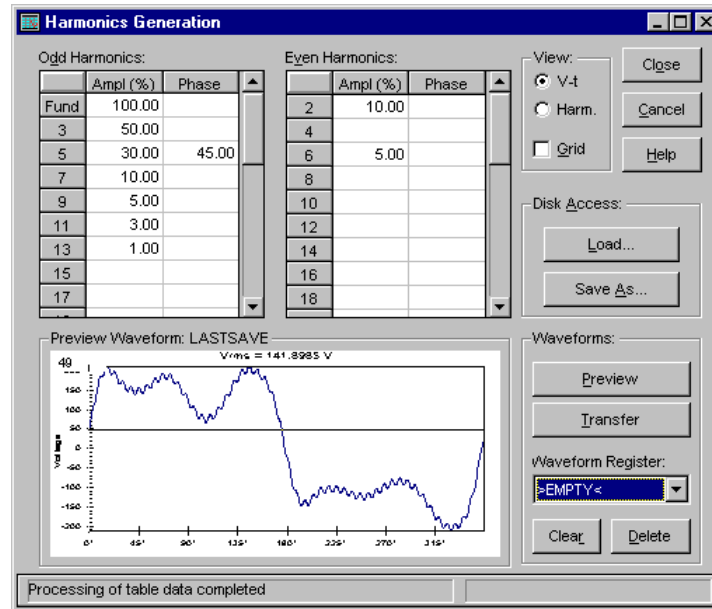


Figure 4-30: Custom waveform creation with GUI program

Once downloaded, waveforms remain in non-volatile memory and will be visible in the WAVEFORMS menu for selection. The user can assign a 12-character name to each custom waveform. Avoid using any of the standard waveform names (SINE, SQUARE or CLIPPED) as these names will not be accepted.

Waveforms may be deleted using the IEEE-488 or RS232C interface as well. Custom waveforms cannot be deleted from the front panel however to avoid accidental erasure.

#### 4.4.4 Waveform Groups

Waveform groups extend the number of available custom waveform to 200. Each group can contain up to 50 user defined waveforms. Groups are numbered 0 through 3 and may be selected from the INITIAL SETUP 3 menu. To switch waveform groups, proceed as follows:

1. Press the MENU key three times to select the MENU 3 screen.
2. Move the cursor to the UTILITY entry and press ENTER. You are now in the UTILITY 1 menu.
3. Move the cursor to the INITIAL SETUP field and press ENTER. You are now in the INITIAL SETUP 1 menu.
4. Move the cursor to the MORE field at the end of this menu and press the ENTER key. You are now in the INITIAL SETUP 2 menu.
5. Move the cursor to the MORE field at the end of this menu and press the ENTER key. You are now in the INITIAL SETUP 3 menu.
6. Move the cursor to the WAVE GROUP = field. You can now use the knob or the 0 through 3 key on the front panel to select a different waveform group.
7. Press ENTER to confirm your new selection.
8. To activate your new selection, YOU MUST CYCLE THE POWER so the AC source re-initializes. If the source is operated over the bus, a IEEE-488 Device Clear or reset command (\*RST) command will have the same effect.

The new wave group will be active after you turn the power to the unit back on.

#### 4.4.5 RMS Amplitude Restrictions

The output of a sinewave may be programmed to the full rms value of the voltage range selected. If the AC source is in the 300 V range, the maximum programmable rms voltage is 300 Volt. If a custom waveform is used however, the maximum programmable rms voltage may be less than the maximum range value. The voltage range limit is based on the use of a sinewave with a 1.414 crest factor. A 300 V rms sinewave has a 424 Volt peak voltage. The AC source has a maximum peak voltage capability that is determined by the selected voltage range. If the user selects a custom waveform with a crest factor that is higher than 1.414, the peak voltage would exceed this maximum if the rms voltage were to be programmed at 300 V rms.

The iX Series automatically limits the maximum allowable programmed rms voltage of a any custom waveform by calculating the crest factor of the selected waveform and controlling the rms limit accordingly. Thus, each custom waveform may have a different maximum rms value. The iX controller will prevent the user from programming the rms voltage above this limit. If a value is entered in the PROGRAM 1 menu above this value, a “Voltage peak error” message is generated.

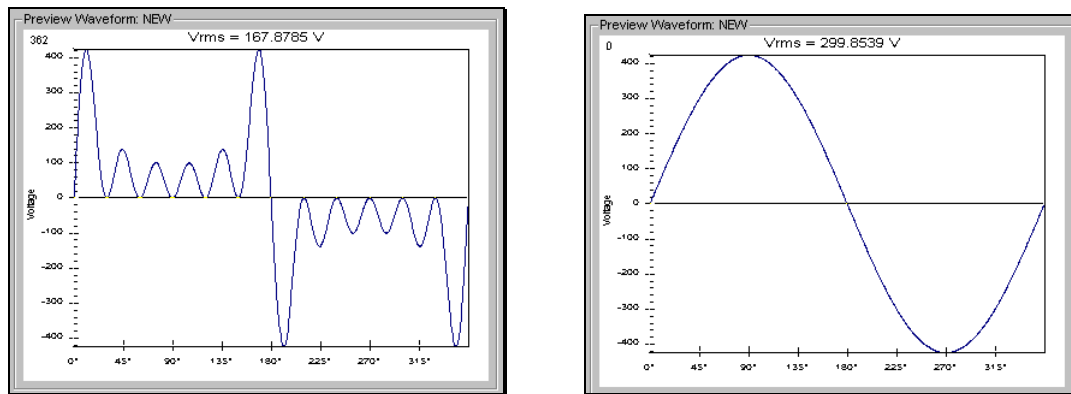


Figure 4-31: Waveform crest factor affects max. rms voltage

The figure shown here illustrates the relationship between the crest factor of the waveshape (or its “peakiness”) and the maximum peak voltage allowed for a given voltage range. Since the peak voltage cannot exceed the AC source’s capabilities, the programmable rms voltage has to be restricted, in this case to only 167.8785 volt for the waveform on the left. The sinewave on the right can be programmed to the full 300 V rms as this still falls within the same peak voltage limitation of the AC source.

If the iX Series is used through the bus, the :VOLT? MAX query can be used to determine the maximum allowable rms voltage for the selected waveform. Using the returned value as part of a program will prevent range errors.

#### 4.4.6 Frequency Response Restrictions

The user may create a waveform that contains any number of harmonic frequencies of the fundamental. The AC Source itself however has a finite signal bandwidth and will attenuate higher frequency components of the signal. To limit the maximum frequency component of the output signal, the iX controller automatically applies a band-pass filter to all custom waveforms as they are downloaded. This will limit the signal bandwidth to no more than 50 times the fundamental frequency. Consequently, very fast transients embedded in the user provided waveform data points may be modified as part of the download process. The frequency domain VIEW mode in the WAVEFORMS menu may be used to visualize the content of each custom waveform register on the LCD.

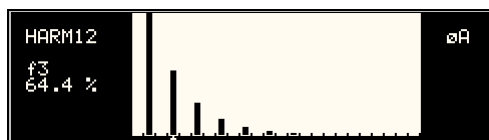


Figure 4-32: Waveform frequency domain view mode

---

#### 4.4.7 Switching Waveforms

Waveforms can be switched as part of the transient system. Each transient type setup menu has a FUNCTION field. This field allows selection of any of the standard or custom waveforms available in the selected group. Refer to the section on transients for more details on using transient list to switch output waveforms.



## 4.5 Standard Measurements

Standard measurements are always available through the MEAS key on the front panel. These measurements are spread across two to four screens to enhance readability. Switching between these screens can be done by successively pressing the MEAS button on the front panel. This will cause the screen to cycle through all available measurement screens.

### 4.5.1 i Series Measurements

For i Series units, the following two measurement screens are available:

Mode	AC	DC	
MEASUREMENTS 1			
VOLTAGE	AC rms voltage	DC Voltage	
CURRENT	AC rms current	DC Current	
FREQUENCY	Frequency	n/a	
POWER	Real power	power	
MEASUREMENTS 2			
VA POWER	Apparent power	power	
PEAK CURR	Highest AC current found	Highest DC current found	
POWER FACT	Power factor	n/a	
CREST FACT	Crest factor	n/a	

### 4.5.2 iX Series Measurements

For iX Series, the following four measurement screens are available:

Mode	AC	DC	AC+DC
MEASUREMENTS 1			
VOLTAGE	AC rms voltage	DC Voltage	AC rms voltage
CURRENT	AC rms current	DC Current	AC rms current
FREQUENCY	Frequency	n/a	Frequency
POWER	Real power	n/a	n/a
MEASUREMENTS 2			
VA POWER	Apparent power	power	Apparent power
PEAK CURR	Highest AC current found	Highest DC current found	Highest AC current found
POWER FACT	Power factor	n/a	Power factor
CREST FACT	Crest factor	n/a	Crest factor
MEASUREMENTS 3			
VOLT THD	Voltage distortion	n/a	Voltage distortion
CURR THD	Current distortion	n/a	Current distortion
INST PK CURR	Instantaneous peak current	Highest DC current found	Instantaneous peak current
PHASE	Phase angle	n/a	Phase angle

The iX Series has a fourth measurement screen for harmonics and trace analysis measurements. This subject is covered in the next chapter.

Measurements are always running in the background. When the user selects a measurement screen for display, the AC source first updates all the measurement parameters before displaying the requested screen. This process may take up to a second. Consequently, pressing

the MEAS key may not always bring up the selected screen immediately. There will be a perceptible delay. This will prevent the screen from appearing with invalid or blank readouts.

The measurement method for voltage and current will depend on the power source operating mode. The following table shows the return value type (rms or average) and method of coupling when the measurement command is initiated with a different extension at various operating modes (AC, DC or AC + DC).

Measurement Extension and Coupling	Operating Mode		
	AC	DC	AC + DC
AC	rms	rms	rms
DC	rms	rms	average
Coupling	AC	DC	DC

---

#### 4.5.3 Accuracy Considerations

---

Any measurement system has a finite accuracy specification. Measurement specifications are listed in Section 2. When using the AC source for measurement purposes, always consider these specifications when interpreting results. Measurement inaccuracies become more pronounced as the signal being measured is at the low end of the measurement range. This is particularly relevant for low current measurements. The i and iX Series are high power AC sources optimized for providing and measuring high load currents. When powering low power loads, measurement inaccuracies on rms and peak current measurements will greatly affect derived measurements such as power, power factor and crest factor.

The measurement system on the i and iX Series uses a data acquisition system with a 20 kHz bandwidth. This means that high frequency components of the measured signal are filtered out. Any contribution to the rms value of voltage and current above this cutoff frequency will not be reflected in the i and iX Series measurements. When using an external measurement reference, this may account for discrepancies in readings.

## 4.6 Advanced Measurements *[iX Series only]*

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The iX Series offers advanced power analyzer measurement capabilities. These functions may be accessed from the MEAS button or the MENU 2 screen. The phase for which the analysis or waveform acquisition is done may be selected using the PHASE key in three phase configurations. This chapter covers the use and application of these advanced measurement functions.

### 4.6.1 Harmonic Analysis

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The iX power analyzer performs fast fourrier transformation on both voltage and current on each available phase. The resulting frequency spectrum can be displayed on the LCD display in a tabular as well as a graphical mode.

#### 4.6.1.1 Acquiring FFT data

---

To perform an FFT analysis on the output of the AC source, proceed as follows:

1. Press the MEAS button four times or until the HARMONICS/TRACE ANALYSIS screen appears.
2. Move the cursor to the FUNCTION field and select VOLT or CURR. (The BOTH selection will default to CURR as only one FFT result can be displayed at a time.)
3. Move the cursor to the VIEW field and select the TABLE or BAR display mode. The TRACE display mode does not apply to FFT results.
4. Move the cursor to the DATA MODE field and select ABS or REL. Absolute display mode will show all harmonic components in volts or amps. Relative display mode will use the fundamental as a 100 % reference and display all harmonics as a percentage of the fundamental. Phase angles are always shown with respect to the fundamental frequency. The phase angle of the fundamental is always shown with respect to phase A.
5. Skip the SCALE field as it only applies to the TRACE display mode.
6. Move the cursor to the TRIG MODE and select SINGLE or CONT. The SINGLE mode will acquire the data once and show the result. If you select CONT, the data will be updated continuously.
7. Move the cursor to the TRIG SOURCE field and select IMM. We will cover additional trigger modes later.
8. Move the cursor to the START field and press the ENTER key. The display that you selected will be shown. If you are in CONT trigger mode, the data will be updated about once per second.

You can return to the HARMONICS/TRACE ANALYSIS screen by pressing the ENTER key. To display the data in a different format, change to the selections you want and move the cursor to the VIEW field. Pressing the ENTER key will re-display the data without triggering a new acquisition. (This is true even if you were in CONT trigger mode.) To start a new acquisition, you must go through the START field instead.

#### 4.6.1.2 Analyzing FFT data

The data displays available for FFT data allow you to scroll through the entire data set. For table displays, the UP and DOWN arrow keys may be used to scroll through the table data vertically. The knob has no function while in this display mode. The triangle on the left edge of the LCD screen points to the current position in the table.

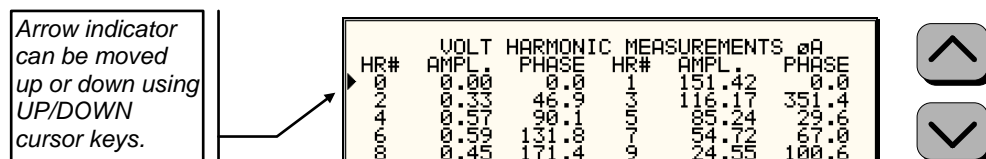


Figure 4-33: Scrolling through tabular FFT data

Bar chart format FFT data displays show the same data in a graphical format. While the amplitude information is shown graphically, phase data is only displayed in numeric form to the left for the currently selected component. The display can show up to 24 components at a time. The triangle at the bottom of the display shows the currently selected component for which numeric data is shown on the left. This data includes the harmonic number (DC through 50), the absolute or relative amplitude (depending on selected VIEW mode) and the phase angle with respect to the fundamental. The knob can be used to scroll through the display horizontally. The UP and DOWN cursor keys have no effect in this display mode.

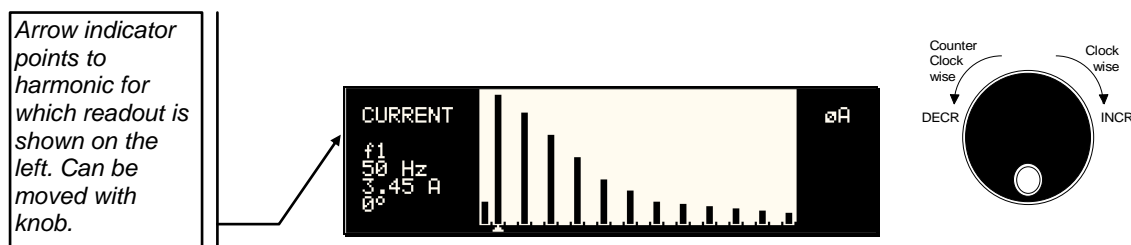


Figure 4-34: Scrolling through bar chart FFT data

## **4.6.2 Waveform Acquisition**

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The waveform acquisition mode allows voltage and/or current data waveforms to be captured and displayed. This mode is selected by choosing the VIEW =TRACE mode in the HARMONICS/TRACE ANALYSIS screen. Voltage and current may be viewed separately or combined into a single display using the FUNCTION field.

### **4.6.2.1 Acquiring waveform data**

---

To perform a waveform acquisition on the output of the AC source, proceed as follows:

1. Press the MEAS button four times or until the HARMONICS/TRACE ANALYSIS screen appears.
2. Move the cursor to the FUNCTION field and select VOLT, CURR or BOTH.
3. Move the cursor to the VIEW field and select the TRACE display mode.
4. Skip the DATA MODE field as it only applies to the TABLE and BAR display modes.
5. Move the cursor to the SCALE field and select a horizontal time base value to allow you to see at least one cycle of the output waveform. If the output is programmed at 50 Hz, a 20 ms scale would display exactly one signal period.
6. Move the cursor to the TRIG MODE and select SINGLE or CONT. The SINGLE mode will acquire the data once and show the result. If you select CONT, the data will be updated continuously.
7. Move the cursor to the TRIG SOURCE field and select IMM. We will cover additional trigger modes later.
8. Move the cursor to the START field and press the ENTER key. The display that you selected will be shown. If you are in CONT trigger mode, the data will be updated about once per second.

You can return to the HARMONICS/TRACE ANALYSIS screen by pressing the ENTER key. To display the data in a different format or to select voltage instead of current or current instead of voltage, change to the selections you want and move the cursor to the VIEW field. Pressing the ENTER key will re-display the data without triggering a new acquisition. (This is true even if you were in CONT trigger mode.) To start a new acquisition, you must go through the START field instead.

#### 4.6.2.2 Analyzing waveform data

The data displays available for acquired waveform data allow you to scroll through the entire acquisition buffer. For waveform displays, the knob can be used to scroll through the display horizontally. The UP and DOWN cursor keys have no effect in this display mode.

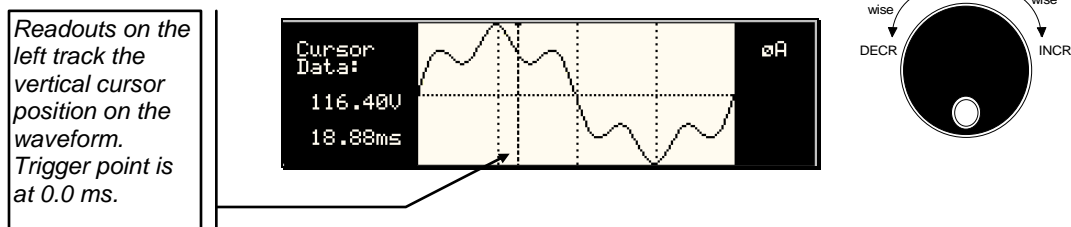


Figure 4-35: Scrolling through acquired waveform data

The acquisition buffer may be longer than the selected horizontal scale in which case only a portion of the acquisition window will be visible. The left portion of the LCD display is used to read out the data under the vertical cursor. This cursor is a dotted line that can be moved using the knob. If the left or right edge of the display window is reached, the entire display will shift so the cursor always remains visible. The time from the trigger point to the vertical cursor is displayed in the left hand portion of the LCD in ms. Also displayed here are the absolute voltage and/or current value under the cursor.

To change the horizontal display scale without re-triggering an acquisition, press the ENTER key to return to the HARMONICS/TRACE ANALYSIS screen, change the SCALE value, move the cursor to the VIEW field and press ENTER. This will display the same data set at the new scale without triggering a new acquisition.

### 4.6.3 Triggering Measurements

---

Both FFT results and waveform acquisitions may have to be positioned at a specific moment in time. To allow the data acquisition to coincide with user specified events, the measurement system can be triggered in different ways. Trigger modes are available from both the bus and the front panel. If the IEEE-488 or RS232C bus is used, acquisitions may also be triggered from the transient list system. Refer to the programming manual for details on this mode of operation.

#### 4.6.3.1 Trigger mode

---

The following trigger modes are supported by the iX Series:

Single (SINGLE)	<p>This mode causes the acquisition system to be armed only once. The iX source waits for the user to press the ENTER key while on the START field. As soon as the trigger event specified occurs, data is acquired and the acquisition system is put in an idle state. A new user initiated START event must be given to trigger a new acquisition.</p> <p>This mode is appropriate for capturing events that occur only once such as the inrush current when turning on a load.</p>
Continuous (CONT)	<p>This mode causes the trigger system to re-arm itself after each trigger event. Every time a new trigger event occurs, new data is acquired and the LCD display is updated. No user intervention is required after the initial START event.</p> <p>This mode is appropriate for capturing repetitive events or to monitor the source output continuously. Display updates will occur about once per second.</p>

#### 4.6.3.2 Trigger source

---

The iX Series offers a choice of trigger sources in front panel operation mode. The following trigger sources are available from the HARMONICS/TRACE ANALYSIS, TRIG SOURCE field:

Immediate (IMM)	<p>This mode causes a trigger to occur as soon as the ENTER key is pressed with the cursor on the START field. No trigger source needs to be specified for this trigger mode. This mode is equivalent to the INIT:IMM:ACQ bus command.</p> <p>This trigger source is appropriate if no trigger condition is known or desired. When using this trigger source, the acquisition is always triggered.</p>
Phase (PHASE A)	<p>This mode causes the iX acquisition system to wait for a specified phase angle on the phase A voltage output. This allows the acquisition to be positioned in time with respect to any phase angle on phase A, B or C. Note that phase A, B and C are typically at 0°, 240° and 120° with respect to the specified trigger phase in this field. An example of this trigger source mode is shown in Figure 4-37.</p> <p>When selecting this trigger source, the field below the TRIG SOURCE field changed to "TRIG PHASE =". Use this field to enter the desired voltage phase angle to trigger the measurement on.</p>

This mode is appropriate when capturing analyzing events at a specific phase angle such as the zero crossing of the voltage. Note that the phase angle of the current with respect to the voltage is determined by the load, so triggering at a specific phase current angle is not possible as it is not controlled by the AC source. However, when capturing current waveform data, the phase relationship to the voltage can be determined easily by triggering at the 0° point on the voltage.

#### Voltage step (SET VOLT)

This mode performs two functions. It programs the output voltage for the selected phase or phases to the rms or DC value specified and it triggers the measurement acquisition at the same moment in time.

When selecting this trigger source, the field below the TRIG SOURCE field changed to "SET VOLT =". Use this field to enter the desired voltage to program the output to and trigger the measurement on. If only one phase in a three phase system is selected, only that phase's output will be programmed. If all phases are selected, all three phases' outputs will be programmed. Use the PHASE key to select the desired phase or all phases. Figure 4-36 shows an example of using the SET VOLT trigger source to capture the turn-on of the voltage. In this case, a negative trigger delay was specified and the voltage start phase angle was set to 90° in the PROGRAM 2 screen.

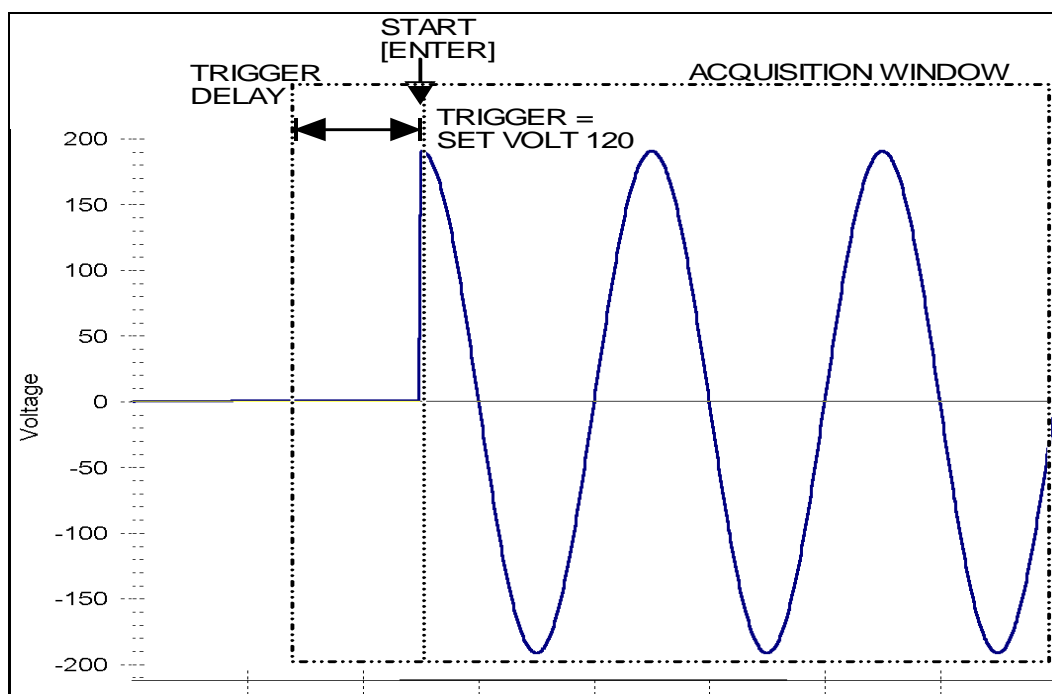


Figure 4-36: SET VOLT trigger source acquisition



This mode is appropriate for capturing the inrush current of a load by programming the voltage to a specified value and capturing the voltage and current at that moment in time. A further refinement can be made by specifying the voltage start phase angle in the PROGRAM 2 screen. If this field is changed from RANDOM to 90°, the inrush current can be captured under worst case conditions. In this case, the voltage should be programmed to 0 volt before triggering the acquisition using the START field.

---

**Note:** *When using the SET VOLT trigger source, the output relay **MUST** be closed to generate a trigger. If the output is open, the acquisition will be armed when the START [ENTER] key is pressed but will wait for the trigger event. Closing the output relay will generate the trigger event. If the output relay was already closed when the START [ENTER] key is pressed, the trigger will occur immediately.*

---

### 4.6.3.3 Trigger delay

The trigger delay field allows the user to set the amount of pre- or post-trigger data that should be used when positioning the data acquisition window with respect to the trigger moment.

#### POST-TRIGGER DELAY

A positive trigger delay value means the acquisition window is delayed by the amount of time specified. In this case, the actual trigger moment itself is no longer present in the acquisition buffer. This situation is shown in Figure 4-37 where a 20 ms trigger delay is used after triggering on phase A = 180°. The fundamental frequency of the output is 50 Hz. The trigger point is indicated by the dashed line. It occurs on the first 180 degree point that occurs after the user presses the ENTER key while on the START field. Once the trigger occurs, the acquisition holds off the specified 20 ms at which point the data requested is captured. Using a positive trigger delay value always yields post trigger data.

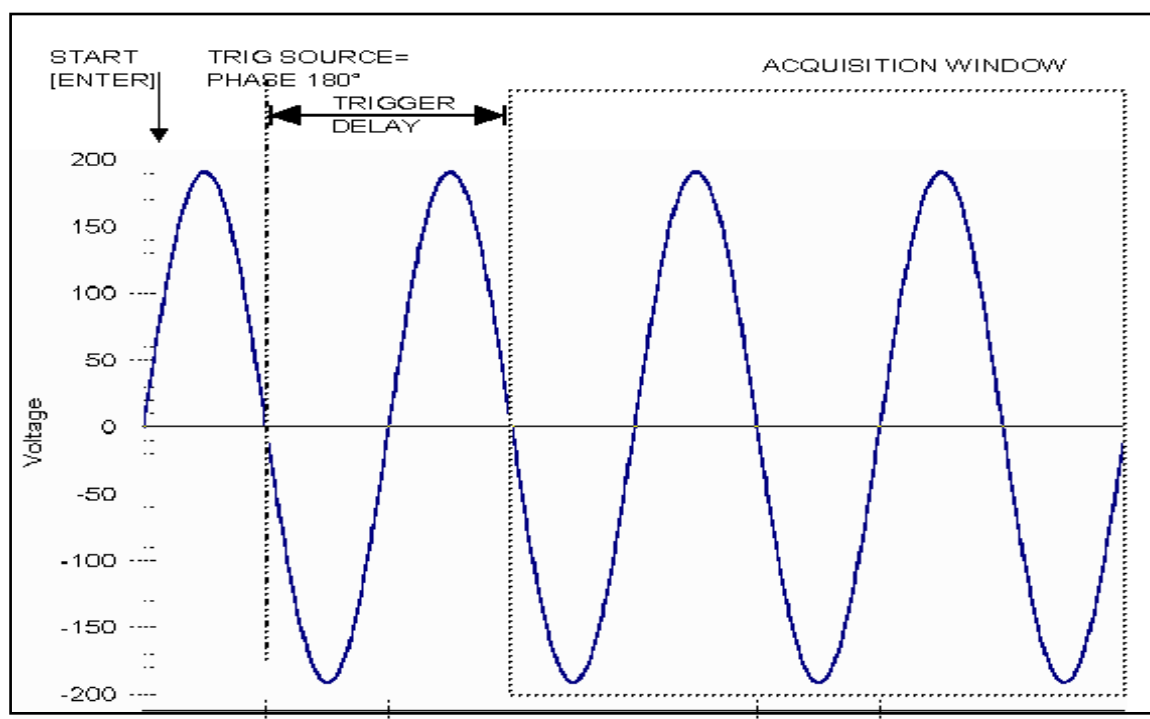


Figure 4-37: Positive trigger delay (Post trigger data)

Positive trigger delay values may be set from 0.0 ms to 1000.0 ms (1 second) in 0.1 ms increments. The value may be entered directly from the keyboard or using the knob.

### PRE TRIGGER DELAY

Alternatively, a negative trigger delay value may be specified up to the maximum time window depth of the acquisition window. (104 ms for single phase configurations, 312 ms for three phase configurations). This situation is shown in Figure 4-38. The example shows a similar scenario as before, only this time the trigger delay was set a -20 ms. Notice that the data acquisition window now contains data that occurred before the user pressed the ENTER key to start the acquisition.

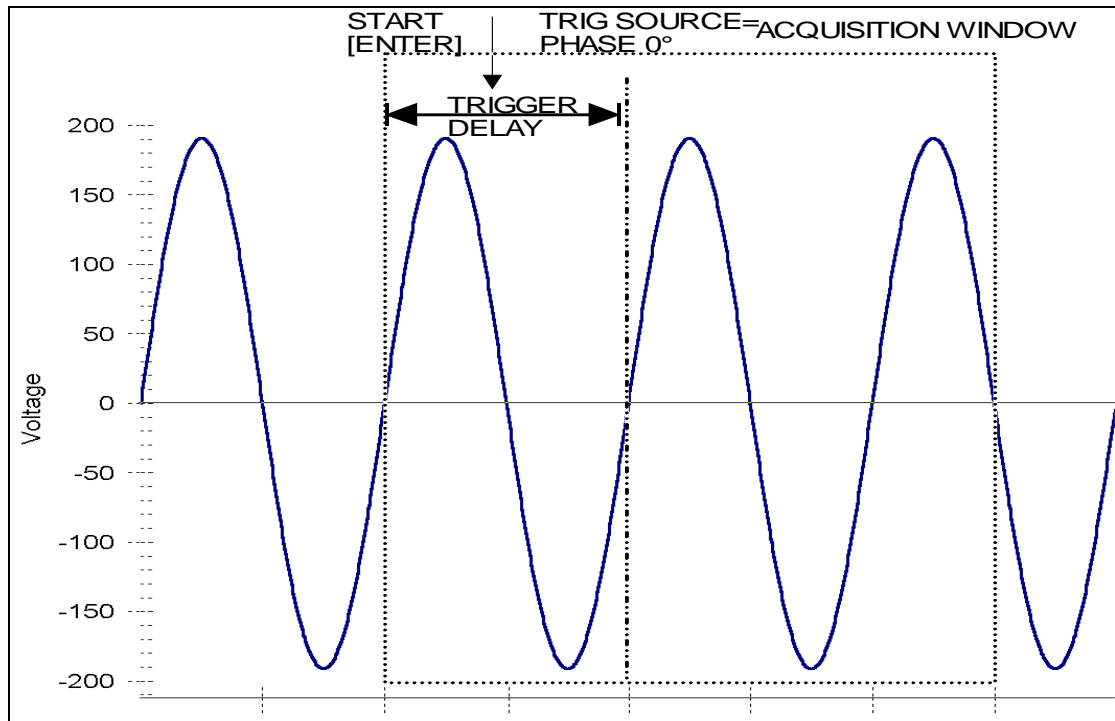


Figure 4-38: Negative trigger delay (Pre-trigger data)

For single phase iX configurations, negative trigger delay values may be set from 0.0 ms to -104.0 ms (1 second) in 0.1 ms increments. For three phase iX configurations, the maximum negative trigger delay value equals -312.0 ms. The value may be entered directly from the keyboard or using the knob.

## 4.7 Transient Programming

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### 4.7.1 Introduction

---

Transient programming provides a precise timing control over output voltage and frequency changes. This mode of operation can be used to test a product for susceptibility to common AC line conditions such as surges, sags, brownouts and spikes. By combining transient programming with custom waveforms [*iX Series only*], virtually any AC condition can be simulated on the output of the AC source.

The default voltage mode is FIXED which means the output voltage is constant and remains at the level set by the user. Changes made to the output voltage made from the PROGRAM 1 menu take effect immediately. In front panel operation mode, the voltage and frequency slew rates (rate of change) are always at their maximum of 1E9 V/s and 1E9 Hz/s. Slew rate programming is only possible over the IEEE-488 or RS232C bus. On power up, the AC source always reverts to the maximum slew rate for both voltage and frequency.

### 4.7.2 Using Transient Modes

---

The voltage can be programmed in the following transient operating modes:

STEP	causes the output to permanently change to its triggered value.
PULSE	causes the output to change to its triggered value for a specific time, as determined by the Pulse menu parameters.
LIST	causes the output to sequence through a number of values, as determined by points entered in the List menu.
FIXED	disables transient operation for the selected function.

### 4.7.3 Step Transients

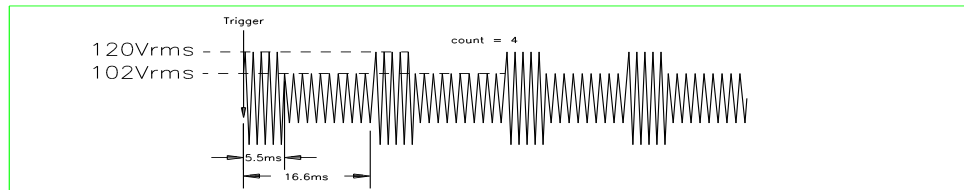
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Step transients let you specify an alternate or triggered voltage level that the AC source will apply to the output when it receives a trigger. Because the default transient voltage level is zero volts, you must first enter a triggered voltage before you can trigger the AC source to change the output amplitude. Step transients can only be programmed through the bus, not the front panel. Refer to the SCPI Programming Manual for more information about programming Step transients and triggers.

#### 4.7.4 Pulse Transients

---

Pulse transients let you program the output to a specified value for a predetermined amount of time. At the end of the Pulse transient, the output voltage returns to its previous value. Parameters required to set up a Pulse transient include the pulse count, pulse period, and pulse duty cycle. An example of a Pulse transient is shown in Figure 4-39. In this case, the count is 4, the pulse period is 16.6 ms or 60 Hz and the duty cycle is 33%.



*Figure 4-39: Pulse Transients*

Note that Pulse transients can only be programmed over the bus, not the front panel. Refer to the SCPI Programming Manual for more information about programming Pulse transients and triggers.

### 4.7.5 List Transients

List transients provide the most versatile means of controlling the output in a specific manner as they allow a series of parameters to be programmed in a timed sequence. The following figure shows a voltage output generated from a list. The output shown represents three different AC voltage pulses (160 volts for 33 milliseconds, 120 volts for 83 milliseconds, and 80 volts for 150 milliseconds) separated by 67 millisecond, zero volt intervals.

Transient list programming is supported from the front panel and may be accessed by selecting the TRANSIENTS entry in the MENU 1 screen. Transient lists can also be programmed over the bus. Refer to the SCPI Programming Manual for more information about programming List transients and triggers over the bus.

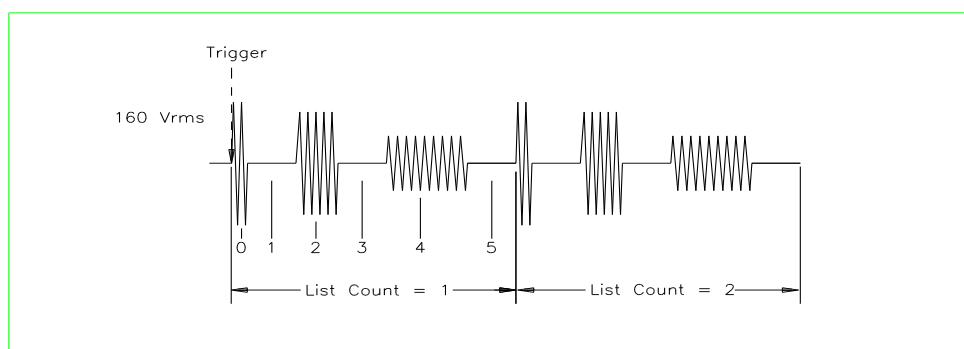


Figure 4-40: List Transients

The list specifies the pulses as three voltage points (point 0, 2, and 4), each with its corresponding dwell point. The intervals are three zero-voltage points (point 1, 3, and 5) of equal intervals. The count parameter causes the list to execute twice when started by a single trigger.

To set up this type of transient list, proceed as follows:

1. Press the PROG key to bring up the PROGRAM 1 menu.
2. Move the cursor to the VOLTAGE field and enter 0 Volt. Press ENTER to confirm your setting.
3. Make sure you are in the HIGH voltage range as we will program a surge to 160 V rms. The low range would only allow 150 V rms.

PROGRAM 1		0ABC
VOLTAGE = 0.0VAC	VOLT RANGE = 300V	
FREQ = 60.0Hz	CURR LIMIT = 11.1A	
PREVIOUS SCREEN	MORE	

4. Press the MENU key to bring up MENU 1.
5. Move the cursor to the TRANSIENTS entry and press the ENTER key. You are now in the TRANSIENTS menu.
6. Move the cursor to the VOLT SURGE/SAG entry and press the ENTER key. You are now in the VOLT SURGE/SAG SETUP menu.
7. If you have a three phase configuration and are in the three phase mode, use the PHASE key to select all three phases. (0ABC will be displayed in the top right corner of the screen.)

8. The START  $\phi$  may be left at RANDOM as we are not interested in starting at a specific phase angle. If a number is already present in this field, use the BACKSPACE (<-) key to clear it.
9. Move the cursor to the GO TO VOLT field and enter 160.0
10. Move the cursor to the DUR SCALE field and set this field to TIME. We will be entering delays in time rather than cycles since this example was stated in ms.
11. Move the cursor to the DURATION field and enter 0.033 seconds. Be sure not to enter 33 as this field is specified in seconds, not milliseconds. The highest time resolution available for list transients is 1 ms or 0.001 s.
12. Move to the END VOLT field and enter 0.0. We want the voltage to return to 0 Volt after the first burst.
13. Move the cursor to the END DELAY field and enter 0.067 for a interval delay of 67 ms. Notice that we effectively combined steps 0 and 1 from Figure 4-40 into a single list event.
14. If you have an iX Series AC source, move down to the FUNCTION field and use the knob to select SINE. The knob will allow you to scroll through all available waveshapes in the active WAVE GROUP. If you have an i Series AC Source, this field will not be visible.
15. Move the cursor to the REPEAT field and enter 0. This means this event will be executed once and not repeated. Do not confuse this event level repeat capability with the entire list level repeat field which we will use later.
16. Move the cursor down to the EVENT # field and enter a number from 1 through 99. The transient list will be executed in order of event number. Leaving a gap between event numbers allows you to insert events at different places later in the sequence. Deleting events is always possible regardless of the event number. For the purpose of this exercise, we will start with EVENT # 5. Enter 5 and press the ENTER key. This brings you back to the TRANSIENTS menu.

```

VOLT SURGE/SAG SETUP      ABC
START  $\phi$  =RANDOM             END VOLT =0.0
GO TO VOLT=160.0           END DELAY =0.067S
DUR SCALE =TIME            FUNCTION =SINE
DURATION =0.033S           REPEAT =0
PREVIOUS SCREEN            EVENT # =5

```

17. Repeat steps 6 through 16 two more times using 120 V, 83 ms and 80 V, 150 ms as values for EVENT # 10 and EVENT #15.
18. Once you have programmed these three events, move the cursor in the TRANSIENTS menu to the START/VIEW SEQUENCE field and press the ENTER key. This will get you to the START/VIEW TRANSIENT SEQUENCE menu from which you can run transient programs. This screen shows all available events in the transient list on the right hand side. If more than five events are programmed, you can scroll through the list using the UP and DOWN arrow keys. To edit an existing event, move the cursor to the relevant event number and press the ENTER key.
19. Move the cursor to the REPEAT #0 field and enter 1. This will cause the transient program to repeat once and thus run two times total. Do not confuse this global list level repeat capability with the list event level repeat field we skipped in step 15.
20. Make sure the output relay is closed using the OUTPUT ON/OFF key. If you start a transient program with the relay open, an error message will appear.
21. Move the cursor to the START field and press the ENTER key. The transient program you just created will execute two times. If you have an oscilloscope connected to the output, you may be able to see the output voltage change per Figure 4-40.

```
START/VIEW TRANSIENT SEQUENCE
STEP #0
PAUSE #0
REPEAT #0
CLEAR SEQ
PREV. SCREEN
#05= VOLTAGE SURG/SAG
#10= VOLTAGE SURG/SAG
#15= VOLTAGE SURG/SAG
```

---

**Note:** *The AC source output remains at the last programmed values at the completion of the list.*

---

In three phase mode, the voltage lists are phase selectable. You can set up a different voltage list for each phase. To do this, use the PHASE key to choose the desired phase, as described in the example. Note that fields common to all phases such as DURATION, END DELAY and REPEAT always apply to all three phases in three phase mode. When the cursor is moved to any of these fields, the phase annunciator in the top right-hand corner always reverts to ØABC. Frequency transients are identical to voltage transients except they apply to all three phases at all times in a three phase configuration.

---

#### 4.7.6 Programming Slew Rates

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As shown in the previous examples there are a number of ways that you can generate custom waveforms. Programmable slew rates provide additional flexibility when customizing waveforms. Slew rates determine how fast the voltage or frequency is changed by the controller when a step, pulse, or list transient is triggered. Slew rates cannot be programmed from the front panel and are always set to their maximum values at power on. To use programmable slew rates, the AC source must be programmed over the bus. Refer to the SCPI Programming Manual for more information about programming slew rates.

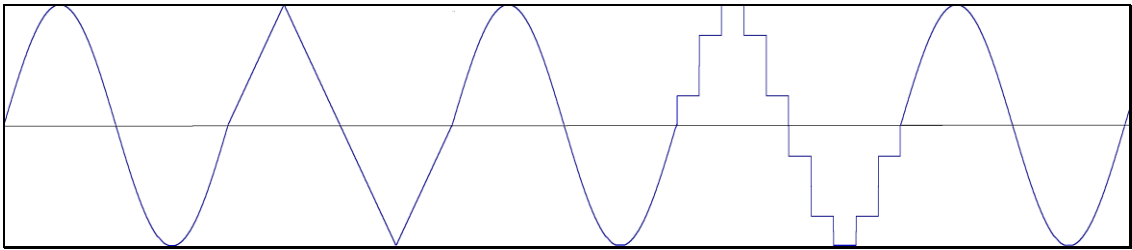


#### 4.7.7 Switching Waveforms

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The FUNCTION field available in each transient list event setup menu may be used to dynamically switch waveforms during transient execution. This allows different waveforms to be used during transient execution. Waveforms may be switched without the output of the source being turned off. For three phase configurations, each phase has its own waveform list so different waveforms may be programmed on different phases during transient execution.

Figure 4-41 illustrates the concept of using different waveforms at different steps in a transient list. In this case, the change was programmed to occur at the zero crossing. Any phase angle can be used to start a transient step however.



*Figure 4-41: Switching waveforms in a transient list*

## 4.7.8 Transient Execution

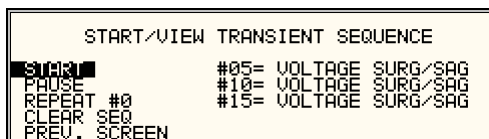


Figure 4-42: START/VIEW TRANSIENT SEQUENCE menu

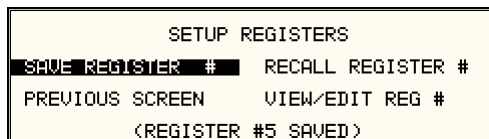
A transient list can be executed from the START/VIEW TRANSIENT SEQUENCE menu. To start a transient list, position the cursor on the START field as shown in Figure 4-42 and press the ENTER key. Transients may be aborted by pressing the ENTER key again while on the same field as the field changes to ABORT while a transient execution is in progress. For short duration transients, this will likely not be visible as the transient will complete before the screen is updated. Longer duration transients however may be aborted in this fashion.

Longer duration transients may also be suspended using the PAUSE field located below the START/ABORT field. Pressing the ENTER key while on the PAUSE field will suspend the transient execution. Once suspended, it can be resumed using the same field as the field changes to RESUME while the transient execution is suspended. Suspending a transient may be useful when running slowly changing output transients to 'hold' the output at a specific setting while observing the effect on the unit under test.

## 4.7.9 Saving Transient List Programs

When the AC source is turned off, the transient list that was programmed is not automatically retained. Thus, if you turn the unit off, you will lose your programmed transient list. However, transient programs may be saved in nonvolatile memory for later recall. This allows multiple transient list programs to be recalled quickly without the need to enter all parameters each time. Transient lists are stored as part of the overall instrument front panel setup in any of the available setup registers.

To save the transient list you created in the previous example, proceed as follows:



1. Press the MENU key two times to bring up the MENU 2 screen.
2. Move the cursor to the SETUP REGISTERS entry and press the ENTER key.
3. The cursor will default to the SAVE REGISTER # position. Enter a number from 0 through 7 and press the ENTER key.
4. A message will appear at the bottom of the screen indicating that the front panel settings and the transient list data have been saved in the setup register you selected.

## 5. Principle of Operation

### 5.1 General

An explanation of the circuits in the 3001iX and 5001iX is given in this section. Refer to Figure 5-1 for a block diagram of the system. Figure 5-2 shows the system interconnect.

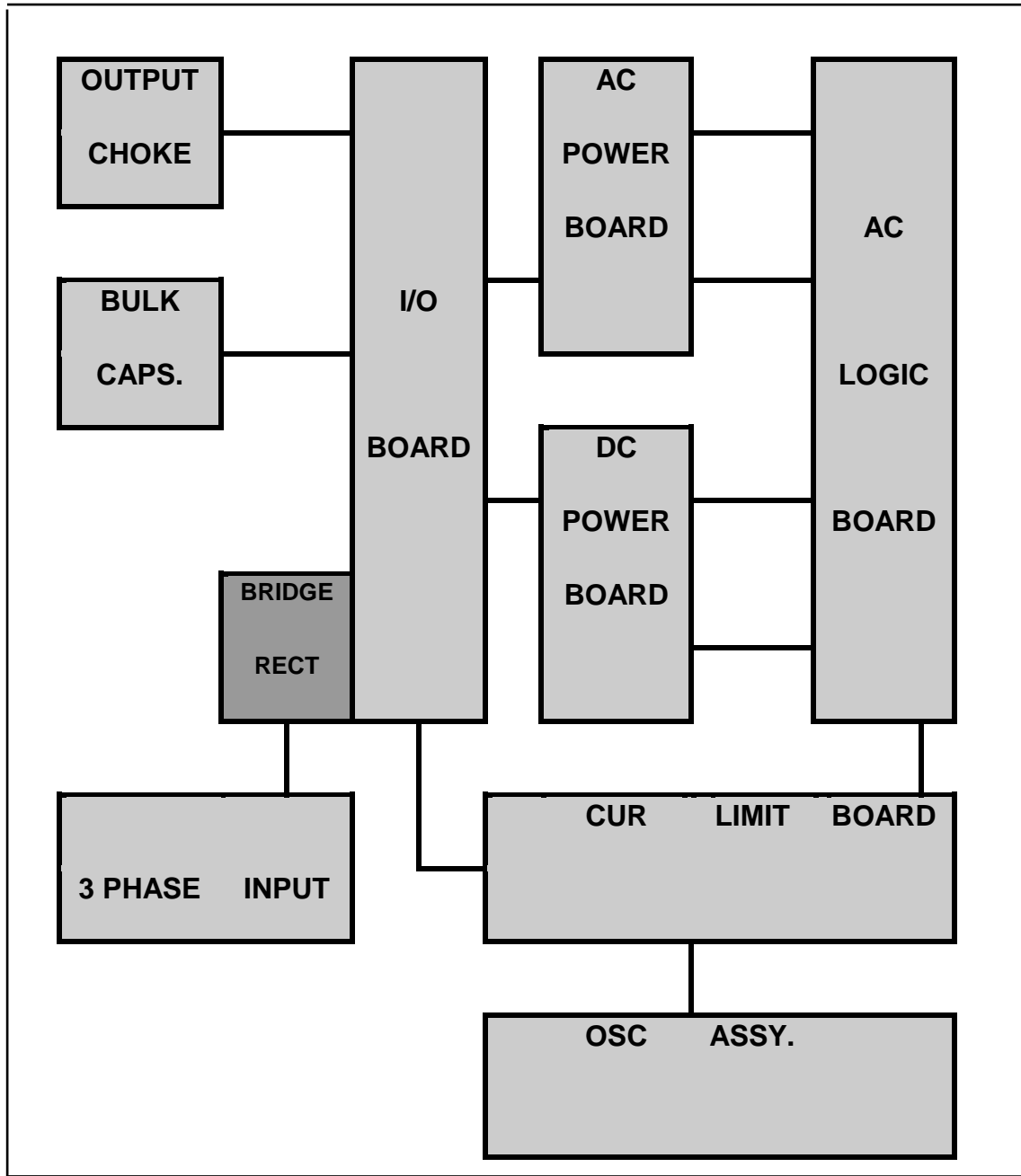


Figure 5-1: AC Power System Block Diagram

## 5.2 Overall Description

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Three or single phase input power is routed in from the back panel through an EMI filter and the circuit breaker to the input bridge rectifier. The DC output from the bridge rectifier is smoothed by a small amount of capacitance in order to keep the input power factor as high as possible. This DC output supplies the converter on the DC power board.

The DC converter turns the unregulated rectified AC into a smoothed, isolated, tightly regulated DC supply. Also mounted on the DC power board is the auxiliary power supply. The auxiliary power supply creates low voltages to operate the control logic board, the oscillator board, the AC power board, and the fan. The output of the DC converter is fed to two large electrolytic capacitors on the I/O board. These capacitors also provide holdover storage energy to ride through line dropouts.

The AC power board takes the DC input and puts out isolated, direct coupled, AC power.

The DC bus is regulated at 250 volts for the 135/150 VAC output and 500 volts for the 270/300 VAC output.

The oscillator assembly generates the reference waveforms and provides frequency, amplitude, and impedance control. The current limit board, in conjunction with the oscillator board, provides the current limit function.

The assemblies are described in more detail in the following paragraphs. Refer to Figure 5-1 for an overall block diagram.

## 5.3 Oscillator Assembly

---

The oscillator assembly consists of three printed circuit board assemblies connected by a ribbon cable. The oscillator generates the sine wave signal setting the frequency, amplitude and current limit level. It also senses the output voltage to provide closed loop control of the output.

### 5.3.1 CPU/Phase A Board

---

This board assembly, A7, consists of the components for the DSP, generating the input signal for the power amplifier, programmable impedance and all of the memory. In addition, the waveform board contains the circuits for all measurements and remote sense. The clock and lock circuit for 3-phase operation is also on this board assembly.

This board has several jumpers that are used to enable various option. Refer to the following table for the options. See Figure 5-2.

	JUMPER ( += in, - = out)						
	W3	W4	W5	W6	W7	W8	W9
<b>Standard, CLK &amp; LK Master</b>	-	+	+	-	+	-	+
<b>CLK &amp; LK Slave</b>	+	-	-	+	-	+	-

### **5.3.2 Keyboard/Display Board**

---

The keyboard/display assembly is assembly A9. It is mounted to the front panel and holds the 23 rubber keys. It also has the LCD graphics display. A shaft encoder is mounted on the board that is used for a shuttle input.

### **5.3.3 Phase B and C Board**

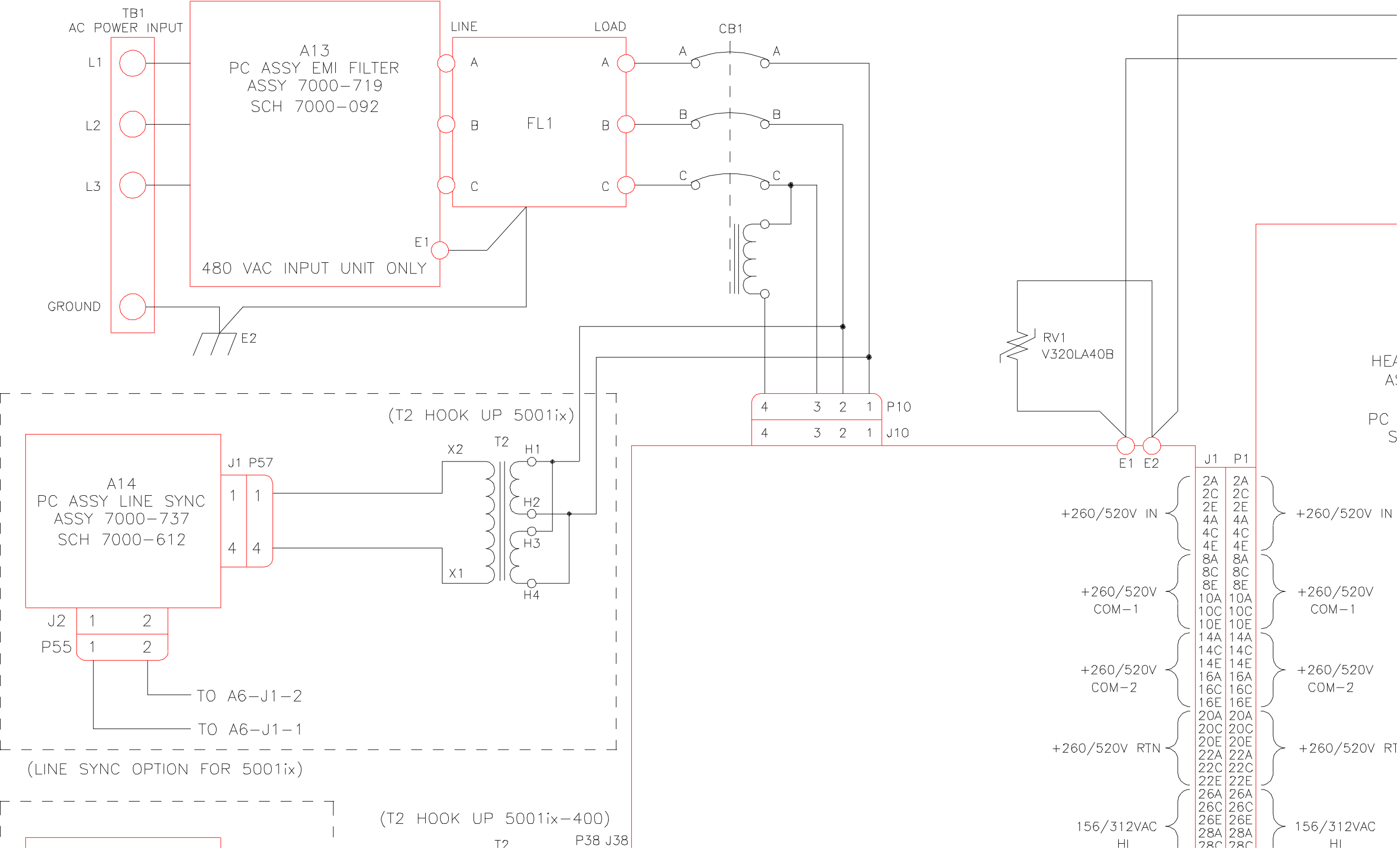
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This assembly, A8, has the waveform, measurement and impedance programming components for the Phase B and C outputs. This board is only installed for a 15003iX power system, with one controller for the Master Phase A power source.

### **5.3.4 GPIB/RS232 Board**

---

This board assembly is identified as A10. It has the IEEE 488 and RS232 transceivers. It also has optocouplers for both interfaces.



## 5.4 Current Limit Board

---

The current limit board, A6, receives the oscillator signal and passes it through an amplifier whose gain is controlled by a signal from the overcurrent circuit. The overcurrent circuit senses the rms value of the current. If the load current exceeds the programmed value the output of this sensing circuit reduces the output of the oscillator amplifier. The output of the unit then becomes a constant current output, with the output voltage dropping as the load increases.

When two or three units are connected as a single phase system the MRA output from the master oscillator amplifier drives all the power amplifiers over the system interface cable.

An overcurrent condition on any amplifier will act to reduce the output voltage and put the entire system into the constant current mode.

## 5.5 Auxiliary Power Supply

---

The auxiliary power supply is mounted on the DC-DC power board. This assembly generates nine low voltage outputs. These outputs from the auxiliary power supply provide logic power to all the modules.

- a) +/- 18V to the AC logic board and the oscillator.
- b) +8V to the oscillator.
- c) + 15V to the DC-DC converter.
- d) Three + 18V supplies to the AC power amplifier gate drives.
- e) +24V for the fan and relay power.
- f) +8V for the digital front panel meter or GPIB/RS232 board.

All the supplies a), b) and e) have a common ground. The supplies in c) and d) are all isolated from each other and from a), b) and e). LED's on the AC logic board and the AC power board are lit when each output is in regulation. If an overload condition causes the output to drop more than 10% or the output has failed, the corresponding LED will extinguish. This feature is helpful in troubleshooting the unit. See Service section 7.

## 5.6 DC-DC Power Converter

---

The DC-DC power converter, A3, is powered from the rectified AC input. The converter is a PWM (pulse width modulated) full bridge type that uses IGBT's as the power switches. The control logic supply for the DC-DC converter is derived from the auxiliary power supply so the DC-DC converter does not start switching until after the auxiliary power supply has started up and comes into regulation. This feature ensures a smooth start up.

The output of the DC converter is automatically selected for 250 VDC or 500 VDC output depending on whether the low range output (135/150 Vac) or high range output (270/300 Vac) is selected. The 250/500 VDC range selection is made by a relay that selects one of two taps on the DC output transformer. The converter is fully protected with input current limit and overvoltage protection. When the output of the DC converter is up and in regulation, the LED on the input/output board will be lit. The LED can only be seen by looking directly down between the large storage capacitors and the input/output board. (See Figure 5-3)

## 5.7 AC Control Logic

---

The main function of the control board, A4, is to generate the gate drive signals for the AC power stage. This board also includes the circuit for the current limit and when two or three units are operated in parallel, the load sharing circuit. (See Figure 5-6)

The signal from the oscillator is fed through a low pass filter circuit and sent to the reference input of the error amplifier. The voltage output of the unit is differentially sensed and fed back to the error amplifier thereby completing the control loop. The output of the error amplifier drives a 37.5 kHz pulse width modulator. The modulator output is sent to four gate drivers which drive the IGBT's on the AC power board after going through opto couplers that provide the necessary isolation.



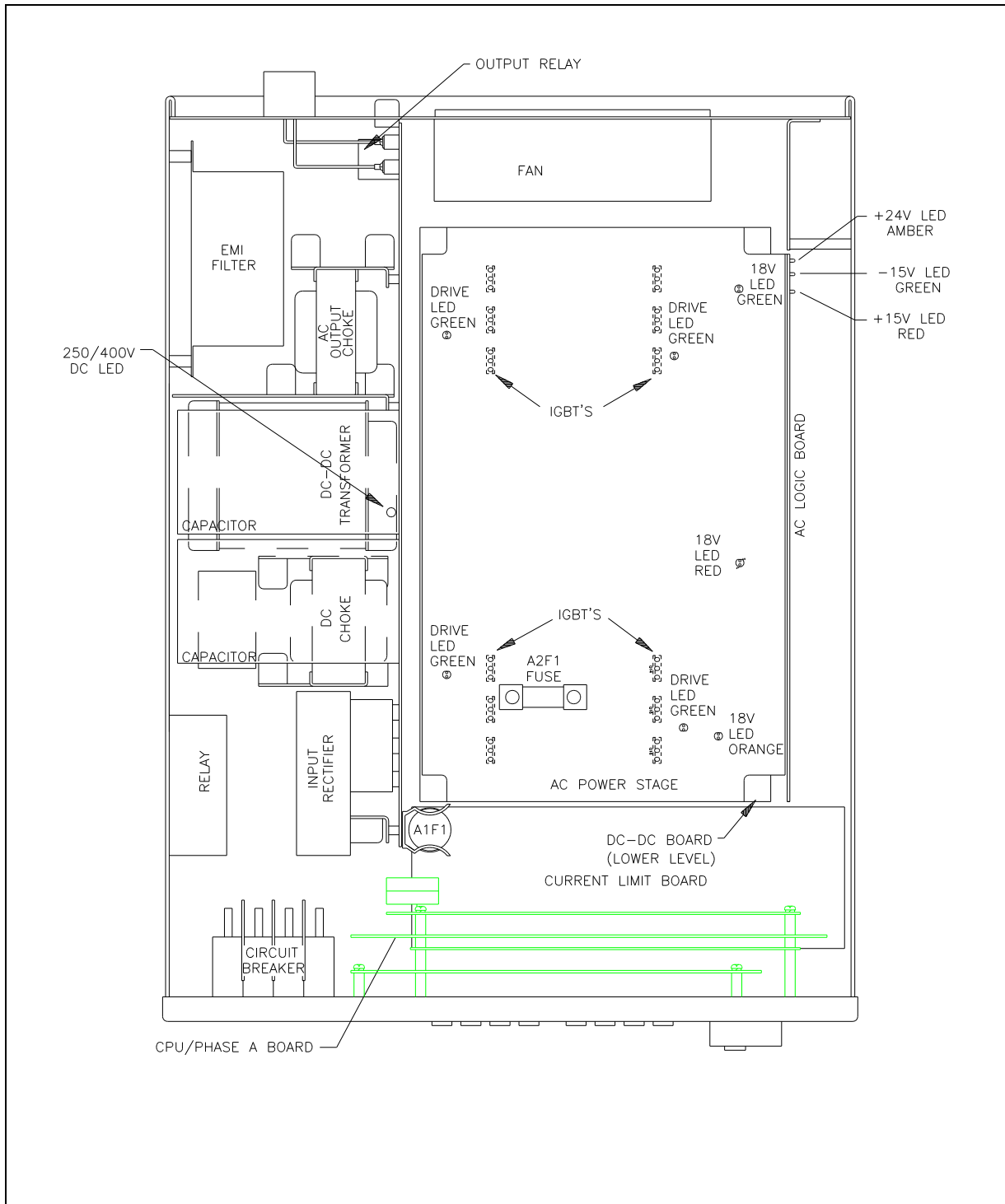


Figure 5-3: 5001i Internal Layout

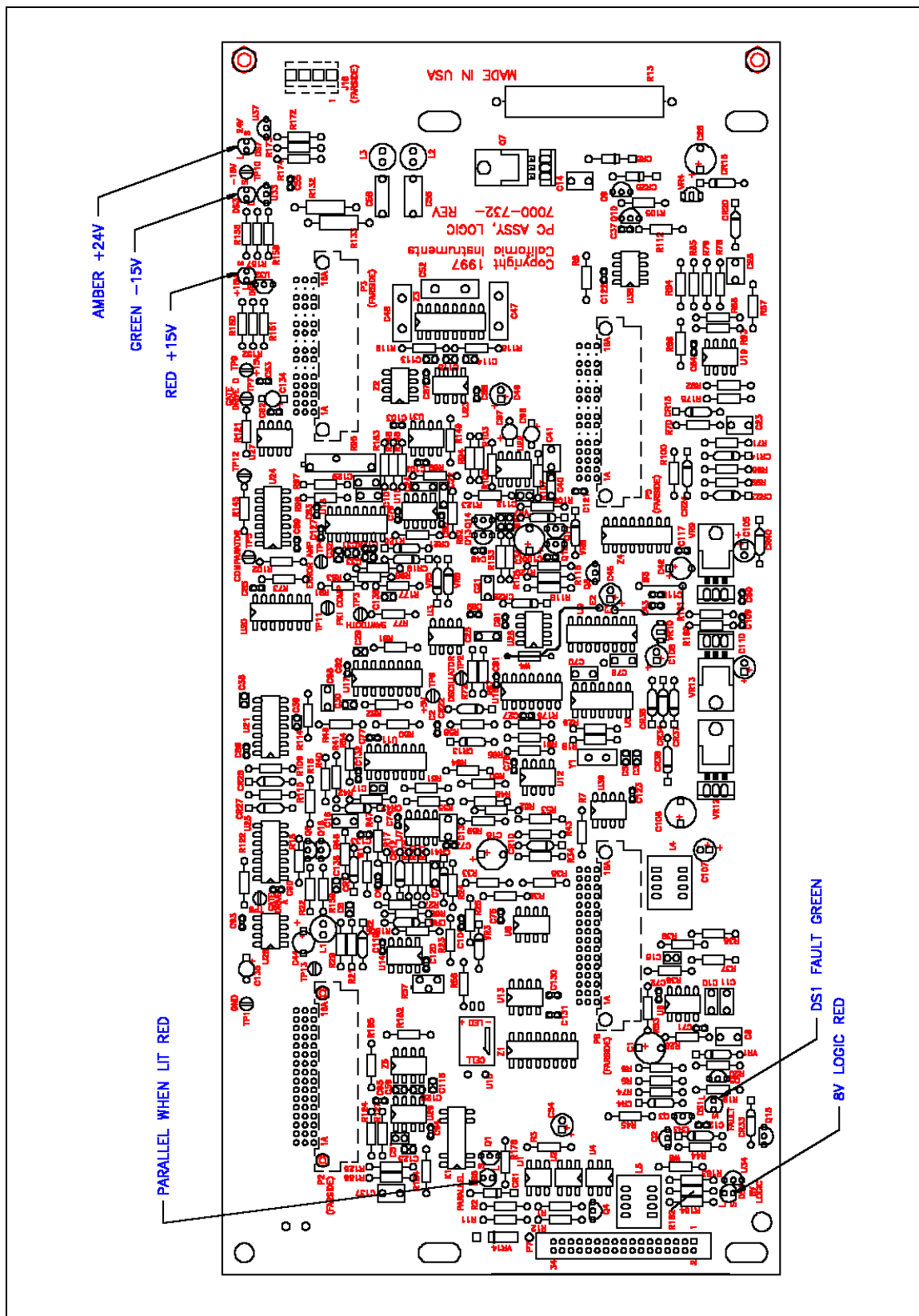


Figure 5-4: Logic Board LED's

There are six LED indicators on the logic board. Their positions are shown in Figure 5-4. The LED functions are listed in Table 5-1.

*Table 5-1: Logic Board LED's*

LED#	FUNCTION	COMMENTS
DS2	+15V	+15V logic supply
DS3	-15V	-15V logic supply
DS4	+8V	+8V oscillator supply
DS7	+24V	+24V supply for relays and logic.
DS5	PARALLEL	LED should be lit when units are paralleled and K1 is closed.
DS1	FAULT	LED is lit - unit normal. No light indicates pwr. stage failed

---

## 5.8 AC Power Board

The AC power assembly takes a 250V/500V DC input and generates a 150V/300V AC direct coupled output. The AC power amplifier is a full bridge inverter with three paralleled IGBT's in each leg for a total of twelve IGBT's. The switching frequency of the bridge is 37.5 kHz and this frequency is smoothed out by two inductors that are mounted behind the input/output board and several smoothing capacitors on the AC power board to provide a precision low frequency (16-500 Hz) output. (See Figure 5-3 and Figure 5-5)

Three isolated 18V supplies provide power for the gate drives. The 18V is regulated down to 15V by three TO220 regulators that are mounted on three discrete sheet metal heat sinks. If the 15V is in regulation, an LED will be lit in front of each heat sink. There is a red, a green and an orange LED, one for each supply. The other four green LED's will be lit when there is gate drive present at the IGBT's. If the green LED's are not lit there will be no gate drive and hence no output.

---

## 5.9 Input/Output Board

The input/output board holds a lot of the large components and provides interconnection between the AC input, the DC-DC board, the AC power board and the output without the use of heavy cables. The output relay and the output current metering circuit are also mounted on this board. The output AC inductors, the DC-DC transformer and the DC output choke are mounted on brackets behind the input/output board. These brackets also provide support for the input/output board.

Figure 5-5: AC Power Stage Layout

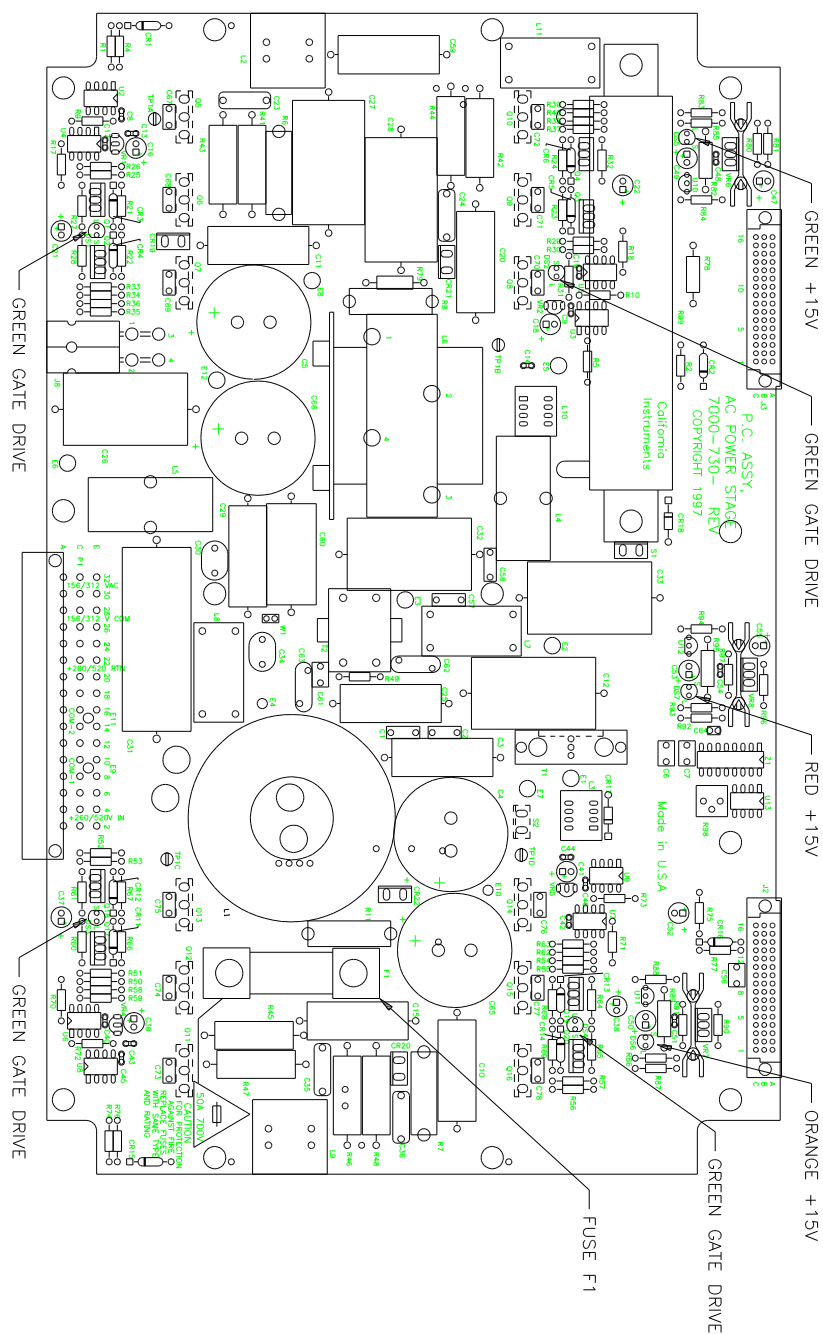
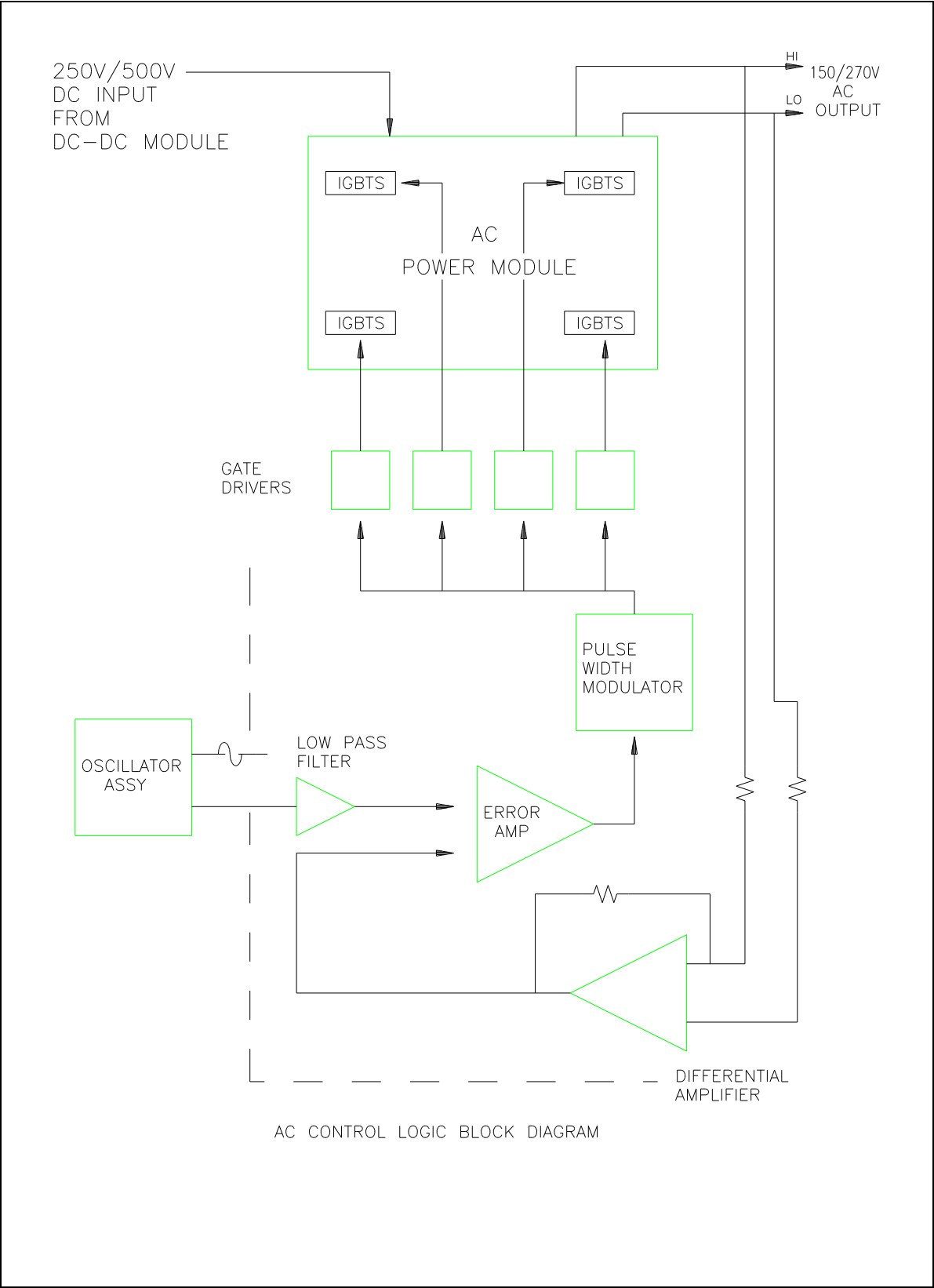
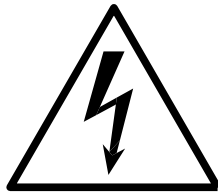


Figure 5-6: AC Control Logic Block Diagram





# **CAUTION**

**VOLTAGES UP TO 480 VAC AND 700 VDC ARE PRESENT IN CERTAIN SECTIONS OF THIS POWER SOURCE. THIS EQUIPMENT GENERATES POTENTIALLY LETHAL VOLTAGES.**



# **DEATH**

**ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED.**

## 6. Calibration

---

The Routine Calibration should be performed every 12 months. Non-routine Calibration is only required if a related assembly is replaced or if the periodic calibration is unsuccessful.

All standard models and configurations of the iX/i Series may be calibrated using a PC running Windows 98/2000/XP, and the latest version of the CIGUI32 AC source control software. Refer to the CIGUI32 online help file of the CIGUI32 software for additional procedures and guidance. To download the latest version of the CIGUI32, visit [www.calinst.com](http://www.calinst.com).

### 6.1 Calibration Equipment

---

Digital Phase Meter:	Krohn-Hite, Model 6620 or equivalent. (0.01° resolution, 0.02° accuracy.)
Digital Multimeter:	Fluke 8506A HP 34401A (two required)
10 milliohm Current Shunt:	Isotek Model RUG-Z-R010-0.1 or equivalent
1 milliohm Current Shunt: (10001i/iX, 15001i/iX and 15003iX-MODE):	Isotek Model RUG-Z-R001-0.1
Load Bank:	Various high power load resistors will be needed.
Computer (Optional)	PC to operate California Instruments CIGui32.

### 6.2 The Output Calibration Screen

---

To show the OUTPUT CALIBRATION screen for the first time press the MENU key twice to display the MENU 3 screen. Press the ↑ or ↓ key several times to highlight OUTPUT CAL. Press the ENTER key. Type 5000 and press the ENTER key to show the OUTPUT CALIBRATION screen. Press the PHASE key to select the phase to be calibrated for a 15003iX power system with one controller.

### 6.3 The Measurement Calibration Screen

---

To show the MEASUREMENT CALIBRATION screen follow the steps in paragraph 6.2. Select the MEASUREMENT CAL function instead of OUTPUT CAL from the MENU 2 screen. If another CALIBRATION screen has been accessed since power-up no password is needed. If a password is needed use the value 5000.

## 6.4 Routine Output Calibration

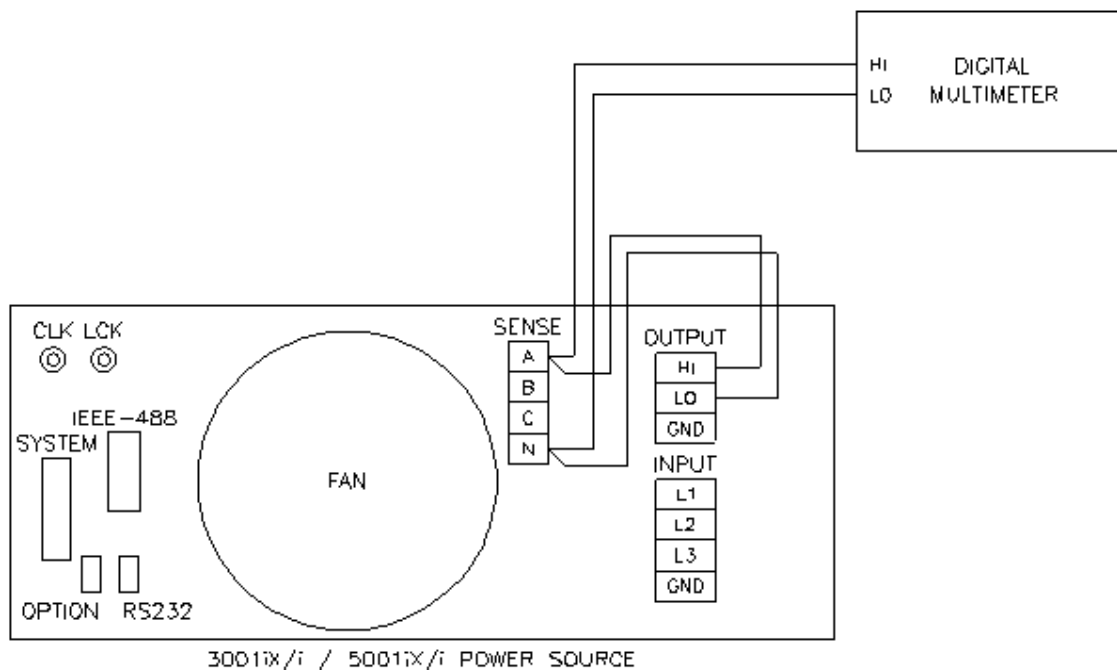
### Setup:

Connect the test equipment to the power source as shown in Figure 6-1. If any output parameter can't be calibrated refer to the Power Source Gain Adjustment in the Non-routine Output Calibration section of the manual.

For the AC Output Calibration either the Fluke 8506A or HP 34401A may be used. If the HP 34401A is used it must be put into the slow filter mode.

**Note:** For purposes of calibrating the output voltage, the 135 and 150 volt ranges are the same. In other words, the 150 volt range can be calibrated on the 135 volt range. The same is true for the 270 and 300 volt range.

Figure 6-1: Test Equipment Hookup for Routine Output Calibration





The Output Calibration Table is a summary of the output calibration procedure. The following text is a detailed explanation of the procedure.

**150 VAC Range DC Zero:**

Press the PROGRAM key and select the 150 Range with the shuttle. Program the output to 0.0 volts. Go to the Output Calibration, press the PHASE key for the phase to be calibrated and select the VOLT ZERO parameter. Close the Output Relay by pressing the OUTPUT ON/OFF key. Monitor the DC output voltage with the external DVM. With shuttle control adjust the output voltage for  $0.0 \pm 0.005$  VDC.

**150 VAC Range Full-scale:**

Press the PROGRAM key and program 120.0 volts and 60 Hz. Go to the OUTPUT CAL screen by choosing the PREVIOUS screen selection. Select the VOLT FS parameter and adjust the output to  $120.0 \pm 0.05$  volts.

**150 VAC Range HI Freq:**

Press the PROGRAM key and program the output to 120.0 volts and 400 Hz. Go the OUTPUT CAL screen and select the V HI FREQ parameter. Adjust the output with the shuttle for an output of  $120.0 \pm 0.05$  volts. Repeat the 60 Hz and 400 Hz adjustments until the output is within  $\pm 0.05$  volts of the programmed value.

**300 VAC Range DC Zero:**

Program the output to the 300 VAC Range by pressing and selecting the 300 Range with the shuttle. Go the OUTPUT CAL screen, select the VOLT ZERO parameter and adjust the output to  $0.0 \pm 0.005$  VDC.

**300 VAC Range Volt Full-scale:**

Program the output to 240.0 volts and 60 Hz. Go to the OUTPUT CAL screen and adjust VOLT FS parameter for an output of  $240.0 \pm 0.05$  volts.

**300 VAC Range Volt HI Freq:**

Program the output to 240.0 volts and 400 Hz. Go to the OUTPUT CAL screen and select the V HI FREQ parameter. Adjust the output with the shuttle for an output of  $240.0 \pm 0.05$  volts. Repeat the 60 and 400 Hz adjustments until the output is within  $\pm 0.05$  volts of the programmed value.

**300 VDC Range Volt Zero:**

Press the PROGRAM key. Select the MORE option to go to the PROGRAM 2 screen. Highlight the VOLT MODE parameter and select the DC Mode by moving the shuttle. Press the PROGRAM key and program the 300 Range and 0.0 volts. Go to the OUTPUT CAL screen by pressing the MENU key three times followed by pressing the ENTER key to display the OUTPUT CAL screen. Adjust the VOLT ZERO for  $0.0 \pm 0.005$  volts DC.

**300 VDC Range + Full-scale:**

Program + 240.0 volts. Go to the OUTPUT CALIBRATION screen and adjust the VOLT FS parameter for an output voltage of  $+240.0 \pm 0.05$  volts DC.

**300 VDC Range - Full-scale:**

Program - 240.0 volts. Go the OUTPUT CALIBRATION screen and adjust the VOLT FS parameter for an output voltage of  $-240.0 \pm 0.05$  volts DC.

**150 VDC Range Volt Zero:**

Press the PROGRAM key. Select VOLT RANGE and program the 150 VDC range with the shuttle. Go to the OUTPUT CAL screen and adjust the VOLT ZERO for  $0.0 \pm 0.005$  volts DC on the output.

**150 VDC Range + Full-scale:**

Program +120.0 volts. Go to the OUTPUT CALIBRATION screen and adjust the VOLT FS parameter for an output voltage of  $+120.0 \pm 0.05$  volts DC.

**150 VDC Range - Full-scale:**

Program -120.0 volts. Go to the OUTPUT CALIBRATION screen and adjust the VOLT FS parameter for an output voltage of  $-120.0 \pm 0.05$  volts DC.

For a 9003iX or 15003iX 3-Phase power system with one controller, repeat the preceding steps for the Phase B and C outputs. Press the PHASE key to select the output to be calibrated. Monitor the output of the respective phase by moving the HI input of the Digital Multimeter. The LO input should remain connected to the common LO of the sense connector, TB3.

The following Table is a summary of the preceding calibration steps.

Program the following values in the table and make the adjustments in the OUTPUT CALIBRATION screen. Select the phase to be calibrated by pressing the PHASE key.

TITLE	PROGRAM VALUES	CALIBRATION VALUE	ADJUST TO
150 VAC range DC Zero	150 range, 0.0 V	VOLT ZERO	$0 \pm 5$ mv DC
150 VAC range Volt FS	120.0 V, 60 Hz	VOLT FS	$120 \pm 0.05$ VAC
150 VAC range Volt Hi Freq	120.0 V, 400 Hz	V HI FREQ	$120 \pm 0.05$ VAC
Repeat the adjustments at 60 and 400 Hz until the output is within $\pm 0.05$ volts			
300 VAC range DC Zero	270 range, 0.0 V	VOLT ZERO	$0 \pm 5$ mv DC
300 VAC range Volt FS	240.0 V, 60 Hz	VOLT FS	$240 \pm 0.05$ VAC
300 VAC range Volt Hi Freq	240.0 V, 400 Hz	VOLT HI FREQ	$240 \pm 0.05$ VAC
Repeat the adjustments at 60 and 400 Hz until the output is within $\pm 0.05$ volts			
150 VDC range DC Zero	135 range, 0.0 V	VOLT ZERO	$0 \pm 5$ mv DC
150 VDC range Volt +FS	+120.0 V	VOLT FS	$+120 \pm 0.05$ VDC
150 VDC range Volt -FS	-120.0 V	VOLT FS	$-120 \pm 0.05$ VDC
300 VDC range DC Zero	270 range 0.0 V	VOLT ZERO	$0 \pm 5$ mv DC
300 VDC range Volt	+240.0 V	VOLT FS	$+240 \pm 0.05$ VDC
300 VDC range Volt -FS	-240.0 V	VOLT FS	$-240 \pm 0.05$ VDC

*Table 6-1: Output Calibration Table*

For a multi-phase power system that uses one controller, 9003iX or 15003iX, repeat paragraph 6.4 for each phase. Move the external multimeter to the phase being calibrated. Make sure that the phase being calibrated is programmed to the correct voltage. While viewing the calibration screen, press the PHASE key to select the respective key.

## 6.5 Routine Measurement Calibration

Connect the test equipment to the power source as shown in Figure 6-2. If the power system is a multi-phase system with one controller, the DVM for calibrating the measurement voltage should always be connected to the Remote Sense connector (TB3) on the Phase A power source.

The shunt must be connected to the power source as shown in Figure 6-2. If the Current measurement can't be successfully performed, adjust the Current Measurement Pot. This adjustment is described in the Non-routine Calibration section of this manual. If the DC current measurement displays more than 70 counts on the display, perform the non-routine current monitor adjustment.

Connect the load to the output. Use the 10 milliohm current shunt in series with the load to measure the AC and DC load current. When programming a DC load always program the output voltage to 0 volts before changing the output load. This will prevent load switch contacts from being damaged.

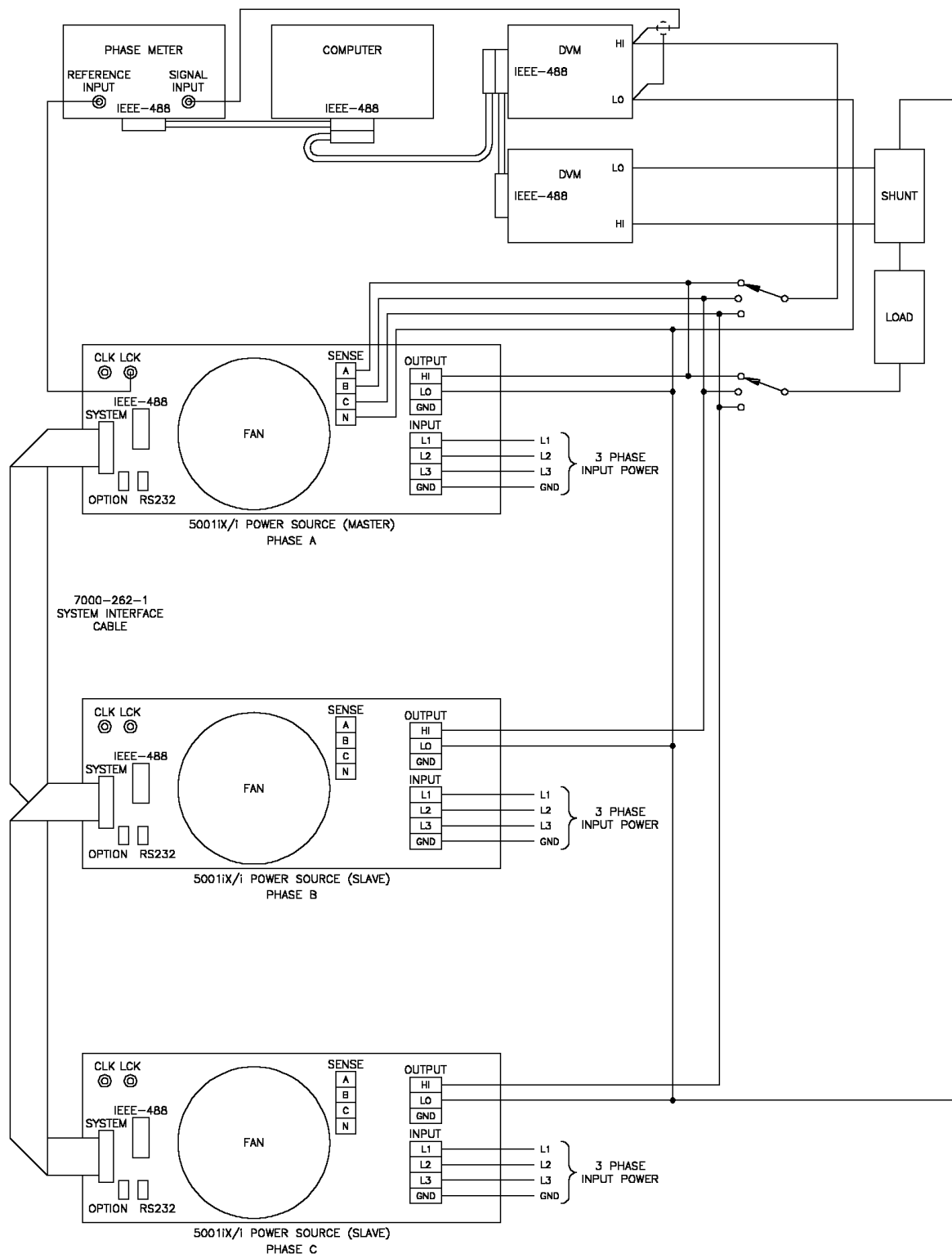
To calibrate all measurement functions, the desired value for the measurement value of current or voltage must be entered for the corresponding calibration value. Make the indicated adjustments by typing in the desired display value. This should be the value indicated by the external DVM. If a 10 milliohm current shunt is used for current, 300 millivolts represents 30 amps.

The Measurement Calibration Table is a summary of the measurement calibration procedure. The following text is a detailed explanation of the procedure.

PARAMETER	POWER SYSTEM			
	<u>3001</u>	5001 <u>15003</u>	<u>10001</u>	<u>15001</u>
AC Current Full-Scale	6.8Ω, 3KW	4.1Ω, 5KW	2.1Ω, 10KW	1.35Ω, 15KW
DC Current Full-Scale	13.5Ω, 1.5KW	8Ω, 2.5KW	4Ω, 5KW	2.7Ω, 7.5KW

Table 6-2: Calibration Load For Each Phase

Figure 6-2: Test Equipment Hook-up for Measurement Calibration



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**Note: The Fluke 8506A Digital Multimeter must be used for the following calibration. The 8506A must be set to the AC HI ACCUR mode for all AC measurements.**

---

**AC Volt Full-scale:**

Program the output to the 300 volt range. Close the output relay. Program the output to 240 volts and 60 Hz. Go to the MEASUREMENT CALIBRATION screen. Enter the actual AC output voltage for the VOLT FS parameter and press the ENTER key.

**AC Current Full-scale:**

Apply a load to the output. Refer to Table 6-2. Program the output to 150 volts on the 150 volt range and 60 Hz. Observe the actual output current and enter this value for the CURR FS parameter. Press the ENTER key.

**For the following calibration steps put the external Digital Multimeter into the DC mode.**

**DC Volt Zero:**

Go to the PROGRAM 2 screen and program the DC mode. Go the PROGRAM screen and program the 300 range and +2.0 volts. Go to the MEASUREMENT CALIBRATION screen and enter the value displayed on the external meter for the VOLT ZERO parameter.

**DC Volt +Full-scale:**

Program the output to +240 volts. Go to the MEASUREMENT CALIBRATION screen. Enter the actual DC output voltage displayed on the external multimeter for the VOLT FS parameter and press the ENTER key.

**DC Current Zero:**

Program the 150 volt range and 0 volts. Apply a 67 ohm, 270 watt load to the output. This resistor will represent approximately a 2 amp load. Program the output to 135 volts. Enter the actual DC load current for the CURR ZERO parameter in the MEASUREMENT CALIBRATION screen and press the ENTER key. If this adjustment can't be successfully made, perform the Current Monitor Offset Adjustment in paragraph 6.6.

**DC Current Full-scale:**

Program the output to 0 volts on the 150 range. Apply load resistor to the output. Refer to Table 5. Program 135 volts. Enter the actual output current for the CURR FS parameter in the MEASUREMENT CALIBRATION screen. The value indicated by the External DVM is called  $V_{ac}$  or  $V_{DC}$ . The current measured by the current shunt is called  $I_{ac}$  or  $I_{DC}$ .

TITLE	PROGRAM/LOAD PARAMETERS	PARAMETER	ADJUST TO
AC Volt Full-scale	240 VAC, 60 Hz	VOLT FS	$V_{ac}$
AC Current Full-scale	150 Range, 150 VAC, full load	CURR FS	$I_{ac}$
DC Volt Zero	300 Range, +2.0 VDC	VOLT ZERO	$V_{DC}$
DC Volt + Full-scale	+240 VDC	VOLT FS	$V_{DC}$
DC Current Zero	150 Range, 135 VDC, 67 ohm load	CURR ZERO	$I_{DC}$
DC Current Full-scale	150 Range, 135 VDC, full load	CURR FS	$I_{DC}$

*Table 6-3: Measurement Calibration Table*

For a multi-phase power system that uses one controller, 15003iX, repeat paragraph 6.5 for each phase. Move the external test equipment to the phase that is being calibrated. Refer to Figure 6-2.

While viewing the calibration screen, press the PHASE key to select the respective phase.

## 6.6 Non-Routine Calibration

The non-routine calibration involves removing the top cover from the power source. Remove the line power from the power source before removing the top cover. Most of the adjustments are on the Current Limit Assembly. One adjustment is on I/O Board Assembly. Refer to Figure 6-3 for the location of the adjustments.

### 6.6.1 Power Source Gain Adjustment:

To make this adjustment the top cover must be removed and voltages must be monitored at various test points. The test point used depends upon the phase to be adjusted. Refer to Table 6-4 for the test point. The adjustment is R14 on the Current Limit Board. Refer to Figure 6-3 for the location R14 on the Current Limit Board.

On the Phase A/CPU board, monitor TP31 with respect to TP1. Program +300 VDC. Adjust R14 on the Current Limit Board so that the voltage at TP31 is 13.0 VDC. Program -300 VDC. Check voltage at TP31. If it is greater than 13.0 VDC, adjust R14 for 13.0 VDC. If it is less than 13.0 VDC, do nothing.

For multiphase power systems with one controller, 15003iX, the adjustment for Phase B and C must be made to R14 on the Current Limit Board for the power source of the respective phase.

PHASE	TEST POINT (Controller in Phase A Power Source)
A	TP31 to TP1 CPU/Phase A
B	TP5 to TP1A Phase B/C
C	TP6 to TP1A Phase B/C

Table 6-4: Gain Adjustments

### 6.6.2 Current Limit Calibration:

Program the output to the 150 VAC range and the current limit to IPROG in Table 6-5. Program the output to the constant current mode (CC). Apply full load for the 150 volt range to the output. Adjust R38 on the Current Limit Board for an output current of ISET in Table 6-5.

If the current is less than the set value, observe the Front Panel Overload Indicator for each power source. Adjust R38 on the Current Limit Board of the Power Sources with the Indicator illuminated. Adjust R38 just to the point the output current is on 103% above the programmed value.

MODEL	IPROG	ISET	R LOAD (ohms)
5001, 15003	30	31.0	4.5, 5KW
10001, 30003	90	63.0	2.25, 10KW
15001	90	93.0	1.5, 15KW
3001, 9003	18	18.6	8, 3KW

Table 6-5: Current Limit Calibration

Repeat this adjustment for the Phase B and Phase C power sources of a 15003 power system.

### 6.6.3 Output Impedance Calibration (3001iX, 5001iX, 9003iX, and 15003iX models only)

For the output impedance calibration, two HP 34401A DMM's or equivalent must be used. The following modes must be programmed: 6 digits, AC Filter, slow: 3 Hz and 6 digits. One DMM is used to measure the output voltage, one to measure the load current using a suitable CT. The calibration should be done for each phase individually. Furthermore, an accurate phase meter with at least  $0.01^\circ$  resolution is needed. (See equipment list section 6.1). The reference input of the phase meter must be connected to the LOCK output of the controller at the rear panel of the master 5001iX chassis. This is a square wave TTL signal. Select Square wave input on the phase meter. The other input of the phase meter must be connected at the AC source output of the phase being calibrated. Select Sine wave input on the phase meter for this input. Note that this is a 230 Vrms signal so the Phase Meter must have sufficient input range on this input. The phase meter is used to determine the phase shift between no load and full load conditions ( $\Delta\Phi$ ).

Connect the test equipment required as shown in Figure 6-2. If the DMM and phase meter have an IEEE/GPIB interface, it is possible to use the 16-bit version of the CIGUI program version 3.18 or higher supplied on the CD ROM that came with the iX Series to operate the test equipment. The 16-bit CIGUI requires a Windows 98 PC. (This function is not included in the 32 bit Cigui32 program however).

The calibration for impedance can be found in the Calibration Menu on the main CIGUI screen. In this case, the GPIB interface must be connected to the PC, the DMM's and the Phase meter. The GPIB addresses for the DMM's and Phase meter expected by the CIGUI program are shown in the table below.

Instrument	Address
iX AC Power Source (Do not use 4,5 or 6 for AC source)	Set in CIGUI Interface screen and Utility Menu on iX controller.
DMM1, Used for voltage measurement	4
DMM2, Used for current measurement	5
Phase Meter, Used for phase measurement	6

Table 6-6: GPIB addresses for impedance calibration

Note that the CIGUI32 (32 bit version) does not support computer aided impedance calibration. Instead, the readings from the DMM's and Phase meter can be made manually and written down. In that case, a calculator may be used to calculate the R and L portions of the impedance using the formulas shown in Table 6-8.

To verify or adjust the programmable impedance function, proceed as follows for each phase:

1. Program the power source to 230.0VAC and 50Hz.
2. Program the output impedance resistance and inductance to the lowest values from the OUTPUT IMPEDANCE screen. This will be the IMP. REAL MIN and IMP. REACT MIN values that have been set in the OUTPUT CAL screen. Press the PHASE key to select the phase to be calibrated. (A, B or C).
3. Measure the output voltage of the power source with no load and record this value ( $V_{NL}$ ).
4. Using a resistive load bank, load the output of the power source to about 16 amps. Measure the output voltage of the power source under load and record this value ( $V_L$ ). Also measure the load current and record this value. (I).

5. Calculate the resistive and inductive component R and L using the formulas shown in Table 6-8. (Alternatively, use the 16 bit CIGUI.)
6. Enter these values, in the OUTPUT CAL screen for the IMP. REAL MIN and IMP. REACT MIN value respectively. Make sure the correct phase is selected or use the PHASE key if not.
7. Remove or turn off the load.
8. From the MENU 3 screen, select OUTPUT IMPEDANCE. Press the PHASE key to select the phase to be calibrated. Program the output inductance to 796 uH and the resistance to 400 mOhms.
9. Select the Calibration, Output screen and move the cursor to the IMP REAL FS field. Measure the R and L by removing and applying the load as described before and calculating the R and L using the formula's in Table 6-7. Adjust the resistive output impedance using the shuttle until the measured output is as close as possible to 400 mOhm. Make sure the correct phase is selected or use the PHASE key if not. Do the same with the IMP REACT FS field. Note that the adjustment range for R is 0 to 100, for L is 0 to 300.
10. If there is not enough range in the full-scale calibration coefficient for either resistive or inductive portion, it may be necessary to tweak the adjustment pots on the iX controller. These pots were originally adjusted at the factory and normally do not have to be adjusted again. The Full Scale calibration coefficients should have enough adjustment range. Double check the connections and phase measurements if this is not the case to make sure the measurement readings you get are indeed correct.  
If it is necessary to adjust the pots, see Table 6-7 for the corresponding pot designators. The top cover has to be removed to access these pots. They are located along the top edge of the controller board(s). Adjustments for phase A are on the phase A/CPU board (5100-707), adjustments for phase B and C are on the phase B/C board (7000-722).
11. Repeat steps 2 through 10 for phase B and C.

Phase / Board Assembly #	R resistive	XI inductive
Phase A /CPU (5100-707)	R121	R122
Phase B (7000-722)	R112	R111
Phase C (7000-722)	R114	R115

Table 6-7: Programmable Z adjustment pots

**Definitions:**

$V_{NL}$  = Measured RMS voltage under no load.

$V_L$  = Measured RMS voltage under load

$I$  = Measured RMS current.

$F$  = Source frequency (50 Hz).

$\Delta\Phi$  = Phase angle shift between load and no load conditions. Record phase angle from phase meter under NL and L condition and determine phase shift.

Formulas to calculate R and L component of output impedance:

$$R = (V_{NL} * \cos(\Delta\Phi) - V_L) / I$$

$$X_L = (V_{NL} * \sin(\Delta\Phi)) / I$$

$$L = X_L / (2 * \pi * F)$$

Table 6-8: Formulas to calculate R and L



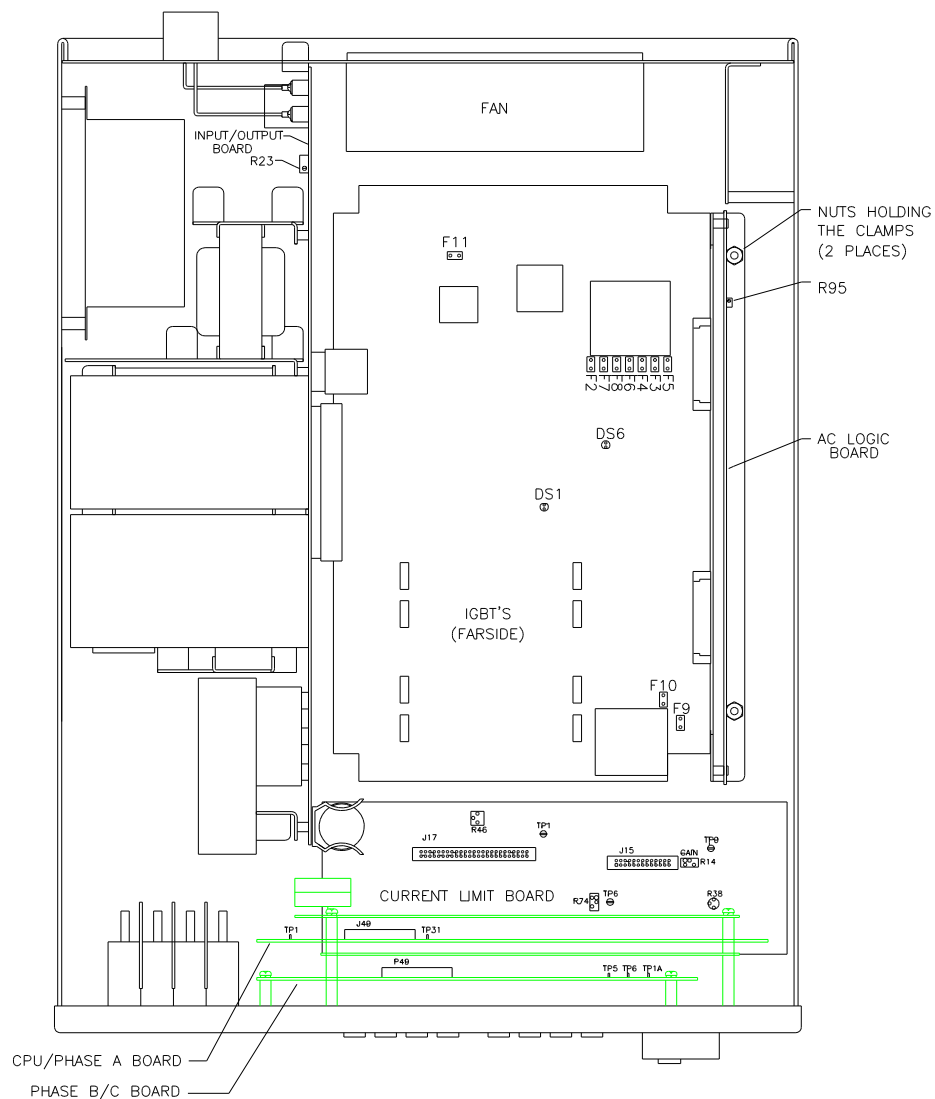
#### 6.6.4 Current Monitor Offset Adjustment

---

1. Program the 300 Vac range, zero volts, and turn the Output ON.
2. On the current limit board, monitor TP5 with respect to TP1. Adjust R23 on the input/output board for  $0.0 \text{ mVDC} \pm 0.5 \text{ mVDC}$ .

**CAUTION:** Use extreme care in adjusting R23. Do not touch any connections on the Input/Output Board Assy. Dangerous voltages exist on most exposed connections.

Figure 6-3: Adjustment Location



## 7. Service

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### 7.1 Cleaning

---

The exterior of the power source may be cleaned with a cloth dampened with a mild detergent and wrung out. Disconnect mains power to the source before cleaning. Do not spray water or other cleaning agents directly on the power source.

### 7.2 General

---

This section describes the suggested maintenance and troubleshooting procedures. The troubleshooting procedure is divided into two sections. The first section deals with basic operation and connection of the equipment. The second section requires opening the unit and using the LED indicators and a simple multimeter to troubleshoot the unit down to the module level. Only a qualified electronic technician should attempt this level troubleshooting.

### 7.3 Basic operation

---

*Table 7-1: Basic Symptoms*

PARAGRAPH	PROBLEM
7.3.1	Excessive Output Voltage
7.3.2	Poor Output Voltage Regulation
7.3.3	Overload Light On
7.3.4	Distorted Output
7.3.5	Unit Shuts Down After 1-2 Seconds
7.3.6	No Output and no lights on front panel
7.3.7	No output but "power on" LED on front panel is lit.

#### 7.3.1 Excessive Output Voltage

---

CAUSE	SOLUTION
External sense not connected	Connect the external sense to the AC power outlet TB2.

#### 7.3.2 Poor Output Voltage Regulation

---

CAUSE	SOLUTION
Unit is overloaded	Remove overload
Unit is programmed to wrong voltage range.	Select correct voltage range.
Input line has fallen below spec. limit.	Check supply voltage.

#### 7.3.3 Overload Light is On

---

CAUSE	SOLUTION
Unit is overloaded	Remove overload
Unit is switched to high voltage range.	Select correct voltage range.

### 7.3.4 Distorted Output

---

CAUSE	SOLUTION
Power source is grossly overloaded.	Reduce load
The crest factor of the load exceeds 3:1 on the low range or 5:1 on the high range.	Reduce load current peaks by reducing load.

### 7.3.5 Unit Shuts Down after 1-2 Seconds

---

CAUSE	SOLUTION
Output shorted	Remove output short
Output grossly overloaded.	Remove overload.
Operating load with too high inrush or start up currents.	Consult factory for application advice.

### 7.3.6 No Output and No Lights on Front Panel

---

CAUSE	SOLUTION
Input circuit breaker switched off.	Switch the breaker on.
No input power to TB3.	Ensure 3 phase power is getting to TB3.
Unit tripped on overvoltage or overcurrent.	Turn circuit breaker off - wait five seconds - turn circuit breaker back on.

### 7.3.7 No Output But "Power On" LED on Front Panel is Lit

---

CAUSE	SOLUTION
"OUTPUT ON" switch is turned off.	Turn OUTPUT ON switch to "ON".
REMOTE SHUTDOWN logic line at J22 pin 36 is shorted to D COM or A COM.	Remove connection from J22 pin 3.
Current limit programmed down or to zero.	Program current limit higher.
Voltage programmed down or to zero.	Turn amplitude control up.
Unit tripped on overvoltage or overcurrent.	Turn circuit breaker off - wait five seconds - turn circuit breaker back on.

## 7.4 Advanced Troubleshooting.

---



**WARNING:** Do not connect 400-480V into the 208-240V unit, the result could be a severely damaged unit.

---



**CAUTION:** VOLTAGES UP TO 480 VAC AND 700 VDC ARE PRESENT IN CERTAIN SECTIONS OF THIS POWER SOURCE.

---



**WARNING:** THIS EQUIPMENT GENERATES POTENTIALLY LETHAL VOLTAGES. DEATH ON CONTACT MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. DO NOT TOUCH ELECTRONIC CIRCUITS WHEN POWER IS APPLIED

---

### 7.4.1 Switch Off Unit

---

Switch of the unit at the circuit breaker on the front panel as well as removing the input power from the unit.

---



**WARNING:** Wait 10 minutes for all internal capacitors to discharge.

---

### 7.4.2 Removing Top Cover

---

Remove the screws securing the top cover and remove the top cover.

---

### 7.4.3 Initial Inspection

---

Make a visual inspection of the unit and ensure all the connectors are properly mated and there are no loose or broken wires.

---

#### 7.4.4 Fuse Check

---

See Figure 5-3 and Figure 5-5. Check the fuse F1 on the AC power board at the top of the unit using the ohmmeter. If the fuse is open do not replace but check all the IGBT's. To check the IGBT's connect the positive lead of the ohmmeter to the collector (center leg) and measure the resistance to the gate and the emitter (outside legs) of each IGBT. If the resistance reading is lower than 1000 ohms it indicates a blown IGBT. The IGBT's are not field replaceable and the module should be returned to the factory for exchange or repair. See paragraph 7.4.6. for disassembly instructions. If a low resistance reading is not found, replace the fuse and proceed with the check procedure.

Check the fuse F1 on the end of the input/output board. If the fuse is blown do not replace but proceed to paragraph 7.4.6 for disassembly instructions and remove the AC power board. With the AC power board removed check the IGBT's Q2 through Q9 using the procedure detailed in the paragraph above. See Figure 6-1: Internal Top View of DC-DC Converter Board.

If one or more IGBT's show a low resistance reading do not replace the fuse but return the module to the factory for exchange or repair. If a low resistance is not found, replace the fuse and carry on with the check procedure.

#### 7.4.5 Power-on Troubleshooting Using the LED's.

---

If no fuses were blown or if fuses were found blown but all the IGBT's checked out as good, replace blown fuses and reconnect power to the unit.



**WARNING:**     *Do not touch any parts inside the unit during this test as they will be live and dangerous. Always wear safety glasses.*

---

**Auxiliary PS:** Turn the main breaker on and check the LED's on the AC logic board.(see Figure 5-4). The +15V (DS2-red), -15V (DS3-green), and the 24V (DS7-amber) LED's located at the top right of the board should all be lit. The 8V logic supply LED (DS4- red) should be lit. On the AC power board (see Figure 5-5) the three gate drive power supply lights, DS5-green, DS6-amber, and DS7-red, should all be lit. If any of these LED's are not lit then the most likely cause is a blown fuse. These logic power fuses are all located on the DC-DC board. Switch the unit off at the front panel breaker **and** remove the input power.

***Wait 10 minutes to allow the capacitors to discharge before attempting to disassemble the unit.***

Proceed to paragraph 7.4.6. for disassembly instructions. Remove the AC power board and locate the P.C. mount fuses F2 through F10 (see Table 7-2 for fuse functions). Replace any blown fuses. Always replace fuses with same type and rating. (See Table 8-2.)

FUSE #	FUNCTION	FUSE VALUE
F2	DC-DC Converter logic	1 amp
F3	18V - AC gate drive (2)	1 amp
F4	18V - AC gate drive (3)	1 amp
F5	18V - AC gate drive (1)	1 amp
F6	24V Fan and relay power.	3 amp
F7	+15V logic power	1 amp
F8	-15V logic power	1 amp
F9	8V Front panel meter power	1 amp
F10	+8V logic power	3 amp
F11	Auxiliary power supply input fuse.	10 amp

Table 7-2: Auxiliary Power Supply Fuse Ratings

Fuse F9 supplies power to the front panel meter. If F9 blows then there is no readout. If no LED's are on at all, then the auxiliary power supply may have failed. Check F11 and replace if necessary. If none of these fuses has blown proceed to the next step.

**DC-DC Converter:** The output of the DC-DC converter 250V/500V will light the LED that is located directly down between the large storage capacitor and the input/output board (see Figure 5-3). This LED should be lit. If this LED is not lit, but the other auxiliary power supply LED's are lit, then check F2 on the DC-DC board. See Table 7-2 and the preceding paragraph.

If no failures have been found to this point, then the AC power board has high power input and gate drive power. The gate drives on the AC power board should all be present (see Figure 5-5). These are the green LED's DS1 through DS4. They should all be lit. If they are not lit then the gate drive has been inhibited. Recheck paragraph 7.3.7.

**Oscillator:** If the LED's DS1 through DS4 on the AC Power Board are lit and there is still no output then there may be no output from the oscillator. To check the oscillator output, turn off the unit at the main breaker. Set the DVM to AC volts and connect the meter to Test Point 2 (TP2) with the return on TP1. See Figure 5-4. TP2 is in the center of the AC logic board and TP1 is at the top left. Turn the breaker back on. There should be a reading on the meter which can be varied from 0 to 5 volts by programming the output from zero to 300V. If no reading is present, check the output at the CPU/Phase A Board. Check the signal between TP29 and TP1 (return) on the CPU/Phase A Board. **Switch power to the unit off before relocating probes.**

If a signal is present at the CPU/Phase A Board but not at the AC Logic Board then the fault is in the wiring or the current limit board. Check the continuity of cables from the oscillator to the AC logic board. If there is no signal at TP29 then recheck the inhibit at paragraph 7.3.7 or replace the oscillator assembly. The presence of the oscillator signal at the AC logic board would indicate a fault in the output relay or output wiring. See Figure 5-2.

**AC output: Switch unit off** - Check that P1 on the AC power board is making good contact with its mating half and J8 (the output to the AC smoothing inductors) is firmly engaged. Switch the unit back on and operate the power on/off switch on the front panel. Listen to hear if the relay operates. If the relay does not operate replace the input/output board. If it does, check the continuity of the output wiring.

If the problem with the unit has not been isolated, contact the factory for assistance.

#### 7.4.6 Disassembly Procedure

---

Disconnect mains power to the source and ***wait 10 minutes to allow the capacitors to discharge before attempting to disassemble the unit.*** Remove the top cover, unplug P7 from the current limit board, and unplug the fan from the AC logic board connector. Then carefully unplug the AC logic board from the AC and the DC power boards. The AC logic board can then be lifted from the unit.

Using a 5/16 inch socket driver remove the four bolts that hold the AC power module heatsink. There is one bolt at each corner. Carefully remove all the hardware from the unit. The AC power module can now be unplugged from the input/output board and removed from the unit.

The DC - DC module can be unplugged by first removing the two nuts holding the clamp that secures the heatsink to the chassis. See Figure 6-1. Care must be taken in unplugging the two connectors P4 and J12.

To reassemble, reverse the above procedure, taking care to ensure J12 on the DC-DC board and J8 on the AC board are properly mated. This may entail supporting the connector from behind with a screwdriver.



## 8. Top Assembly Replaceable Parts

TOP ASSEMBLY No:	7000-439-4	3001i
	7000-439-1	3001iX
	7000-438-3	5001i, 240 VAC INPUT
	7000-438-4	5001i, 480 VAC INPUT
	7000-438-1	5001iX, 240 VAC INPUT
	7000-438-2	5001iX, 480 VAC INPUT

SEQ#	CI PART #	DESCRIPTION	VENDOR	QTY
A1	7000-725-1	240V - I/O PC ASSEMBLY	CI	1
A1	7000-726-1	480V - I/O PC ASSEMBLY	CI	1
A2	7000-419-1	AC POWER MODULE, 3001iX	CI	1
A2	7000-419-2	AC POWER MODULE, 5001iX	CI	1
A3	7000-420-1	240V - DC - DC POWER MODULE, 5001i/iX	CI	1
A3	7000-420-2	240V - DC - DC POWER MODULE, 3001i/iX	CI	1
A3	7000-421-1	480V - DC - DC POWER MODULE	CI	1
A4	7000-732-1	LOGIC BOARD PC ASSEMBLY , 3001iX	CI	1
A4	7000-732-2	LOGIC BOARD PC ASSEMBLY , 5001iX	CI	1
A6	7000-724-1	CURRENT LIMIT PC ASSEMBLY	CI	1
2	7000 43 8-11 THRU -30	PROGRAMMABLE OSC. FRONT PANEL ASSY.	CI	1
A10	7000-727-1	IEEE 488 BOARD	CI	1
B1	241183	FAN 6 INCH--JD24B2	Rotron	1
F1	270199	FUSE 50A, 700V, AC BOARD	Bussman FWP-50A14F	1
F1	270184	FUSE 30A 700V I/O BOARD	Bussman-KPB30	1
K1	245217	RELAY ON CHASSIS. KUHP-5DT1-24	Potter & Brumfield	1
F <sub>MISC</sub>	270183	P.C. FUSES ON DC-DC BD, 3A F <sub>6</sub> ,F <sub>10</sub>	Bussman PCC-3	3
F <sub>MISC</sub>	270174	P.C. FUSES ON DC-DC BD, 1A F <sub>2</sub> -F <sub>5</sub> , F <sub>7</sub> -F <sub>9</sub>	Bussman PCC-1	6
CB1	270186	INPUT CIRCUIT BREAKER 35A (240V), 5001i/iX	AIRPAX 205-1111- 28051-2	1
CB1	270196	INPUT CIRCUIT BREAKER 35A (250V), 3001i/iX	AIRPAX IELK21- 28851-1-V	1
CB1	270207	INPUT CIRCUIT BREAKER 15A (480V), 5001i/iX	AIRPAX IELHK-1111- 30431-1-V	1

Table 8-1: Replaceable Parts

SEQ#	CI PART #	DESCRIPTION
<b>DC - DC POWER ASSY. 7000-729 AND 7000-731</b>		
F2	270174	1 amp, 250 vac, quick acting
F3	270174	1 amp, 250 vac, quick acting
F4	270174	1 amp, 250 vac, quick acting
F5	270174	1 amp, 250 vac, quick acting
F6	270183	3 amp, 250 vac, quick acting
F7	270174	1 amp, 250 vac, quick acting
F8	270174	1 amp, 250 vac, quick acting
F9	270174	1 amp, 250 vac, quick acting
F10	270183	3 amp, 250 vac, quick acting
F11	270182	10 amp, 250 vac, time lag
<b>AC POWER ASSY. 7000-730</b>		
F1	270199	50 amp, 700 vac, very quick acting
<b>240 VOLT I/O ASSY. 7000-725</b>		
F1	270184	30 amp, 700 vac, very quick acting
F2	270183	3 amp, 250 vac, quick acting
F3	270183	3 amp, 250 vac, quick acting
<b>400 VOLT I/O ASSY, 7000-726</b>		
F1	270185	15 amp, 700 vac, very quick acting
F2	270183	3 amp, 250 vac, quick acting
F3	270183	3 amp, 250 vac, quick acting
F4	270183	3 amp, 250 vac, quick acting

Table 8-2: Fuses

## 9. Options

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### 9.1 RTCA/DO-160 Option

---

The RTCA/DO-160 Option is made up of both firmware that resides in the power source and the CIGui32 Windows application program. The firmware covers revision D, and the CIGui32 covers revision E.

The user interface for each implementation is different however. The revision D tests can be operated directly from the power source's front panel or through the supplied CIGui32 program. The Revision E tests can only be operated through the Cigui32 windows software. Thus, for Rev E use, a Windows PC and interface is required.

Section 9.1.1 covers operation of the firmware based revision D tests. Section 9.1.2 covers operation of the revision E test. Note that future updates of the CIGui32 may include overlapping coverage for revision D in the software as the CIGui32 program is designed to support all revisions. For now, revision D has no associated data files in the CIGui32.

#### 9.1.1 Option –160: RTCA/DO160 rev D Tests (Firmware)

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##### 9.1.1.1 General

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The RTCA/DO-160D option is capable of performing all sections of RTCA/DO-160D, Section 16 and EUROCAE-14D / RTCA DO160D, Section 16 for the AC Source signal. A selection is made available to specify the type of standard, and groups.

Throughout this document, Groups 1 through 3 will be used to refer to EUROCAE-14D standard.

##### 9.1.1.2 Initial Setup

---

Nominal parameters for the AC Power source are as follows:

Output Voltage	115V L-N or 230V L-N
Output Frequency	360 Hz to 800 Hz

Nominal parameters for the DC Power source are as follows:

Output Voltage	28V or 14V L-N
----------------	----------------

A setting outside these nominal values will disable the test and will prevent accessing to its Menu screens. To access the test for the 230V L-N, the power source must be capable of programming 360V.

### **9.1.1.3 Tests Performed**

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#### **9.1.1.3.1 NORMAL STATE**

**AC Source:**

1. Normal State Voltage and Frequency test
2. Voltage unbalance test
3. Waveform Distortion test
4. Voltage Modulation test
5. Frequency Modulation test
6. Momentary Power Interrupt (Undervoltage) test
7. Voltage Surge (Overvoltage) test
8. Frequency Transients test(Group 1 only)  
Frequency Variation test (Group 2 and 3 only)

**DC Source:**

1. Normal State Voltage test
2. Momentary Power Interrupt (Undervoltage) test
3. Voltage Surge and Under

#### **9.1.1.3.2 EMERGENCY TEST**

**AC Source:**

1. Emergency Voltage and Frequency minimum
2. Emergency Voltage and Frequency maximum
3. Voltage unbalance

**DC Source:**

1. Emergency Voltage

#### **9.1.1.3.3 ABNORMAL TEST**

**AC Source:**

1. Abnormal Voltage minimum
2. Abnormal Voltage maximum
3. Voltage Drop
4. Voltage Surge
5. Frequency Transients test (group 1 only)

**DC Source:**

1. Abnormal Voltage minimum
2. Abnormal Voltage maximum
3. Abnormal Voltage low
4. Voltage Drop
5. Voltage Surge

#### 9.1.1.4 Front Panel Entry

---

To perform a test from the keyboard, from the MENU 2 screen, select the APPLICATIONS screen. The APPLICATIONS screen will appear as shown in Figure 9-1.

APPLICATIONS SETUP	
MIL-STD-704	RTCA/DO-160D
OMIN OPTION	IEC 1000-4-11
PREVIOUS SCREEN	IEC 1000-4-13

*Figure 9-1: Application Menu*

Scroll to the RTCA/DO-160D entry using the up and down cursor keys. Press the ENTER key to select the RTCA/DO 160D main menu. The screen will appear as shown in Figure 9-2.

**Note:** The user has to turn on the Output relay before starting a test.

RTCA/DO-160D AC	
STANDARD =RTCA	NORMAL STATE
GROUP =1	ABNORMAL
PREVIOUS SCREEN	EMERGENCY

*Figure 9-2: DO160 Main Menu*

### 9.1.1.5 AC TESTS

Note: Prior to test selection the standard and the group selection are required. Use the shuttle to select the standard and the group if applicable.

#### 9.1.1.5.1 Normal state test

Scroll to the NORMAL STATE AC entry using the up and down cursor keys. Press the ENTER key to select the NORMAL STATE screens. The screen will appear as shown in Figure 9-3.



Figure 9-3: Normal state

The DO160 NORMAL 1 and NORMAL 2 screens have the following tests:

- 1 VOLT FREQ MIN
- 2 VOLT FREQ MAX
- 3 VOLT UNBALANCE
- 4 WAVEFORM DISTORTION
- 5 VOLT MODULATION
- 6 FREQ MODULATION
- 7 POWER INTERRUPT
- 8 VOLTAGE SURGE
- 9 FREQ TRANSIENT (group 1)  
FREQ VARIATION (group 2 & 3)

The above tests can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test. For some of these tests, numeric data entry may be required to define the test number or the modulation rate.

#### VOLT FREQ MIN

Standard/Group		RTCA	Group1	Group2	Group3
Voltage	1	100	104	104	104
	3	101.5	105.5	105.5	105.5
Frequency		380	390	360	360

Table 9-1: Normal Voltage and Frequency minimum

Standard/Group		RTCA	Group1	Group2	Group3
Voltage	1	122	122	122	122
	3	120.5	120.5	120.5	120.5
Frequency		420	410	650	800

Table 9-2: Normal Voltage and Frequency Maximum

This test will set the voltage and frequency to levels defined by Table 9-1. The test will last for 30 minutes. The test will be repeated for the Group 2 and 3 using the Voltage setting from Table 9-2 and the frequency from Table 9-1. The ← key (backspace) will terminate the test at any time.

**VOLT FREQ MAX**

This test will set the voltage and frequency to levels defined by Table 9-2. The test will last for 30 minutes. The test will be repeated for the EURO standard using the Voltage setting from Table 9-1 and the frequency from Table 9-2. The CLR Key in local operation will terminate the test at any time. Group execute trigger will terminate the test remotely. The unselected phases will remain at 115 volts. The ← key (backspace) will terminate the test at any time.

**VOLT UNBALANCE**

Standard/Group	RTCA	Group1	Group2	Group3
Voltage offset	6	6	6	9
Frequency	400	400	360/650	360/800

*Table 9-3: Normal Voltage Unbalance*

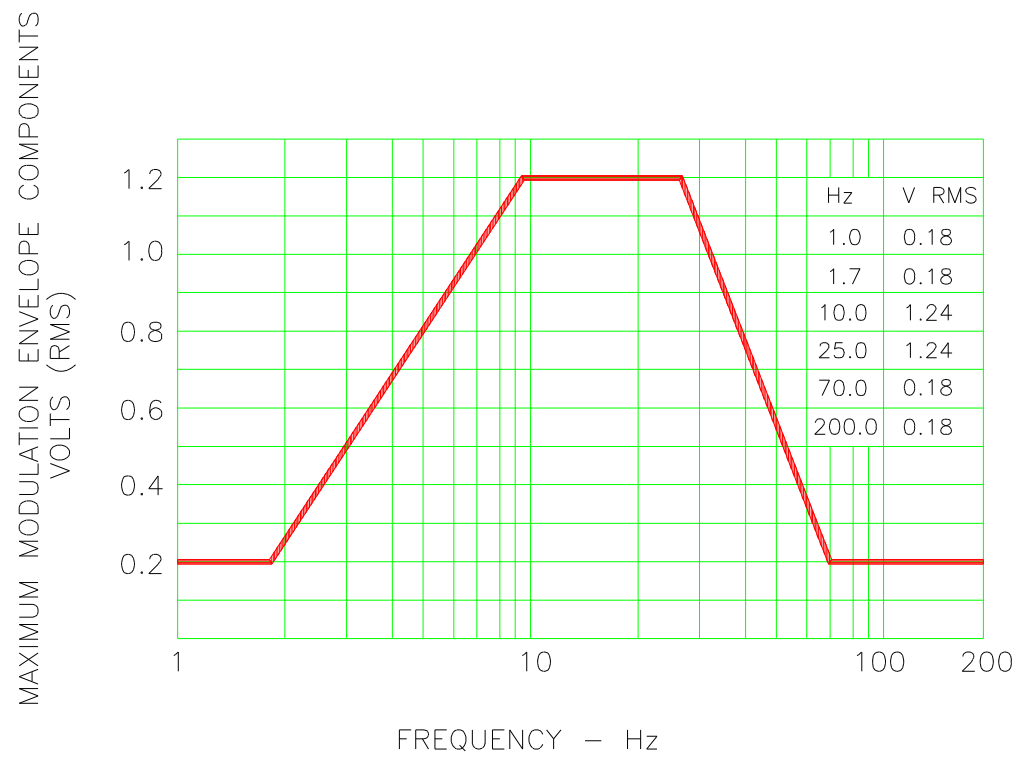
This test will change the output voltage for each phase from 115 volts to 115V + offset. Refer to Table 9-3 for the offset value and the Frequency. The test will last 30 minutes. The test will be repeated for a second Frequency if applicable. The test can be terminated at any time. The ← key will terminate the test at any time.

**WAVEFORM DISTORTION**

This test will generate a 5% THD voltage distortion on the output voltage waveform. The distortion is generated by using a clipped sinewave. The test will last for 30 minutes. The ← key (backspace) will terminate the test at any time.

**VOLTAGE MODULATION**

This test requires a numeric value entry equal to the modulation rate in Hz. This entry value must be between 1 Hz and 200 Hz. The amplitude modulation is calculated based on the modulation rate as defined in Figure 9-4. This test will last for 2 minutes.



FREQUENCY CHARACTERISTICS OF AC VOLTAGE MODULATION ENVELOPE

Figure 9-4: Voltage Modulation



FREQUENCY MODULATION

This test requires a numeric value equal to the modulation rate in Hz. This value must be between 0.01 Hz and 100 Hz. The frequency modulation is calculated based on the modulation rate as defined in Figure 9-5. This test will last for a minimum of 2 minutes.



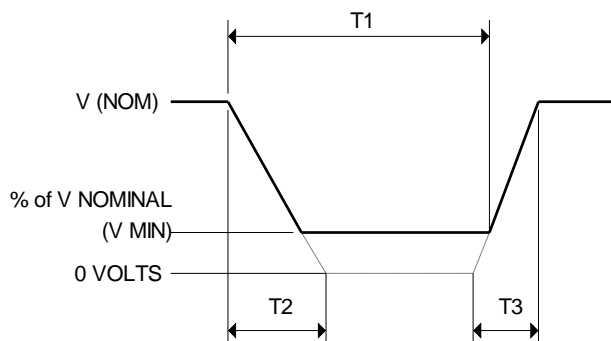
CHARTACTERISTICS OF AC FREQUENCY MODULATION

Figure 9-5: Frequency Modulation

## POWER INTERRUPT

This test requires a numeric entry value equal to the test number. The tests are grouped as follows:

- Test numbers 1 through 15 are for all Standard and Groups. See Figure 9-6 for details of the tests.
- Test numbers 16 and 17 for all equipment that does not incorporate digital circuit. Test number 16 will drop the output to zero voltage for 50 ms. Test number 17 will drop the output to zero voltage for 200 ms. Test number 18 is used for DC equipment and will drop the output for 1 sec.
- Test numbers 21 through 26 are applicable for Groups 2 and 3 only. Output frequency will be set to the F1 value for 1 second prior to the test. The output frequency will remain set to the F2 value when the test is completed. This will allow the user to apply sequence of power interrupts. See Figure 9-7 for detail of the tests.



DO160 Table 16-1: Test conditions for equipment with digital circuits.

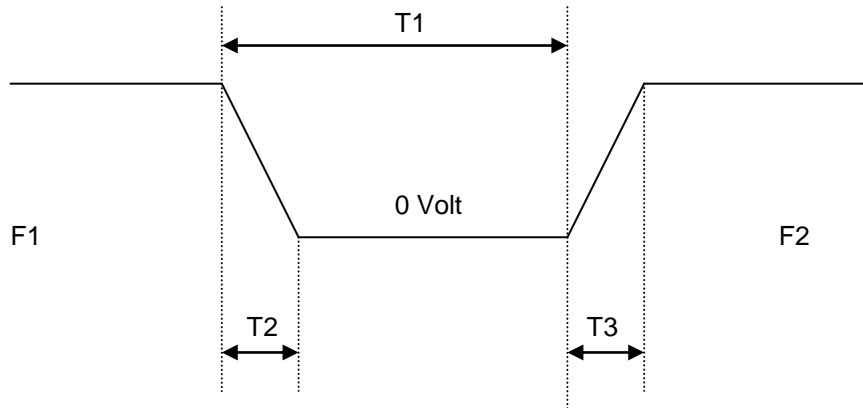
- NOTES
- 1: Definitions:
    - T1 Power interrupt time
    - T2 Time it would take for the applied voltage to decay from V (nom) to zero volts.
    - T3 Time it would take for the applied voltage to rise from zero to V (nom) volts.
    - V MIN The minimum level (expressed as a percentage of V NOMINAL) to which the applied voltage is permitted to decay.
  - 2: Tolerance to T1, T2, T3 =  $\pm 10\%$
  - 3: Test condition numbers 8 and 15 are for category Z, dc powered equipment only.

Applicable Category:	A				A, Z			Z	A, B, Z			A, Z			Z
Test Condition No.	1**	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T1 (ms)	2**	10	25	50	75	100	200	1000	10	25	50	75	100	200	1000
T2 (ms)	<1	20*	20	20	20	20	20	20	50*	50*	50	50	50	50	50
T3 (ms)	<1	5	5	5	5	5	5	5	20	20	20	20	20	20	20
%V Nom. (V min)	0	50	15	10	5	0	0	0	80	50	0	15	5	0	0

\* Voltage will not reach zero in this test condition.

\*\* Equipment performance standards may require to repeat test n°1 with T1 varying from 5 to 200 ms by step defined in the test equipment performance standards (step typically comprised between 5 ms and 20 ms depending on equipment design).

Figure 9-6: Power Interrupt



Test no.	21(I)	22(II)	23(III)	24(IV)	25(V)	26(VI)
T1 (ms)	50	50	100	100	200	200
F1 (Hz)	360	Fmax	360	Fmax	360	Fmax
F2 (Hz)	Fmax	360	Fmax	360	Fmax	360

Fmax = 650 Hz for Group 2

Fmax = 800 Hz for Group 3

T2 = 20 msec

T3 = 5 msec

Figure 9-7: Power Interrupt for Group 2 and 3

## VOLTAGE SURGE

This test requires 160 volts output. If the power source is set at the low voltage range, the high voltage range will be selected before the test starts. At the end of the test, the power source will be switched back to the low range automatically.

Seq. No.	Voltage				Time
	RTCA	Group 1	Group 2	Group 3	ALL
1	115	115	115	115	5 Minute
2	160	160	160	170	30msec
3	115	115	115	115	5 Sec.
4	60	70	70	70	30msec
5	115	115	115	115	5 Sec.

Table 9-4: Normal Voltage Surge Sequence

The output voltage will follow the sequence in Table 9-4. The above sequence will repeat itself three times. Each repeat will start from sequence two. US and Group 1 will run at 400 Hz. Group 2 and Group 3 will run at 360 Hz and 650 Hz for Group 2 and 800 Hz for Group 3. The frequency will return to the nominal setting when the test is completed. The ← key (backspace) will terminate the test at any time.

**FREQUENCY TRANSIENTS** (Group 1 only)

Seq. No	Frequency	Time
1	400	5 Minute
2	440	150msec
3	400	5Sec.
4	350	150msec
5	400	5Sec.

*Table 9-5: Normal Frequency Transient Sequence*

This test applies to Group 1 only. At 115 voltage, change the frequency per sequence listed in Table 9-5. The test will cycle 5 times starting from sequence 2.

**FREQUENCY VARIATION** (Group 2 and 3 only)

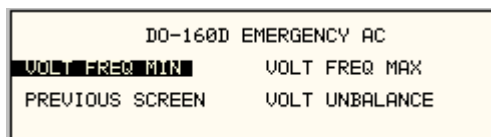
Seq. No	Initial Frequency		Slew rate Hz/Sec	Final Frequency	
	Group2	Group3		Group2	Group3
1	360	360	100	650	800
2	650	800	100	360	360
3	360	360	Pause 5 sec	360	360

*Table 9-6: Normal Frequency Variation Sequence*

This test will apply to Group 2 and 3 only. At 115 voltage, the frequency is set to 360Hz for 5 minutes. The frequency is slowed per sequence listed in Table 9-6. The test will cycle 3 times. The frequency will return to nominal after the test is completed.

**9.1.1.5.2 EMERGENCY TEST**

From the DO160 MENU scroll to the EMERGENCY AC entry using the up and down cursor keys. Press the ENTER key to select the EMERGENCY screens. The screen will appear as shown in Figure 9-8.

*Figure 9-8: Emergency Screen*

The EMERGENCY SCREEN has the following tests:

- 1 VOLT FREQ MIN
- 2 VOLT FREQ MAX
- 3 VOLT UNBALANCE

The above tests can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test.

**VOLT FREQ MIN**

Standard/Group		RTCA	Group1	Group2	Group3
Voltage	1 $\Phi$	100	104	104	104
	3 $\Phi$	101.5	105.5	105.5	105.5
Frequency		360	360	360	360

*Table 9-7: Emergency Voltage and Frequency Minimum*

Standard/Group		RTCA	Group1	Group2	Group3
Voltage	1 $\Phi$	122	122	122	122
	3 $\Phi$	120.5	120.5	120.5	120.5
Frequency		440	440	650	800

*Table 9-8: Emergency Voltage and Frequency Maximum*

This test will set the voltage and frequency for a level defined by Table 9-7. The test will last for 30 minutes. The test will be repeated using the voltage from Table 9-8 and frequency from Table 9-7. The ← key (backspace) will terminate the test at any time.

**VOLT FREQ MAX**

This test will set the voltage and frequency for a level defined by Table 9-8. The test will last for 30 minutes. The test will be repeated using the voltage from Table 9-7 and frequency from Table 9-8. The ← key (backspace) will terminate the test at any time.

**VOLT UNBALANCE**

Standard/Group	RTCA	Group1	Group2	Group3
Voltage offset	8	8	8	12
Frequency	400	400	360/650	360/800

*Table 9-9: Emergency Voltage Unbalance*

This test will change the output voltage for each phase from 115 volts to 115V + offset. Refer to Table 9-9 for the offset value and the Frequency. The test will last 30 minutes. The test will be repeated for a second Frequency if applicable. The ← key (backspace) will terminate the test at any time.

### 9.1.1.5.3 ABNORMAL TEST

From the DO160 MENU Scroll to the ABNORMAL AC entry using the up and down cursor keys. Press the ENTER key to select the ABNORMAL screens. The screen will appear as shown in Figure 9-9.

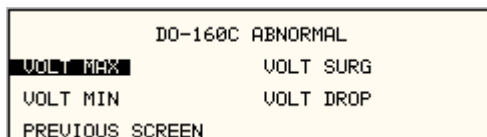


Figure 9-9: Abnormal Screen

The ABNORMAL SCREEN has the following tests:

- 1 VOLT MAX
- 2 VOLT MIN
- 3 VOLT SURG
- 4 VOLT DROP
- 5 FREQ TRANSIENTS

The above test can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test.

#### VOLT MAX

Standard/Group		RTCA	Group1		Group2	Group3
Voltage	1	97	97	104	97	97
	3	98.5	98.5	105.5	98.5	98.5
Frequency		400	400	370	360	360

Table 9-10: Abnormal Voltage Minimum

Standard/Group		RTCA	Group1		Group2	Group3
Voltage	1	134	134	122	134	134
	3	120.5	132.5	120.5	132.5	132.5
Frequency		400	400	430	650	800

Table 9-11: Abnormal Voltage Maximum

This test will set the voltage and frequency to levels defined by Figure 9-10 for 5 minutes. The test will be repeated for Group1 only as indicated in Table 9-10 for voltage and Table 9-11 for frequency. All Groups will repeat the test using Table 9-10 for the voltage setting and Table 9-10 or Table 9-11 for the frequency setting. The ← key (backspace) will terminate the test at any time.

**VOLT MIN**

This test will set the voltage and frequency to levels defined by Table 9-11 for 5 minutes. The test will be repeated for Group1 only as indicated in Table 9-11. All Groups will repeat the test using Table 9-11 for the voltage setting and Table 9-10 for the frequency setting. The ← key (backspace) will terminate the test at any time.

**VOLT UNDER**

This test will drop the output voltage from 115 volts to 60 volts for 7 seconds.

**VOLT SURGE**

This test requires 180 volts output. If the power source is set at the low voltage range, the high voltage range will be selected before the test starts. At the end of the test the AC source will be switched back to the low range.

The output voltage will surge to 180 volts for 100 ms. followed by drop to 148 volts for 1 sec before it returns to 115 volts. The ← key (backspace) will terminate the test at any time.

**FREQUENCY TRANSIENTS (Group 1 only)**

Seq. No.	Frequency	Time
1	400	5 minutes
2	480	5 sec.
3	400	10 sec.
4	320	5 sec.
5	400	10 sec.

*Table 9-12: Abnormal Frequency Transient*

This test will set the voltage at 115V and will remain at this voltage through out the test. The test will cycle the frequency three times as shown in Table 9-12. Each repeat will start from sequence 2.

### 9.1.1.6 DC TESTS

If the output voltage is set for 24V DC or 14V DC the DO-160 DC Main selection screen will appear as seen in Figure 9-10.

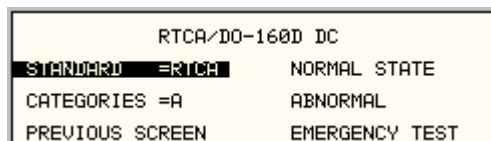


Figure 9-10: DO-160 DC Main Menu

Note: Prior to test selection the Standard selection and Category selection are required. Use the shuttle to select Standard RTCA or EUROCAE. Also, select equipment category A, B or Z.

#### 9.1.1.6.1 Normal State Test

Scroll to the NORMAL STATE entry using the up and down cursor keys. Press the ENTER key to select the NORMAL STATE screen. The screen will appear as shown in Figure 9-11.

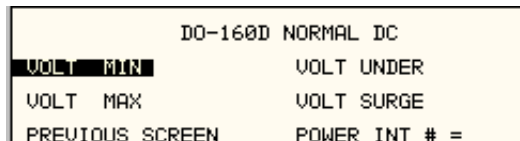


Figure 9-11: Normal State

The DO-160 NORMAL screen has the following tests:

1. VOLT MIN
2. VOLT MAX
3. VOLT UNDER
4. VOLT SURGE
5. POWER INTERRUPT

The above tests can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test. For some of these tests, numeric data entry may be required to define the test number or the modulation rate.

#### VOLT MIN

Standard	Categories		
	A and Z	B 28V / 14V	
RTCA	22.0	22.0	11.0
EUROCAE	22.0	25.1	12.5

Table 9-13: Normal Voltage Minimum

This test will change the output voltage from 28V or 14V to 22V or 11V. The test will last for 30 minutes. The ← (backspace) will terminate the test at any time.



**VOLT MAX**

Standard	Categories		
	A and Z	B 28V / 14V	
RTCA	30.3	30.3	15.1
EUROCAE	30.3	29.3	14.6

*Table 9-14: Normal Voltage Maximum*

This test will change the output voltage from 28V or 14V to 30.3V or 15.1V. The test will last for 30 minutes. The ← (backspace) will terminate the test at any time.

**VOLT UNDER**

This test applies to category Z and 28 volt category B equipment. The output voltage will drop to 10 volts and will ramp up at a rate of 0.15 volt/sec for the US standard and at a rate of 0.30 volt/sec for EUROCAE standard for 30 seconds before it returns to nominal value.

**VOLT SURGE**

This test will surge and sag the voltage to a level and duration specified Table 9-15 with 5 seconds between transients. The test is repeated three times.

Category	Surge			Sags		
	Volt		Dwell(msec)	Volt		Dwell(msec)
	RTCA	EUR		US	EUR	
A	40	40	30	15	17	30
B	40	40	30	15	17	30
Z	50	50	50	12	12	30

*Table 9-15: Voltage Surge***POWER INTERRUPT**

Refer to section POWER INTERRUPT.

#### 9.1.1.6.2 Abnormal Test

From the DO-160 MENU scroll to the ABNORMAL DC entry using the up and down cursor keys. Press the ENTER key to select the ABNORMAL screen. The screen will appear as shown Figure 9-12.

DO-160D ABNORMAL DC	
VOLT MAX	VOLT LOW
VOLT MIN	VOLT DROP
PREVIOUS SCREEN	VOLT SURGE

*Figure 9-12: Abnormal State*

The Abnormal Test has the following tests:

1. VOLT MIN
2. VOLT MAX
3. VOLT LOW
4. VOLT DROP
5. VOLT SURGE

The above tests can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test.

##### **VOLT MIN**

This test will change the output voltage from 28V or 14V to 20.5V or 10V. The test will last for 30 minutes. The ← key (backspace) will terminate the test at any time.

##### **VOLT MAX**

This test will change the output voltage from 28V or 14V to 32.2V or 16V. The test will last for 30 minutes. The ← key (backspace) will terminate the test at any time.

##### **VOLT LOW**

This test applies for category B equipment.

This test will change the output voltage to the voltage minimum for one minute. The voltage will decay linearly to zero voltage in a ten minute period before returning to its nominal voltage.

##### **VOLT DROP**

This test will change the output to 12V from 28V or to 6V from 14V for seven seconds. The output voltage will return to nominal voltage after seven seconds.

**VOLT SURGE**

This test will produce voltage surge defined by Table 9-16. This test will be repeated three times with ten seconds intervals. The voltage values are halved for 14.0V category B equipment.

Category	Surge 1		Surge 2	
	Volt	Dwell(msec)	Volt	Dwell(msec)
A	46.3	100	37.8	1000
B	60	100	40	1000
Z	80	100	48	1000

*Table 9-16: Abnormal Voltage Surge*

**9.1.1.6.3 Emergency Test**

The Emergency test is selected from the DO-160 DC Main Menu. This test will set the output voltage to 18V for 28V equipment and to 9V for 14V equipment. The test will last for 30 minutes. The ← key (backspace) will terminate the test at any time.

### 9.1.2 Option –160: RTCA/DO-160 Rev E Tests (Software)

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Use of this option requires the following:

- iX Series<sup>1</sup> Power Source with firmware version 2.38 or higher.
- -160 option. Options installed are listed on unit's serial tag or shown on Configuration screen.
- Windows XP/2000 PC with RS232C or National Instruments GPIB controller interface. California Instruments recommends the use of the GPIB interface for best performance.
- CIGui32 Windows software revision 1.26 or higher. Provided on CI P/N CIC496 CD ROM or available for download from California Instruments' website.
- For specific tests, additional test equipment may be required to perform all section 16 tests.

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#### ***Table of Contents - 160 Option Manual Section.***

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9.1.2.1	General
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9.1.2.4	General Test Procedure
9.1.2.5	Initial Setup
9.1.2.6	CIGui32 160 Control Window
9.1.2.7	160 Menus
9.1.2.8	160 Test Selection
9.1.2.9	160 Test Control
9.1.2.10	EUT Performance Measurements
9.1.2.11	Test Description Files – Creating Custom Tests
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#### ***9.1.2.1 General***

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The -160 option supports RTCA/DO-160 rev E, Section 16, voltage and frequency immunity tests in either of the AC or DC modes. This option can only be used in conjunction with the provided CIGui32 Windows application software due to the amount of selections and data presentation involved. As such, these tests require the use of a PC running Windows XP / 2000 and cannot be operated from the front panel.

The –160 option is based on the RTCA/DO-160 Environmental Conditions and Test Procedures for Airborne Equipment: Section 16 – Power Input dated December 9 2004.

Future revisions of the RTCA/DO-160 directive may be issued over time and updates may be made available to cover any changes in test levels, durations, procedures etc. Furthermore, the –160 option is completely data file driven to allow a large degree of customization by the end-user if needed so many changes can be supported without the need for software updates.

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<sup>1</sup> Note: This DO160 Rev E implementation uses arbitrary waveform capabilities, harmonic measurements and AC+DC mode, none of which are supported on i Series models. Contact California Instruments for information on upgrading i Series models to iX Series.

This section of the manual covers operation of the –160 option using the CIGui32 program. Version 1.26 or higher of the CIGui32 program is required. The CIGui32 program is supplied with all iX systems free of charge on CD ROM CIC496. It can also be downloaded from the California Instruments web site ([www.calinst.com](http://www.calinst.com)).

The information provided in this user manual is aimed at guiding the operator in the use of the 160 option through the use of the CIGui32 program. Much of the same information can be found in the on-line help system of the CIGUI32.

This manual is **not** intended to elaborate on the intent or purpose of the immunity tests and the expected behavior of the EUT as described in the RTCA/DO-160 documents. It is assumed that the end-user is familiar with the content of the RTCA/DO-160 test standard.

### 9.1.2.2 Test Coverage

The comprehensiveness of the tests that can be performed with the –160 option is determined primarily by the capabilities of the power source used. Tests that are outside the hardware capabilities of the power source used will not be enabled and cannot be selected. For these tests, additional equipment may be required as indicated. The extent of coverage of the –160 option as implemented on the iX Series platform is shown in the table below. Tests marked with an 'x' generally require additional hardware to be used. Tests marked 'N/A' are not applicable to the corresponding table. Tests marked with a '√' are covered by the –160 option. Tests marked with a 'P' are limited in scope and may require additional equipment to perform completely.

No.	115V Tests Description	Table A(CF)	Table A(NF)	Table A(WF)	No.	28 VDC Tests Description	Table ADC	Table BDC	Table ZDC
16.5.1.1	Voltage and Frequency	√	√	√	16.6.1.1	Voltage	√	√	√
16.5.1.2	Voltage Modulation	√	√	√	16.6.1.2	Ripple Voltage	P	P	P
16.5.1.3	Frequency Modulation	√	√	√	16.6.1.3	Momentary Power Interruptions	√	√	√
16.5.1.4	Momentary Power Interruptions	√	√	√	16.6.1.4	Normal Surge Voltage	√	√	√
16.5.1.5.1	Normal Surge Voltage	√	√	√	16.6.1.5	Engine Starting Under Voltage	N/A	√	√
16.5.1.5.2	Normal Frequency Transients	√	N/A	N/A	16.6.2.1	Abnormal Voltage	√	√	√
16.5.1.6	Normal Frequency Variations	N/A	√	√	16.6.2.2	Low Voltage Conditions	N/A	√	N/A
16.5.1.7	Voltage DC Content	√	√	√	16.6.2.3	Momentary Under Voltage Operation	√	√	√
16.5.1.8	Voltage Distortion	P	P	P	16.6.2.4	Abnormal Voltage Surge	√	√	√
16.5.2.1	Abnormal Voltage and Frequency	√	√	√					
16.5.2.2	Momentary Under Voltage Operation	√	√	√					
16.5.2.3.1	Abnormal Surge Voltage	√	√	√					
16.5.2.3.2	Abnormal Frequency Transient	√	N/A	N/A					

Table 9-17: -160 Option Test Coverage, 115VAC and 28VDC

No.	230V Tests Description	Table A(CF)	Table A(NF)	Table A(WF)	No.	14 VDC Tests Description	Table ADC	Table BDC	Table ZDC
16.5.1.1	Voltage and Frequency	√	X	X	16.6.1.1	Voltage	√	√	√
16.5.1.2	Voltage Modulation	√	X	X	16.6.1.2	Ripple Voltage	P	P	P
16.5.1.3	Frequency Modulation	√	X	X	16.6.1.3	Momentary Power Interruptions	√	√	√
16.5.1.4	Momentary Power Interruptions	√	X	X	16.6.1.4	Normal Surge Voltage	√	√	√
16.5.1.5.1	Normal Surge Voltage	X	X	X	16.6.1.5	Engine Starting Under Voltage	N/A	√	√
16.5.1.5.2	Normal Frequency Transients	√	X	X	16.6.2.1	Abnormal Voltage	√	√	√
16.5.1.6	Normal Frequency Variations	N/A	X	X	16.6.2.2	Low Voltage Conditions	N/A	√	N/A
16.5.1.7	Voltage DC Content	√	X	X	16.6.2.3	Momentary Under Voltage Operation	√	√	√
16.5.1.8	Voltage Distortion	P	X	X	16.6.2.4	Abnormal Voltage Surge	√	√	√
16.5.2.1	Abnormal Voltage and Frequency	√	X	X					
16.5.2.2	Momentary Under Voltage Operation	√	X	X					
16.5.2.3.1	Abnormal Surge Voltage	X	X	X					
16.5.2.3.2	Abnormal Frequency Transient	√	X	X					

Table 9-18: -160 Option Test Coverage, 230VAC and 14VDC

**Note** that the iX Series does not support 800 Hz testing at more than 150Vrms. Consequently, all 230V nominal tests for A(NF) and A(WF) categories are not supported. Some A(CF) tests requiring more than 300V output are also unavailable due to hardware limitations of the iX Series power source.

### 9.1.2.3 Specific Test Limitations and Discrepancies

While every effort has been made to provide comprehensive coverage of the RTCA/DO-160 tests, some limitations apply, largely due to hardware limitations of the iX power source such as available programming resolution or rounding. The following table lists specific implementation issues by test number. The deviation from the standard requirement is shown in the “Actual setting” column. The reason for the deviation is shown in the last column.

Vnom	Test	Std requirement	Actual setting	Reason
230VAC	A(NF)		No Tests Performed	Max. output voltage limitation
230VAC	A(WF)		No Tests Performed	Max. output voltage limitation
115VAC	A(CF):16.5.1.2	115 +/- .18 Vrms	115 +/- .2 Vrms	Resolution
115VAC	A(NF):16.5.1.2	115 +/- .18 Vrms	115 +/- .2 Vrms	Resolution
115VAC	A(WF):16.5.1.2	115 +/- .18 Vrms	115 +/- .2 Vrms	Resolution
115VAC	A(CF):16.5.1.2	115 +/- 1.24 Vrms	115 +/- 1.2 Vrms	Resolution
115VAC	A(NF):16.5.1.2	115 +/- 1.24 Vrms	115 +/- 1.2 Vrms	Resolution
115VAC	A(WF):16.5.1.2	115 +/- 1.24 Vrms	115 +/- 1.2 Vrms	Resolution
230VAC	A(CF):16.5.1.2	230 +/- .36 Vrms	230 +/- .4 Vrms	Resolution
230VAC	A(CF):16.5.1.2	230 +/- 2.48 Vrms	230 +/- 2.5 Vrms	Resolution
115VAC	A(CF):16.5.1.3	400Hz mod by .75Hz	400Hz mod by .8Hz	Resolution
115VAC	A(NF):16.5.1.3	360Hz mod by .75Hz	360Hz mod by .8Hz	Resolution
115VAC	A(NF):16.5.1.3	650Hz mod by .75Hz	650Hz mod by .8Hz	Resolution
115VAC	A(WF):16.5.1.3	360Hz mod by .75Hz	360Hz mod by .8Hz	Resolution
115VAC	A(WF):16.5.1.3	800Hz mod by .75Hz	800Hz mod by .8Hz	Resolution
230VAC	A(CF):16.5.1.3	400Hz mod by .75Hz	400Hz mod by .8Hz	Resolution
230VAC	A(CF):16.5.1.5.1	320V Transient	Test skipped	Requires additional equipment
230VAC	A(CF):16.5.2.3.1	360V Transient	Test skipped	Requires additional equipment
14VDC	ADC:16.6.1.1	15.15 V nom	15.2 V nom	Resolution
14VDC	BDC:16.6.1.1	15.15 V nom	15.2 V nom	Resolution
14VDC	ZDC:16.6.1.1	15.15 V nom	15.2 V nom	Resolution
28VDC	ADC:16.6.1.2	> 5 kHz ripple voltage	Test skipped	Requires additional equipment
28VDC	BDC:16.6.1.2	> 5 kHz ripple voltage	Test skipped	Requires additional equipment
28VDC	ZDC:16.6.1.2	> 5 kHz ripple voltage	Test skipped	Requires additional equipment
14VDC	ADC:16.6.1.2	> 5 kHz ripple voltage	Test skipped	Requires additional equipment
14VDC	BDC:16.6.1.2	> 5 kHz ripple voltage	Test skipped	Requires additional equipment
14VDC	ZDC:16.6.1.2	> 5 kHz ripple voltage	Test skipped	Requires additional equipment
14VDC	ADC:16.6.2.1	10.25 V nom	10.3 V nom	Resolution
14VDC	BDC:16.6.2.1	10.25 V nom	10.3 V nom	Resolution
14VDC	ZDC:16.6.2.1	10.25 V nom	10.3 V nom	Resolution
14VDC	ADC:16.6.2.4	23.15V in transient	23.2V in transient	Resolution

#### 9.1.2.4 General Test Procedure

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Generally, the following steps are needed to perform a 160 test on an EUT.

1. Connect the EUT to the power source.
2. Select the correct mode of operation for the EUT, AC or DC mode, single or three-phase mode.
3. Program the relevant nominal voltage and frequency using the CIGui32 main screen.
4. Apply power by closing the output relay. This can be done at a later stage or will be done automatically after prompting the operator when a test is started.
5. Open the RTCA/DO-160 Revision E control screen from the Applications menu or click on the 160 toolbar icon.
6. Select the correct airframe directory or use the default DO160\_RevE.
7. Select the correct Power Group Test Category.
8. Select a test from the test table displayed in the bottom part of this screen. You can select a test by clicking on a row. The selected row will be highlighted.
9. Switch to the **Test Control** tab (middle tab along the top of the screen).
10. Verify that the test sequence and description shown in the table on the Test Control screen is indeed the desired test.
11. Click the Start button to initiate the test.
12. Observe the test progress monitor at the top of the window and observe the EUT.
13. Wait for test completion. You can Abort a test in progress by clicking the Abort button.
14. Select the **EUT Performance Measurements** tab (Right tab along top of the screen).
15. Click the **Update Meas.** Button located in the top center of the screen. This will initiate a measurement cycle. Measurements in three-phase mode may take some time to complete.
16. Use the tabs located along the top of the measurement tab (**Parameters, Waveforms, Curr Graph and Curr Spectrum**) to review the EUT data. Any anomalies can be noted in the observations tab located on the **Parameters** screen. This information will be included in the test report.
17. Click on the **Print** button or use File, Print to print a test report for this test.
18. Return to step 8 as needed.

The following chapters provide details on the various screens, menus, displays and controls available to the operator to manage the test process.



#### 9.1.2.5 Initial Setup

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The –160 option supports both AC and DC modes of operation. The correct mode is a function of the EUT to be tested and the operator must select the corresponding operating mode first. This can be done from the front panel if needed or using the CIGui32 program. Use of the CIGui32 program for all settings will be assumed for the remainder of this chapter.

The following twelve power groups are covered in the RTCA/DO-160 directive:

Category reference:

- For ac equipment: A(CF), A(NF), and A(WF)
- For dc equipment: A, B, Z
- AC tests can be performed at 115V nominal or 230V nominal, except A(NF) and A(CF) which can only be done at 115V nominal. All AC line voltage shown are L-N.
- DC tests can be performed at 28V nominal or 14V nominal

Definitions:

**A(CF):** designates ac equipment intended for use on aircraft electrical systems where the primary power is from constant frequency (400 Hz) ac system.

**A(NF):** designates ac equipment intended for use on aircraft electrical systems where the primary power is from narrow variable frequency (360 to 650 Hz) ac system.

**A(WF):** designates ac equipment intended for use on aircraft electrical systems where the primary power is from wide variable frequency (360 to 800 Hz) ac system.

**A:** designates dc equipment intended for use on aircraft electrical systems where the dc is generated from primary power supplied from either a constant or variable frequency ac system.

**B:** designates dc equipment intended for use on aircraft electrical systems supplied by engine-driven alternator/rectifiers, or dc generators where a battery of significant capacity is floating on the dc bus at all times.

**Z:** designates dc equipment that may be used on all other types of aircraft electrical systems applicable to these standards. Category Z shall be acceptable for use in lieu of Category A or Category B.

The required steady state output settings for each power group must be selected based on the type of EUT to be tested. These settings can be made from the front panel of the iX Series power source or from the main CIGui32 control screen.

### 9.1.2.6 CIGui32 -160 Control Window

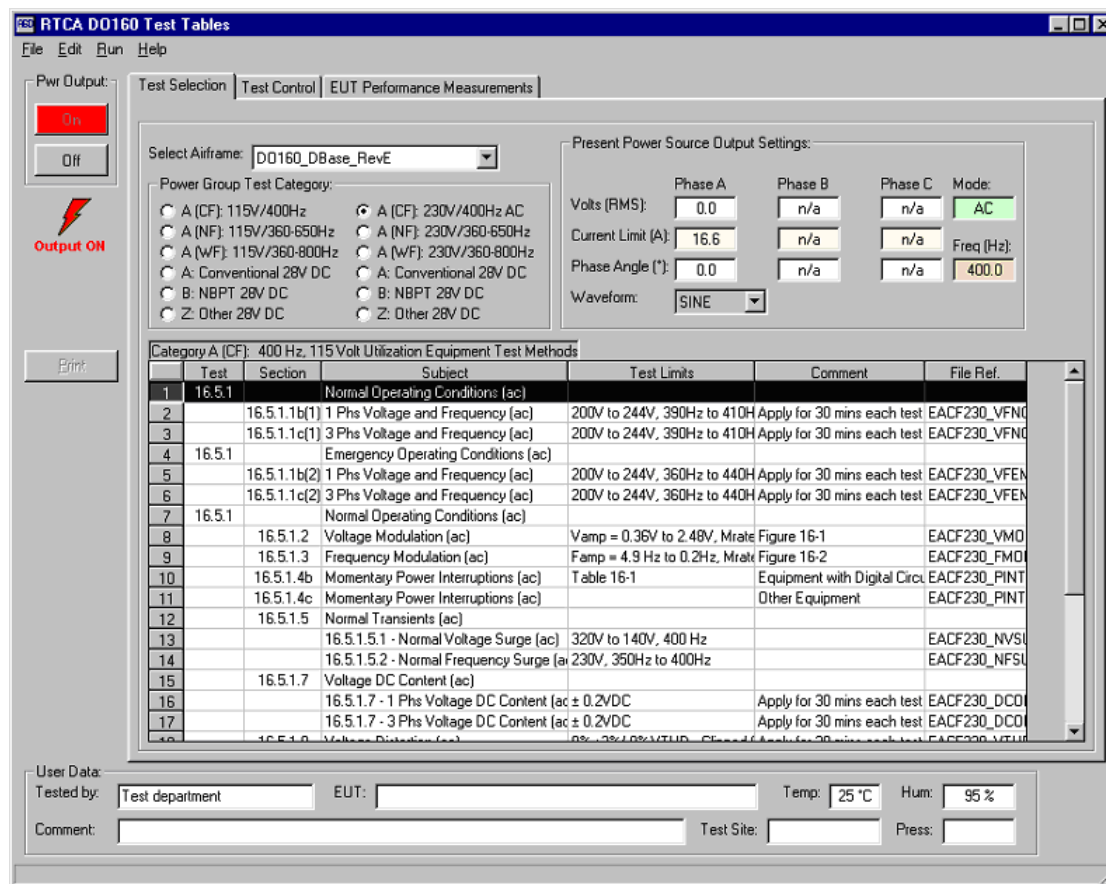


Figure 9-13: 160 Option Test Selection Screen.

To access the –160 option, select the RTCA/DO-160 Revision E from the Applications menu of the CIGui32 main screen or click on the 160 button in the toolbar. The 160 Tables control window will open selecting the last power group that was selected in a previous instance. It may still be necessary to select the desired power group first however. Also verify that the selected power group in the 160 screen is the correct one for the EUT being tested.

The 160 tests can be operated from the 160 test screen. This screen contains three main tabs located along the top edge of the window. The following tabs are available. Click on the tab name for additional help on how to use each tab.

Tab	Description
Test Selection	This tab allows the operator to select the library of test files to use (Select Airframe) and the relevant Power group. It also displays the AC power source settings that are in effect on the right hand side. Available power group selections are shown below the airframe selection field. The table shown at the bottom of this tab shows the available test sections that can be selected. This table matches the test outline of the RTCA/DO-160 test standard.
Test Control	This tab provides information on the test sequence that is presently selected and also contains the execution controls. It shows the progress of any test that is executing.
EUT Performance Measurements	This tab may be used to display EUT performance data as measured by the power source's advanced data acquisition system. If the source used does not support advanced measurement function such as waveform capture and FFT, some of the information in this tab may not be displayed.

In addition to the three tab controls, the left pane of the 160 window contains a set of output on/off control buttons and a print button. The on/off buttons may be used to open or close the output relay of the power source at any time. If the output relay is opened during a test run, the test is automatically aborted when the operator clicks on the Off button. The ON button will be shown in red while the output relay is closed. The Off button is shown in green if the output relay is open. The report print function can be invoked by either clicking on the Print button or using the File, Print menu.

If the GUI program is used in demo mode, the “DEMO MODE ONLY!!!” banner will be displayed in this area as well. In Demo mode, all test runs and all measurements are simulated. This mode may be used to develop new test sequences off-line but any run-time errors will not be detected until executed with an actual power source.

### 9.1.2.7 160 Menus

The top of the 160 window contains a standard Windows menu bar. Available menus are:

Menu	Sub Menu	Description
File	New	The selected clears all data from the Test Control data grid. This operation is not normally recommended unless a complete new test sequence is to be entered manually.
	Open	Opens a specific test sequence file. This menu may be used to directly select a test file without using the Test Selection table tab.
	Save	Saves the contents of the test sequence data grid to the selected test file.
	Save As...	Saves the contents of the test sequence data grid to a user defined file name. A file dialog box will appear enabling selection of the directory and file name under which to store the contents of the test sequence data grid.
	Print	Prints a test report using MS Word format. Only data for the presently selected test sequence is printed. The test reports also include EUT performance measurement data. Note: To print reports, the MS Word report format selection must be made from the Main GUI, Options menu → Report Format menu before opening the 160 test screen. If not, an error prompt will indicate that no supported report format is selected.
	Exit	Closes the 160 test window.
Edit	Cut	Cuts the selected row from either the Test selection data grid or the Test sequence data grid. The data in the row cut is available for a Paste operation.
	Copy	Copies the selected row from either the Test selection data grid or the Test sequence data grid. Copied rows can be pasted to the same grid at a different location.
	Paste	Pastes a copied row from to either the Test selection data grid or the Test sequence data grid.
	Insert Row	Inserts a new blank row at the selected data grid location.
	Delete Row	Deletes the selected row from either the Test selection data grid or the Test sequence data grid. The row contents are permanently discarded.
Run	All	Run selected test
	Stop	Abort test in progress
Help		Opens the on-line help file.

### 9.1.2.8 160 Test Selection

The Test Selections tab in the 160 test window contains the following controls and displays.

Control / Display	Description																				
Select Airframe.	This drop down control allows the operator to select from one or more libraries of test sequences grouped by airframe. This allows multiple sets of test sequences to be organized by application. The GUI program is supplied with a generic DO160_RevE set of test sequences.																				
Power Group Test Table	<p>A library can contain up to twelve power group test tables labeled ACF115, ANF115, AWF115, ACF230, ANF230, AWF230, ADC28, BDC28, ZDC28, ADC14, BDC14, or ZDC14. These table names correspond to the Power Groups identified in the RTCA/DO-160 standard. The operator cannot select a group that is not supported by the present mode of operation of the power source. Thus, if the power source is in AC mode, an error message will be displayed when trying to select a DC group. Operating modes such as AC or DC must be changed from the main GUI screen. The 160 screen can remain open while switching back to the main screen. Upon return to the 160 screen, the relevant power groups can be selected.</p> <p>Available power groups are:</p> <table> <tr> <td>A(CF)</td><td>115V / 400 Hz (CF) AC Power tests.</td></tr> <tr> <td>A(NF)</td><td>115V / 360 – 650 Hz (VF) AC Power tests.</td></tr> <tr> <td>A(WF)</td><td>115V / 360 - 800 Hz (VF) AC Power tests.</td></tr> <tr> <td>A</td><td>28 VDC Power Tests</td></tr> <tr> <td>B</td><td>28 VDC Power Tests</td></tr> <tr> <td>Z</td><td>28 VDC Power tests.</td></tr> <tr> <td>A(CF)</td><td>230V / 400 Hz (CF) AC Power tests.</td></tr> <tr> <td>A</td><td>14 VDC Power Tests</td></tr> <tr> <td>B</td><td>14 VDC Power Tests</td></tr> <tr> <td>Z</td><td>14 VDC Power tests.</td></tr> </table> <p>The operator needs to determine what the relevant power group selection is for the unit under test. (EUT). When switching power groups, the table data shown at the bottom of this tab will be updated to reflect the new selection. The first test section of the table will automatically be selected when switching power groups.</p>	A(CF)	115V / 400 Hz (CF) AC Power tests.	A(NF)	115V / 360 – 650 Hz (VF) AC Power tests.	A(WF)	115V / 360 - 800 Hz (VF) AC Power tests.	A	28 VDC Power Tests	B	28 VDC Power Tests	Z	28 VDC Power tests.	A(CF)	230V / 400 Hz (CF) AC Power tests.	A	14 VDC Power Tests	B	14 VDC Power Tests	Z	14 VDC Power tests.
A(CF)	115V / 400 Hz (CF) AC Power tests.																				
A(NF)	115V / 360 – 650 Hz (VF) AC Power tests.																				
A(WF)	115V / 360 - 800 Hz (VF) AC Power tests.																				
A	28 VDC Power Tests																				
B	28 VDC Power Tests																				
Z	28 VDC Power tests.																				
A(CF)	230V / 400 Hz (CF) AC Power tests.																				
A	14 VDC Power Tests																				
B	14 VDC Power Tests																				
Z	14 VDC Power tests.																				
Present Power Source Output Settings	This section displays the programmed steady state settings that are in effect. This information is updated each time the 160 form regains focus. The mode of operation (AC, DC or AC+DC) is displayed for reference but cannot be changed from this screen. When in DC mode, the frequency setting will show “DC”. Note that changes in steady state settings can only be made from the main GUI screen. The operator can toggle between the main screen and the 160 screen for this purpose as needed.																				
Table Header	The table header is shown against a blue background and contains the table reference designator and a description of the selected power group.																				
Test Table Display	<p>The data grid at the bottom of the tab displays the selected power group test table. It is also used to select the specific test section and number to be executed. Thus, every test starts by selecting the desired test step from this table. Clicking on the desired ROW does this. The selected row will be highlighted and the associated file shown in the File Ref. Field will be loaded in the Test Control tab.</p> <p>For better readability, the user can adjust the column widths by dragging the dividers between columns. If the window is too small to display all rows and columns, scroll bars will appear at the bottom and/or right of the data grid. The following fields are displayed in the test data tables.</p> <table> <tr> <td>Test</td><td>Number of the test from the RTCA/DO-160 standard. For sub sections of a test number, this field will be blank.</td></tr> <tr> <td>Section</td><td>Test section. Some tests may only have one section in which case this field is blank.</td></tr> <tr> <td>Subject</td><td>Description of the type of test.</td></tr> <tr> <td>Test Limits</td><td>A summary of the test limits that will be applied by this test.</td></tr> <tr> <td>Comment</td><td>Comments concerning this test or its parameters.</td></tr> </table>	Test	Number of the test from the RTCA/DO-160 standard. For sub sections of a test number, this field will be blank.	Section	Test section. Some tests may only have one section in which case this field is blank.	Subject	Description of the type of test.	Test Limits	A summary of the test limits that will be applied by this test.	Comment	Comments concerning this test or its parameters.										
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Section	Test section. Some tests may only have one section in which case this field is blank.																				
Subject	Description of the type of test.																				
Test Limits	A summary of the test limits that will be applied by this test.																				
Comment	Comments concerning this test or its parameters.																				

Control / Display	Description	
	File Reference	The test sequence file that is used to implement this test section on the power source.
User Data	The area at the bottom of this tab may be used to enter general information regarding the unit under test, the test location and operator and environmental conditions in effect during the test. This information will be incorporated in the test reports generated by the GUI.	

### 9.1.2.9 160 Test Control

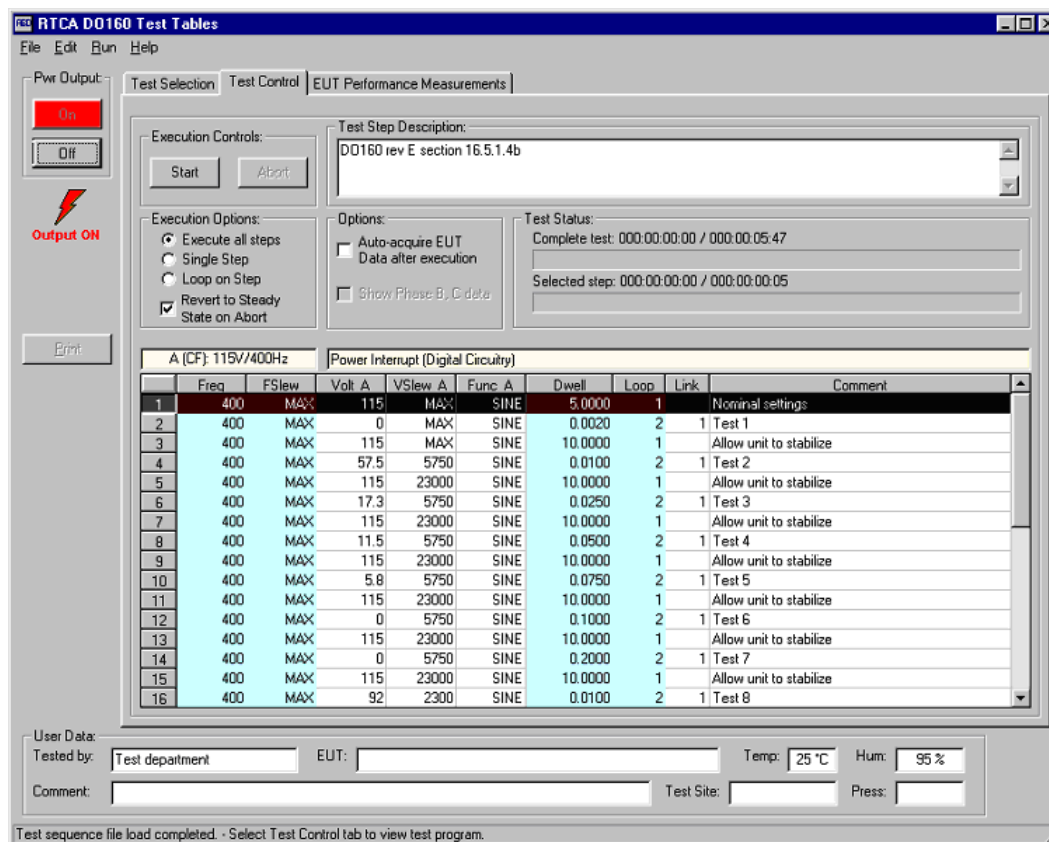


Figure 9-14: 160 Option Test Control Screen.

The Test Control tab in the 160 test window is used to display and execute a selected 160 test. This tab contains the following controls and displays.

Control / Display	Description
Execution Controls	The Start and Abort buttons are used to start and stop the selected test step. The execution mode that will be used is determined by the Execution Options setting. The same can be accomplished using the Run menu entries. When operating in Single Step or Loop mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab as this will be the one used by the program.
Execution Options	The execution options determine the mode of operation when the Start button is clicked. Available execution modes and settings are:
Execute all steps	In this mode, all steps in the test sequence will be executed sequentially until the end of the table is reached.
Single Step	Runs only the selected test step. When operating in Single Step mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab before clicking on the Start button.
Loop on Step	In this mode, the same step will be executed repeatedly until the operator clicks on the Abort button. In this mode, the Complete test progress status bar may run past its maximum and will no longer update as the total test time is determined by the operator now and not the program.
Revert to Steady State	When selected, the output of the power source will be set back to the steady state settings in effect before the start of the test

Control / Display	Description	
	on Abort	when the operator aborts a test. Normally, the output of the source at the end of a test run is determined by the settings in the test sequence file loaded.
Options	This section contains additional options that can be set by the operator as needed. The following options are available:	
	Auto Acquire EUT Data after execution	When set, this option causes the GUI program to initiate an EUT performance data measurement sequence automatically at the end of a test (normal mode) or test step (single step mode).
	Show Phase B, C data	For three-phase EUT's, data for phases B and C can be displayed as well. In most cases, the settings for all three phases are the same and there is no need to display them all as it takes up screen space. However, this is not the case for voltage imbalance tests. This is a display feature only and has no effect on the actual test. Note however that if the power source is in single-phase mode, settings for phase B and C will be ignored. The phase mode of the power source can only be changed from the main GUI screen.
Test Status	This area of the Test Control tab displays test execution status for each individual test step as well as the complete test. The top section shows the complete test time and what part has been completed so far. The bottom section shows the same information for the present test step.	
Test Description	The area at the top of the Test Control tab is used to display additional information about the selected test tab. It is for information purposes only and has no effect on the actual test execution.	
Table Header	The table header is shown against a yellow background and shows the table from which this test sequence was selected.	
Test Sequence Data Grid	The test sequence data grid displays the specific parameters used to program the power source. This data implements the required tests. The parameters are loaded for the referenced ini file in the test table on the Test Selection tab. It is possible to edit this information if needed which allows variations on any of these tests to be made. Any changes can be saved to a new file. The standard provided test files are write protected however and should not be overwritten. The following columns/data fields are available in this table for each test step (row).	
	Step number	Sequential number from 1 through end of sequence.
	Freq	Test frequency in Hz
	FSlew	Frequency slew rate in Hz/sec
	Volt A	Test voltage for phase/output A in Vrms or Vdc depending on mode.
	VSlew A	Voltage slew rate in V/sec
	Func A	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.
	Volt B	Test voltage for phase/output B in Vrms or Vdc depending on mode.
	VSlew B	Voltage slew rate in V/sec
	Func B	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.
	Volt C	Test voltage for phase/output C in Vrms or Vdc depending on mode.
	VSlew C	Voltage slew rate in V/sec
	Func C	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.
	Dwell	Dwell time in seconds.
	Loop	Repeat count for each step. Default is 1.
	Link	Number of subsequent rows that are linked to this step. This

Control / Display	Description	
		function is required to implement complex transients that require multiple steps with zero time skew. When set to a value other than blank or "0", subsequent rows are considered part of the same test step for single step or loop on step execution modes.
	PhsB	Phase angle of phase B, only visible if phase angle is changed.
	PhsC	Phase angle of phase C, only visible if phase angle is changed.
	Comment	A comment about the specific test step.

#### 9.1.2.10 DC Ripple Test Window - Section 16.6.1.2

DC ripple tests for 28VDC or 14VDC EUT's are provided through a separate control screen. This is required to extend the range of the ripple frequency to 5000 Hz. The actual requirement for DO160 Rev E is testing up to 150 KHz ripple. This is out of the available range of the iX Series power source. To test to the full 150 KHz range, an external audio generator and coupling transformer as outlined in RTCA/DO160, Section 18, Figure 18-1 is required.

The DO160 DC Ripple test screen is available from the main screen, **Applications, RTCA/DO160, DC Ripple Test** menu. Once selected, the DC ripple test control screen is modal and must be closed before any other tests can be run. Opening this screens requires several seconds as the power source is being set up to perform the DC ripple tests. This screen also places the power source in AC+DC mode.

Available test settings are 14VDC or 28VDC nominal, category A,Z or category B and phase/output selection. For single-phase iX systems, only phase A can be selected. The test pattern is fixed per section 18.3.1 with a ripple frequency range from 16 Hz to 5000 Hz per Figure 18-2 (Cat A,Z) or 18-3 (Cat B). The frequency slew rate is 30 minutes for each decade covered or one hour and 15 minutes total. Tests can be aborted sooner if needed.

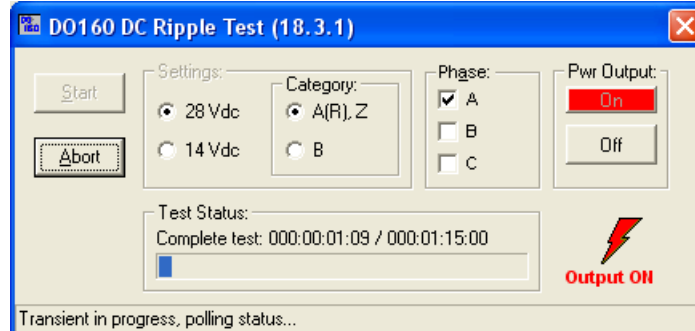


Figure 9-15: DO160E DC Ripple Test Window.



9.1.2.11 160 EUT Performance Measurements

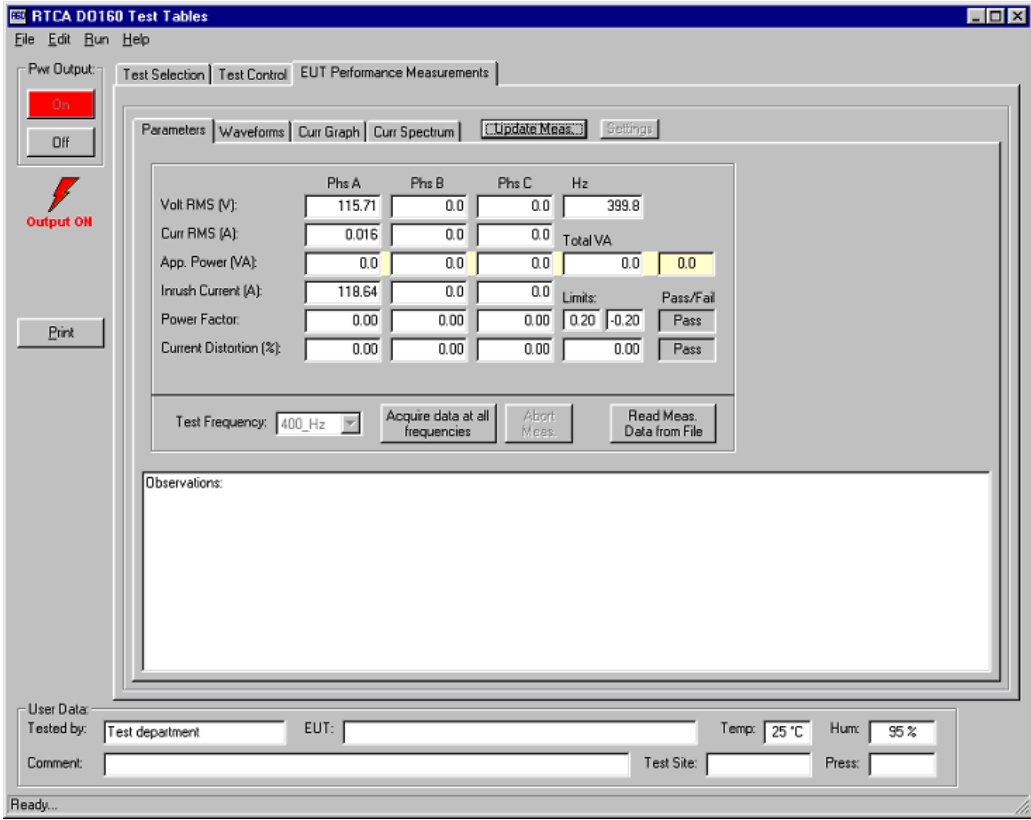


Figure 9-16: 160 Option EUT Measurement Data Screen.

The EUT Performance Measurements tab in the 160 tests window provides measurement data taken by the power source's data acquisition system. This tab contains four sub-tabs that each present different aspects of the EUT measurement data. Additional user controls for measurement updates and graph scaling are provided right next to the four sub tabs. The following sub tabs are available for selection.

Sub-Tab	Description
Parameters	This tab displays the parametric measurement data in tabular form. This includes voltage, current, power, power factor, distortion etc. For three-phase EUT's data is shown for all three phases. For single phase EUT, data is shown for phase A only as long as the power source is in single-phase mode.
	The top half of the Parameters tab displays all parametric measurement data. The following data is available:
	Volt RMS (V) Displays source voltage per phase in Volt RMS or DC depending on power source mode of operation.
	Curr RMS (A) Displays EUT current per phase in amps RMS or DC depending on power source mode of operation.
	App. Power (VA) Displays the apparent power for each phase as well as the total power for all three phases. For three-phase EUT's, any imbalance in power between the three phases is calculated by the GUI. The amount of imbalance is displayed in % of total VA to the right of the power readings.
	Inrush Current (A) Displays peak current detected per phase in Amps since last measurement was taken.
	Power Factor Displays power factor for each phase. If one or more phases

Sub-Tab	Description	
		is outside the allowable limits, a Fail indication is displayed.
	Current Distortion (%)	Displays Total Current Distortion for each phase in percent of fundamental current. No limits are applied although the user can set a maximum limit for this parameter if needed in the "DO160_Distortion_Limits.ini" setting file by adding "lthd = n.n" in either PHASES_1 or PHASES_3 sections..
	The bottom half of the Parameters tab contains user controls and a text entry field for entering observations regarding the EUT operation.	
	Test Frequency Dropdown control	The frequency selection drop down control is active only for Variable Frequency tables and can be used to set the frequency at which data from the EUT is to be acquired. For all other modes, it is fixed to either 400 Hz or DC.
	Acquire Data at all frequencies	This button causes data to be acquired at all frequencies available in the Test Frequency Dropdown control. For all constant frequency, this button functions like the Update Meas. Button located above the sub tabs.
	Abort Meas.	This button aborts measurements in progress. In case of Variable Frequency Tables, acquiring data at all 12 frequency settings can take a long time. This button allows this process to be aborted.
	Read Meas. Data from File	This button reads measurement data from disk. Each time measurement data is acquired by the GUI, it is saved to an ASCII text file. A separate file is used for each frequency or DC setting. To recall data taken at a specific frequency setting, select the desired frequency using the Test Frequency Dropdown control before clicking on this button. Note that all measurement data files are saved in the Reports subdirectory of the GUI application directory using file name convention "MeasData_DO160_nnn_Hz.txt" where 'nnn' is the frequency setting or DC.
Waveforms	This tab displays the voltage and current waveform (time domain) for each phase. The sample rate is automatically set to display about 20 msec of time.	
Cur Graph	This tab displays the Current harmonics in a bar graph format. Up to 50 harmonics are displayed.	
Cur Spectrum	This tab displays the same current harmonics as the Current Graph tab except in a tabular format. Data is shown in both absolute and relative from (percent of fundamental current). A limit table is applied and a pass or fail indication is shown in the last column. Values that exceed the allowable limits are shown with a red background in the Pass/Fail column. Note that the voltage harmonics are used to scale the allowable current limit values per Table 16-6.	
	<b>Note:</b> The iX Series power source measurement bandwidth is less than required to make full compliance current harmonics measurements. This feature is provided for pre-compliance assessment purposes only. A high bandwidth power analyzer with a 100 KHz sampling rate or better is generally required. Harmonics that are outside of the range of the iX measurement system are indicated with a "BWL" (bandwidth limited) label instead of a readout.	
	No.	Harmonic number, 1 through 40
	Freq (Hz)	Frequency of harmonic in Hz.
	Curr (A)	Absolute current (rms) in Amps.
	% Fund.	Relative current in percent of the fundamental current (I1).
	Limit	Allowable current harmonic limits per individual EUT specifications. These limits are located in the file named "DO160_Distortion_Limits.ini" located in the C:\Gui32 application directory. They are set to correspond with the limits called out in Tables 16-4 and 16-5 of the 160 Standard.
	P/F	Pass or Fail indication.
	A phase selection is available to the left of the graphs and table, which allows each phase to be displayed, one at a time.	

Additional user controls located on the EUT Performance Measurements Tab:

Control / Display	Description
Update Meas.	Triggers a new acquisition cycle and updates measurement data for all tabs. For Variable Frequency tables, data will be acquired at the frequency set by the Test Frequency Dropdown control. This button is always available regardless of what sub tab is selected.
Settings	Brings up a dialog box that allows scaling and color changes for the Waveform or Current harmonics graphs. Note that setting changes will apply to graphs for all phases. For current harmonics graphs, only the absolute bar settings apply. The 160 measurement screen does not display relative current harmonic bar charts but relative data is available in tabular format on the Cur Spectrum tab. This button is available only if either the Waveforms or Cur Graph sub tab is selected

### **9.1.2.12 Test Description Files – Creating Custom Tests**

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The 160 option uses a set of configuration files that contain the relevant test descriptions. These files are contained in the DO160\_RevE subdirectory of the CIGUI32 application directory.

The contents of these tables is defined by the “DO160\_Structure\_Tbl\_X.ini” configuration files located in the DO160\_RevE directory. “X” references the relevant table.

The test description files used to perform a specific test are listed in the last column labeled “Test File”. These files must be present in the DO160\_RevE directory or the user directory.

For customer created tests, these file names can be renamed as needed as long as they are correctly referenced in the DO160\_Structure\_Tbl\_X.ini configuration files.

Tests can be customized as needed by editing these table configuration and test sequence files. To do so, create a new subdirectory under the application directory. To access any new sub directory from within the 160 test window, the directory name must be added to the “DO160UserTestLibraries.txt” file located in the CIGui32 application directory. This is a simple text file listing all test description directories available.

Example “DO160UserTestLibraries.txt” file content:

```
MyNew_DBase
Dummy_Dir_Entry
```

These two directories listed will now be available for selection from the AirFrame selection in the 160 Test Setup screen.

To facilitate creating new test directories, it is easiest to create a copy of the DO160\_RevE directory first and rename it as required.

### **9.1.2.13 Test Tables**

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The tables shown on the next few pages list the test sections covered by the –160 option. Where relevant, the numbering used matches that of the RTCA/DO-160 document. Test tables are listed by power group.

**Rev E:****Table A(CF)115:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.1b(1)	1 Phs Voltage and Frequency (ac)	100V to 122V, 390Hz to 410Hz	Apply for 30 mins each test	EACF115_VFNORM1P
	16.5.1.1c(1)	3 Phs Voltage and Frequency (ac)	100V to 122V, 390Hz to 410Hz	Apply for 30 mins each test	EACF115_VFNORM3P
16.5.1		Emergency Operating Conditions (ac)			
	16.5.1.1b(2)	1 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 440Hz	Apply for 30 mins each test	EACF115_VFEMER1P
	16.5.1.1c(2)	3 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 440Hz	Apply for 30 mins each test	EACF115_VFEMER3P
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.2	Voltage Modulation (ac)	Vamp = 0.18V to 1.24V, Mrate = 1Hz to 200Hz	Figure 16-1	EACF115_VMOD
	16.5.1.3	Frequency Modulation (ac)	Famp = 4.9 Hz to 0.2Hz, Mrate = 0.014Hz to 100Hz	Figure 16-2	EACF115_FMOD
	16.5.1.4b	Momentary Power Interruptions (ac)	Table 16-1	Equipment with Digital Circuits	EACF115_PINTB
	16.5.1.4c	Momentary Power Interruptions (ac)		Other Equipment	EACF115_PINTC
	16.5.1.5	Normal Transients (ac)			
		16.5.1.5.1 - Normal Voltage Surge (ac)	160V to 70V, 400 Hz		EACF115_NVSUR
		16.5.1.5.2 - Normal Frequency Surge (ac)	115V, 350Hz to 400Hz		EACF115_NFSUR
	16.5.1.7	Voltage DC Content (ac)			
		16.5.1.7 - 1 Phs Voltage DC Content (ac)	± 0.1VDC	Apply for 30 mins each test	EACF115_DCOFS1P
		16.5.1.7 - 3 Phs Voltage DC Content (ac)	± 0.1VDC	Apply for 30 mins each test	EACF115_DCOFS3P
	16.5.1.8	Voltage Distortion (ac)	8% +2%/-0% VTHD - Clipped Sine, 400Hz	Apply for 30 mins each test	EACF115_VTHD
16.5.2		Abnormal Operating Conditions (ac)			
	16.5.2.1b	1 Phs Voltage (ac)	97V to 134V, 400Hz	Apply for 5 mins each test	EACF115_VABN1P
	16.5.2.1c	3 Phs Voltage (ac)	97V to 134V, 400Hz	Apply for 5 mins each test	EACF115_VABN3P
	16.5.2.1d	1 Phs Voltage and Frequency (ac)	100V to 122V, 370Hz to 430Hz	Apply for 5 mins each test	EACF115_VFABN1P
	16.5.2.1e	3 Phs Voltage and Frequency (ac)	100V to 122V, 370Hz to 430Hz	Apply for 5 mins each test	EACF115_VFABN3P
	16.5.2.2	Momentary Undervoltage (ac)	10V and 60V, 400Hz	Apply for 7 seconds each test	EACF115_VUND
	16.5.2.3	Abnormal Transients (ac)			
		16.5.2.3.1 - Abnormal Voltage surge	148V to 180V, 400Hz	Figure 16.5 - apply at 10 sec intervals	EACF115_AVSUR
		16.5.2.3.1 - Abnormal Frequency transients	0V to 115V, 320Hz to 480Hz	Figure 16.5 - apply at 10 sec intervals	EACF115_AFSUR

**Table A(NF)115:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.1b(1)	1 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 650Hz	Apply for 30 mins each test	EANF115_VFNORM1P
	16.5.1.1c(1)	3 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 650Hz	Apply for 30 mins each test	EANF115_VFNORM3P
16.5.1		Emergency Operating Conditions (ac)			
	16.5.1.1c(2)	3 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 650Hz	Apply for 30 mins each test	EANF115_VFEMER3P
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.2	Voltage Modulation 360Hz (ac)	Vamp = 0.18V to 1.24V, Mrate = 1Hz to 200Hz	Figure 16-1	EANF115_VMOD360
	16.5.1.2	Voltage Modulation 650Hz (ac)	Vamp = 0.18V to 1.24V, Mrate = 1Hz to 200Hz	Figure 16-1	EANF115_VMOD650
	16.5.1.3	Frequency Modulation 360Hz (ac)	Famp = 4.9 Hz to 0.2Hz, Mrate = 0.014Hz to 100Hz	Figure 16-2	EANF115_FMOD360
	16.5.1.3	Frequency Modulation 650Hz (ac)	Famp = 4.9 Hz to 0.2Hz, Mrate = 0.014Hz to 100Hz	Figure 16-2	EANF115_FMOD650
	16.5.1.4b	Momentary Power Interruptions (ac)	Table 16-1 360Hz nom	Equipment with Digital Circuits	EANF115_PINTB360
	16.5.1.4b	Momentary Power Interruptions (ac)	Table 16-1 650Hz nom	Equipment with Digital Circuits	EANF115_PINTB650
	16.5.1.4c	Momentary Power Interruptions (ac)	360Hz nom	Other Equipment	EANF115_PINTC360
	16.5.1.4c	Momentary Power Interruptions (ac)	650Hz nom	Other Equipment	EANF115_PINTC650
	16.5.1.4d	Momentary Power Interruptions (ac)	Table 16-2	Additional Requirement (Var Freq)	EANF115_PINTD
	16.5.1.5	Normal Transients (ac)			
		16.5.1.5.1 - Normal Voltage Surge (ac)	160V to 70V, 360 Hz		EANF115_NV SUR360
		16.5.1.5.1 - Normal Voltage Surge (ac)	160V to 70V, 650 Hz		EANF115_NV SUR650
	16.5.1.6	Normal Frequency Surge (ac)	115V, 360Hz to 650Hz		EANF115_NFSUR
	16.5.1.7	Voltage DC Content (ac)			
		16.5.1.7 - 1 Phs Voltage DC Content (ac)	± 0.1VDC (360Hz nom)	Apply for 30 mins each test	EANF115_DCOFS1P360
		16.5.1.7 - 1 Phs Voltage DC Content (ac)	± 0.1VDC (650Hz nom)	Apply for 30 mins each test	EANF115_DCOFS1P650
		16.5.1.7 - 3 Phs Voltage DC Content (ac)	± 0.1VDC (360Hz nom)	Apply for 30 mins each test	EANF115_DCOFS3P360
		16.5.1.7 - 3 Phs Voltage DC Content (ac)	± 0.1VDC (650Hz nom)	Apply for 30 mins each test	EANF115_DCOFS3P650
	16.5.1.8	Voltage Distortion (ac)	8% +2%/-0% VTHD - Clipped Sine, 360Hz	Apply for 30 mins each test	EANF115_VTHD360
	16.5.1.8	Voltage Distortion (ac)	8% +2%/-0% VTHD - Clipped Sine, 650Hz	Apply for 30 mins each test	EANF115_VTHD650
16.5.2		Abnormal Operating Conditions (ac)			
	16.5.2.1b	1 Phs Voltage (ac)	97V to 134V, 360Hz	Apply for 5 mins each test	EANF115_VABN1P360
	16.5.2.1b	1 Phs Voltage (ac)	97V to 134V, 650Hz	Apply for 5 mins each test	EANF115_VABN1P650
	16.5.2.1c	3 Phs Voltage (ac)	97V to 134V, 360Hz	Apply for 5 mins each test	EANF115_VABN3P360
	16.5.2.1c	3 Phs Voltage (ac)	97V to 134V, 650Hz	Apply for 5 mins each test	EANF115_VABN3P650
	16.5.2.2	Momentary Undervoltage (ac)	10V and 60V, 360Hz	Apply for 7 seconds each test	EANF115_VUND360

	16.5.2.2	Momentary Undervoltage (ac)	10V and 60V, 650Hz	Apply for 7 seconds each test	EANF115_VUND650
	16.5.2.3	Abnormal Transients (ac)			
		16.5.2.3.1 - Abnormal Voltage surge	148V to 180V, 360Hz	Figure 16.5 - apply at 10 sec intervals	EANF115_AVSUR360
		16.5.2.3.1 - Abnormal Voltage surge	148V to 180V, 650Hz	Figure 16.5 - apply at 10 sec intervals	EANF115_AVSUR650

**Table A(WF)115:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.1b(1)	1 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 800Hz	Apply for 30 mins each test	EAWF115_VFNORM1P
	16.5.1.1c.2(1)	3 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 800Hz	Apply for 30 mins each test	EAWF115_VFNORM3P
16.5.1		Emergency Operating Conditions (ac)			
	16.5.1.1c.2(2)	3 Phs Voltage and Frequency (ac)	100V to 122V, 360Hz to 800Hz	Apply for 30 mins each test	EAWF115_VFEMER3P
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.2	Voltage Modulation 360Hz (ac)	Vamp = 0.18V to 1.24V, Mrate = 1Hz to 200Hz	Figure 16-1	EAWF115_VMOD360
	16.5.1.2	Voltage Modulation 800Hz (ac)	Vamp = 0.18V to 1.24V, Mrate = 1Hz to 200Hz	Figure 16-1	EAWF115_VMOD800
	16.5.1.3	Frequency Modulation 360Hz (ac)	Famp = 4.9 Hz to 0.2Hz, Mrate = 0.014Hz to 100Hz	Figure 16-2	EAWF115_FMOD360
	16.5.1.3	Frequency Modulation 800Hz (ac)	Famp = 4.9 Hz to 0.2Hz, Mrate = 0.014Hz to 100Hz	Figure 16-2	EAWF115_FMOD800
	16.5.1.4b	Momentary Power Interruptions (ac)	Table 16-1 360Hz nom	Equipment with Digital Circuits	EAWF115_PINTB360
	16.5.1.4b	Momentary Power Interruptions (ac)	Table 16-1 800Hz nom	Equipment with Digital Circuits	EAWF115_PINTB800
	16.5.1.4c	Momentary Power Interruptions (ac)	360Hz nom	Other Equipment	EAWF115_PINTC360
	16.5.1.4c	Momentary Power Interruptions (ac)	800Hz nom	Other Equipment	EAWF115_PINTC800
	16.5.1.4d	Momentary Power Interruptions (ac)	Table 16-2	Additional Requirement (Var Freq)	EAWF115_PINTD
	16.5.1.5	Normal Transients (ac)			
		16.5.1.5.1 - Normal Voltage Surge (ac)	160V to 70V, 360 Hz		EAWF115_NVSUR360
		16.5.1.5.1 - Normal Voltage Surge (ac)	160V to 70V, 800 Hz		EAWF115_NVSUR800
	16.5.1.6	Normal Frequency Surge (ac)	115V, 360Hz to 800Hz		EAWF115_NFSUR
	16.5.1.7	Voltage DC Content (ac)			
		16.5.1.7 - 1 Phs Voltage DC Content (ac)	± 0.1VDC (360Hz nom)	Apply for 30 mins each test	EAWF115_DCOFS1P360
		16.5.1.7 - 1 Phs Voltage DC Content (ac)	± 0.1VDC (800Hz nom)	Apply for 30 mins each test	EAWF115_DCOFS1P800
		16.5.1.7 - 3 Phs Voltage DC Content (ac)	± 0.1VDC (360Hz nom)	Apply for 30 mins each test	EAWF115_DCOFS3P360
		16.5.1.7 - 3 Phs Voltage DC Content (ac)	± 0.1VDC (800Hz nom)	Apply for 30 mins each test	EAWF115_DCOFS3P800
	16.5.1.8	Voltage Distortion (ac)	10% +2%/-0% VTHD - Clipped Sine, 360Hz	Apply for 30 mins each test	EAWF115_VTHD360
	16.5.1.8	Voltage Distortion (ac)	10% +2%/-0% VTHD - Clipped Sine, 800Hz	Apply for 30 mins each test	EAWF115_VTHD800
16.5.2		Abnormal Operating Conditions (ac)			
	16.5.2.1b	1 Phs Voltage (ac)	97V to 134V, 360Hz	Apply for 5 mins each test	EAWF115_VABN1P360
	16.5.2.1b	1 Phs Voltage (ac)	97V to 134V, 800Hz	Apply for 5 mins each test	EAWF115_VABN1P800



	16.5.2.1c	3 Phs Voltage (ac)	97V to 134V, 360Hz	Apply for 5 mins each test	EAWF115_VABN3P360
	16.5.2.1c	3 Phs Voltage (ac)	97V to 134V, 800Hz	Apply for 5 mins each test	EAWF115_VABN3P800
	16.5.2.2	Momentary Undervoltage (ac)	10V and 60V, 360Hz	Apply for 7 seconds each test	EAWF115_VUND360
	16.5.2.2	Momentary Undervoltage (ac)	10V and 60V, 800Hz	Apply for 7 seconds each test	EAWF115_VUND800
	16.5.2.3	Abnormal Transients (ac)			
		16.5.2.3.1 - Abnormal Voltage surge	148V to 180V, 360Hz	Figure 16.5 - apply at 10 sec intervals	EAWF115_AVSUR360
		16.5.2.3.1 - Abnormal Voltage surge	148V to 180V, 800Hz	Figure 16.5 - apply at 10 sec intervals	EAWF115_AVSUR800

**Table ADC28:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.1b	Voltage (Average Value dc)	22.0V to 30.3V	Apply for 30 mins each test	EADC28_VAVG
16.6.1		Emergency Operating Conditions (dc)			
	16.6.1.1b(3)	Voltage (Average Value dc)	18.0V	Apply for 30 mins each test	EADC28_VAVGEMER
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.2 <sup>1</sup>	Ripple Voltage (dc)	Vp-p = 0.6V to 1.6V, Freq = 10Hz to 200Hz	Figure 18-2	EADC28_VRIP
	16.6.1.3b	Momentary Power Interruptions (dc)	Table 16-3	Equipment with Digital Circuits	EADC28_PINTB
	16.6.1.3c	Momentary Power Interruptions (dc)		Other Equipment	EADC28_PINTC
	16.6.1.4	Normal Transients (dc)			
		16.6.1.4b - Normal Voltage Surge (dc)	47V to 17V		EADC28_NV SUR
16.6.2		Abnormal Operating Conditions (dc)			
	16.6.2.1	Voltage Steady State (dc)	20.5V to 32.2V	Apply for 5 mins each test	EADC28_VABN
	16.6.2.3	Momentary Undervoltage (dc)	12V	Apply for 7 seconds each test	EADC28_VUND
	16.6.2.4	Abnormal Transients (ac)			
		16.6.2.4c - Abnormal Voltage Surge	46.3V	Figure 16-4 - apply at 10 sec intervals	EADC28_AV SUR

<sup>1</sup> For more comprehensive DC Ripple tests, refer to section 9.1.2.10.

**Table BDC28:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.1b	Voltage (Average Value dc)	22.0V to 30.3V	Apply for 30 mins each test	EBDC28_VAVG
16.6.1		Emergency Operating Conditions (dc)			
	16.6.1.1b(3)	Voltage (Average Value dc)	18.0V	Apply for 30 mins each test	EBDC28_VAVGEMER
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.2 <sup>1</sup>	Ripple Voltage (dc)	Vp-p = 1.6V, Freq = 200Hz	Figure 18-2	EBDC28_V RIP
	16.6.1.3b	Momentary Power Interruptions (dc)	Table 16-3	Equipment with Digital Circuits	EBDC28_PINTB
	16.6.1.3c	Momentary Power Interruptions (dc)		Other Equipment	EBDC28_PINTC
	16.6.1.4	Normal Transients (dc)			
		16.6.1.4b - Normal Voltage Surge (dc)	47V to 17V		EBDC28_NV SUR
	16.6.1.5	Engine Starting Under Voltage Operation (dc)	10V min	Slew for 35 sec	EBDC28_VENG
16.6.2		Abnormal Operating Conditions (dc)			
	16.6.2.1	Voltage Steady State (dc)	20.5V to 32.2V	Apply for 5 mins each test	EBDC28_VABN
	16.6.2.2	Low Voltage Conditions (dc)	0V over 10 minutes		EBDC28_LVABN
	16.6.2.3	Momentary Undervoltage (dc)	12V	Apply for 7 seconds each test	EBDC28_VUND
	16.6.2.4	Abnormal Transients (ac)			
		16.6.2.4d - Abnormal Voltage Surge	60VDC	Figure 16-4 - apply at 10 sec intervals	EBDC28_AVSUR

<sup>1</sup> For more comprehensive DC Ripple tests, refer to section 9.1.2.10.

**Table ZDC28:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.1b	Voltage (Average Value dc)	22.0V to 30.3V	Apply for 30 mins each test	EZDC28_VAVG
16.6.1		Emergency Operating Conditions (dc)			
	16.6.1.1b(3)	Voltage (Average Value dc)	18.0V	Apply for 30 mins each test	EZDC28_VAVGEMER
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.2 <sup>1</sup>	Ripple Voltage (dc)	Vp-p = 0.6V to 1.6V, Freq = 10Hz to 200Hz	Figure 18-2	EZDC28_V RIP
	16.6.1.3b	Momentary Power Interruptions (dc)	Table 16-3	Equipment with Digital Circuits	EZDC28_PINTB
	16.6.1.3c	Momentary Power Interruptions (dc)		Other Equipment	EZDC28_PINTC
	16.6.1.4	Normal Transients (dc)			
		16.6.1.4b - Normal Voltage Surge (dc)	50V to 12V		EZDC28_NV SUR
	16.6.1.5	Engine Starting Under Voltage Operation (dc)	10V min	Slew for 35 sec	EZDC28_VENG
16.6.2		Abnormal Operating Conditions (dc)			
	16.6.2.1	Voltage Steady State (dc)	20.5V to 32.2V	Apply for 5 mins each test	EZDC28_VABN
	16.6.2.3	Momentary Undervoltage (dc)	12V	Apply for 7 seconds each test	EZDC28_VUND
	16.6.2.4	Abnormal Transients (ac)			
		16.6.2.4b - Abnormal Voltage Surge	80VDC	Figure 16-4 - apply at 10 sec intervals	EZDC28_AV SUR

<sup>1</sup> For more comprehensive DC Ripple tests, refer to section 9.1.2.10.

**Table A(CF)230:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.1b(1)	1 Phs Voltage and Frequency (ac)	200V to 244V, 390Hz to 410Hz	Apply for 30 mins each test	EACF230_VFNORM1P
	16.5.1.1c(1)	3 Phs Voltage and Frequency (ac)	200V to 244V, 390Hz to 410Hz	Apply for 30 mins each test	EACF230_VFNORM3P
16.5.1		Emergency Operating Conditions (ac)			
	16.5.1.1b(2)	1 Phs Voltage and Frequency (ac)	200V to 244V, 360Hz to 440Hz	Apply for 30 mins each test	EACF230_VFEMER1P
	16.5.1.1c(2)	3 Phs Voltage and Frequency (ac)	200V to 244V, 360Hz to 440Hz	Apply for 30 mins each test	EACF230_VFEMER3P
16.5.1		Normal Operating Conditions (ac)			
	16.5.1.2	Voltage Modulation (ac)	Vamp = 0.36V to 2.48V, Mrate = 1Hz to 200Hz	Figure 16-1	EACF230_VMOD
	16.5.1.3	Frequency Modulation (ac)	Famp = 4.9 Hz to 0.2Hz, Mrate = 0.014Hz to 100Hz	Figure 16-2	EACF230_FMOD
	16.5.1.4b	Momentary Power Interruptions (ac)	Table 16-1	Equipment with Digital Circuits	EACF230_PINTB
	16.5.1.4c	Momentary Power Interruptions (ac)		Other Equipment	EACF230_PINTC
	16.5.1.5	Normal Transients (ac)			
		16.5.1.5.1 - Normal Voltage Surge (ac)	320V to 140V, 400 Hz		EACF230_NVSUR
		16.5.1.5.2 - Normal Frequency Surge (ac)	230V, 350Hz to 400Hz		EACF230_NFSUR
	16.5.1.7	Voltage DC Content (ac)			
		16.5.1.7 - 1 Phs Voltage DC Content (ac)	± 0.2VDC	Apply for 30 mins each test	EACF230_DCOFS1P
		16.5.1.7 - 3 Phs Voltage DC Content (ac)	± 0.2VDC	Apply for 30 mins each test	EACF230_DCOFS3P
	16.5.1.8	Voltage Distortion (ac)	8% +2%/-0% VTHD - Clipped Sine, 400Hz	Apply for 30 mins each test	EACF230_VTHD
16.5.2		Abnormal Operating Conditions (ac)			
	16.5.2.1b	1 Phs Voltage (ac)	194V to 268V, 400Hz	Apply for 5 mins each test	EACF230_VABN1P
	16.5.2.1c	3 Phs Voltage (ac)	194V to 268V, 400Hz	Apply for 5 mins each test	EACF230_VABN3P
	16.5.2.1d	1 Phs Voltage and Frequency (ac)	200V to 244V, 370Hz to 430Hz	Apply for 5 mins each test	EACF230_VFABN1P
	16.5.2.1e	3 Phs Voltage and Frequency (ac)	200V to 244V, 370Hz to 430Hz	Apply for 5 mins each test	EACF230_VFABN3P
	16.5.2.2	Momentary Undervoltage (ac)	20V and 120V, 400Hz	Apply for 7 seconds each test	EACF230_VUND
	16.5.2.3	Abnormal Transients (ac)			
		16.5.2.3.1 - Abnormal Voltage surge	296V to 360V, 400Hz	Figure 16.5 - apply at 10 sec intervals	EACF230_AVSUR
		16.5.2.3.1 - Abnormal Frequency transients	0V to 230V, 320Hz to 480Hz	Figure 16.5 - apply at 10 sec intervals	EACF230_AFSUR

**Table ADC14:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.1b	Voltage (Average Value dc)	11.0V to 15.2V	Apply for 30 mins each test	EADC14_VAVG
16.6.1		Emergency Operating Conditions (dc)			
	16.6.1.1b(3)	Voltage (Average Value dc)	9.0V	Apply for 30 mins each test	EADC14_VAVGEMER
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.2 <sup>1</sup>	Ripple Voltage (dc)	Vp-p = 0.3V to .8V, Freq = 10Hz to 200Hz	Figure 18-2	EADC14_V RIP
	16.6.1.3b	Momentary Power Interruptions (dc)	Table 16-3	Equipment with Digital Circuits	EADC14_PINTB
	16.6.1.3c	Momentary Power Interruptions (dc)		Other Equipment	EADC14_PINTC
	16.6.1.4	Normal Transients (dc)			
		16.6.1.4b - Normal Voltage Surge (dc)	23.5V to 8.5V		EADC14_NVSUR
16.6.2		Abnormal Operating Conditions (dc)			
	16.6.2.1	Voltage Steady State (dc)	10.3V to 16.1V	Apply for 5 mins each test	EADC14_VABN
	16.6.2.3	Momentary Undervoltage (dc)	6V	Apply for 7 seconds each test	EADC14_VUND
	16.6.2.4	Abnormal Transients (ac)			
		16.6.2.4c - Abnormal Voltage Surge	23.2V	Figure 16-4 - apply at 10 sec intervals	EADC14_AVSUR

<sup>1</sup> For more comprehensive DC Ripple tests, refer to section 9.1.2.10.

**Table BDC14:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.1b	Voltage (Average Value dc)	11.0V to 15.2V	Apply for 30 mins each test	EBDC14_VAVG
16.6.1		Emergency Operating Conditions (dc)			
	16.6.1.1b(3)	Voltage (Average Value dc)	9.0V	Apply for 30 mins each test	EBDC14_VAVGEMER
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.2 <sup>1</sup>	Ripple Voltage (dc)	Vp-p = .8V, Freq = 200Hz	Figure 18-2	EBDC14_VRIP
	16.6.1.3b	Momentary Power Interruptions (dc)	Table 16-3	Equipment with Digital Circuits	EBDC14_PINTB
	16.6.1.3c	Momentary Power Interruptions (dc)		Other Equipment	EBDC14_PINTC
	16.6.1.4	Normal Transients (dc)			
		16.6.1.4b - Normal Voltage Surge (dc)	23.5V to 8.5V		EBDC14_NV SUR
	16.6.1.5	Engine Starting Under Voltage Operation (dc)	5V min	Slew for 35 sec	EBDC14_VENG
16.6.2		Abnormal Operating Conditions (dc)			
	16.6.2.1	Voltage Steady State (dc)	10.3V to 16.1V	Apply for 5 mins each test	EBDC14_VABN
	16.6.2.2	Low Voltage Conditions (dc)	0V over 10 minutes		EBDC14_LVABN
	16.6.2.3	Momentary Undervoltage (dc)	6V	Apply for 7 seconds each test	EBDC14_VUND
	16.6.2.4	Abnormal Transients (ac)			
		16.6.2.4d - Abnormal Voltage Surge	30VDC	Figure 16-4 - apply at 10 sec intervals	EBDC14_AVSUR

<sup>1</sup> For more comprehensive DC Ripple tests, refer to section 9.1.2.10.

**Table ZDC14:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.1b	Voltage (Average Value dc)	11.0V to 15.2V	Apply for 30 mins each test	EZDC14_VAVG
16.6.1		Emergency Operating Conditions (dc)			
	16.6.1.1b(3)	Voltage (Average Value dc)	9.0V	Apply for 30 mins each test	EZDC14_VAVGEMER
16.6.1		Normal Operating Conditions (dc)			
	16.6.1.2 <sup>1</sup>	Ripple Voltage (dc)	Vp-p = 0.3V to .8V, Freq = 10Hz to 200Hz	Figure 18-2	EZDC14_VRIP
	16.6.1.3b	Momentary Power Interruptions (dc)	Table 16-3	Equipment with Digital Circuits	EZDC14_PINTB
	16.6.1.3c	Momentary Power Interruptions (dc)		Other Equipment	EZDC14_PINTC
	16.6.1.4	Normal Transients (dc)			
		16.6.1.4b - Normal Voltage Surge (dc)	25V to 6V		EZDC14_NV SUR
	16.6.1.5	Engine Starting Under Voltage Operation (dc)	5V min	Slew for 35 sec	EZDC14_VENG
16.6.2		Abnormal Operating Conditions (dc)			
	16.6.2.1	Voltage Steady State (dc)	10.3V to 16.1V	Apply for 5 mins each test	EZDC14_VABN
	16.6.2.3	Momentary Undervoltage (dc)	6V	Apply for 7 seconds each test	EZDC14_VUND
	16.6.2.4	Abnormal Transients (ac)			
		16.6.2.4b - Abnormal Voltage Surge	40VDC	Figure 16-4 - apply at 10 sec intervals	EZDC14_AVSUR

<sup>1</sup> For more comprehensive DC Ripple tests, refer to section 9.1.2.10.



### 9.1.2.14 160 Option Related Error Messages

The CIGui32 program will monitor the power source on a regular basis for any run time errors. If an error is reported by the power source, any test step execution will be aborted. Possible errors and error sources are:

No	Description	Potential cause
2	Current Limit Fault	EUT may require more current than the programmed current limit setting. This is possible on constant power loads during reduced voltage (low line) type test steps. If the power source is set to Constant Voltage (CV) mode, the output will trip off when the current limit is exceeded and a Current Limit fault is generated. In Constant Current (CC) mode, the output voltage will be reduced to reduce the current to the set limit. In this case, no error message will be generated.
-113	Undefined Header	Generally caused by a communication problem between the PC and the power source.  If the RS232 interface is used and these problems persist, try using the GPIB interface instead. (Requires National Instruments GPIB controller).
15	Slew exceeds dwell	The power source transient system was programmed to slew to a voltage and/or frequency value that would take longer to accomplish than the slew time set. This error can result in single step mode if the steps are executed out of order or one or more steps are skipped. The voltage/frequency values may no longer line up. Try running the test from the first step.
16	Illegal during transient	A transient step is still in progress. Try using the Abort button to abort any test in progress. If other CIGui32 screens other than the Main GUI screen are open, they may have initiated a transient, which conflicts with the 160 option. Try closing all other CIGui32 windows.

Great efforts have been made to check all test sequence files provided as part of the –160 option. However, due to the breadth and complexity of the 160 database, an occasional error may occur while using these files. If an error cannot be resolved, turn on the CIGui32 bus monitor window and rerun the test that yields the error and save the bus trace to a text file using the File, Save All menu in the bus monitor window. This file can be emailed to [support@calinst.com](mailto:support@calinst.com) along with a description of the error.

Furthermore, test files were developed making reasonable assumptions concerning the intent of the RTCA/DO-160 directive. The user is free to modify, edit, revise or otherwise update any of these tests to match his/her own requirements. In this case, we recommend you copy the supplied DO160\_RevE subdirectory and use this copy to make modifications to. This will preserve the original data provided.

## 9.2 IEC 61000-4-11 Option

---

### 9.2.1 General

---

The IEC1000-4-11 option is capable of performing IEC1000-4 section 11 voltage dips, short interruptions and voltage variations immunity tests. On three-phase iX/i Configurations, the user can select one, two or all three phases to be active during the IEC1000-4-11 tests in this configuration.

### 9.2.2 Standard Revisions and EUT Classes

---

The 411 option supports both the first (1994-06) and the second edition (2004-03) of the IEC 61000-4-11 test standard as of firmware revision 2.38. Older firmware revisions only support the first edition. Contact [support@calinst.com](mailto:support@calinst.com) for upgrade information. If Edition 2.0 is supported, the standard revision can be selected when using the Cigui32 Windows program. From the front panel, there is no need to select the revision but data values can be set that support either version of the standard.

Generic tests files are distributed with the CIGui32 program for both editions of the test standard. Files applicable to Edition 2.0 have ED20 in their file name. Do not mix these files, as the data setup will not be correct if you do. To load a test file, select the Mode (Dips or Vars) and test standard revision first, then use the File, Open menu to load the test parameters. Test parameters can be a function of the EUT class. The different files provided with the program cover the various EUT classes. The relevant EUT class 1, 2, 3 or X is listed in the file names.

When using front panel operation, the user has to set levels for each individual test step in SINGLE mode.

### 9.2.3 Initial Setup

---

The user must set the operating frequency and voltage and close the output relay prior to the start of test. It is possible to change the normal voltage ( $U_t$ ) from the IEC1000-4-11 menus before running each test. To run any IEC 61000-4-11 test, the IEC411 state must be turned on. If an EOS1 or EOS3 is detected, it will be put in ACTIVE mode as long as the IEC411 state is ON.

### 9.2.4 Tests Performed

---

#### DIPS AND INTERRUPTIONS

- |               |                                   |
|---------------|-----------------------------------|
| 1. Run All    | Run predefined sequence of tests. |
| 2. Run Single | Run user defined test.            |

#### VOLTAGE VARIATIONS

- |               |                                   |
|---------------|-----------------------------------|
| 1. Run All    | Run predefined sequence of tests. |
| 2. Run Single | Run user defined test.            |

### 9.2.5 Front Panel Entry

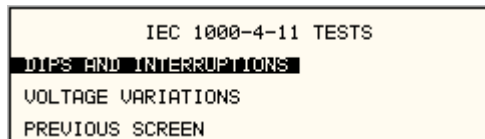
---

To perform a test from the keyboard, select the APPLICATIONS screen from the MENU 2 screen. The APPLICATIONS screen will appear as shown in Figure 9-17



*Figure 9-17: Application menu*

Scroll to the IEC 1000-4-11 entry using the up and down cursor keys. Press the ENTER key to select the IEC 1000-4-11 main menu. The screen will appear as shown in Figure 9-18.



*Figure 9-18: IEC1000-4-11 Menu*

### 9.2.5.1 DIPS AND INTERRUPTIONS TEST

Scroll to the DIPS AND INTERRUPTIONS entry using the up and down cursor keys. Press the ENTER key to select the DIPS AND INTERRUPTIONS menu. The screen will appear as shown in Figure 9-19.

```

IEC 1000-4-11 DIPS/INTERRUPTIONS  0A
STATE = ON
NOMINAL Ut =230.0V
DIP TO =0.0%
EOS ST.=ACTIVE NO CYCLES =0.5
PREVIOUS SCREEN START ANGLE =0.0

```

Figure 9-19: IEC Dips and Interrupts

#### STATE

This field enables or disables the -411 test mode. If an EOS option is present, it will be engaged when the STATE is toggled on. This field may also be used to reset a fault condition occurring on the EOS option due to a temperature or over current fault.

#### EOS STATE

This field can have one of three values:

N/A	Indicates no EOS option is present or the EOS option was not powered up when the STATE was enabled.
ACTIVE	The EOS option is active. When active, the -411 firmware will use the EOS for voltage dips at 0, 40 or 70% test levels. If a second generation EOS is used and the 70/80 Tap selection on the EOS is set to 80%, you must still program 70 as the DIP TO level to activate the 80% tap as the firmware only has one control code for this tap. Thus, the 70% programmed level will activate the 70/80 tap. The actual level will be determined by the setting of the EOS in this case.
OFF	The EOS option is in Bypass mode.

**RUN ALL**

The RUN ALL selection will cause the following automated test sequence suggested by the standard to be run:

Step	Output in % of $U_T$	No of Cycles	Start angle (degrees)	Repeat # times	Delay between repeats (s)
1	0	0.5	0	3	10
2	0	0.5	180	3	10
3	0	1	0,45,90	3 at diff $\emptyset$	10
4	0	5	45,90,135	3 at diff $\emptyset$	10
5	0	10	90,135,180	3 at diff $\emptyset$	10
6	0	25	180,225,270	3 at diff $\emptyset$	10
7	0	50	270,315,0	3 at diff $\emptyset$	10
8	40	0.5	0	3	10
9	40	0.5	180	3	10
10	40	1	0,45,90	3 at diff $\emptyset$	10
11	40	5	45,90,135	3 at diff $\emptyset$	10
12	40	10	90,135,180	3 at diff $\emptyset$	10
13	40	25	180,225,270	3 at diff $\emptyset$	10
14	40	50	270,315,0	3 at diff $\emptyset$	10
15	70	0.5	0	3	10
16	70	0.5	180	3	10
17	70	1	0,45,90	3 at diff $\emptyset$	10
18	70	5	45,90,135	3 at diff $\emptyset$	10
19	70	10	90,135,180	3 at diff $\emptyset$	10
20	70	25	180,225,270	3 at diff $\emptyset$	10
21	70	50	270,315,0	3 at diff $\emptyset$	10

*Table 9-19: Dips and Interruptions Tests Performed During RUN ALL*

The user can change the NOMINAL  $U_t$  voltage for this. The RUN ALL Command line will change to ABORT during the test. Selecting ABORT and pressing the ENTER key will terminate the test at any time and the output voltage will return to the nominal value.

**RUN SINGLE**

RUN SINGLE command will run a single test once. The Dip or Interrupt test is defined by the DIP TO, NO CYCLES, and START ANGLE parameters. These parameters must be set before starting the test. The following is a description of these parameters.

- DIP TO: The dip voltage level as a percentage of the nominal voltage.
- NO CYCLES: The dip duration in cycles.
- START ANGLE: The start phase angle of the dip

Note: After each individual run, a 10 second delay is inserted.

### 9.2.5.2 VOLTAGE VARIATION TESTS

From the IEC1000-4-11 Main Menu screen shown in Figure 9-18, scroll to the VOLTAGE VARIATIONS entry using the up and down cursor keys. Press the ENTER key to select the VOLTAGE VARIATIONS menu. The screen will appear as shown in Figure 9-20.

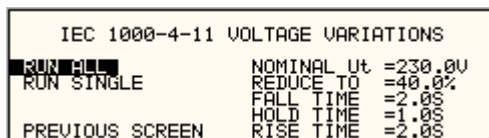


Figure 9-20: Voltage Variation screen

#### RUN ALL

The RUN ALL selection will cause the following automated test sequence suggested by the standard to be run:

Step	Type	Start V in % of $U_T$	Dwell time	End V in % of $U_T$	Delay between steps (s)
1	VSweep	100	2	40	0
2	Hold	40	1	40	0
3	VSweep	40	2	100	10
4	VSweep	100	2	40	0
5	Hold	40	1	40	0
6	VSweep	40	2	100	10
7	VSweep	100	2	40	0
8	Hold	40	1	40	0
9	VSweep	40	2	100	10
10	VSweep	100	2	0	0
11	Hold	0	1	0	0
12	VSweep	0	2	100	10
13	VSweep	100	2	0	0
14	Hold	0	1	0	0
15	VSweep	0	2	100	10
16	VSweep	100	2	0	0
17	Hold	0	1	0	0
18	VSweep	0	2	100	10

Table 9-20: Voltage Variations Test Performed During RUN ALL

The user can change the NOMINAL  $U_T$  voltage for this test. The RUN ALL Command line will change to ABORT during the test. Selecting ABORT and pressing the ENTER key will terminate the test at any time and the output voltage will return to the nominal value.

## RUN SINGLE

RUN SINGLE command will run the test once. The Variation test is defined by the REDUCE TO, FALL TIME, HOLD TIME and RISE TIME parameters. These parameters must be set before starting the test. The following is a description of these parameters.

REDUCE TO:	The lowest voltage level as a percentage of the nominal voltage. Thus, 0% is 0 Volts. 100% is full nominal voltage.
FALL TIME:	The time in seconds it will take the output to reach the REDUCE TO voltage. Values must be entered in seconds. A 0.000 sec time may be used for abrupt voltage drops instead of voltage sweeps to support Edition 2.0 of the test standard. This requires firmware 2.38 or higher however.
HOLD TIME:	The time in seconds the output will hold at the REDUCE TO voltage. Values must be entered in seconds.
RISE TIME:	The time in seconds the output will reach the NOMINAL voltage from the REDUCE TO voltage. Values must be entered in seconds.

The timing of voltage variations is different between editions 1.0 and 2.0 of the IEC 61000-4-11 test standard. While the original standard used voltage ramps on both sides of the variation test level, the Edition 2.0 standard calls out an abrupt drop to the test level, followed by a voltage ramp back to the nominal voltage. Thus, for Edition 2.0, the fall time must be set to 0.000 seconds. This requires firmware revision 2.38 or higher. Older firmware revision will not accept 0.000 sec for fall time. The shortest allowable fall time for older revision firmware is 0.02 sec.

Furthermore, where under Edition 1.0 rise and fall times were specified in seconds, they are specified in number of cycles in Edition 2.0. This is an effort to normalize both 50 Hz and 60 Hz voltage variations.

Refer to Figure 9-21 and Figure 9-22 for an illustration of how these parameters affect the V RMS output under the different standard revisions.

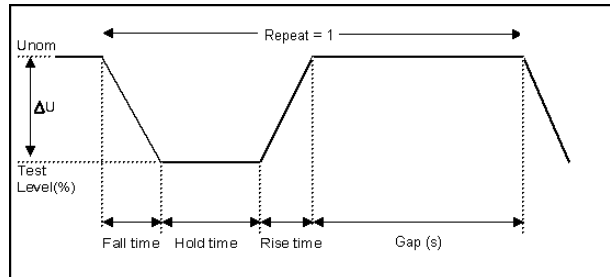


Figure 9-21: EN 61000-4-11 Voltage Variation specification- Edition 1.0

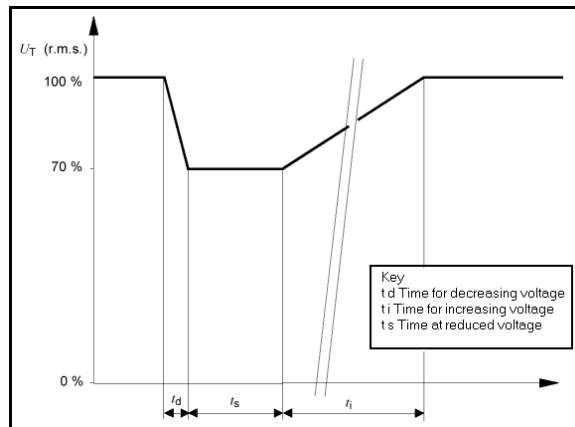


Figure 9-22: EN 61000-4-11 Voltage Variation specification- Edition 2.0

## 9.2.6 Using the CIGui32 Windows Program for IEC 61000-4-11 Testing

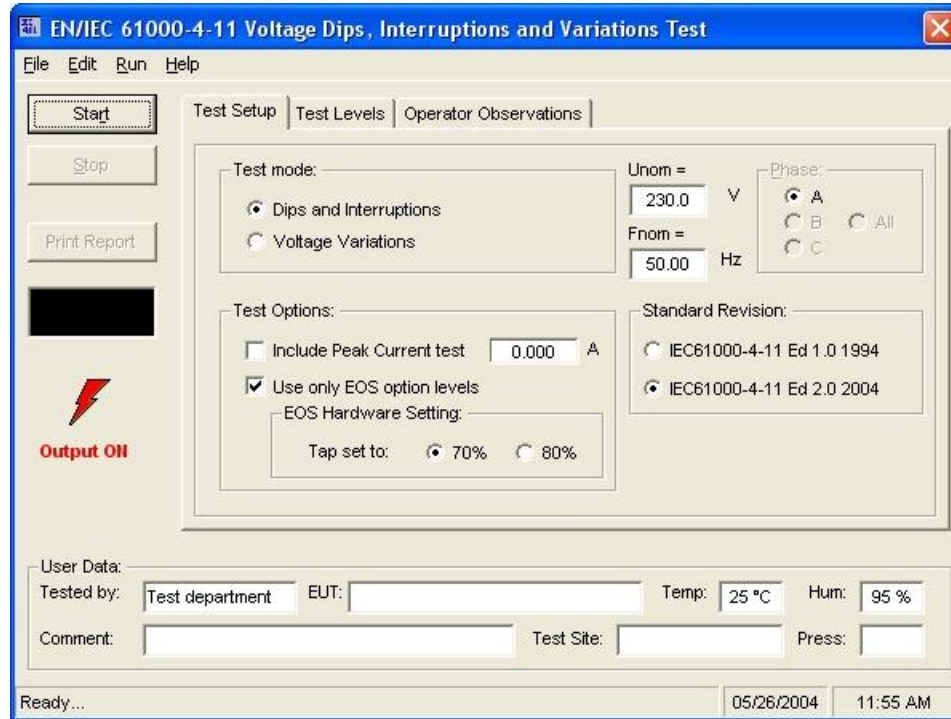


Figure 9-23: IEC 61000-4-11 GUI screen.

The CIGui32 Windows control program will detect the presence of the –411 option on the iX/i AC power source. It will also detect the presence of an EOS1 or EOS3 and use the EOS for the appropriate test levels. Test reports can be generated at the end of a test for documentation purposes.

To support Edition 2.0 of the IEC 61000-4-11 test standard, version 1.20 of the CIGui32 or higher is required. Older versions of the Cigui32 will only support Edition 1.0 tests. The desired Edition can be selected by the user and provides the relevant data entry mode for the Edition selected.

Generic tests files are distributed with the CIGui32 program for both editions of the test standard. Files applicable to Edition 2.0 have ED20 in their file name. Do not mix these files, as the data setup will not be correct if you do. To load a test file, select the Mode (Dips or Vars) and test standard revision first, then use the File, Open menu to load the test parameters. Test parameters can be a function of the EUT class. The different files provided with the program cover the various EUT classes. The relevant EUT class 1, 2, 3 or X is listed in the file names.

The user must select the desired test type before executing the test. Since both test types require a number of test parameters, the test sequence parameters must be entered in the data entry grid or loaded from disk using the File, Open menu entry.

For complete details on how to use the Cgui32 –411 option test screen, refer to the on-line help of the Cigui32 program available from the Help menu.



## 9.3 IEC 61000-4-13 Option

---

### 9.3.1 General

---

The IEC413 option is capable of performing IEC 61000-4 section 13 Harmonics and inter harmonics low frequency immunity tests. The tests are based on IEC 61000-4-13:2002-03, First Edition. It is assumed that the user has a copy of the test standard available. This manual section only cover operation of the –413 option from the front-panel of the iX Series power source.

**Note 1:** The initial release of the –413 option for the iX Series power sources was based on a draft version (CDV) of the IEC 61000-4-13 standard. Minor changes were made between the CDV draft and the final released version. Units with firmware revision 2.37 or higher conform to the official released IEC standard. Units with older firmware conform to the draft version. A firmware upgrade can be ordered through California Instruments' service department by contacting [support@calinst.com](mailto:support@calinst.com) and requesting part number CIC463. Provide the model and serial number of the unit (master unit in multi-box systems) to ensure the correct firmware is provided. The firmware revision is displayed on the LCD screen immediately after power up for a few seconds. It can also be queried over the bus using the “\*IDN?” command.

Where relevant, the requirement for the correct firmware revision to obtain specific test modes is indicated in this manual.

**Note 2:** The –413 option is only available on iX Series AC power sources, not i Series. It is possible to upgrade most i Series AC source to an iX Series and add the –413 option. Contact the California Instruments service department for information. [support@calinst.com](mailto:support@calinst.com)

### 9.3.2 Initial Setup

---

The user must set the operating voltage and close the output relay prior to the start of test. The following set of parameters must be set before the start of test.

1. Frequency to 50 or 60 Hz.
2. Voltage mode to AC.
3. Waveform to sine wave.

### 9.3.3 Tests Performed

---

The IEC61000-4-13 test consists of several types of tests. These tests can be run individually or in sequence (ALL). The following tests are available:

1. Harmonic combination test flat curve and over swing.
2. Sweep in frequency and resonance frequency detection.
3. Individual harmonics and inter harmonics.
4. Meister curve test (Firmware revision 2.37 or higher required)

### 9.3.4 Front Panel Entry

While it is possible to perform IEC 61000-4-13 testing from the front panel of the iX Series AC power source, it is recommended to use the provided Cigui32 Windows program for report generation. This also provides a more convenient way to perform Class 1 and User class tests as test levels can be saved to disk.

To perform a test from the keyboard, select the APPLICATIONS screen from the MENU 2 screen. The APPLICATIONS screen will appear as shown in Figure 9-24.



Figure 9-24: Application menu

Scroll to the IEC 61000-4-13 entry using the up and down cursor keys. Press the ENTER key to select the IEC 61000-4-13 main menu. The screen will appear as shown in Figure 9-25.

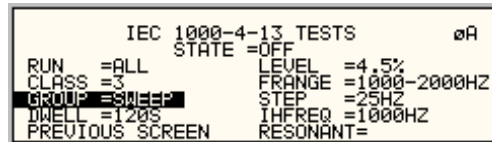


Figure 9-25: IEC 61000-4-13 Menu

#### 9.3.4.1 IEC 61000-4-13 Screen Parameters

The IEC 61000-4-13 screen has the following common fields for all IEC 61000-4-13 test groups.

##### STATE

The STATE field must be set to ON before the test can run. Initial setup conditions must be met to run the test.

##### RUN

The RUN field has the following selections:

1. ALL Run all IEC 61000-4-13.
2. GROUP Run the selected group.
3. RANGE Run the selected range for the selected group.
4. POINT Run the selected frequency for the selected range and selected group.

Note: The RANGE and POINT do not apply to all groups. See individual groups for details.

When the test is running, this field will have the following selection:

1. ABORT The test will stop running and all parameters will return to the state prior to the start of the test.
2. PAUSE The test will pause at the time the ENTER key is pressed while the PAUSE field is selected. The field will change to RESUME. When the ENTER key is pressed again, the test will resume from the point it stopped.

### **EUT CLASS**

This field selects the desired product or EUT class. There are four EUT classes. Class 1, 2 and 3 are predefined by the standard and its level parameters cannot be changed. The user class can be edited at any time. Changing between class 2 and 3 can be done while the state is on. Changing to the user class requires the state to be in the off position.

For Class 1 EUT, the user class must be used. Only class 2 and 3 test levels are pre-programmed. When using the provided, Cigui32 Windows program, class 1 tests are set up by the Cigui32 program automatically.

### **GROUP**

This field selects the test GROUP. Selecting a group is required for editing the data fields associated with the group as well as running the individual group if run group is selected. The field has the following groups:

1. FCURVE This is the first part of harmonic combination test.
2. OSWING This is the second part of harmonic combination test.
3. SWEEP This is the sweep in frequency and resonance frequency detection.
4. HRAM This is the first part of the Individual harmonics and inter harmonics test.
5. IHARM This is the second part of the Individual harmonics and inter harmonics test.
6. MCURVE This is the Meister test. (Firmware revision 2.37 or higher required)

See the appropriate sections for details on each group.

### **DWELL**

This field will show the dwell time in seconds for each group during the test and will allow changes to the dwell time to be made.

The dwell time for the Meister curve group is the dwell time for each inter harmonics. This combined with the frequency step size results in a 5-minute test time per frequency decade.

The dwell time for the sweep group is the dwell time for each frequency decade.

### 9.3.4.2 IEC GROUPS

---

This section will describe the groups and parameters associated with IEC 61000-4-13. Refer to paragraph 9.3.4.1 for groups associated with the test.

#### **FCURVE GROUP**

If the FCURVE group is selected, the screen will appear as shown in Figure 9-26. The screen has the following parameters that are unique to the group:

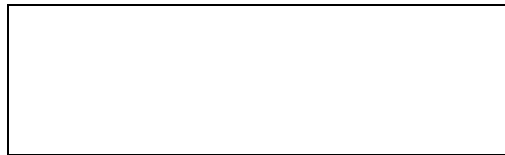


*Figure 9-26: IEC 61000-4-13 FCurve*

1. **LEVEL** Set the Flat curve clip level. This field can be set when the IEC 1000-4-13 is in the OFF state and the Class is set for USER class.
2. **PAUSE** Time in seconds the test will pause prior to proceeding to the following test. This field can be set at any time when the test is not running.

#### **OSWING GROUP**

If the OSWING group is selected, the screen will appear as shown in Figure 9-27. The screen has the following parameters that are unique to the group:



*Figure 9-27: IEC 61000-4-13 OSwing*

1. **LEVEL** The level of the harmonics relative to the fundamental in percent. There are two levels, one for harmonic #3 and the other for harmonic #5. The harmonic number must be selected prior to the harmonic level entry. To change levels, the test state must be off and USER class must be selected.
2. **HARM NO** There are only two harmonic numbers. This field is used to set the harmonics level that corresponds to the harmonics number.
3. **PHASE** Sets the phase angle of the harmonics relative to the fundamental. The phase can be set when the test state is off and USER class is selected.
4. **PAUSE** Sets the time in seconds. The test will pause prior to proceeding to the following test. This field may be changed at any time as long as the test is not running.

## SWEEP GROUP

If the SWEEP group is selected, the screen will appear as shown in Figure 9-28. The screen has the following parameters that are unique to the group:



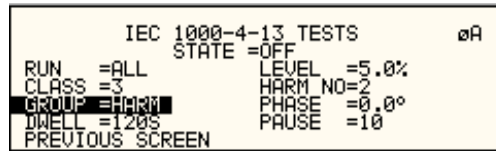
```
IEC 1000-4-13 TESTS      @A
STATE =OFF
RUN  =ALL                LEVEL =4.5%
CLASS =3                 FRANGE =1000-2000HZ
GROUP =SWEEP             STEP  =25HZ
DWEEL =120S              IHFREQ =1000HZ
PREVIOUS SCREEN          RESONANT=
```

*Figure 9-28: IEC 61000-4-13 Sweep*

1. LEVEL Sets the percentage level of the inter harmonics relative to the fundamental. The level is fixed for the entire frequency range, which is defined by FRANGE. To change level, the test state must be off and user class must be selected.
2. FRANGE The range is selected by rotating the shuttle. The range selection is required to change the level for the selected range. Also, an individual range sweep is possible by selecting the desired range and selecting RUN RANGE from the RUN field.
3. STEP The step size defines the inter harmonics sweep points. Step size is fixed for the entire sweep range. The STEP size can be changed when the test state is off.
4. IHFREQ This field will show the current inter harmonic frequency when the test is running. An inter harmonic frequency can be selected using the shuttle. To run a frequency without sweeping through the entire range, a RUN POINT can be selected.
5. RESONANT This field is used to report the resonant points, if any, after running the sweep test. No editing is allowed in this field. When the test is completed, a display of harmonics current versus frequency plot is available. To view the graph, select the field and press the ENTER key.

## HARMONICS GROUP

If the Harmonics group is selected, the screen will appear as shown in Figure 9-29. The screen has the following parameters that are unique to the group:



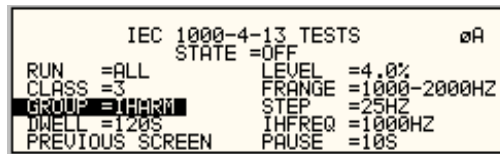
```
IEC 1000-4-13 TESTS      0A
STATE =OFF
RUN  =ALL                LEVEL =5.0%
CLASS =3                 HARM NO=2
GROUP =HARM              PHASE =0.0°
DWELL =120S              PAUSE =10
PREVIOUS SCREEN
```

*Figure 9-29: IEC 61000-4-13 Harmonics*

1. **LEVEL** Sets the percentage level of the harmonic relative to the fundamental. Each level is associated with a harmonic number. To change levels, the test state must be off and user class must be selected.
2. **HARM NO** Selecting a harmonic number using the shuttle knob will allow examination of the LEVEL and PHASE of each harmonic and changing the level and phase angle when USER class is selected.
3. **PHASE** Sets the phase angle of the harmonics relative to the fundamental. To change phase, the test state must be off and user class must be selected.
4. **PAUSE** Sets the pause time in seconds between harmonics tests. There is only one value for the entire test. The PAUSE value can be changed when the test is not running.

### INTERHARMONICS GROUP

If the Harmonics group is selected, the screen will appear as shown in Figure 9-30. The screen has the following parameters that are unique to the group:



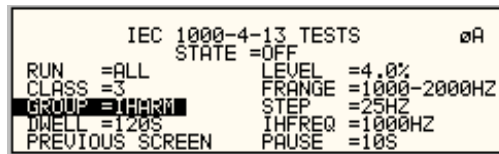
```
IEC 1000-4-13 TESTS      @A
STATE =OFF
RUN  =ALL                LEVEL =4.0%
CLASS =3                 FRANGE =1000-2000HZ
GROUP =IHARM             STEP  =25HZ
DWELL =120S              IHFREQ =1000HZ
PREVIOUS SCREEN          PAUSE =10S
```

*Figure 9-30: IEC 61000-4-13 Inter harmonics*

1. **LEVEL**      Sets the percentage level of the inter harmonics relative to the fundamental. The level is fixed for the entire frequency range defined by FRANGE. To change levels, the test state must be off and user class must be selected.
2. **FRANGE**    The range is selected by rotating the shuttle. The range selection is required to change the level. An individual range step can be run by selecting the desired range, followed by RUN RANGE from the RUN field.
3. **STEP**       The step size defines the inter harmonics sweep points. This step size is fixed for the entire range of the sweep. The STEP size can be changed when the test state is off.
4. **IHFREQ**     This field shows the current inter harmonic frequency when the test is running. An inter harmonic frequency can be selected with the shuttle. To run an inter harmonic frequency without sweeping through the entire range, RUN POINT must be selected.
5. **PAUSE**      Sets the time in seconds for which the test will pause between inter harmonic frequencies. There is only one value for the entire test. The PAUSE can be set when the test is not running.

### MEISTER CURVE GROUP

If the Meister curve group is selected, the screen will appear as shown in Figure 9-31. The screen has the following parameters that are unique to the group:



```
IEC 1000-4-13 TESTS      0A
STATE =OFF
RUN  =ALL      LEVEL  =4.0%
CLASS =3      FRANGE =1000-2000HZ
GROUP =IHARM   STEP   =25HZ
DWELL =120S    IHFREQ =1000HZ
PREVIOUS SCREEN PAUSE  =10S
```

*Figure 9-31: IEC 61000-4-13 Meister Curve*

1. **LEVEL** Sets the percentage level of the inter harmonics relative to the fundamental. The level is fixed for the entire frequency range defined by FRANGE. To change levels, the test state must be off and user class must be selected.
2. **FRANGE** The range is selected by rotating the shuttle. The range selection is required to change the level. An individual range step can be run by selecting the desired range, followed by RUN RANGE from the RUN field.
3. **STEP** The step size defines the inter harmonics sweep points. This step size is fixed for the entire range of the sweep. The STEP size can be changed when the test state is off.
4. **PAUSE** Sets the time in seconds for which the test will pause between ranges. There is only one value for the entire test. The PAUSE can be set when the test is not running. For the Meister curve test, the pause time is normally set to 0 secs. If a value other than 0 is entered, the inter harmonics are set to 0% during the pause times.
5. **RESONANT** This field is used to report the resonant points, if any, after running the Meister curve test. No editing is allowed in this field. When the test is completed, a display of harmonics current versus frequency plot is available. To view the graph, select the field and press the ENTER key.

---

#### 9.3.4.3 RUNNING THE TEST

The test sequence used is a function of the EUT class. The end user needs to determine the appropriate class of EUT. The test protocol is document in the IEC 61000-4-13 test standard. For reference, the test flow charts are shown here. It is assumed that the end user has a copy of the actual test standard however.



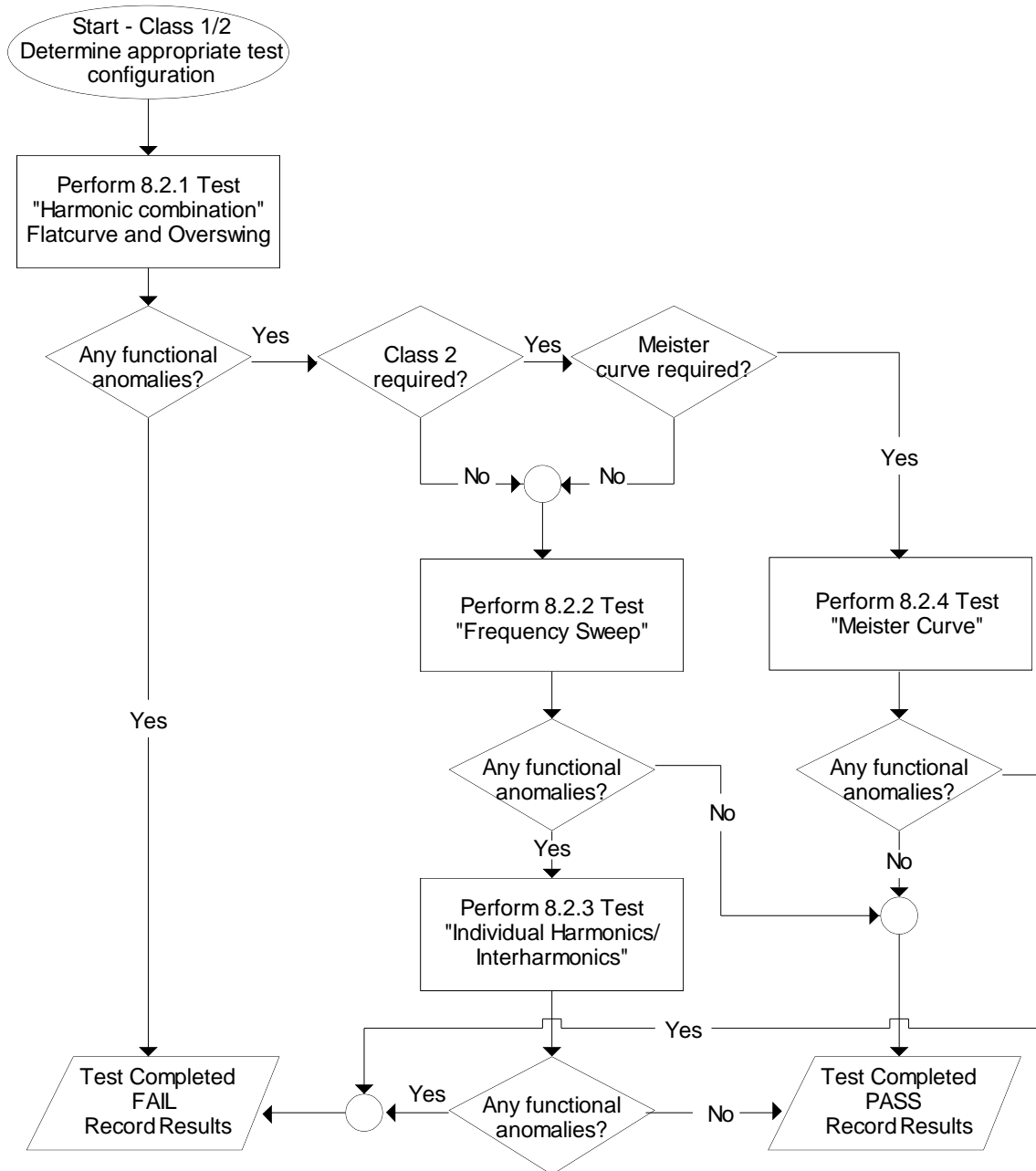


Figure 9-32: IEC 61000-4-13 Test Flowchart Class 1 and 2

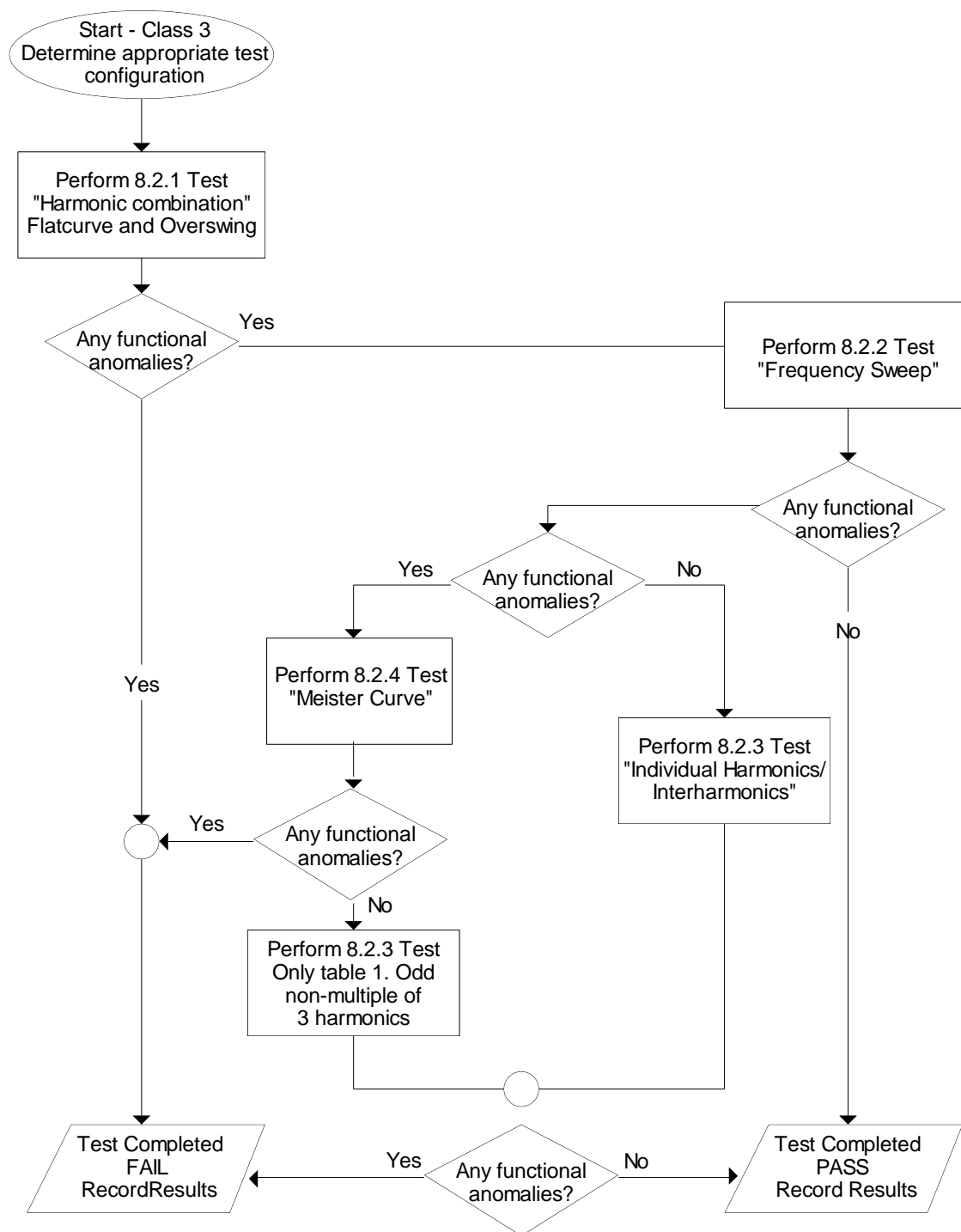


Figure 9-33: IEC 61000-4-13 Test Flowchart Class 3

To run the test, the IEC 61000-4-13 mode must be selected. Refer to paragraph 9.3.4 for access to the screen. The following conditions have to be met before running the test:

1. Prior to the test, set the nominal voltage, frequency, and phase angle. The frequency must be 50 or 60 Hz. Function must be set to sine wave.
2. Select EUT CLASS 2, 3 or USER. The default parameters for the USER class are identical to those for class 3. If USER class is selected, the level and phase parameters can be edited. For Class 1 EUT's, the USER class must be used as well. In this case, set the levels to those called out in the test document.
3. Set the STATE to ON. It will take a few seconds to initialize data required to perform the test.
4. If it is desired to run all tests, select ALL from the RUN parameter with the shuttle knob and press the ENTER key. The tests will run in the following sequence:

FCURVE, OSWING, SWEEP, HARM, IHARM, MCURVE

**Note:** The test for class 3 will take about 25 minutes, class 2 slightly less.

5. While the test is running, the ABORT and PAUSE selection is accessible from the RUN field by rotating the shuttle.
6. If it is desired to run a specific group, the group must be selected from the group screen. Also, the RUN GROUP must be selected prior to the start of test.
7. To run an individual range, applicable for sweep and individual harmonics only, the desired range and the RUN RANGE mode must be selected prior to the start of the test. In case the harmonics group is selected, RUN RANGE will run the harmonics from the second harmonics to the harmonics number specified by the HARM NO field. See Figure 9-29.
8. To run individual harmonics or individual inter harmonics, set the harmonic number or the inter harmonics frequency and select RUN POINT prior to running the test.

### 9.3.4.4 INTERHARMONICS

A single inter harmonic frequency may be generated using the INTERHARMONICS screen. This screen allows insertion of any inter harmonic from 1Hz to 2400Hz in 1Hz steps. The amplitude level of the harmonics range is from 0 to 20% of the programmed voltage. To select the inter harmonics screen, press the menu screen until the MENU 2 screen appears as shown in Figure 9-34. Select INTERHARMONICS using the up or down key.

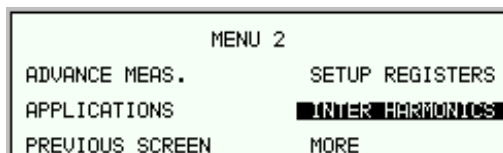


Figure 9-34: MENU 2 SCREEN

### INTERHARMONICS SCREEN

The inter harmonics screen will appear as shown in Figure 9-35. This screen has the following parameters:

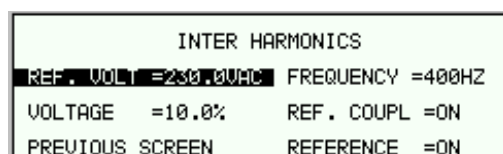


Figure 9-35: INTERHARMONICS SCREEN

1. REFERENCE This field will enable the Inter harmonics generator if ON is selected and will disable the inter harmonics generation if OFF is selected.
2. REF. COUPL If turned on, the REF. VOLT will follow the programmed voltage value.
3. REF. VOLT This field must be programmed to a value if REF. COUPL is off. This value has a range from 0 to 230 volts. This value is set to a value equal to the phase A voltage if the REF. COUPL is turned on.
4. VOLTAGE This field programs the Inter harmonic level in percentage of the REF.VOLT. This value has a range from 0 to 20%

## 9.4 EOS Option

---

### 9.4.1 Introduction

---

This section contains information on the installation and operation of the EOS-1 and EOS-3 electronic output switches to be used with the California Instruments i/iX-series of power sources.

### 9.4.2 EOS Revisions

---

There are two versions of the EOS1 and EOS3. The first generation EOS1 is the original version and has top assembly number 5100-407-1. The second generation EOS1 adds an additional output tap at the 80% test level selectable through a front panel switch and has top assembly number 5100-410-1, Rev A. For the EOS3, the top assembly number remains the same at 5100-407-3. However, the revision of the second generation EOS-3 is Rev E. First generation EOS-3 units will have an older revision letter. The selection between a 70% tap and an 80% tap on the EOS-3 must be hard wired which requires removal of the top cover.

Top assembly number and revision information can be obtained from the model number/serial tag.

Model	Generation	Assembly	Revision
EOS1	1	5100-407-1	D or lower
	2	5100-410-1	A
EOS3	1	5100-407-3	D or lower
	2	5100-407-3	E

*Table 9-21: EOS Versions*

### 9.4.3 General Description

---

The EOS-1 and EOS-3 electronic output switches are used with the IEC1000-4-11 option (option –411) to perform IEC1000-4-11 voltage dips and interruptions tests. The –411 option must be installed in the iX/i power source for the EOS to function. It is configured if the EOS was ordered with the iX/i AC source. If the -411 option is not present, contact California Instruments at [support@calinst.com](mailto:support@calinst.com) for support.

The tests are fully compliant as long as the equipment under test draws less than 70% of the peak current drive capability of the controlling power source. The EOS-1 may be used with a 5001iX power source for single-phase tests. The EOS-3 may be used with a 15003iX power system for three phase tests. During IEC1000-4-11 testing the EOS directs power from the iX source to a multi-tap power transformer and a set of electronic switches. The switches are opened and closed as required to select the appropriate tap from the transformer to send to the EOS output. During standard operation, the transformer and switches are bypassed within the EOS unit.

All control of the EOS unit is performed automatically by the controlling California Instruments iX power source. The controlling power source automatically detects whether an EOS is operating in the system or not. If the EOS unit is not powered on and active, the controlling source will still perform non-compliant IEC1000-4-11 tests. No user controls are provided. Refer to Section 9.2 for instructions regarding performing IEC1000-4-11 tests with this equipment.

## 9.4.4 Specifications

### 9.4.4.1 Input

Line Voltage (user configurable)	115 VAC $\pm 10\%$ 230 VAC $\pm 10\%$
Line Current	< 0.4 amps at 115 VAC input < 0.2 amps at 230 VAC input
Line Frequency	47 to 63 Hz
Fuse Rating	0.5 amp, slow acting at 115 VAC input 0.25 amp, slow acting at 230 VAC input

### 9.4.4.2 Output

	EOS-1	EOS-3
Phases	1	3
<b>IEC 1000-4-11 Test Mode Engaged:</b>		
Voltage		
Range	100-270 V <sub>RMS</sub>	
Regulation	<5%, 100% output < 7%, 80% output (EOS Gen 2 only) <7%, 70% output <10%, 40% output	
Over/Undershoot	<5% into a 100 ohm resistive load	
Rise/Fall Times	Between 1 $\mu$ s & 5 $\mu$ s into a 100 ohm resistive load measured from 10% to 90% of transition	
Programmable Output Levels	100%, 70%, 40%, and 0% of U <sub>NOM</sub>	
Frequency		
Range	50 Hz/60 Hz	
Accuracy	+/- 0.02%	
Phase		
Range	0.0° - 360°	
Accuracy	+/- 1.0°	
Maximum Current		
at 100% U <sub>NOM</sub>	18.5 A <sub>RMS</sub>	18.5 A <sub>RMS</sub> /phase
at 80% U <sub>NOM</sub> (EOS Gen 2 only)	26.4 A <sub>RMS</sub>	26.4 A <sub>RMS</sub> /phase
at 70% U <sub>NOM</sub>	23.1 A <sub>RMS</sub>	23.1 A <sub>RMS</sub> /phase
at 40% U <sub>NOM</sub>	46.2 A <sub>RMS</sub>	46.2 A <sub>RMS</sub> /phase
Maximum Peak Current	92.5 A	92.5 A/ phase

(limited by 5001iX / 15003iX)		
at 0% $U_{NOM}$	N/A	N/A
<b>Bypass Mode Engaged:</b>		
Maximum Current	37 $A_{RMS}$	37 $A_{RMS}$ /phase

#### 9.4.4.3 Controls/Indicators

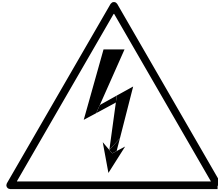
Control / Indicator	Comments
ON/OFF toggle switch	
70 / 80 Tap Select toggle switch	(EOS1, second generation only).
Power On lamp	
Active lamp	
Fault lamp	

#### 9.4.4.4 Mechanical

Dimensions	7"H x 19"W x 24"D 178 mm H x 483 mm W x 610 mm D
Weight	
EOS-1	70 lbs, 32 kg
EOS-3	160 lbs, 73 kg
Connectors:	
Input mains	IEC 320
Source	Compression
Load	Compression
Option In/Out	9 pin D-subminiature
Chassis Slide	General Devices C300S-120-B308

#### 9.4.4.5 Environmental

Temperature	0 to 40 °C
Relative Humidity	80% max. to 31 °C derate linearly to 50% max. at 40°C
Altitude	2000 m max.
Installation Over voltage Category	II
Pollution Degree	2
Equipment Class	I
Usage	Indoors



**CAUTION**

Voltages up to 600 VAC are available in certain sections of this product. This equipment uses potentially lethal voltages.



**DEATH**

On contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied.



## **9.4.5 Installation and Acceptance**

---

### **9.4.5.1 Unpacking**

---

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. Do not return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

### **9.4.5.2 Power Requirements**

---

The EOS-1 and EOS-3 electronic switches use either 115 or 230 VAC to power the control circuits. The user may select the desired input voltage using the range selector within the input module.

To change the input voltage range, pry open the cover to the input module. Remove the fuse carrier. Install the correct fuses in the carrier. Reinstall the carrier into the input module so that the desired voltage range appears in the module cover window. Close the cover.

Note that attempting to operate the EOS from an input range that does not match the actual AC power voltage may cause permanent damage to the unit.

The line power source to the EOS must provide protective earth grounding.

### **9.4.5.3 Mechanical Installation**

---

The EOS-1 and EOS-3 have been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the bottom with a shelf-track or supported from the sides with optional rack slides (-RMS option).

The cooling fan at the rear of the unit must be free of any obstructions that would interfere with the flow of air. A 2.5-inch clearance should be maintained between the rear panel of the EOS unit and the rear panel of the mounting cabinet. Also, the air intake holes on the sides of the power chassis must not be obstructed.

#### 9.4.5.4 Output Wiring

---

The EOS-1 or EOS-3 is wired in series with the output of specified California Instruments power systems. The EOS terminal block marked SOURCE should be wired to the output of the power source/system. The terminal block marked LOAD is wired to the user's load. Refer to

Figure 9-36 and Figure 9-37 in this section for examples of proper connections. Refer to Section 3.5 to determine the appropriate wire gauge needed for the output wiring.

Note in Figure 9-36 the sequence of instruments. This is the recommended sequence between the iX source and the equipment under test. For systems that do not include all the instruments shown, maintain the sequence of the remaining instruments.

Note also that for all applications the remote sense wiring must be connected **before** the EOS unit.



**Note:** The output voltage of the iX/i-series power sources into the EOS box may be at hazardous potentials as high as 300 volts line to neutral (600 volts line to line). Wiring used between the power sources and the EOS and between the EOS and the user's load must be insulated to withstand this potential.

---



**Note:** The SOURCE and LOAD terminals of the EOS will be at the hazardous live potentials of the iX/i-series power sources driving it even if EOS box has not been switched on.

---

Figure 9-36: Example Connection With 5001iX and EOS-1

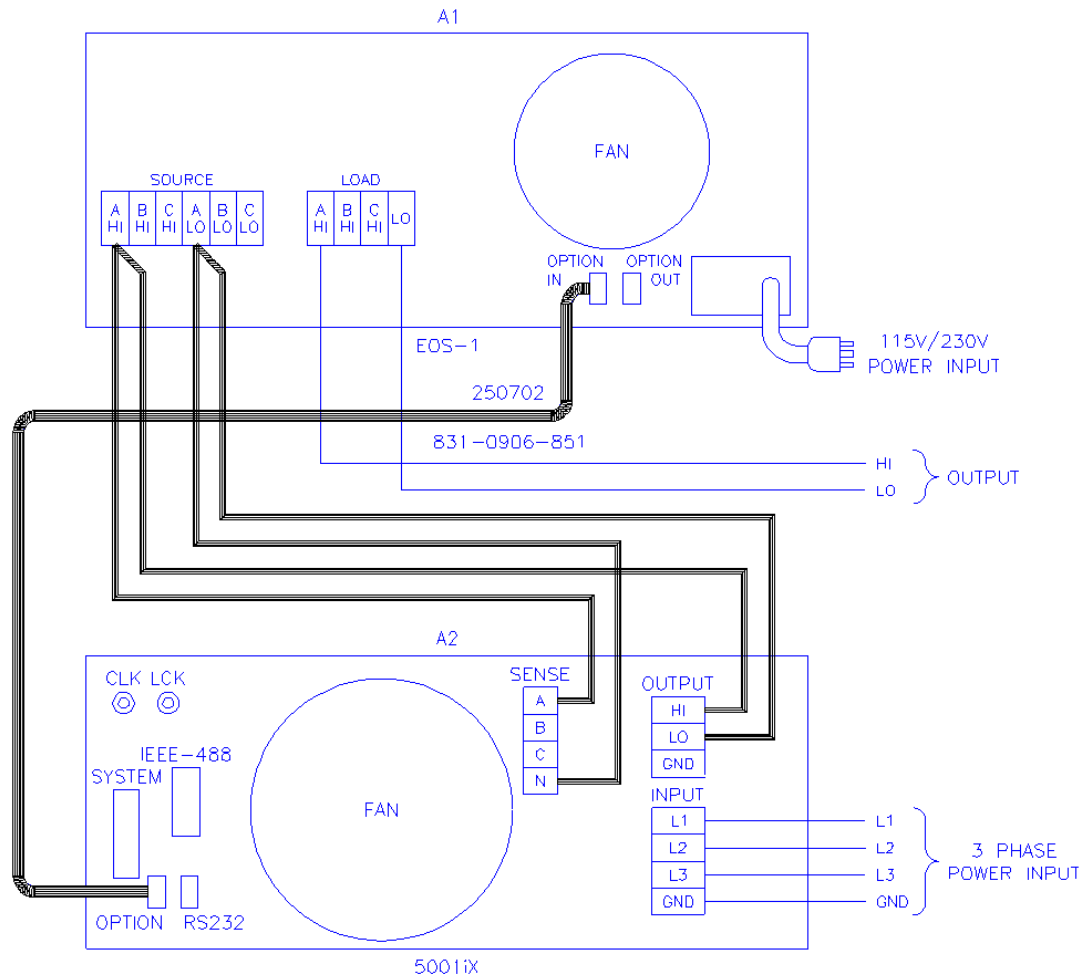


Figure 9-37: Example Connection With Compliance Test System and EOS-1

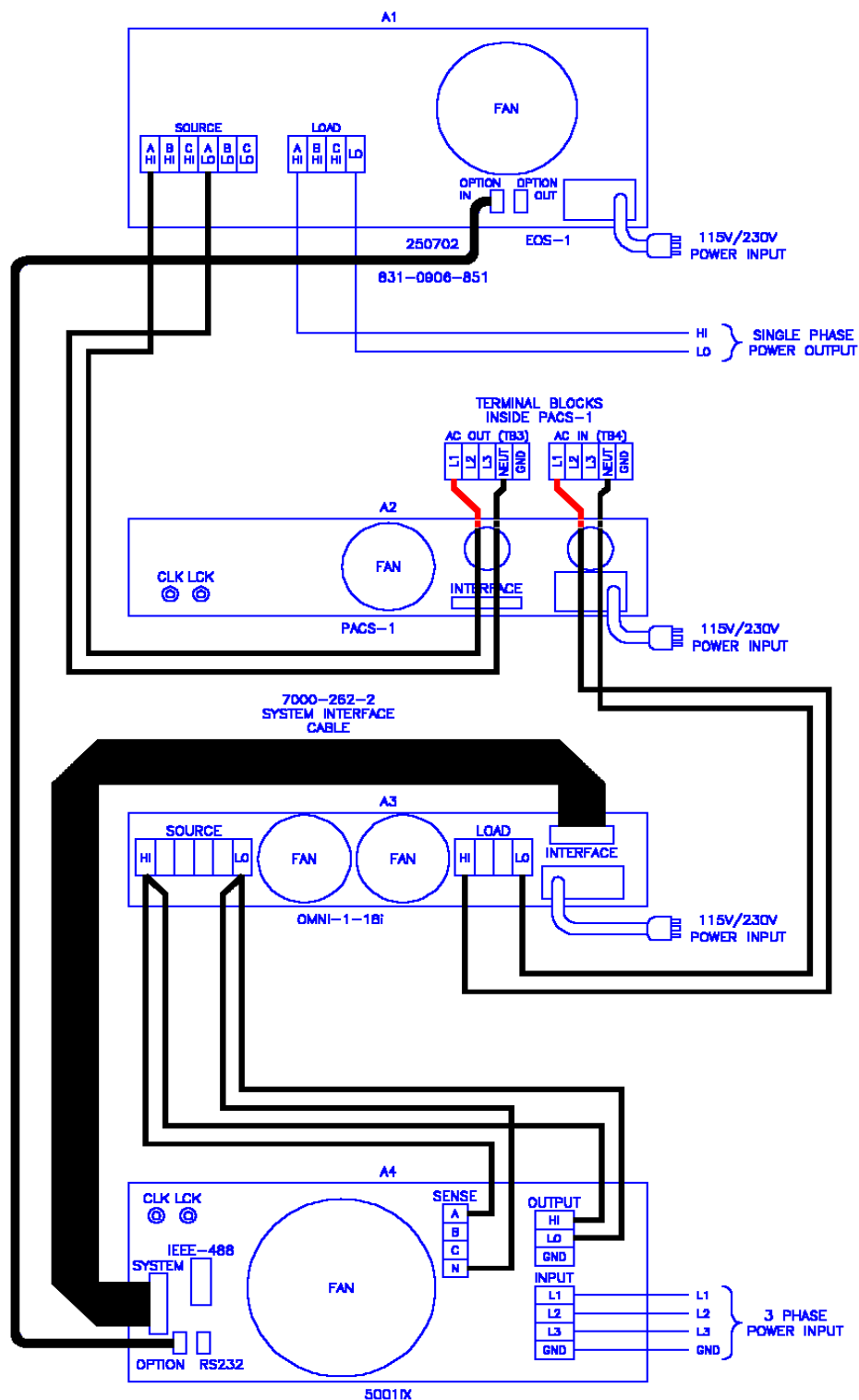
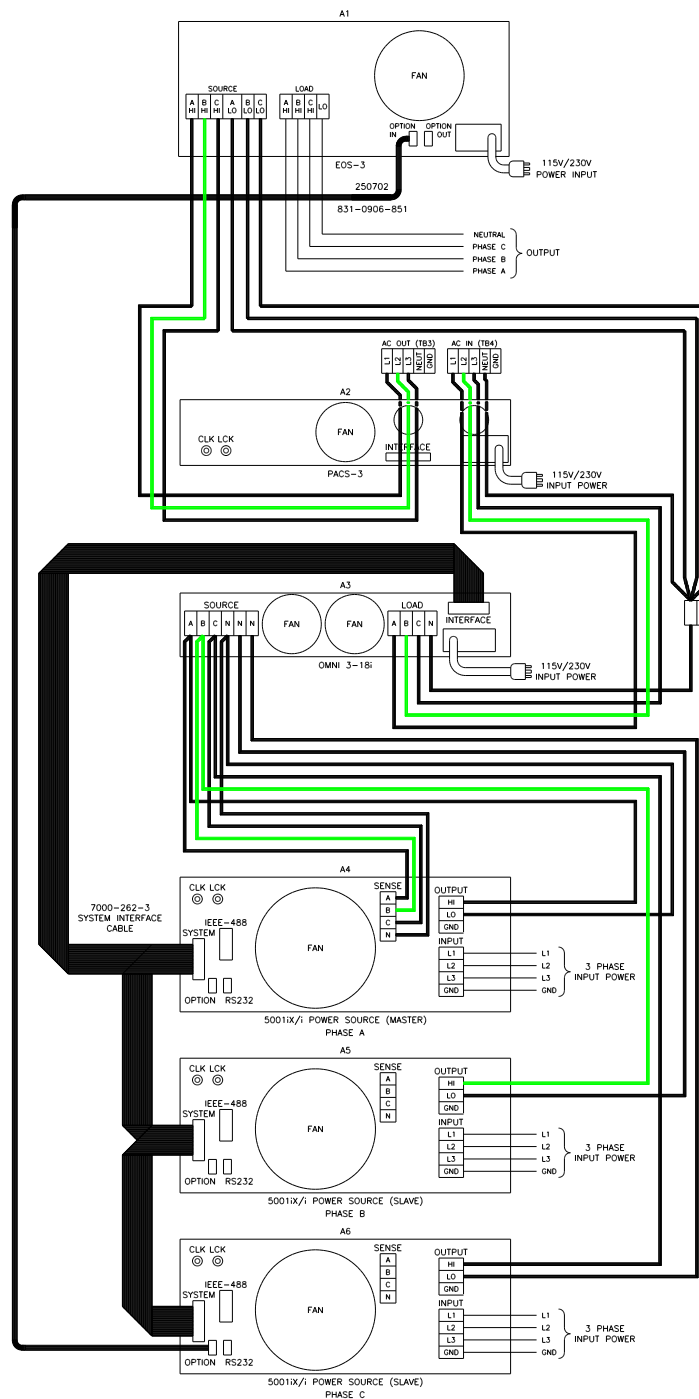
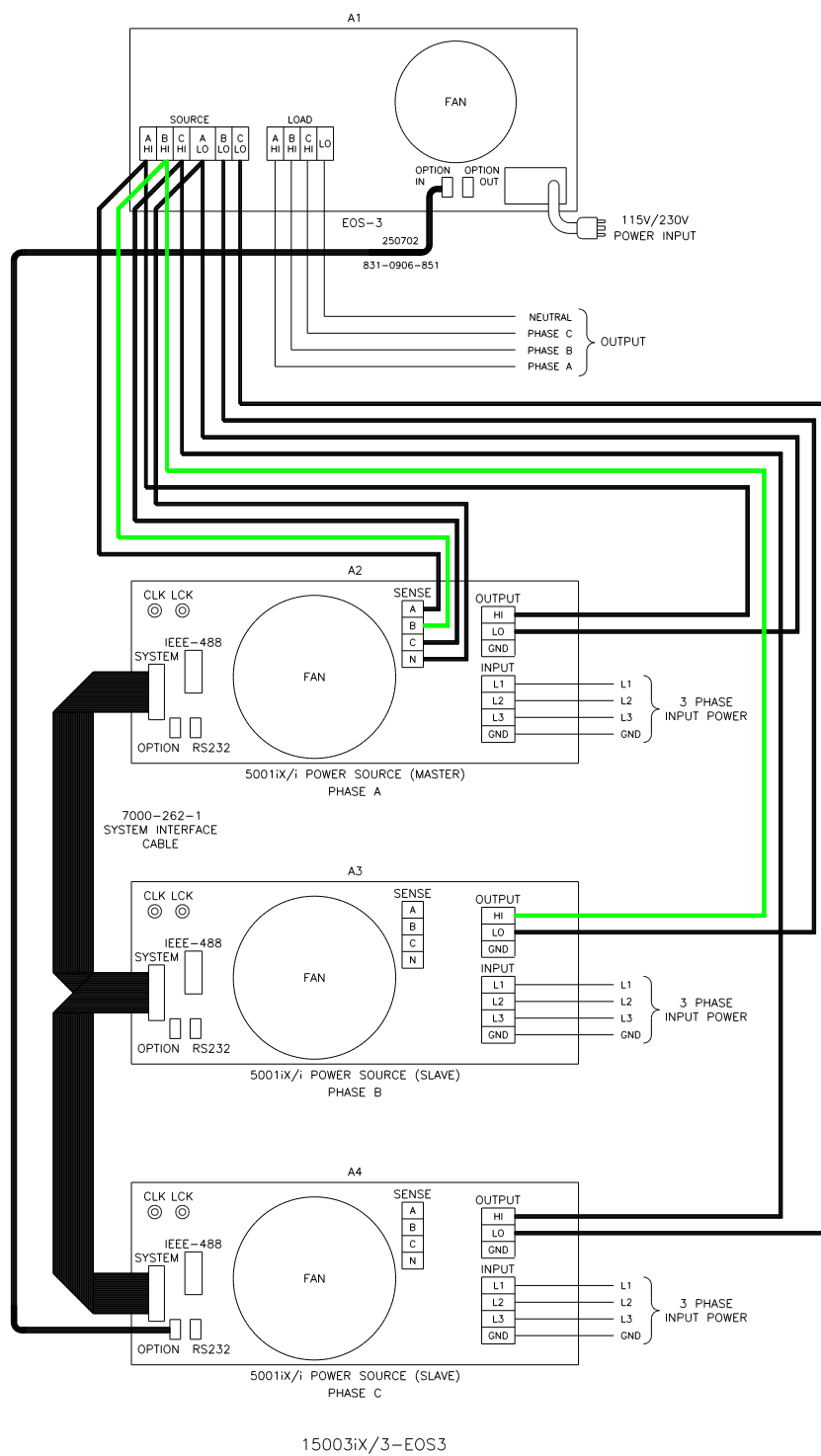


Figure 9-38: 15003iX-CTS-EOS3-LR3



15003iX/3-CTS-EOS3-LR3

Figure 9-39: 15003iX/3-EOS3



## 9.4.6 Operation

---

### 9.4.6.1 General

---

The EOS-1 is used with a California Instruments i/iX power source to perform testing compliant with the requirements of IEC1000-4-11. The EOS routes the voltage from the power source to an internal, tapped power transformer. Voltage from each of four taps is sent through an electronic switch to the EOS-1 output. During IEC1000-4-11 testing, the controlling California Instruments power source selects which voltage tap to connect to the EOS output. When IEC1000-4-11 testing is not active, the controlling power source puts the EOS-1 into bypass mode, shunting the EOS input terminals directly to the output terminals.

All control of the EOS-1 is performed automatically by the California Instruments power source. The control signals are sent from the power source to the EOS via the option interface cable. Refer to Section 9.2 for instructions regarding performing IEC1000-4-11 tests with this equipment.

The rated operating current for the EOS in active mode is 18.5 amps. If the controlling power source is set for an RMS current limit greater than 18.5 amps, it will not activate the EOS unit. An attempt to do so will indicate Error -222, "Data out of range". IEC 1000-4-11 tests may still be run, but in pre-compliance mode with the EOS unit bypassed.

Note that while the EOS is engaged, there is no Function Strobe output. Normally, the function strobe - outside the transient system - is associated with any output voltage change. When the EOS is in use however, the function strobe is generated only when the EOS is engaged. This is because the output is programmed down during relay activation. These strobes are meaningless and are not related to any output drops occurring through the EOS. During the EOS transients that use any of the available EOS drop levels, there are no function strobes. Voltage drops that do not use one of the available fixed drop levels are done by dropping the output of the power source itself and will result in function strobes on J22. It is possible to use the OPTION OUT on the back of the EOS - a DB9 connector, pin 6. The return can be either pin 2, 3 or 4. The strobe is a low going level that last for only 400 to 500 nsec. This strobe will coincide with drops performed by the EOS switch.

If the EOS is already in active mode, the controlling power source will not allow its RMS current limit to be programmed above 18.5 amps.

The EOS-3 is similar to EOS-1 with provision for three-phase operation.

#### **9.4.6.2 Front Panel Controls/Indicators**

---

##### **Power Switch and Lamp**

A power switch turns the EOS on or off. A lamp above the switch illuminates when power is on.

##### **Active Lamp**

This lamp is illuminated when the EOS is operating with the power transformer and electronic switches active for IEC1000-4-11 testing. During normal power source operation the lamp is off.

##### **Fault Lamp**

This lamp is illuminated when an overtemperature or an overcurrent condition has occurred in the EOS. If a fault occurs during IEC1000-4-11 testing, the FAULT lamp will be turned on and the EOS electronic switches will be turned off. The next time the controlling power source attempts to change the EOS state, the test will be aborted, the FAULT lamp will be turned off, the controlling power source will indicate an EOS error, and the EOS unit will be programmed to normal (bypassing EOS) mode.

The overtemperature condition will be released when the internal circuits have sufficiently cooled. An overcurrent condition may be reset by reactivating the EOS option from the iX controller 4-11 option screen.

##### **Tap Select Switch (Second generation EOS1 only)**

The EOS1 tap selection between the 70% and the 80% dip level taps is made using a toggle switch on the front panel of the EOS1. If this toggle switch is not present, the EOS1 is a first generation version. See Table 9-21 for revision details.

To use the 70% dip level, set the toggle switch in the 70% position.

To use the 80% dip level, set the toggle switch in the 80% position.

#### **9.4.6.3 EOS1 70/80 Tap setting change**

---

Second generation EOS1 units are equipped with both a 70% and an 80% output tap. The default configuration shipped from the factor is set to the 70% tap. This is the most commonly used dip level for product standards. However, Edition 2.0 of the IEC 61000-4-11 test standard does allow for a 80% dip level for which the alternate tap setting may be used. The EOS1 tap selection between the 70% and the 80% dip level taps is made using a toggle switch on the front panel of the EOS1. If this toggle switch is not present, the EOS1 is a first generation version. See Table 9-21 for revision details.

To use the 70% dip level, set the toggle switch in the 70% position.

To use the 80% dip level, set the toggle switch in the 80% position.

---

**Note:** When using the Cigui32 Windows GUI program to run IEC 61000-4-11 tests, select the EOS1 tap setting on the IEC 61000-4-11 test screen to match the toggle switch position. The GUI has no way to determining the switch setting on its own. If set correctly, the Cigui32 program will use the EOS when the correct dip level is programmed in the voltage dips data grid.

---



**9.4.6.4 EOS3 70/80 Tap setting change**

---

Second generation EOS3 units are equipped with both a 70% and an 80% output tap. The default EOS3 configuration shipped from the factor is set to the 70% tap. This is the most commonly used dip level for product standards. However, Edition 2.0 of the IEC 61000-4-11 test standard does allow for a 80% dip level for which the alternate tap setting may be used. If testing for 80% dips is required, the EOS3 must be reconfigured. This can only be done by removing the top cover and changing the connections on the three transformer taps inside the EOS3, one for each phase. As such, this configuration change should be avoided as much as possible. Should a configuration change be required, follow the procedure outlined below.

1. Remove all input power from the EOS3 first. Make sure the 15001iX is turned off. Then disconnect the output of the 15003iX power source from the EOS input.
2. With the EOS3 completely disconnected, remove the top cover by removing the Phillips screws of the top cover.
3. Each transformer – one per phase – has five output tap lugs connected to a wire harness. The wire harness routes the output of each tap the electronic switches on the control board. There is one control board for each phase mounted to a heat sink.
4. The output tap lugs are numbered 1, 2, 3, 5, 4 in that order on the transformer. The 70% output tap is available on lug number 3. The 80% output tap is available on lug number 5. To change taps, some hand tools (wrench, pliers) will be required.
  - To switch from 70% to 80% tap, disconnect the wire from lug 3 and reconnect it to lug 5 on each of the three transformers.
  - To switch from 80% to 70% tap, disconnect the wire from lug 5 and reconnect it to lug 3 on each of the three transformers.
5. Replace the top cover.

Although it is possible to wire each phase for a different tap level, this is not recommended. It may be advisable to mark the unit to reflect the configured tap after making a configuration change.

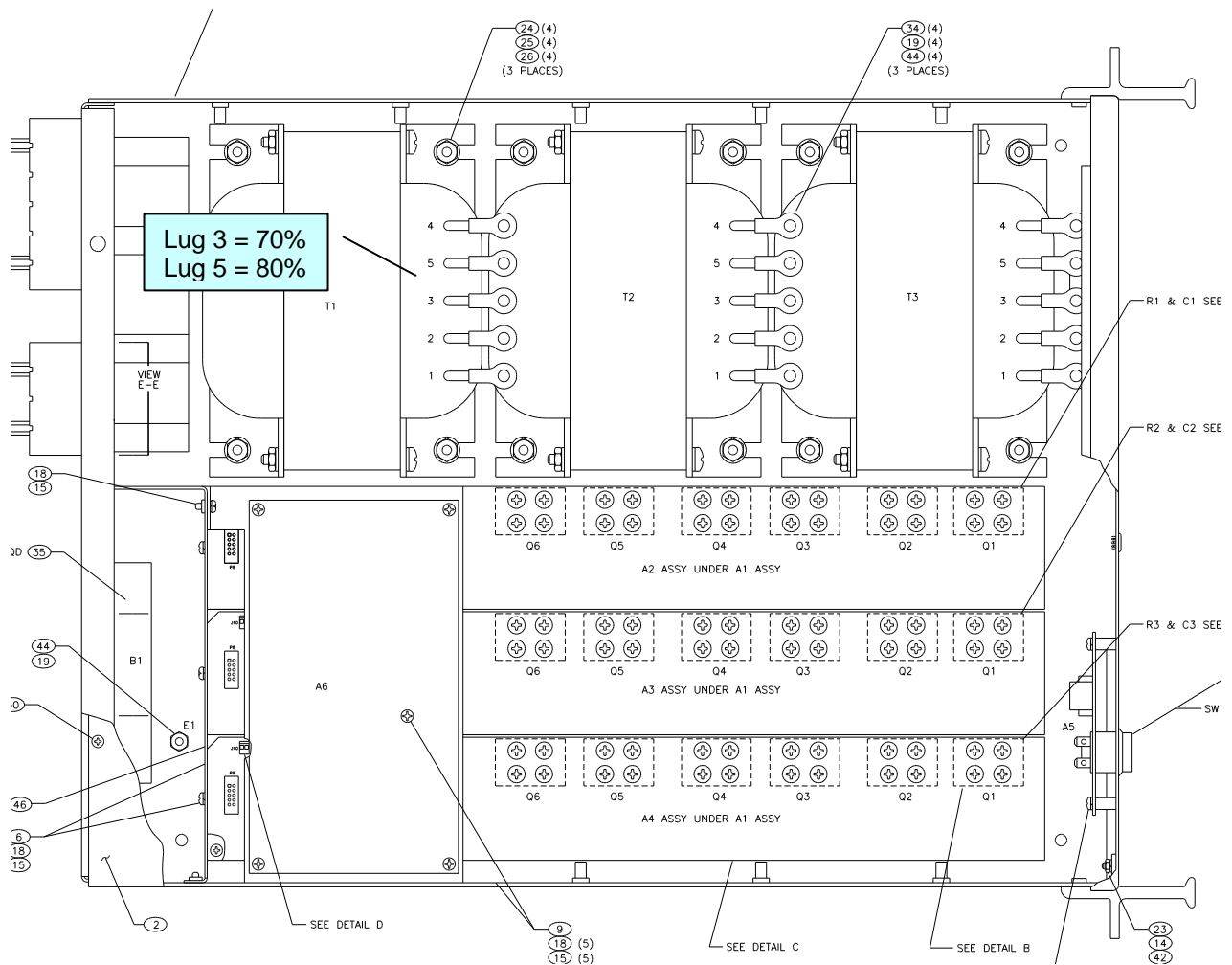


Figure 9-40: EOS3 Location of 70/80 Taps for each phase.

## **9.4.7 Service and Maintenance**

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### **9.4.7.1 Cleaning**

---

The exterior of the instrument may be cleaned with a cloth dampened with a mild detergent and wrung out. Disconnect all sources of power (mains, i/iX-power sources, etc.) before cleaning. Do not spray water or other cleaning agents directly on the instrument.

### **9.4.7.2 Fuses**

---

There are two fuses used in the EOS-1 or EOS-3. They are located in the mains connector. For continued protection against fire hazard, replace fuses with same type and rating.

<b>Mains Voltage</b>	<b>Fuse Rating</b>	<b>Fuse Type</b>	<b>CI Stock Number</b>
115 VAC, nominal	0.5 amp	3AG, slow acting	270064
230 VAC, nominal	0.25 amp	5x20mm, slow acting	

## 9.5 Mode iX Option

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### 9.5.1 Introduction

---

This section contains information on the installation and operation of the Mode-iX phase mode controller to be used with the California Instruments iX-series of power sources.

#### GENERAL DESCRIPTION

The Mode-iX phase mode controller accepts three outputs from California Instruments iX-series power systems and directs them to one output for a single phase system or three outputs for a three phase system. This switching action is performed automatically via a control signal from the power system to the Mode-iX phase mode controller.

### 9.5.2 Specifications

---

#### 9.5.2.1 Input

---

Line Voltage (user configurable)	115 VAC $\pm 10\%$ 230 VAC $\pm 10\%$
Line Current	< 0.25 amps at 115 VAC input < 0.125 amps at 230 VAC input
Line Frequency	47 to 63 Hz
Fuse Rating	0.25 amp, slow acting at 115 VAC input 0.125 amp, slow acting at 230 VAC input

#### 9.5.2.2 Phase Mode Terminals

---

Voltage	300 volts line to chassis 600 volts line to line
Current	37A rms, SOURCE A, B, C, N 37A rms, LOAD B, C 112A rms, LOAD A, N

#### 9.5.2.3 Controls/Indicators

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ON/OFF toggle switch  
Phase mode push button switch  
Power lamp  
One Phase Mode lamp  
Three Phase Mode lamp

**9.5.2.4 Mechanical**

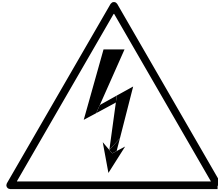
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Dimensions	3.5"H x 19"W x 22"D 89 mm H x 480 mm W x 560 mm D
Weight	14.1 lbs, 6.39 kg
Connectors: Input mains Source A, B, C, N Load A, N Load B, C	IEC 320 Phoenix Contact HDFK10 Phoenix Contact HDFK50 Phoenix Contact HDFK10
System Interface	3M 3367-1000 (mates with 3M 3366-1001)
Chassis Slide	General Devices C300S-118-U/B308 BKT

**9.5.2.5 Environmental**

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Temperature	0 to 40 °C
Relative Humidity	80% max. to 31 °C derate linearly to 50% max. at 40°C
Altitude	2000 m max.
Installation Overvoltage Category	II
Pollution Degree	2
Equipment Class	I
Usage	indoor



## CAUTION

Voltages up to 600 VAC are available in certain sections of this product. This equipment uses potentially lethal voltages.



## DEATH

On contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied.

### 9.5.3 Installation and Acceptance

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#### 9.5.3.1 Unpacking

---

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. Do not return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

#### 9.5.3.2 Power Requirements

---

The Mode-iX uses either 115 or 230 VAC to power the control circuits. The user may select the desired input voltage using the small range selector card within the IEC input module. The selector card may be removed from the input module by removing the line cord, sliding the plastic window to the left, and extracting the card.

Note that attempting to operate the Mode-iX from an input range that does not match the actual AC power voltage may cause permanent damage to the unit.

The selector card is marked 100/220 on one side and 120/240 on the opposite side. Mode-iX may be operated from a 115 volt line by selecting the 120 volt range. It may be operated from 230 volts by selecting the 240 volt range. The 100 volt and 220 volt ranges are not active.

The selected range is the one that is marked on the upper left side of the selector card as the card is slid into the IEC 320 module.

The power source to the Mode-iX must provide protective earth grounding.

#### 9.5.3.3 Mechanical Installation

---

The Mode-iX has been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the bottom with a shelf-track or supported from the sides with optional rack slides.

The cooling fan at the rear of the unit must be free of any obstructions that would interfere with the flow of air. A 2.5 inch clearance should be maintained between the rear of the unit and the rear panel of the mounting cabinet. Also, the air intake holes on the sides of the power chassis must not be obstructed.

#### 9.5.3.4 Output Wiring

---

The Mode-iX is wired in series with the output of specified California Instruments power source systems. The Mode-iX terminal block marked SOURCE should be wired to the output of the power source/system. The terminal block marked LOAD is wired to the user's load (unit under test, UUT). Refer to Figure 9-37 in this section for an example of proper connections.

Refer to Section **Error! Reference source not found.** to determine the appropriate wire gauge needed for the output wiring.



**Note:** The output voltage of the iX-series power sources into the Mode-iX box may be at hazardous potentials as high as 300 volts line to neutral (600 volts line to line). Wiring used between the power sources and Mode-iX and between the Mode-iX and the user's load must be insulated to withstand this potential.

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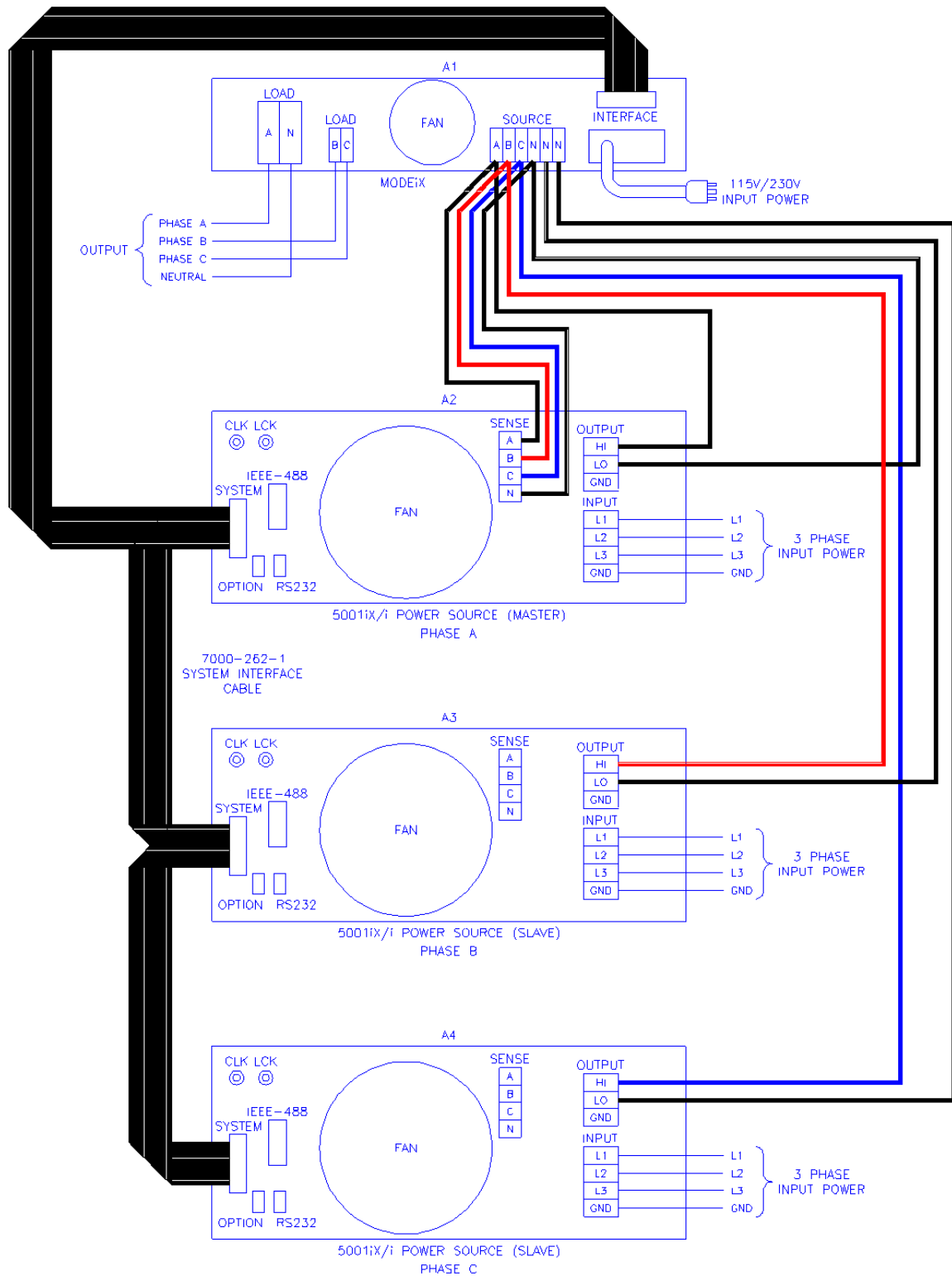


**Note:** The SOURCE and LOAD terminals of Mode-iX will be at the hazardous live potentials of the iX-series power sources driving it even if Mode-iX box has not been switched on.

---



Figure 9-41: Example Connection With MODE iX



## 9.5.4 Operation

---

### 9.5.4.1 General

---

The Mode-iX phase mode controller switches the three outputs from three California Instruments iX-series power sources to one or three sets of outputs on the phase mode controller. This allows the three power sources to be operated in either three phase or single phase mode with the system output being taken from the phase mode controller.

This switching is performed automatically via a control signal on the system interface connector. The signal is generated by the master power source. The master power source also automatically configures the complete power system for proper output phase angles and power source current sharing.

### 9.5.4.2 Front Panel Controls/Indicators

---

#### Power Switch and Lamp

A power switch turns the phase mode controller on or off. A lamp above the switch illuminates when power is on.

#### Mode Switch

This momentary contact push button switch toggles the phase mode controller between three phase and one phase mode. The function of this switch is normally disabled and switching is remotely controlled via a signal on the system interface connector.

#### One Phase Lamp

This lamp is illuminated when the phase mode controller is operating in single phase mode. The power source outputs connected to the SOURCE A, B and C terminals are shorted together in the phase mode controller and directed to the LOAD A terminal.

#### Three Phase Lamp

This lamp is illuminated when the phase mode controller is operating in three phase mode. The power source outputs connected to the SOURCE A, B, C terminals are directed to the LOAD A, B, C terminals, respectively.

#### Programmed Control

The phase mode controller is normally remotely programmed by the master iX-series power source.

A system interface cable must be connected between the Mode-iX and the power sources to carry the control signal to the Mode-iX. When configured for programmed control, the Mode-iX may not be controlled by the front panel MODE switch. Refer to Section 4.2.11.2 for details on controlling the number of output phases with the Mode-iX option.

## **9.5.5 Service and Maintenance**

---

### **9.5.5.1 Cleaning**

---

The exterior of the instrument may be cleaned with a cloth dampened with a mild detergent and wrung out. Disconnect all sources of power (mains, iX-power sources, etc.) before cleaning. Do not spray water or other cleaning agents directly on the instrument.

### **9.5.5.2 Fuses**

---

There is one fuse used in the Mode-iX phase controller. It is located in the mains connector. For continued protection against fire hazard, replace fuse with same type and rating.

<b>Mains Voltage</b>	<b>Fuse Rating</b>	<b>Fuse Type</b>	<b>CI Stock Number</b>
115 v rms, nominal	0.25 amp	3AG, slow acting	270117
230 v rms, nominal	0.125 amp	3AG, slow acting	270109

## 9.6 Omni Options

---

### 9.6.1 Introduction

---

This section contains information on the installation and operation of the OMNI (Output Matching Network Impedance) impedance network to be used with the California Instruments

i- or iX-series of power sources.

### 9.6.2 General Description

---

The OMNI impedance network adds inductive and resistive impedance to California Instruments i- or iX-series power sources. This additional impedance brings the combined system impedance up to the levels required of the power source for IEC 555-3 and IEC 1000-3-3 (flicker) testing.

### 9.6.3 Specifications

---

#### 9.6.3.1 Input

---

	Omni 1-18i and 3-18i	Omni 1-37i, 1-37iJ and 3-37i
Line Voltage (user configurable)	115 VAC $\pm 10\%$ or 230 VAC $\pm 10\%$	115 VAC $\pm 10\%$ or 230 VAC $\pm 10\%$
Line Current	< 0.25 amps at 115 VAC input < 0.125 amps at 230 VAC input	< 1.0 amps at 115 VAC input < 0.5 amps at 230 VAC input
Line Frequency	47 to 63 Hz	47 to 63 Hz
Fuse Rating	0.25 amp, slow acting at 115 VAC input 0.125 amp, slow acting at 230 VAC input	2 Amp, slow acting used for both input ranges

#### 9.6.3.2 Output

---

OMNI Type	1-18i	3-18i	1-37i and 1-37iJ	3-37i
Phases	1	3	1	3
Current max, rms.	18.5A per phase	18.5A per phase	37A per phase	37A per phase
Current in bypass	37A per phase	37A per phase	74A per phase	74A per phase

---

**NOTE:** To prevent damage to the OMNI unit, the BYPASS mode must be selected when the power source is operated on low output voltage range or if currents in excess of OMNI ratings will be drawn.

---

OMNI Type	1-18i, 3-18i, 1-37i, 3-37i	1-37iJ
Impedance $\pm 5\%$	(in combination with power source output impedance)	
Phase	0.24 ohms + j 0.15 ohms at 50 Hz	0.24 ohms + j 0.062 ohms at 50 Hz
Neutral	0.16 ohms + j 0.10 ohms at 50 Hz	0.16 ohms + j 0.054 ohms at 50 Hz

---

#### 9.6.3.3 Controls/Indicators

ON/OFF toggle switch  
Flicker On/Off push button switch  
Power Lamp  
Bypass Lamp  
Flicker Lamp

---

#### 9.6.3.4 Mechanical

Dimensions	Omni 1-18i and 3-18i:	Omni 1-37i, 1-37iJ and 3-37i:
	3.5"H x 19"W x 22"D 89mmH x 480mmW x 560mmD	5.25"H x 19"W x 22"D 133mmH x 480mmW x 560mmD
Weight		
OMNI-1-18i	31 lb. (14 kg)	
OMNI-3-18i	37 lb. (17 kg)	
OMNI-1-37iJ	55 lb. (25 kg)	
OMNI-3-37i	55 lb. (25 kg)	
Connectors		
Input AC	IEC 320	
Impedance Network	Kulka 9-85 series	
Input and Output	3M 3367-1000 (mates with 3M 3366-1001)	
System Interface		
Chassis Slide	General Devices C300S-118-U/B308 BK	

---

### 9.6.4 Installation and Acceptance

---

#### 9.6.4.1 Unpacking

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. Do not return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

---

#### 9.6.4.2 Power Requirements

The OMNI 1-18i and 3-18i use either 115 or 230 VAC to power the control circuits. The user may select the desired input voltage using the small range selector card within the IEC input

module. The selector card may be removed from the input module by removing the line cord, sliding the plastic window to the left, and extracting the card.

For the Omni 1-18i and 3-18i the selector card is marked 100/220 on one side and 120/240 on the opposite side. OMNI 1-18i and 3-18i may be operated from a 115 volt line by selecting the 120 volt range. It may be operated from 230 volts by selecting the 240 volt range. The 100 volt and 220 volt ranges are not active.

The selected range is the one that is marked on the upper left side of the selector card as the card is slid into the IEC 320 module.

The OMNI 1-37i, 1-37iJ and 3-37i are designed to operate on either 115V or 230V AC power. The input voltage is user-selectable by orienting the input selector module inside the rear panel power entry module. To change input voltage proceed as outlined below.

**Note that attempting to operate the OMNI from an input range that does not match the actual AC power voltage may cause permanent damage to the unit.**

---

#### 9.6.5 Voltage Range Configuration for the OMNI 1-37i, 1-37iJ and OMNI 3-37i

---

To change input range:

1. Remove power cord from input module.
2. Pry cover loose with a small screwdriver.
3. Pull out fuse holder, prying with a screwdriver will be necessary.
4. Orient the red fuse holder so that the desired voltage shows through the window. It is necessary that the fuse always sits on the top side of the fuse holder when it is re-inserted into the module. Likewise, the shorting clip must always be on the bottom of the fuse holder.

For example, if the input voltage is being changed from 115 to 230, the fuse holder must first be removed, and then the clip and the fuse must swap location. The fuse assembly can then be inserted back into the input module.

---

##### 9.6.5.1 Mechanical Installation

---

The OMNI has been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the bottom with a shelf-track or supported from the sides with optional rack slides.

The cooling fans at the rear of the unit must be free of any obstructions that would interfere with the flow of air. A 2.5 inch clearance should be maintained between the rear of the unit and the rear panel of the mounting cabinet. Also, the air intake holes on the sides of the power chassis must not be obstructed.

---

##### 9.6.5.2 Output Wiring

---

The OMNI impedance network is wired in series with the output of specified California Instruments power sources or power source systems. The OMNI terminal block marked SOURCE should be wired to the output of the power source/system. The terminal block marked

LOAD is wired to the user's load (unit under test, UUT). Refer to the figures in this section for examples of proper connections.

Refer to the power source manual to determine the appropriate wire gauge needed for the output wiring.

---

#### **9.6.5.3 External Sense Wiring**

---

The external sense wires of the power source must be connected at the output of the power source and NOT at the output of the OMNI or at the load. If the external sense wires were connected at the load or the OMNI output, the power source error amplifier would lower the effective OMNI impedance making the system unsuitable for IEC 555-3 or IEC 1000-3-3 flicker testing.

Refer to the figures in this section for examples of proper external sense connections.

Figure 9-42: Example Connections With OMNI 1-18i

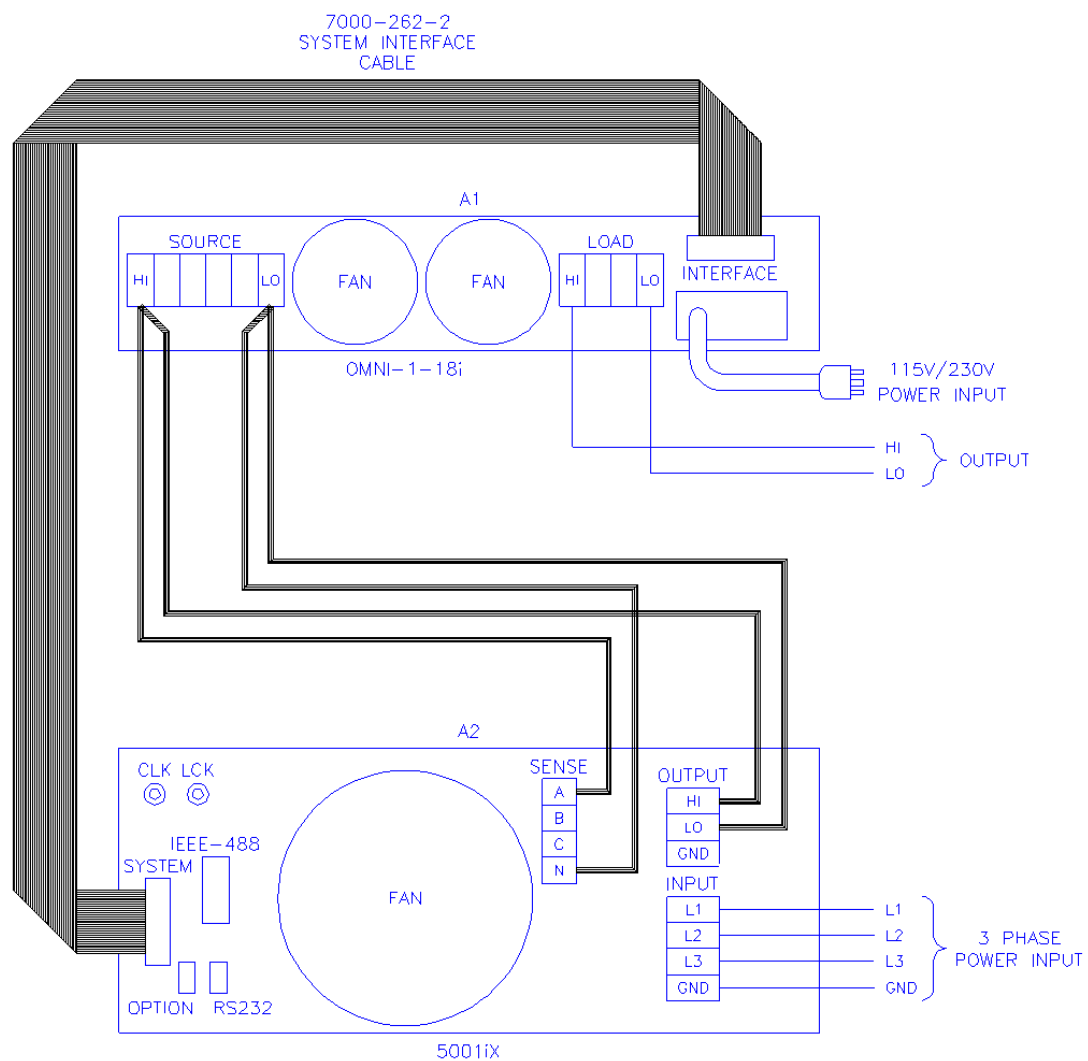




Figure 9-43: Example Connections With OMNI 3-18i

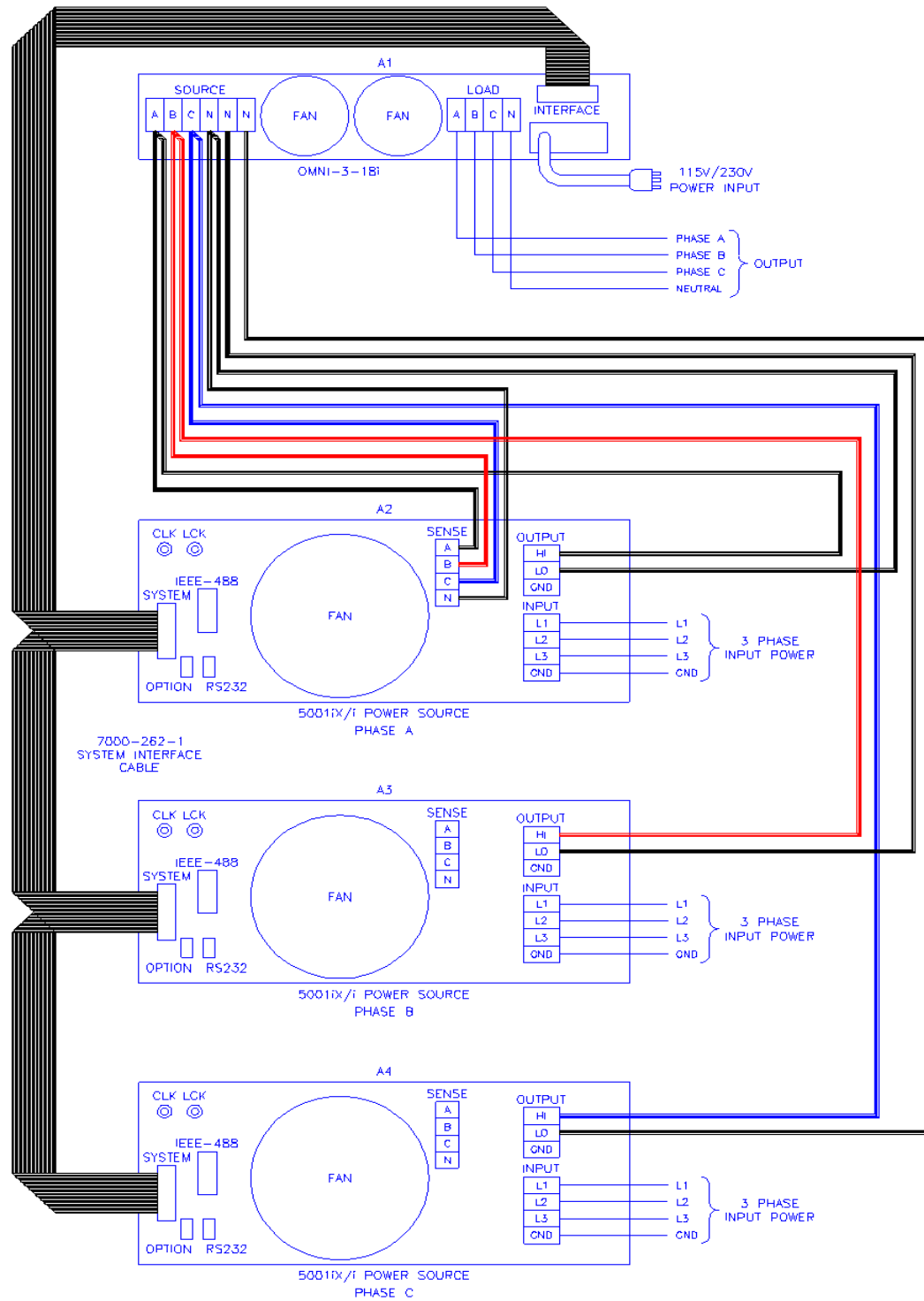


Figure 9-44: Schematic Showing OMNI 1-37i and 1-37iJ Connected to 5001iX System

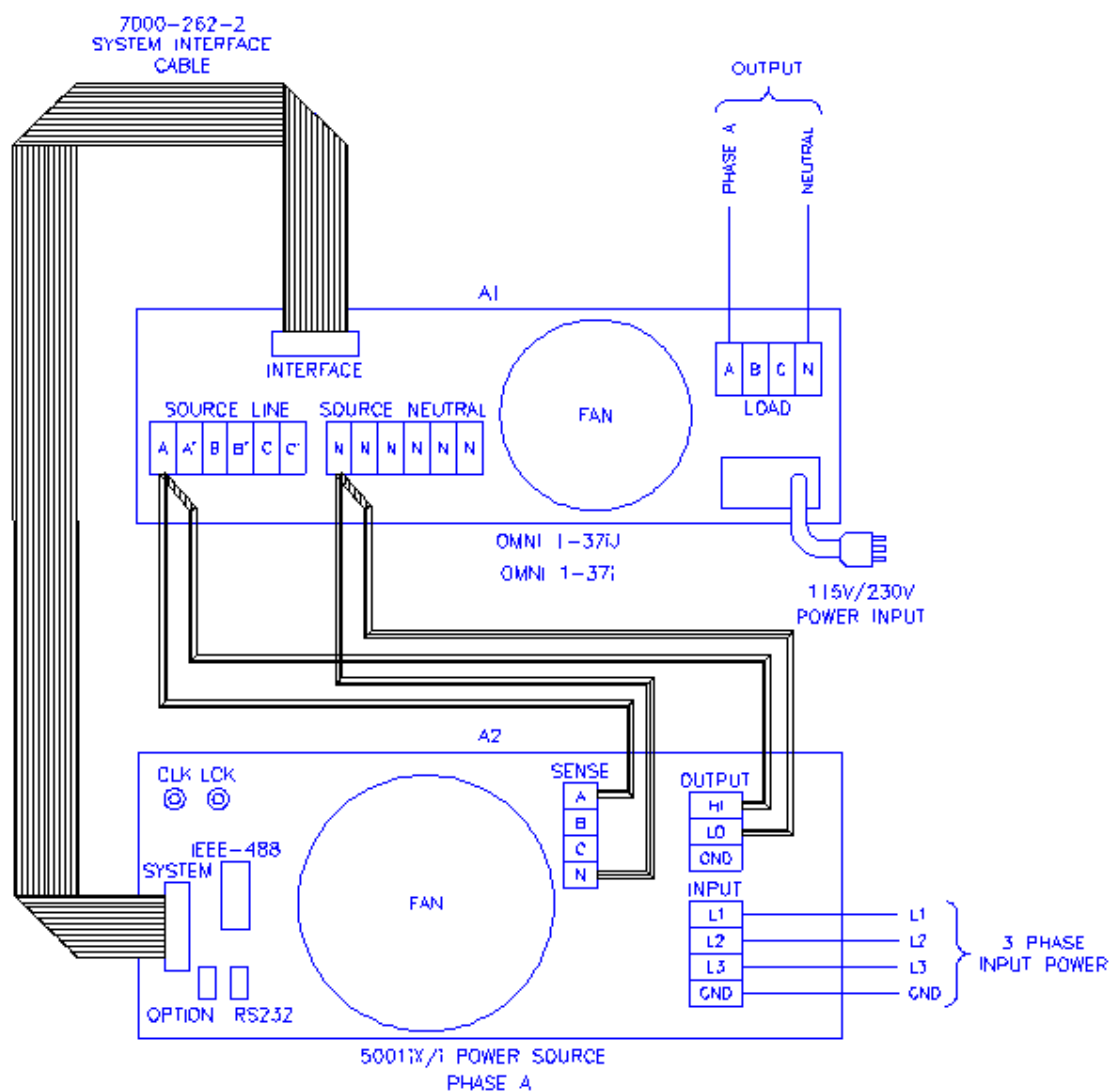
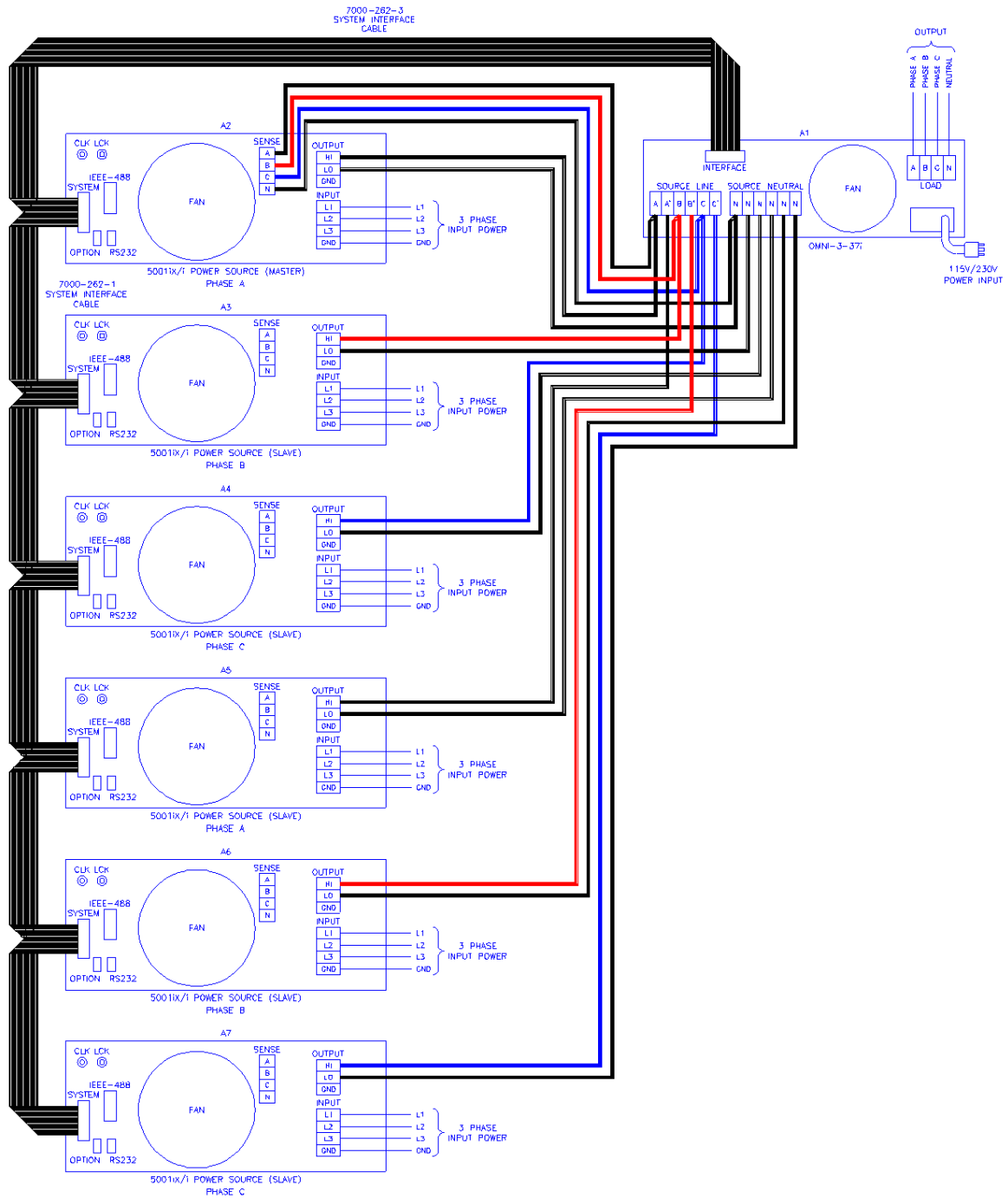


Figure 9-45: Schematic Showing OMNI 3-37i Connected to 30003iX System



## 9.6.6 Operation

---

### 9.6.6.1 General

---

The OMNI impedance network adds resistive and inductive impedance to the output of selected California Instruments power sources/systems to provide power source impedance levels specified for IEC 555-3 flicker testing. For normal (low impedance) power source operation, the impedance that OMNI adds may be shunted by bypass relays selected on the OMNI front panel.

### 9.6.6.2 Omni i Front Panel Controls/Indicators

---

#### Power Switch and Lamp

A power switch turns the OMNI control circuits on or off. A lamp above the switch illuminates when power is on.

#### Flicker On/Off Switch and Lamps

The momentary contact push button Flicker On/Off switch toggles the OMNI mode between bypass function (no added impedance) and flicker function (IEC 555-3 impedance). Lamps above the switch indicate the selected mode.

---

**NOTE: To prevent damage to the OMNI unit, the BYPASS mode must be selected when the power source is operated on low output voltage range or if currents in excess of OMNI ratings will be drawn.**

---

Bypass relays are provided to short out the OMNI impedance so that the power source may be used with its normal low output impedance or whenever the load current will be in excess of the OMNI maximum current rating. When the BYPASS mode is selected, the OMNI impedance is shorted out. When the FLICKER mode is selected, the OMNI impedance is added to the power source output impedance.

Select the BYPASS position when low power source output impedance is required or desirable. This is the case for most tests other than IEC 555-3 flicker tests. Also select the BYPASS position when the power source is operated on the low voltage output range. The low voltage output range can deliver currents well in excess of the OMNI maximum current rating.

### 9.6.6.3 Omni Control Through i/iX Front Panel

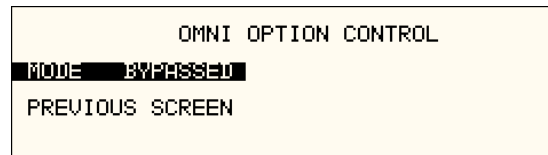
---

Select the APPLICATIONS screen from the MENU2 screen. The following screen will appear as shown in Figure 9-46

APPLICATIONS SETUP	
MIL-STD-704	RTCA/DO-160C
<b>OMNI OPTION</b>	IEC 1000-4-11
PREVIOUS SCREEN	

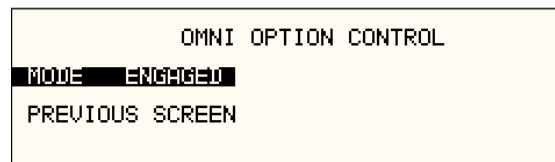
Figure 9-46: Applications Screen

Scroll to the OMNI OPTION entry using the up and down cursor key. Press the ENTER key. The following MENU will appear as shown in Figure 9-47



*Figure 9-47: OMNI Control Screen*

Scroll to the MODE entry using the up and down cursor key. USE the Shuttle Knob to engage the OMNI. The display will indicate that the OMNI mode as shown in Figure 9-48



*Figure 9-48: OMNI Control Screen*

Note: The output of the AC source will drop for about 50 ms when the OMNI MODE changes state.

To Bypass the OMNI, turn the Shuttle Knob counterclockwise.

---

#### **9.6.6.4 Programmed Control**

The FLICKER/BYPASS mode may be remotely programmed by the power source if the power source and OMNI are configured for this function. A system interface cable must be connected between the OMNI and the power source to carry the control signal to the OMNI. When configured for programmed control, the OMNI may not be controlled by the front panel FLICKER/BYPASS switch. Refer to the power source manual for details on programming instructions.

### 9.6.6.5 Control Configuration

---

Manual versus programmable control of the OMNI is configured using a two pole DIP switch on the DC Supply/Relay Board assembly inside the OMNI chassis. To reconfigure the control feature, perform the following steps:

**WARNING:** Disconnect all sources of power to the OMNI before performing any of these steps. Hazardous voltages may be present internally from the AC mains and from AC power source connected to the OMNI rear panel.

1. Disconnect all sources of power to the OMNI.
2. Remove the OMNI top cover.
3. Configure S1 DIP switch setting according to table:

MODE	S1 POSITION 1	S1 POSITION 2
Manual	OFF	ON
Programmable	ON	OFF

Note: Position 1 is toward the OMNI front panel, position 2 is toward the OMNI rear panel.

4. Replace the top cover.
5. Reconnect power to the OMNI

## 9.7 LNS Option and XLS Option

The Line Sync option and the External Line Sync option both provide the same function, namely synchronizing the iX output to the input line. The LNS option is internal to the iX power source and will sync the output to the iX input line only.

The XLS option however, is external to the power source, it can be added to the source as needed and it will sync to any line voltage whether it is connected to the iX source or not.

### 9.7.1 Specifications

The -LNS and -XLS options meet the following specifications. The specifications shown here are for these line sync options only. All other power source specifications for i Series and iX Series power systems are covered in their respective data sheets.

<b>Internal Line Sync (-LNS)</b>			
AC Line Voltage input		Taken from AC input	
		Internally in power source	
Frequency		45 – 66	Hz
Phase offset		0.0° - 360.0°	
Phase error		± 1.0°	
<b>External Line Sync (-XLS)</b>			
AC Line Voltage input			
	Low range	80 – 250	V RMS
	High range	250 – 500	V RMS
Frequency		45 – 66	Hz
Phase offset		0.0° - 360.0°	
Phase error		± 1.0°	
Input connectors		Banana Jacks	
		Screw Terminals	
Interface to Power Source		36 Pin System Interface	

**Note:** During external sync mode operation, some features such as clock and lock mode, external sync and frequency transients are disabled.

### 9.7.2 LNS Option

---

The Line Sync Option (LNS) allows the output of the i/iX AC Source to be synchronized to the line input. This capability may be needed to support tests that require the use of additional equipment. The –LNS option needs to be ordered at the time of purchase and cannot be installed in the field.

The LNS Option – if installed – can be turned on from the front panel as follows:

Select the PROGRAM 2 screen and move the cursor to the CLK MODE field. The default value for the field is INT for internal clock mode. Use the knob to select the SYNC mode in order to enable the LNS. If the LNS is not installed a “LINE SYNC ERROR” will appear after a short period in the top left of the screen. This means the LNS option is either not present or not receiving a phase input signal from the line.

To turn the sync mode back off, set the CLK MODE field back to INT.

Over the bus, the LNS is enabled or disabled as follows:

FREQ:MODE SENS                   /\* Enables LNS \*/

FREQ:MODE FIX                   /\* Disables LNS \*/

If the LNS is not installed and the FREQ:MODE SENS command is issued, an error message is generated. If done as part of a test program, an error check should be done after a 800 msec delay to allow the i/iX to sense the presence of a sync signal coming from the LNS board. If no error occurs, the LNS is active. If an error occurs, the LNS may not be available or not functioning and the mode has reverted back to internal.

The LNS option is designed to keep the iX output frequency locked to the line frequency. There is a finite phase offset however, between the iX source output and the line input to the iX power source. This phase offset will vary somewhat with the input line voltage. If it is desired to have the iX output in-phase with the line input it will be necessary to monitor the iX output voltage as well as the line input to the iX source using a two channel oscilloscope to compare the zero-crossings of the voltage waveforms. An isolation amplifier must be used when connecting the input line to the o'scope input. To program an offset angle on the iX source, go to PROGRAM 2 screen and select PHASE. Typically 25-30 of phase angle will put the line input and the source output in-phase, but the exact angle to program can only be determined by monitoring the iX source output and the line input voltage and comparing the waveforms.

### 9.7.3 XLS Option

---

The External Line Sync option (-XLS) is housed in a small metal enclosure that interfaces to the power source using a system interface cable. This module has a pass-through connector for the system interface so this interface remains available for other purposes.

The external line sync module provides two input voltage ranges, a low range from 80 V to 250 V RMS and a high range from 250 V to 500 V RMS. The AC line voltage can be connected using standard sheathed banana jacks or a screw terminal strip. The -XLS option provides full safety isolation from input to interface connector. The AC line to synchronize the source output to can be the same as the one feeding the source itself, or a different one altogether for greater flexibility.



## 9.7.4 Mechanical Dimensions

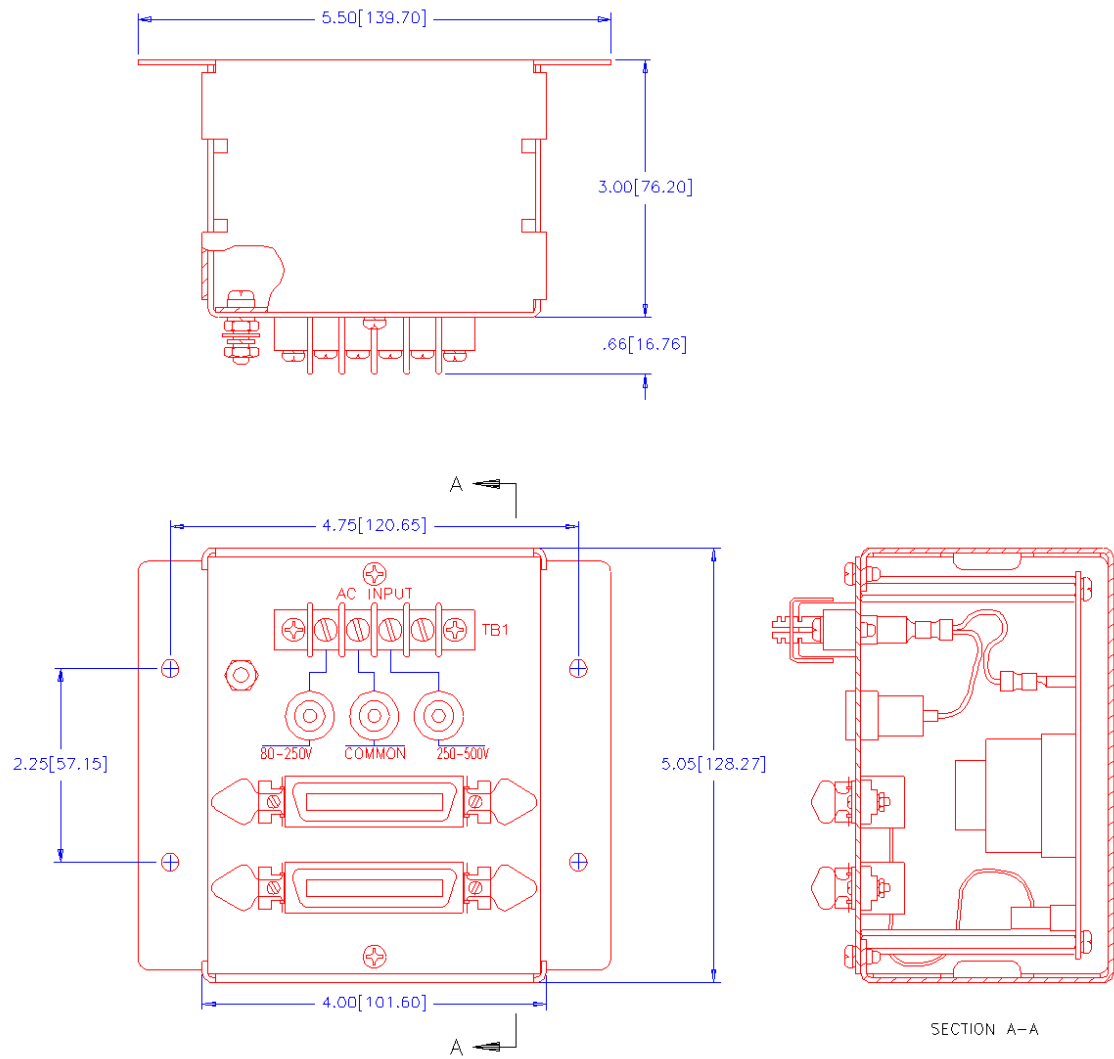


Figure 9-49: XLS Module Dimensions

### 9.7.5 Connection Diagram

The following diagrams illustrate both low range and high range connections between the XLS module, the i/iX Series master power source and the AC Line synchronizing voltage.

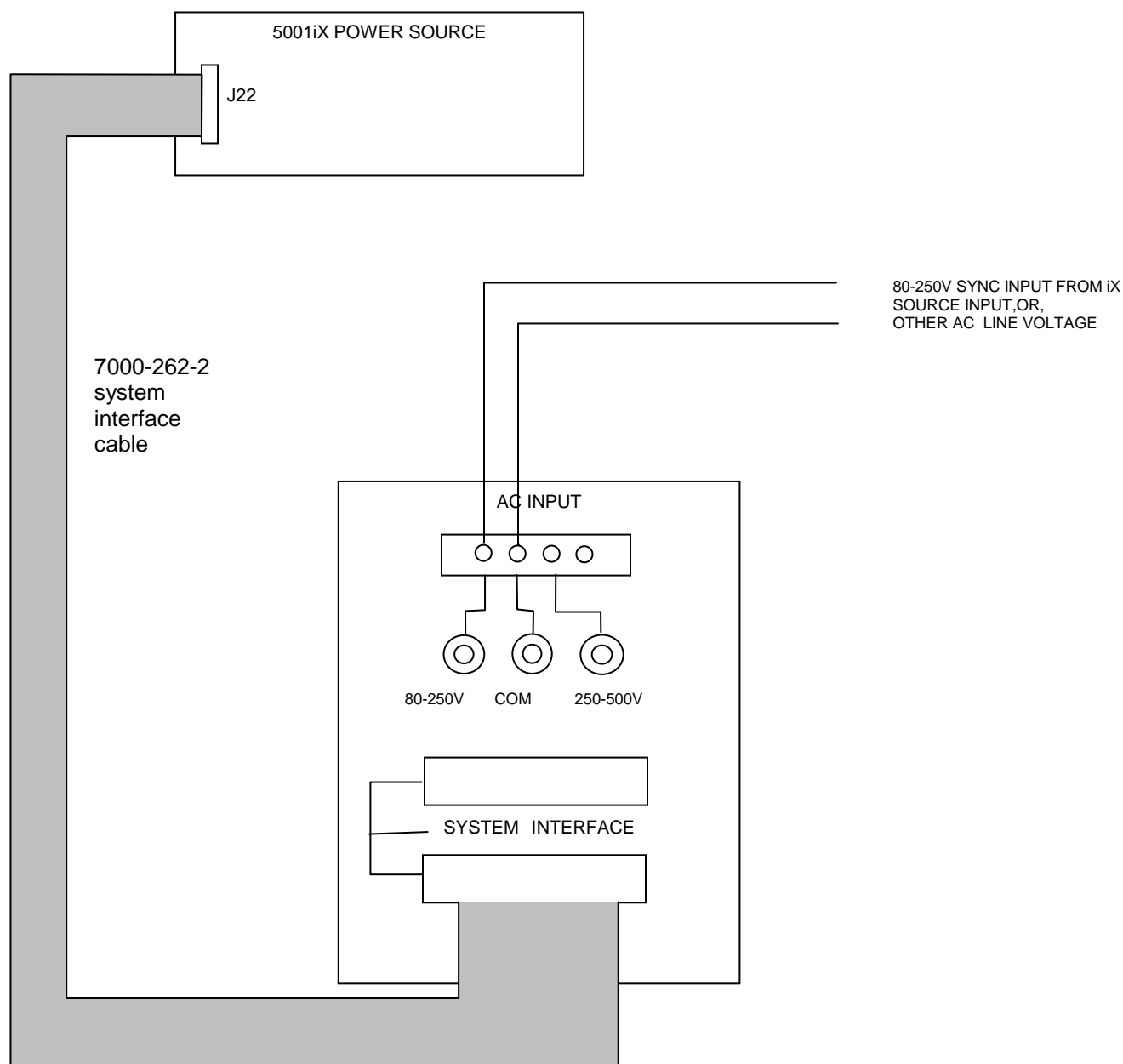


Figure 9-50: XLS Connection on Low Range

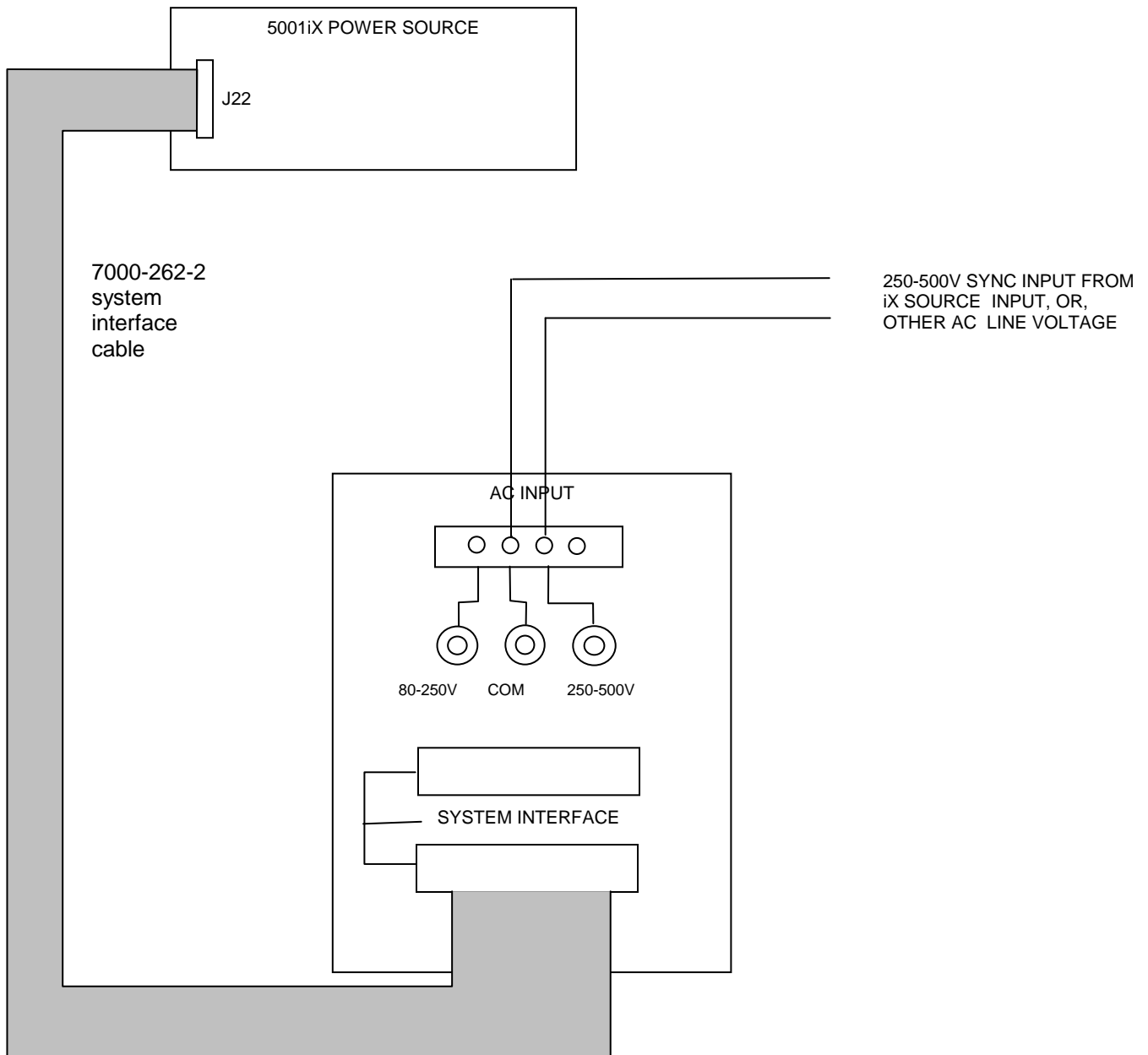


Figure 9-51: XLS Connection on High Range

### 9.7.6 Installation

---

The XLS module can be installed inside a system cabinet or other vertical structure in the vicinity of the iX power source. Refer to Figure 9-50 and Figure 9-51 for connection details. The input voltage can be applied to the AC input terminal strip as shown, or, banana jacks can be used to secure the line voltage to the XLS module. The system interface ribbon cable can be connected to either of the two connectors on the XLS module. The extra connector is provided for pass-through connectivity.

### 9.7.7 XLS Option Operation

---

The External Line Sync option (XLS) allows the output of the i/iX AC Source to be synchronized to any line input, whether it is the line powering the iX source or any other line voltage not necessarily hooked up to the iX source. This capability may be needed to support tests that require the use of additional equipment.

The XLS Option – once installed and connected – can be turned on from the iX front panel as follows:

Select the PROGRAM 2 screen and move the cursor to the CLK MODE field. The default value for the field is INT for internal clock mode. Use the knob to select the SYNC mode in order to enable the XLS. If the XLS is not installed a “LINE SYNC ERROR” will appear after a short period in the top left of the screen. This means the XLS option is either not present or not receiving a phase input signal from the line.

To turn the sync mode back off, set the CLK MODE field back to INT.

Over the bus, the XLS is enabled or disabled as follows:

FREQ:MODE SENS                   /\* Enables XLS \*/

FREQ:MODE FIX                   /\* Disables XLS \*/

If the XLS is not installed and the FREQ:MODE SENS command is issued, an error message is generated. If done as part of a test program, an error check should be done after a 800 msec delay to allow the i/iX to sense the presence of a sync signal coming from the XLS module. If no error occurs, the XLS is active. If an error occurs, the XLS may not be available or not functioning and the mode has reverted back to internal.

The XLS option is designed to keep the iX output frequency locked to the line frequency. There is a finite phase offset however, between the iX source output and the line input to the External Sync Module. This phase offset will vary somewhat with the line voltage going to the XLS module. If it is desired to have the iX output in phase with the line input, it will be necessary to monitor the iX output voltage as well as the line input to the XLS module using a two channel oscilloscope to compare the zero-crossings of the voltage waveforms. An isolation amplifier must be used when connecting the sync input line to the o'scope input. To program an offset angle on the iX source, go to PROGRAM 2 screen and select PHASE. Typically 25-30 of phase angle will put the line input and the source output in-phase, but the exact angle to program can only be determined by monitoring the iX source and the line input voltage and comparing the waveforms.

## **9.8 Option –704: MilStd704 Tests**

---

The MIL704 option is made up of both firmware that resides in the power source and the CIGui32 Windows application program. The firmware covers revision D and E of the Mil-Std704 standard. The CIGui32 covers the remaining revisions A, B, C and F. This provides coverage of all available standard revisions.

The user interface for each implementation is different however. The revision D and E tests can be operated directly from the power source's front panel or through the supplied CIGui32 program. The revision A-C, F tests can only be operated through the supplied CIGui32 program. Thus, for rev A-C and F, a Windows PC and interface is required.

Section 9.8.1 covers operation of the firmware based revision D and E tests. Section 9.8.2 covers operation of the revision A-C and F tests. Note that future updates of the CIGui32 may include overlapping coverage for revisions D and E in the software as the CIGui32 program is designed to support all revisions. For now, revisions D and E have no associated data files in the CIGui32.

### 9.8.1 Option –704: MIL-STD-704 rev D & E Tests. (Firmware)

---

#### 9.8.1.1 General

---

The MIL704 option is capable of performing most sections of MIL-STD-704 rev D and E in either of the AC or DC mode.

---

**Note: The Distortion Spectrum tests:**

*Table I and II, Figure 7*

*Table III, Figure 12*

*Table IV, Figure 18*

**are not supported by the –704 option. These tests require the use of additional external equipment.**

---

#### 9.8.1.2 Initial Setup

---

Nominal parameters for the AC Power source are as follows:

Output Voltage                      115V L-N

Output Frequency                  400 Hz

Nominal parameters for the DC Power source are as follows:

Output Voltage                      28V or 270V L-N

A setting outside these nominal values will disable the test and will prevent access to its Menu screens.

#### 9.8.1.3 Revision

---

The MIL704 option defaults to Revision E. The System is capable of performing Revision D test by changing the selection to Revision D. All Revision D tests can be performed except for the 270V DC TRANSIENT and ABNORMAL where Revision E level are used despite the revision selection.

**All levels and timing in this document refers to Revision E. For Revision D refer to MIL-STD-704D date 9/30/1980**

#### 9.8.1.4 Tests Performed

---

##### 9.8.1.4.1 STEADY STATE

AC Mode:

1. Steady State Voltage and Frequency test
2. Waveform Distortion test
3. Voltage Modulation test
4. Voltage Unbalance test
5. Phase Unbalance test
6. Frequency Modulation test

7. Transient Voltage low and high test
8. Transient Frequency low and high test

DC Mode:

1. Steady State Voltage test
2. Ripple test

#### **9.8.1.4.2 EMERGENCY TEST**

AC Mode:

1. Emergency Voltage minimum and maximum test
2. Emergency Frequency minimum and maximum test

DC Mode:

1. Emergency Voltage minimum and maximum test

#### **9.8.1.4.3 ABNORMAL TEST**

AC Mode:

1. Abnormal Voltage under
2. Abnormal Voltage over
3. Abnormal Frequency under
4. Abnormal Frequency under

DC Mode:

1. Abnormal Voltage under
2. Abnormal Voltage over

#### **9.8.1.5 Front Panel Entry**

To perform a test from the keyboard, from the MENU 2 screen, select the APPLICATIONS screen. The APPLICATIONS screen will appear as shown in Figure 9-52.

APPLICATIONS SETUP	
MIL-STD-704	RTCA/DO-160D
OMNI OPTION	IEC 1000-4-11
PREVIOUS SCREEN	IEC 1000-4-13

*Figure 9-52: Application Menu*

Scroll to the MIL-STD-704 entry using the up and down cursor keys. Press the ENTER key to select the MIL704 main menu. One of the screens will appear as shown in Figure 9-53. The voltage mode and setting will define which menu to select. Refer to Section 9.8.1.2

**Note:** The user has to turn on the Output relay before starting a test and set the steady state setup for the test.



Figure 9-53: MIL704 Menu

### 9.8.1.6 Revision Selection

---

The default Revision is E. Revisions supported are D and E. The Revision can be changed from the front panel. Scroll to the REVISION entry using the up and down cursor keys (see Figure 9-53). Use the shuttle to change the selection.

### 9.8.1.7 AC MODE TESTS

---

#### 9.8.1.7.1 Steady StateTest

Scroll to the STEADY STATE AC entry using the up and down cursor keys. Press the ENTER key to select the STEADY STATE screens. The screen will appear as shown in Figure 9-54.



Figure 9-54: Steady State Menu

The MIL704 Steady state 1 and Steady state 2 screens have the following tests:

- 1 VOLTAGE
- 2 FREQUENCY
- 3 VOLT UNBALANCE
- 4 PHASE DIFFERENCE
- 5 VOLT MODULATION
- 6 FREQ MODULATION
- 7 DISTORTION

The above tests can be selected by scrolling to the highlighted selection using the up and down cursor keys and the ENTER key to start the selected test.

#### VOLTAGE

This test will change the output voltage in the following sequence:

- 108V for 1 minute.
- 118V for 1 minute.
- 115V for 1 minute.

The ← key (backspace) will terminate the test at any time.

#### FREQUENCY



This test will change the output frequency in the following sequence:

- 393Hz for 1 minute.
- 407Hz for 1 minute.
- 400Hz for 1 minute.

The ← key (backspace) will terminate the test at any time.

### **VOLT UNBALANCE**

This test will change the output voltage for the selected phase only in the following sequence:

- 112V for 1 minute.
- 118V for 1 minute.
- 115V for 1 minute.

The test will be repeated on three phase systems to include all three phases if the coupling is set to all.

The ← key (backspace) will terminate the test at any time.

### **PHASE DIFFERENCE**

This test applies to three phase systems only. The phase angle for the selected phase will change relative to phase A in the following sequence:

If phase B is selected:

- 236° for 1 minute.
- 244° for 1 minute.
- 240° for 1 minute.

If phase C is selected:

- 116° for 1 minute.
- 124° for 1 minute.
- 120° for 1 minute

### **VOLTAGE MODULATION**

This test will vary the output voltage by  $\pm 2.5V$  rms over a period of one second. The test will last for 2 minutes. The ← key (backspace) will terminate the test at any time.

### **FREQUENCY MODULATION**

This test will vary the output frequency by  $\pm 4Hz$  over a period of one minute. The test will last for 4 minutes. The ← key (backspace) will terminate the test at any time.

### **WAVEFORM DISTORTION**

This test will generate a 5% THD voltage distortion on the output voltage waveform. The distortion is caused by using a clipped sinewave. The test will last for 1 minute. The ← key (backspace) will terminate the test at any time.

### 9.8.1.7.2 TRANSIENT TEST

From the MIL704 main menu (Figure 9-53) scroll to the TRANSIENT AC entry using the up and down cursor keys. Press the ENTER key to select the TRANSIENT screens. The screen will appear as shown in Figure 9-55.

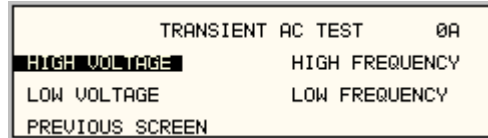


Figure 9-55: Transient Menu

The MIL704 Transient screen has the following tests:

- 1 HIGH VOLTAGE
- 2 LOW VOLTAGE
- 3 HIGH FREQUENCY
- 4 LOW FREQUENCY

The above tests can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test.

#### HIGH VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

- 180V for 10 msec.
- Linearly reduced to 118V in 78msec.
- Stay at 118V for 87msec before returning to 115V.

Prior to the test, a range change may take place if the power source is set for the low voltage range.

The ← key (backspace) will terminate the test at any time.

**Note:** A range change will result in momentary loss of power to the EUT. If this is not acceptable, the power source must be left in high range at all times.

#### LOW VOLTAGE

This test will change the output voltage for the selected phase only in the following sequence:

- 80V for 10 msec.
- Linearly increase to 108V in 70msec.
- Stay at 108V for 95msec before returning to 115V.

The ← key (backspace) will terminate the test at any time.

#### HIGH FREQUENCY

This test will change the output frequency in the following sequence:

- 425Hz for 1 sec.
- 420Hz for 4 sec.

- 410Hz for 5 sec.
- 407Hz for 4 sec.

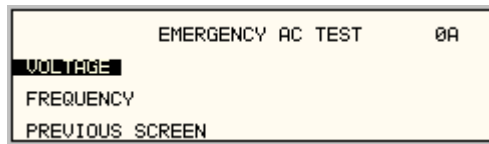
## LOW FREQUENCY

This test will change the output frequency in the following sequence:

- 375Hz for 1 sec.
- 380Hz for 4 sec.
- 390Hz for 5 sec.
- 393Hz for 4 sec.

### 9.8.1.7.3 EMERGENCY TEST

From the MIL704 main menu (Figure 9-53) scroll to the EMERGENCY AC entry using the up and down cursor keys. Press the ENTER key to select the EMERGENCY screens. The screen will appear as shown in Figure 9-56.



*Figure 9-56: Emergency Menu*

The EMERGENCY SCREEN has the following tests:

- 1 VOLTAGE
- 2 FREQUENCY

The above tests can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test.

## VOLTAGE

This test will change the output voltage in the following sequence:

- 108V for 1 minute.
- 118V for 1 minute.
- 115V for 1 minute.

The ← key (backspace) will terminate the test at any time.

## FREQUENCY

This test will change the output frequency in the following sequence:

- 393Hz for 1 minute.
- 407Hz for 1 minute.
- 400Hz for 1 minute.

The ← key (backspace) will terminate the test at any time.

#### 9.8.1.7.4 ABNORMAL TEST

From the MIL704 main menu (Figure 9-53) scroll to the ABNORMAL AC entry using the up and down cursor keys. Press the ENTER key to select the ABNORMAL screens. The screen will appear as shown in Figure 9-57.

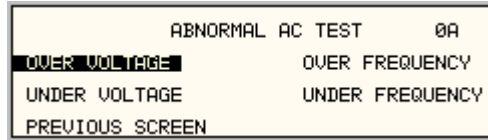


Figure 9-57: Abnormal Screen

The ABNORMAL SCREEN has the following tests:

- 1 OVER VOLTAGE
- 2 UNDER VOLTAGE
- 3 OVER FREQUENCY
- 4 UNDER FREQUENCY

The above test can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test.

#### OVER VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

- 180V for 50msec.
- The voltage gradually decays with time to 125 volt by the following equation:  
 $V = 124.6 + 2.77/t$ , for  $0.05 \leq t \leq 6.925$
- Stay at 125V for 93 seconds before returning to 115V.

Prior to the test, a range change may take place if the power source is set at the low voltage range.

The ← key (backspace) will terminate the test at any time.

**Note:** A range change will result in momentary loss of power to the EUT. If this is not acceptable, the power source must be left in high range at all times.

#### UNDER VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

- 0V for 7 seconds.
- 100V for 93 seconds.
- The ← key (backspace) will terminate the test at any time.

#### OVER FREQUENCY

This test will change the output frequency in the following sequence:

- 480Hz for 5 seconds.
- 420Hz for 9 seconds.

The ← key (backspace) will terminate the test at any time.

## UNDER FREQUENCY

This test will change the output frequency in the following sequence:

- 0Hz for 7 seconds.
- 380Hz for 7 seconds.

The ← key (backspace) will terminate the test at any time.

### 9.8.1.8 DC TESTS

---

If the output voltage is set for 28V DC or 270V DC the MIL704 DC Main selection screen will appear as seen in Figure 9-58.

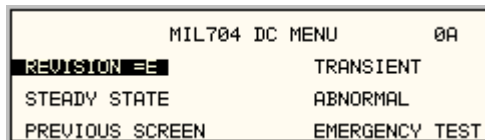


Figure 9-58: MIL704 DC Menu

#### 9.8.1.8.1 Steady State Test

Scroll to the STEADY STATE entry using the up and down cursor keys. Press the ENTER key to select the STEADY STATE screen. The screen will appear as shown Figure 9-59.

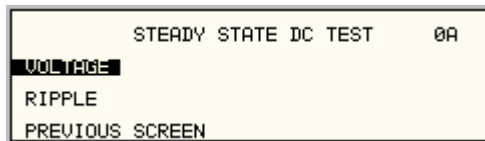


Figure 9-59: Steady State DC

The MIL704 STEADY STATE screen has the following tests:

- 1 VOLTAGE
- 2 RIPPLE

The above tests can be selected by scrolling to the highlighted selection using the up and down key and the ENTER key to start the selected test.

## VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

1. 28V system:
  - 22V for 1 minute.
  - 29V for 1 minute.
  - 28V for 1 minute.
2. 270V system:
  - 250V for 1 minute.
  - 280V for 1 minute.
  - 270V for 1 minute.

The ← key (backspace) will terminate the test at any time.

### DC RIPPLE

This test will impose a 400Hz frequency component to the output voltage. The test will last for 2 minutes. The level of the ripple is as follows:

1. 28V system:  
±1.5V.
2. 270V system:  
±6.0V.

The ← key (backspace) will terminate the test at any time.

#### 9.8.1.8.2 Transient Test

From the MIL704 DC MENU scroll to the TRANSIENT DC entry using the up and down cursor keys. Press the ENTER key to select the TRANSIENT screen. The screen will appear as shown in Figure 9-60.

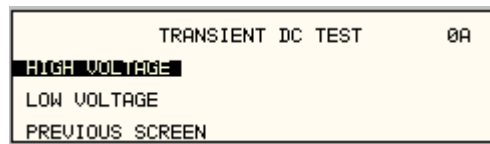


Figure 9-60: Transient Menu

The Transient Test has the following tests:

- 1 HIGH VOLTAGE
- 2 LOW VOLTAGE

### HIGH VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

1. 28V System
  - 50V for 12.5 msec.
  - Linearly reduce to 29V in 70msec.
  - Stay at 29V for 92.5msec before returning to 28V.
2. 270V System
  - 330V for 20 msec.
  - Linearly reduce to 280V in 20msec.
  - Stay at 280V for 135msec before returning to 270V.

Prior to the test, a range change may take place if the power source is set for the low voltage range.

The ← key (backspace) will terminate the test at any time.

**Note:** A range change will result in momentary loss of power to the EUT. If this is not acceptable, the power source must be left in high range at all times.

## LOW VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

1. 28V System
  - 18V for 15 msec.
  - Linearly increase to 22V in 85msec.
  - Stay at 22V for 75msec before returning to 28V.
2. 270V System
  - 200V for 10 msec.
  - Linearly increase to 250V in 30msec.
  - Stay at 250V for 135msec before returning to 270V.

The ← key (backspace) will terminate the test at any time.

### 9.8.1.8.3 Abnormal Test

From the MIL704 DC MENU scroll to the ABNORMAL DC entry using the up and down cursor keys. Press the ENTER key to select the ABNORMAL screen. The screen will appear as shown in Figure 9-61.

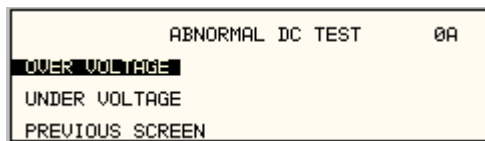


Figure 9-61: Abnormal Test Screen

The Abnormal Test has the following tests:

- 1 OVER VOLTAGE
- 2 UNDER VOLTAGE

The above tests can be selected by scrolling to the highlighted selection using the up and down cursor keys and the ENTER key to start the selected test.

#### OVER VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

1. 28V system:
  - 50V for 50msec.
  - The voltage gradually decays with time to 31.5 volts by the following equation:  
 $V = 31.38 + 0.93/t$  for  $0.05 \leq t \leq 7.758$
  - Stay at 31.5V for 92.242 seconds before returning to 28V.
2. 270V system:
  - 350V for 50msec.
  - The voltage gradually decays with time to 290 volts by the following equation:  
 $V = 289.6 + 3.02/t$  for  $0.05 \leq t \leq 7.55$
  - Stay at 290V for 92.45 seconds before returning to 270V.

Prior to the test, a range change may take place if the power source is set at the low voltage range. Note: See Section 9.8.1.7.2 under HIGH VOLTAGE.

The ← key (backspace) will terminate the test at any time.

**Note:** A range change will result in momentary loss of power to the EUT. If this is not acceptable, the power source must be left in high range at all times.

### UNDER VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

1. 28V system:
  - 0V for 7sec.
  - 20V for 93sec.
2. 270V system:
  - 0V for 7sec.
  - 240V for 93sec.

The ← key (backspace) will terminate the test at any time.

#### 9.8.1.8.4 Emergency Test

From the MIL704 DC MENU scroll to the EMERGENCY DC entry using the up and down cursor keys (Figure 9-62). Press the ENTER key to start the EMERGENCY TEST.

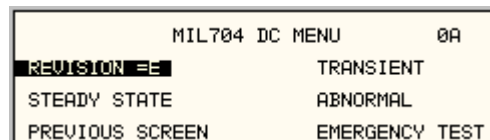


Figure 9-62: Emergency Test

### VOLTAGE

This test will change the output voltage for the selected phase in the following sequence:

1. 28V system:
  - 18V for 1 minute.
  - 29V for 1 minute.
  - 28V for 1 minute.
2. 270V system:
  - 250V for 1 minute.
  - 280V for 1 minute.
  - 270V for 1 minute.

The ← key (backspace) will terminate the test at any time.



## **9.8.2 Option –704: MIL-STD-704 rev A, B, C, & F Tests (Software)**

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Use of this option requires the following:

- i/iX Series Power Source with firmware version 2.1 or higher.
- -704 option. Options installed are listed on unit's serial tag.
- Windows XP/2000 PC with RS232C or National Instruments GPIB controller interface. California Instruments recommends the use of the GPIB interface for best performance.
- CIGui32 Windows software revision 1.25 or higher. Provided on CI P/N CIC496 CD ROM or available for download from California Instruments' website.

### ***Table of Contents - 704 Option Manual Section.***

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9.8.2.1	General
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9.8.2.6	CIGui32 704 Control Window
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9.8.2.9	704 Test Control
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### **9.8.2.1 General**

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The -704 option supports MIL-STD-704 revs A, B, C, and F voltage and frequency immunity tests in either of the AC or DC mode. This option can only be used in conjunction with the provided CIGui32 Windows application software only due to the amount of selections and data presentation involved. As such, these tests require the use of a PC running Windows XP / 2000 and cannot be operated from the front panel.

The –704 option is based on MIL-STD-704 Department of Defense Interface Standard: Aircraft Electric Power Characteristics Appendix A dated March 2004.

Future revisions of the MIL-STD-704 directive may be issued over time and updates may be made available to cover any changes in test levels, durations, procedures etc. Furthermore, the –704 option is completely data file driven to allow a large degree of customization by the end-user if needed so many changes can be supported without the need for software updates.

This section of the manual covers operation of the –704 option using the CIGui32 program. Version 1.25 or higher of the CIGui32 program is required. The CIGui32 program is supplied with all IX systems free of charge on CD ROM CIC496. It can also be downloaded from the California Instruments web site ([www.calinst.com](http://www.calinst.com)).

The information provided in this user manual is aimed at guiding the operator in the use of the 704 option through the use of the CIGui32 program. Much of the same information can be found in the on-line help system of the CIGUI32.

This manual is **not** intended to elaborate on the intent or purpose of the immunity tests and the expected behavior of the EUT as described in the MIL-STD-704 documents. It is assumed that the end-user is familiar with the content of the MIL-STD-704 test standard.

### 9.8.2.2 Test Coverage

The comprehensiveness of the test that can be performed with the –704 option is determined primarily by the capabilities of the power source used. Tests that are outside the hardware capabilities of the power source used will not be enabled and cannot be selected. For these tests, additional equipment may be required as indicated. The extent of coverage of the –704 option as implemented on the IX Series platform is shown in the table below. Tests marked with an 'x' generally require additional hardware to be used. Tests marked 'N/A' are not applicable to the corresponding table. Tests marked with a '√' are covered by at least one rev of the MIL-STD-704.

No.	Description	Table SAC	Table TAC	Table SVF	Table TVF	Table SXF	No.	Description	Table LDC	Table HDC
101	Load and Current Harmonic Measurements	√	√	√	√	√	101	Load Measurements	√	√
102	Steady State Limits for Voltage and Frequency	√	√	√	√	√	102	Steady State Limits for Voltage	√	√
103	Voltage Phase Difference	N/A	√	N/A	√	N/A	103	Voltage Distortion Spectrum	X	X
104	Voltage Modulation	√	√	√	√	√	104	Total Ripple	X	X
105	Frequency Modulation	√	√	√	√	√	105	Normal Voltage Transients	√	√ <sup>1</sup>
106	Voltage Distortion Spectrum	X	X	X	X	X	201	Power Interrupt	√	√
107	Total Voltage Distortion	√	√	√	√	√	301	Abnormal Steady State Limits for Voltage	√	√
108	DC Voltage Component	√	√	√	√	√	302	Abnormal Voltage Transients	√	√ <sup>2</sup>
109	Normal Voltage Transients	√	√	√	√	√	401	Emergency Limits for Voltage	√	√
110	Normal Frequency Transients	√	√	√	√	√	501	Starting Voltage Transients	√	√
201	Power Interrupt	√	√	√	√	√	601	Power Failure	√	√
301	Abnormal Steady State Limits for Voltage and Freq.	√	√	√	√	√	602	Polarity Reversal	√	√
302	Abnormal Voltage Transients	√	√	√	√	√				
303	Abnormal Frequency Transients	√	√	√	√	√				
401	Emergency Steady State Limits for Voltage and Freq.	√	√	√	√	√				
501	Starting Voltage	N/A	N/A	N/A	N/A	N/A				

<sup>1</sup> Note: Some restrictions apply due to voltage range limitations. See section 9.8.2.3 for details.

<sup>2</sup> Note: Some restrictions apply due to voltage range limitations. See section 9.8.2.3 for details.

No.	Description	Table SAC	Table TAC	Table SVF	Table TVF	Table SXF	No.	Description	Table LDC	Table HDC
	Transients									
601	Power Failure	√	√	√	√	√				
602	One and Two Phase Power Failure	N/A	√	N/A	√	N/A				
603	Phase Reversal	√	√	√	√	√				

*Table 9-22: -704 Option Test Coverage*

### 9.8.2.3 Specific Test Limitations and Discrepancies

While every effort has been made to provide comprehensive coverage of the Mil-Std 704 tests, some limitations apply, largely due to hardware limitations of the iX power source. The following table lists specific implementation issues by test number. The deviation from the standard requirement is shown in the “Actual setting” column. The reason for the deviation is shown in the last column.

Rev	Test	Std requirement	Actual setting	Reason
A	SAC104	.5Vp-v modulation (.3536V RMS)	.4V RMS modulation	Resolution
A	SAC104	3.5Vp-v modulation (2.475V RMS)	2.4V RMS modulation	Resolution
A	TAC104	.5Vp-v modulation (.3536V RMS)	.4V RMS modulation	Resolution
A	TAC104	3.5Vp-v modulation (2.475V RMS)	2.4V RMS modulation	Resolution
A-F	SAC106	50kHz	Test skipped	Requires additional equipment
A-F	TAC106	50kHz	Test skipped	Requires additional equipment
A-F	LDC103	50kHz	Test skipped	Requires additional equipment
A-F	LDC104	16.8kHz	Test skipped	Requires additional equipment
B-F	SAC104	.375V RMS modulation	.4V RMS modulation	Resolution
B-F	SAC104	2.5V RMS modulation	2.4V RMS modulation	Resolution
B-F	TAC104	.375V RMS modulation	.4V RMS modulation	Resolution
B-F	TAC104	2.5V RMS modulation	2.4V RMS modulation	Resolution
B-F	HDC103	50kHz	Test skipped	Requires additional equipment
B-F	HDC104	16.8kHz	Test skipped	Requires additional equipment
F	SVF104	.375V RMS modulation	.4V RMS modulation	Resolution
F	SVF104	2.5V RMS modulation	2.4V RMS modulation	Resolution
F	SVF106	50kHz	Test skipped	Requires additional equipment
F	TVF104	.375V RMS modulation	.4V RMS modulation	Resolution
F	TVF104	2.5V RMS modulation	2.4V RMS modulation	Resolution
F	TVF106	50kHz	Test skipped	Requires additional equipment
F	SXF104	.375V RMS modulation	.4V RMS modulation	Resolution
F	SXF104	2.5V RMS modulation	2.4V RMS modulation	Resolution
F	SXF106	50kHz	Test skipped	Requires additional equipment
F	SXF109	Dwell time = 1 cycle (16.666667 msec)	Dwell time = 17msec	Resolution
F	SXF201	Dwell time = 1 cycle (16.666667 msec)	Dwell time = 17msec	Resolution
F	SXF302	Dwell time = 1 cycle (16.666667 msec)	Dwell time = 17msec	Resolution
F	HDC105 <sup>1</sup>	330VDC	300VDC limit (test written but will not run)	Hardware limit DC range i/iX
F	HDC302 <sup>3</sup>	350VDC	300VDC limit (test written but will not run)	Hardware limit DC range i/iX
B, C	HDC105	475VDC	300VDC limit (test written but will not run)	Hardware limit DC range i/iX
B, C	HDC302	475VDC	300VDC limit (test written but will not run)	Hardware limit DC range i/iX
B, C	SAC105	+/-1.75Hz modulation	+/-2Hz modulation	Resolution
B, C	SAC105	+/-0.85Hz modulation	+/-0.9Hz modulation	Resolution
B, C	SAC105	+/-0.58Hz modulation	+/-0.6Hz modulation	Resolution
B, C	TAC105	+/-1.75Hz modulation	+/-2Hz modulation	Resolution
B, C	TAC105	+/-0.85Hz modulation	+/-0.9Hz modulation	Resolution
B, C	TAC105	+/-0.58Hz modulation	+/-0.6Hz modulation	Resolution

<sup>1</sup> **Note:** To perform MIL-STD-704F tests HDC105-1, -3 and HDC302-1, -3, it is advised to use the firmware revision E tests TRANSIENT and ABNORMAL respectively. The –704 firmware implementation overrides the DC voltage range hardware limit making it possible for these tests to be performed. See section 9.8.1.8. The same does not apply to the equivalent rev B or rev C tests, which require 475VDC. The 475 VDC level is not supported on the i/iX Series.

#### 9.8.2.4 General Test Procedure

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Generally, the following steps are needed to perform a 704 test on an EUT.

19. Connect the EUT to the power source.
20. Select the correct mode of operation for the EUT, AC or DC mode, single or three-phase mode.
21. Program the relevant nominal voltage and frequency using the CIGui32 main screen.
22. Apply power by closing the output relay. This can be done at a later stage or will be done automatically after prompting the operator when a test is started.
23. Open the MIL-STD-704 Tables A-F control screen from the toolbar of Applications menu.
24. Select the correct airframe directory or use the default MS704\_RevF.
25. Select the correct Power Group table SAC through HDC.
26. Select a test from the test table displayed in the bottom part of this screen. You can select a test by clicking on a row. The selected row will be highlighted.
27. Switch to the **Test Control** tab (middle tab along the top of the screen).
28. Verify that the test sequence and description shown in the table on the Test Control screen is indeed the desired test.
29. Click the Start button to initiate the test.
30. Observe the test progress monitor at the top of the window and observe the EUT.
31. Wait for test completion. You can Abort a test in progress by clicking the Abort button.
32. Select the **EUT Performance Measurements** tab (Right tab along top of the screen).
33. Click the **Update Meas.** Button located in the top center of the screen. This will initiate a measurement cycle. Measurements in three-phase mode may take some time to complete.
34. Use the tabs located along the top of the measurement tab (**Parameters, Waveforms, Curr Graph and Curr Spectrum**) to review the EUT data. Any anomalies can be noted in the observations tab located on the **Parameters** screen. This information will be included in the test report.
35. Click on the **Print** button or use File, Print to print a test report for this test.
36. Return to step 8 as needed.

The following chapters provide details on the various screens, menus, displays and controls available to the operator to manage the test process.

### 9.8.2.5 Initial Setup

---

The –704 option supports both AC and DC modes of operation. The correct mode is a function of the EUT to be tested and the operator must select the corresponding operating mode first. This can be done from the front panel if needed or using the CIGui32 program. Use of the CIGui32 program for all settings will be assumed for the remainder of this chapter.

Seven power groups are covered in the MIL-STD-704 directive:

Group	Description
SAC	Single Phase 115VAC / 400 Hz (CF)
TAC	Three Phase 115VAC / 400 Hz (CF)
SVF	Single Phase 115VAC / Variable Frequency (VF), 360 – 800 Hz.
TVF	Three Phase 115VAC / Variable Frequency (VF), 360 – 800Hz.
SXF	Single Phase 115VAC / 60 Hz (CF)
LDC	28VDC
HDC	270VDC

The required steady state output settings for each power group must be selected based on the type of EUT to be tested. These settings can be made from the front panel of the IX Series power source or from the main CIGui32 control screen.

9.8.2.6 CIGui32 -704 Control Window

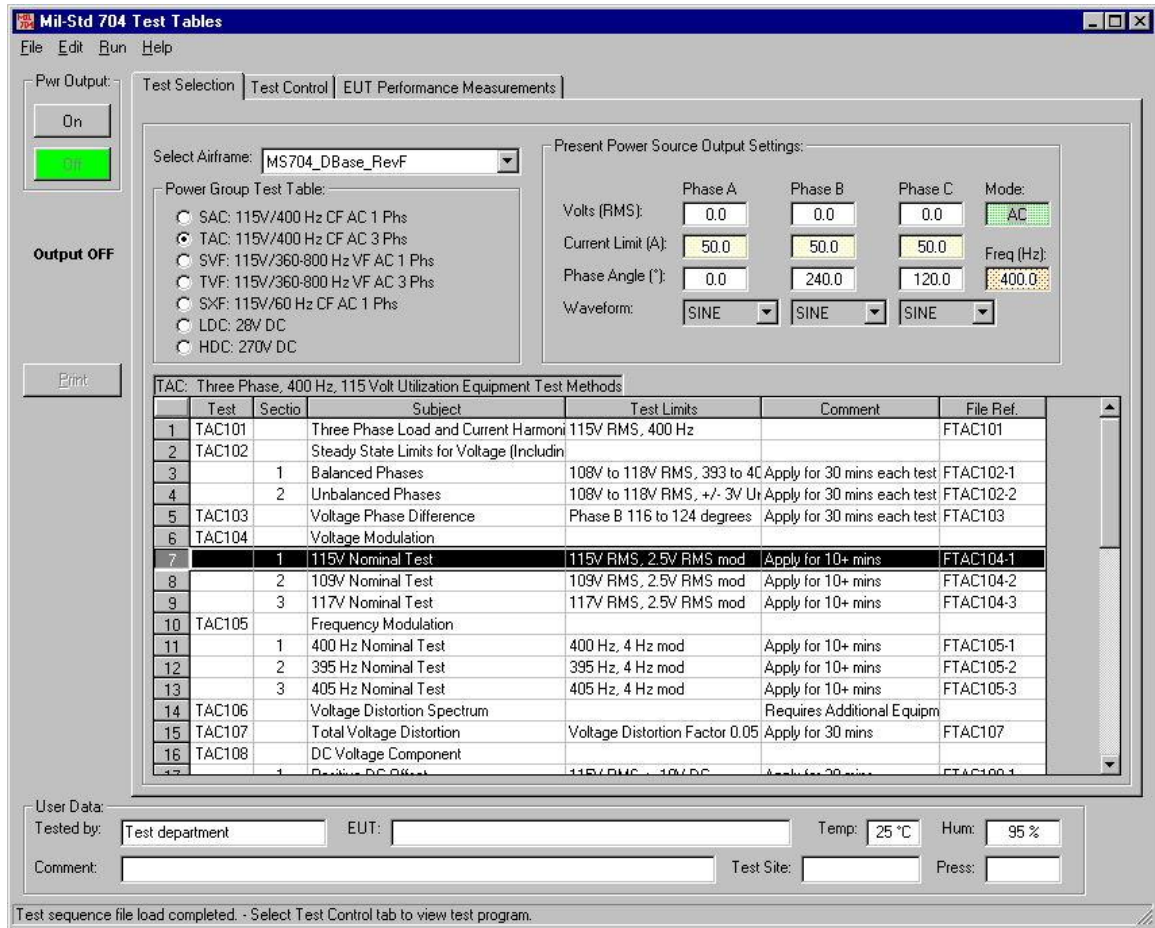


Figure 9-63: 704 Option Test Selection Screen.

To access the –704 option, select the MIL-STD-704 Tables A-F from the Applications menu of the CIGui32 main screen or click on the 704 button in the toolbar. The 704 Tables control window will open selecting the power group that most closely matches the steady state values set. It may still be necessary to select the desired power group first however. Also verify that the selected power group in the 704 screen is the correct one for the EUT being tested.

The 704 tests can be operated from the 704 test screen. This screen contains three main tabs located along the top edge of the window. The following tabs are available. Click on the tab name for additional help on how to use each tab.

Tab	Description
Test Selection	This tab allows the operator to select the library of test files to use (Select Airframe) and the relevant Power group. It also displays the AC power source settings that are in effect on the right hand side. Available power group selections are SAC, TAC, SVF, TVF, and SXF for AC products and LDC and HDC for DC products. The table shown at the bottom of this tab shows the available test sections that can be selected. This table matches the test tables of the MIL-STD-704 test standard.
Test Control	This tab provides information on the test sequence that is presently selected and also contains the execution controls. It shows the progress of any test that is executing.
EUT Performance	This tab may be used to display EUT performance data as measured by the

Tab	Description
Measurements	power source's advanced data acquisition system. If the source used does not support advanced measurement function such as waveform capture and FFT, some of the information in this tab may not be displayed.

In addition to the three tab controls, the left pane of the 704 window contains a set of output on/off control buttons and a print button. The on/off buttons may be used to open or close the output relay of the power source at any time. If the output relay is opened during a test run, the test is automatically aborted when the operator clicks on the Off button. The ON button will be shown in red while the output relay is closed. The Off button is shown in green if the output relay is open. The report print function can be invoked by either clicking on the Print button or using the File, Print menu.

If the GUI program is used in demo mode, the "DEMO MODE ONLY!!!" banner will be displayed in this area as well. In Demo mode, all test runs and all measurements are simulated. This mode may be used to develop new test sequences off-line but any run-time errors will not be detected until executed with an actual power source.

### 9.8.2.7 704 Menus

The top of the 704 window contains a standard Windows menu bar. Available menus are:

Menu	Sub Menu	Description
File	New	The selected clears all data from the Test Control data grid. This operation is not normally recommended unless a complete new test sequence is to be entered manually.
	Open	Opens a specific test sequence file. This menu may be used to directly select a test file without using the Test Selection table tab.
	Save	Saves the contents of the test sequence data grid to the selected test file.
	Save As...	Saves the contents of the test sequence data grid to a user defined file name. A file dialog box will appear enabling selection of the directory and file name under which to store the contents of the test sequence data grid.
	Print	Prints a test report using MS Word format. Only data for the presently selected test sequence is printed. The test reports also include EUT performance measurement data. Note: To print reports, the MS Word report format selection must be made from the Main GUI, Options menu → Report Format menu before opening the MIL-STD-704 test screen. If not, an error prompt will indicate that no supported report format is selected.
	Exit	Closes the 704 test window.
Edit	Cut	Cuts the selected row from either the Test selection data grid or the Test sequence data grid. The data in the row cut is available for a Paste operation.
	Copy	Copies the selected row from either the Test selection data grid or the Test sequence data grid. Copied rows can be pasted to the same grid at a different location.
	Paste	Pastes a copied row from to either the Test selection data grid or the Test sequence data grid.
	Insert Row	Inserts a new blank row at the selected data grid location.
	Delete Row	Deletes the selected row from either the Test selection data grid or the Test sequence data grid. The row contents are permanently discarded.
Run	All	Run selected test
	Stop	Abort test in progress
Help		Opens the on-line help file.



### 9.8.2.8 704 Test Selection

The Test Selections tab in the 704 test window contains the following controls and displays.

Control / Display	Description														
Select Airframe.	This drop down control allows the operator to select from one or more libraries of test sequences grouped by airframe. This allows multiple sets of test sequences to be organized by application. The GUI program is supplied with a generic MS704_RevX set of test sequences, where 'X' is the rev of the standard being tested to, which conform to the MIL-STD-704 document.														
Power Group Test Table	<p>A library can contain up to seven power group test tables labeled SAC, TAC, SVF, TVF, SXF, LDC, or HDC. These table names correspond to the Power Groups identified in the MIL-STD-704 standard. Note that groups SAC, TAC, SVF, TVF, and SXF are AC powered where as groups LDC and HDC are DC powered. The operator cannot select a group that is not supported by the present mode of operation of the power source. Thus, if the power source is in AC mode, an error message will be display when trying to select group D or E. Operating modes such as AC or DC must be changed from the main GUI screen. The 704 screen can remain open while switching back to the main screen. Upon return to the 704 screen, the relevant power groups can be selected.</p> <p>Available power groups are:</p> <table> <tr> <td>Table SAC</td><td>Single Phase 115V / 400 Hz (CF) AC Power tests.</td></tr> <tr> <td>Table TAC</td><td>Three Phase 115V / 400 Hz (CF) AC Power tests.</td></tr> <tr> <td>Table SVF</td><td>Single Phase 115V / 360 to 800 Hz (VF) AC Power tests.</td></tr> <tr> <td>Table TVF</td><td>Three Phase 115V / 360 to 800 Hz (VF) AC Power tests.</td></tr> <tr> <td>Table SXF</td><td>Single Phase 115V / 60 Hz (CF) AC Power tests.</td></tr> <tr> <td>Table LDC</td><td>28 VDC Power tests.</td></tr> <tr> <td>Table HDC</td><td>270 VDC Power tests.</td></tr> </table> <p>The operator needs to determine what the relevant power group selection is for the unit under test. (EUT). When switching power groups, the table data shown at the bottom of this tab will be updated to reflect the new selection. The first test section of the table will automatically be selected when switching power groups.</p>	Table SAC	Single Phase 115V / 400 Hz (CF) AC Power tests.	Table TAC	Three Phase 115V / 400 Hz (CF) AC Power tests.	Table SVF	Single Phase 115V / 360 to 800 Hz (VF) AC Power tests.	Table TVF	Three Phase 115V / 360 to 800 Hz (VF) AC Power tests.	Table SXF	Single Phase 115V / 60 Hz (CF) AC Power tests.	Table LDC	28 VDC Power tests.	Table HDC	270 VDC Power tests.
Table SAC	Single Phase 115V / 400 Hz (CF) AC Power tests.														
Table TAC	Three Phase 115V / 400 Hz (CF) AC Power tests.														
Table SVF	Single Phase 115V / 360 to 800 Hz (VF) AC Power tests.														
Table TVF	Three Phase 115V / 360 to 800 Hz (VF) AC Power tests.														
Table SXF	Single Phase 115V / 60 Hz (CF) AC Power tests.														
Table LDC	28 VDC Power tests.														
Table HDC	270 VDC Power tests.														
Present Power Source Output Settings	This section displays the programmed steady state settings that are in effect. This information is updated each time the 704 form regains focus. The mode of operation (AC, DC or AC+DC) is displayed for reference but cannot be changed from this screen. When in DC mode, the frequency setting will show "DC". Note that changes in steady state settings can only be made from the main GUI screen. The operator can toggle between the main screen and the 704 screen for this purpose as needed.														
Table Header	The table header is shown against a blue background and contains the table reference designator and a description of the selected power group.														
Test Table Display	<p>The data grid at the bottom of the tab displays the selected power group test table. It is also used to select the specific test section and number to be executed. Thus, every test starts by selecting the desired test step from this table. Clicking on the desired ROW does this. The selected row will be highlighted and the associated file shown in the File Ref. Field will be loaded in the Test Control tab.</p> <p>For better readability, the user can adjust the column widths by dragging the dividers between columns. If the window is too small to display all rows and columns, scroll bars will appear at the bottom and/or right of the data grid. The following fields are displayed in the test data tables.</p> <table> <tr> <td>Test</td><td>Number of the test from the MIL-STD-704 standard. For sub sections of a test number, this field will be blank.</td></tr> <tr> <td>Section</td><td>Test section. Some tests may only have one section in which case this field is blank.</td></tr> <tr> <td>Subject</td><td>Description of the type of test.</td></tr> <tr> <td>Test Limits</td><td>A summary of the test limits that will be applied by this test.</td></tr> <tr> <td>Comment</td><td>Comments concerning this test or its parameters.</td></tr> <tr> <td>File Reference</td><td>The test sequence file that is used to implement this test section on the power source.</td></tr> </table>	Test	Number of the test from the MIL-STD-704 standard. For sub sections of a test number, this field will be blank.	Section	Test section. Some tests may only have one section in which case this field is blank.	Subject	Description of the type of test.	Test Limits	A summary of the test limits that will be applied by this test.	Comment	Comments concerning this test or its parameters.	File Reference	The test sequence file that is used to implement this test section on the power source.		
Test	Number of the test from the MIL-STD-704 standard. For sub sections of a test number, this field will be blank.														
Section	Test section. Some tests may only have one section in which case this field is blank.														
Subject	Description of the type of test.														
Test Limits	A summary of the test limits that will be applied by this test.														
Comment	Comments concerning this test or its parameters.														
File Reference	The test sequence file that is used to implement this test section on the power source.														
User Data	The area at the bottom of this tab may be used to enter general information														

Control / Display	Description
	regarding the unit under test, the test location and operator and environmental conditions in effect during the test. This information will be incorporated in the test reports generated by the GUI.

9.8.2.9 704 Test Control

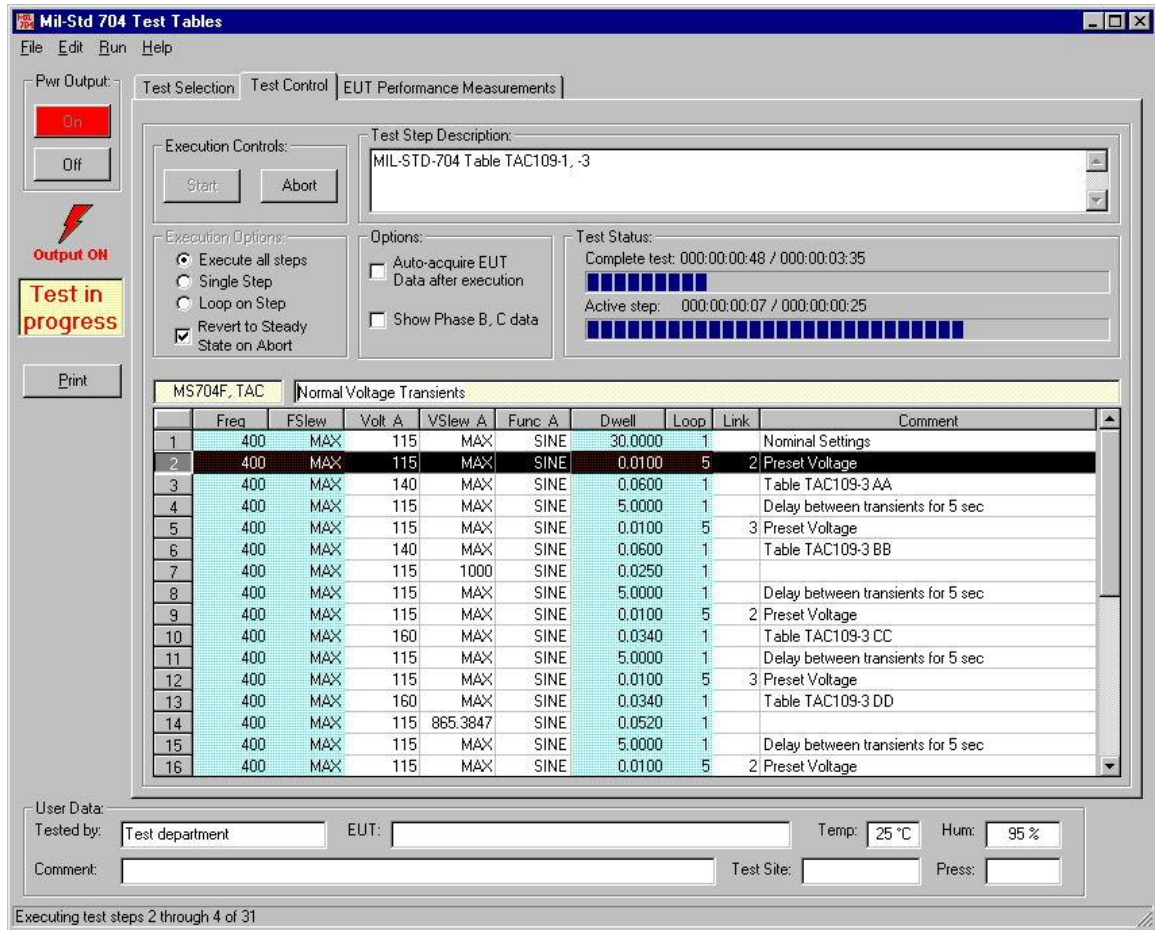


Figure 9-64: 704 Option Test Control Screen.

The Test Control tab in the 704 test window is used to display and execute a selected 704 test. This tab contains the following controls and displays.

Control / Display	Description					
Execution Controls	The Start and Abort buttons are used to start and stop the selected test step. The execution mode that will be used is determined by the Execution Options setting. The same can be accomplished using the Run menu entries. When operating in Single Step or Loop mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab as this will be the one used by the program.					
Execution Options	The execution options determine the mode of operation when the Start button is clicked. Available execution modes and settings are:					
	<table><tr><td>Execute all steps</td><td>In this mode, all steps in the test sequence will be executed sequentially until the end of the table is reached.</td></tr><tr><td>Single Step</td><td>Runs only the selected test step. When operating in Single Step mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab before clicking on the Start button.</td></tr><tr><td>Loop on Step</td><td>In this mode, the same step will be executed repeatedly until the operator clicks on the Abort button. In this mode, the Complete test progress status bar may run past its maximum and will no longer update as the total test time</td></tr></table>	Execute all steps	In this mode, all steps in the test sequence will be executed sequentially until the end of the table is reached.	Single Step	Runs only the selected test step. When operating in Single Step mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab before clicking on the Start button.	Loop on Step
Execute all steps	In this mode, all steps in the test sequence will be executed sequentially until the end of the table is reached.					
Single Step	Runs only the selected test step. When operating in Single Step mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab before clicking on the Start button.					
Loop on Step	In this mode, the same step will be executed repeatedly until the operator clicks on the Abort button. In this mode, the Complete test progress status bar may run past its maximum and will no longer update as the total test time					

Control / Display	Description	
		is determined by the operator now and not the program.
	Revert to Steady State on Abort	When selected, the output of the power source will be set back to the steady state settings in effect before the start of the test when the operator aborts a test. Normally, the output of the source at the end of a test run is determined by the settings in the test sequence file loaded.
Options	This section contains additional options that can be set by the operator as needed. The following options are available:	
	Auto Acquire EUT Data after execution	When set, this option causes the GUI program to initiate an EUT performance data measurement sequence automatically at the end of a test (normal mode) or test step (single step mode).
	Show Phase B, C data	For three-phase EUT's, data for phases B and C can be displayed as well. In most cases, the settings for all three phases are the same and there is no need to display them all as it takes up screen space. However, this is not the case for voltage imbalance tests. This is a display feature only and has no effect on the actual test. Note however that if the power source is in single-phase mode, settings for phase B and C will be ignored. The phase mode of the power source can only be changed from the main GUI screen.
Test Status	This area of the Test Control tab displays test execution status for each individual test step as well as the complete test. The top section shows the complete test time and what part has been completed so far. The bottom section shows the same information for the present test step.	
Test Description	The area at the top of the Test Control tab is used to display additional information about the selected test tab. It is for information purposes only and has no effect on the actual test execution.	
Table Header	The table header is shown against a yellow background and shows the table from which this test sequence was selected.	
Test Sequence Data Grid	The test sequence data grid displays the specific parameters used to program the power source. This data implements the required tests. The parameters are loaded for the referenced ini file in the test table on the Test Selection tab. It is possible to edit this information if needed which allows variations on any of these tests to be made. Any changes can be saved to a new file. The standard provided test files are write protected however and should not be overwritten. The following columns/data fields are available in this table for each test step (row).	
	Step number	Sequential number from 1 through end of sequence.
	Freq	Test frequency in Hz
	FSlew	Frequency slew rate in Hz/sec
	Volt A	Test voltage for phase/output A in Vrms or Vdc depending on mode.
	VSlew A	Voltage slew rate in V/sec
	Func A	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.
	Volt B	Test voltage for phase/output B in Vrms or Vdc depending on mode.
	VSlew B	Voltage slew rate in V/sec
	Func B	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.
	Volt C	Test voltage for phase/output C in Vrms or Vdc depending on mode.
	VSlew C	Voltage slew rate in V/sec
	Func C	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.

Control / Display	Description	
	Dwell	Dwell time in seconds.
	Loop	Repeat count for each step. Default is 1.
	Link	Number of subsequent rows that are linked to this step. This function is required to implement complex transients that require multiple steps with zero time skew. When set to a value other than blank or "0", subsequent rows are considered part of the same test step for single step or loop on step execution modes.
	PhsB	Phase angle of phase B, only visible if phase angle is changed.
	PhsC	Phase angle of phase C, only visible if phase angle is changed.
	Comment	A comment about the specific test step.

### 9.8.2.10 704 EUT Performance Measurements

**Mil-Std 704 Test Tables**

File Edit Run Help

Test Selection | Test Control | **EUT Performance Measurements**

Parameters | Waveforms | Curr Graph | Curr Spectrum | Update Meas. | Settings

**Output OFF**

Print

**EUT Category:**

☒ A  
☐ B  
☐ C

	Phs A	Phs B	Phs C	Hz	
Volt RMS (V):	0.07	0.06	0.04	400.0	
Curr RMS (A):	0.041	0.035	0.022		Total VA
App. Power (VA):	0.0	0.0	0.0		0.0 -- %
Inrush Current (A):	0.44	0.22	0.12		Limits: Pass/Fail
Power Factor:	-0.100	0.000	0.000	0.00	0.00 Fail
Current Distortion (%):	0.00	0.00	0.00	0.00	Pass

Test Frequency: 400\_Hz

Acquire data at all frequencies | Abort Meas. | Read Meas. Data from File

Observations:

User Data:

Tested by: Test department EUT: Temp: 25 °C Hum: 95 %

Comment: Test Site: Press:

Ready...

Figure 9-65: 704 Option EUT Measurement Data Screen.

The EUT Performance Measurements tab in the 704 tests window provides measurement data taken by the power source's data acquisition system. This tab contains four sub-tabs that each present different aspects of the EUT measurement data. Additional user controls for measurement updates and graph scaling are provided right next to the four sub tabs. The following sub tabs are available for selection.

Sub-Tab	Description	
Parameters	This tab displays the parametric measurement data in tabular form. This includes voltage, current, power, power factor, distortion etc. For three-phase EUT's data is shown for all three phases. For single phase EUT, data is shown for phase A only as long as the power source is in single-phase mode.	
	The top half of the Parameters tab displays all parametric measurement data. The following data is available:	
	Volt RMS (V)	Displays source voltage per phase in Volt RMS or DC depending on power source mode of operation.
	Curr RMS (A)	Displays EUT current per phase in amps RMS or DC depending on power source mode of operation.
	App. Power (VA)	Displays the apparent power for each phase as well as the total power for all three phases. For three-phase EUT's, any imbalance in power between the three phases is calculated by the GUI program and compared against Figure 11 of the MIL-STD-704A or Figure 1 of the

Sub-Tab	Description	
		MIL-STD-704(C-F) specifications. The amount of imbalance is displayed in % of total VA to the right of the power readings. <sup>1</sup>
	Inrush Current (A)	Displays peak current detected per phase in Amps since last measurement was taken.
	Power Factor	Displays power factor for each phase. Power factor measurement data is compared against MIL-STD-704 Appendix A specification for both leading and lagging power factors. When testing to rev A, the category of EUT must be selected. Categories are defined in the MIL-STD-704A. If one or more phases is outside the allowable limits, a Fail indication is displayed.
	Current Distortion (%)	Displays Total Current Distortion for each phase in percent of fundamental current. No limits are applied although the user can set a maximum limit for this parameter if needed in the "MS704_Distortion_Limits.ini" setting file by adding "lthd = n.n" in either PHASES_1 or PHASES_3 sections..
	The bottom half of the Parameters tab contains user controls and a text entry field for entering observations regarding the EUT operation.	
	Test Frequency Dropdown control	The frequency selection drop down control is active only for Table SVF and TVF modes (Variable Frequency) and can be used to set the frequency at which data from the EUT is to be acquired. For all other modes, it is fixed to either 400 Hz or DC.
	Acquire Data at all frequencies	This button causes data to be acquired at all frequencies available in the Test Frequency Dropdown control. For all tables other than SVF and TVF, this button functions like the Update Meas. Button located above the sub tabs.
	Abort Meas.	This button aborts measurements in progress. In case of Tables SVF and TVF, acquiring data at all 12 frequency settings can take a long time. This button allows this process to be aborted.
	Read Meas. Data from File	This button reads measurement data from disk. Each time measurement data is acquired by the GUI, it is saved to an ASCII text file. A separate file is used for each frequency or DC setting. To recall data taken at a specific frequency setting, select the desired frequency using the Test Frequency Dropdown control before clicking on this button. Note that all measurement data files are saved in the Reports subdirectory of the GUI application directory using file name convention "MeasData_MS704_nnn_Hz.txt" where 'nnn' is the frequency setting or DC.
Waveforms	This tab displays the voltage and current waveform (time domain) for each phase. The sample rate is automatically set to display about 20 msec of time.	
Cur Graph	This tab displays the Current harmonics in a bar graph format. Up to 50 harmonics are displayed.	
Cur Spectrum	This tab displays the same current harmonics as the Current Graph tab except in a tabular format. Data is shown in both absolute and relative from (percent of fundamental current). A limit table is applied and a pass or fail indication is shown in the last column. Values that exceed the allowable limits are shown with a red background in the Pass/Fail column.	
	No.	Harmonic number, 1 through 50
	Freq (Hz)	Frequency of harmonic in Hz.
	Curr (A)	Absolute current (rms) in Amps.
	% Fund.	Relative current in percent of the fundamental current (I1).
	Limit	Allowable current harmonic limits per individual EUT

<sup>1</sup> Note: Rev B data is compared against the Rev C spec per Appendix A of the MIL-STD-704 standard. The rev C graph was not available at the time of this writing and was assumed to be the same as the rev D graph. Contact [support@calinst.com](mailto:support@calinst.com) if you have information to the contrary.

Sub-Tab	Description	
		specifications. These limits must be entered manually into the provided template file named "MS704_Distortion_Limits.ini" located in the CIGui32 application directory. If the limits are left at 0.00, no pass/fail criteria will be applied.
	P/F	Pass or Fail indication.
	A phase selection is available to the left of the graphs and table, which allows each phase to be displayed, one at a time.	

Additional user controls located on the EUT Performance Measurements Tab:

Control / Display	Description
Update Meas.	Triggers a new acquisition cycle and updates measurement data for all tabs. For table SVF and TVF modes (Variable Frequency), data will be acquired at the frequency set by the Test Frequency Dropdown control. This button is always available regardless of what sub tab is selected.
Settings	Brings up a dialog box that allows scaling and color changes for the Waveform or Current harmonics graphs. Note that setting changes will apply to graphs for all phases. For current harmonics graphs, only the absolute bar settings apply. The 704 measurement screen does not display relative current harmonic bar charts but relative data is available in tabular format on the Cur Spectrum tab. This button is available only if either the Waveforms or Cur Graph sub tab is selected



#### **9.8.2.11 Test Description Files – Creating Custom Tests**

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The 704 option uses a set of configuration files that contain the relevant test descriptions. These files are contained in the MS704\_Rev(A-F) subdirectory of the CIGUI32 application directory.

The contents of these tables is defined by the “MS704\_Structure\_Tbl\_X.ini” configuration files located in the MS704\_Rev(A-F) directory. “X” references the relevant table.

The test description files used to perform a specific test are listed in the last column labeled “Test File”. These files must be present in the MS704\_Rev(A-F) directory or the user directory.

For customer created tests, these file names can be renamed as needed as long as they are correctly referenced in the MS704\_Structure\_Tbl\_X.ini configuration files.

Tests can be customized as needed by editing these table configuration and test sequence files. To do so, create a new subdirectory under the application directory. To access any new sub directory from within the 704 test window, the directory name must be added to the “MS704UserTestLibraries.txt” file located in the CIGui32 application directory. This is a simple text file listing all test description directories available.

Example “MS704UserTestLibraries.txt” file content:

```
MyNew_DBase  
Dummy_Dir_Entry
```

These two directories listed will now be available for selection from the AirFrame selection in the 704 Test Setup screen.

To facilitate creating new test directories, it is easiest to create a copy of the MS704\_RevF directory first and rename it as required.

#### **9.8.2.12 Test Tables**

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The tables shown on the next few pages list the test sections covered by the –704 option. Where relevant, the numbering used matches that of the MIL-STD-704 document. The notes in the right hand column indicate tests that are either not directly supported or require additional external test equipment. Test tables are listed by rev and then by power group. The list starts with the most current rev to date, rev F.

**Rev F:****Table SAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SAC101		Load and Current Harmonic Measurements	115V RMS, 400 Hz		FSAC101
SAC102		Steady State Limits for Voltage and Frequency	108V to 118V RMS, 393 to 407 Hz	Apply for 30 mins each test	FSAC102
SAC103		No Test, Done so test numbers coincide			
SAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FSAC104-1
	2	109V Nominal Test	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FSAC104-2
	3	117V Nominal Test	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FSAC104-3
SAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, 4 Hz mod	Apply for 10+ mins	FSAC105-1
	2	395 Hz Nominal Test	395 Hz, 4 Hz mod	Apply for 10+ mins	FSAC105-2
	3	405 Hz Nominal Test	405 Hz, 4 Hz mod	Apply for 10+ mins	FSAC105-3
SAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
SAC107		Total Voltage Distortion	Voltage Distortion Factor 0.05	Apply for 30 mins	FSAC107
SAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	FSAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	FSAC108-2
SAC109		Normal Voltage Transients	180V RMS to 80V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SAC109-3 AA-GG	FSAC109-1
	2	Undervoltage Transients	Low voltage 80V RMS	Table SAC109-3 HH-LL	FSAC109-2
	3	Combined Transient	180V RMS to 80V RMS	Table SAC109-3 MM	FSAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	FSAC109-4
SAC110		Normal Frequency Transients	375 Hz to 425 Hz		
	1	Overfrequency Transients	High Frequency 425 Hz	Table SAC110-3 AA-DD	FSAC110-1
	2	Underfrequency Transients	Low Frequency 375 Hz	Table SAC110-3 EE-HH	FSAC110-2
	3	Combined Transient	375 Hz to 425 Hz	Table SAC110-3 II	FSAC110-3
SAC201		Power Interrupt	0V for 50 msec	Table SAC201-2 A-L	FSAC201
SAC301		Abnormal Steady State Limits for Voltage and Frequency	100V RMS to 125V RMS, 380 Hz to 420 Hz	Apply for 30 mins	FSAC301
SAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SAC302-3 AA-GG	FSAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table SAC302-3 HH-NN	FSAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table SAC302-3 OO	FSAC302-3
SAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table SAC303-3 AA-EE	FSAC303
SAC401		Emergency Steady State Limits for Voltage and Frequency	Perform Test SAC102		
SAC501		No Tests		N/A to AC Utilization Equipment	
SAC601		Power Failure (Single Phase)	0V for 7 seconds	Table SAC601-2 A-D	FSAC601
SAC602		Power Failure	No test, done so numbers coincide		

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SAC603		Phase Reversal		Phase reversal done physically	FSAC603

**Table TAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TAC101		Three Phase Load and Current Harmonic Measurements	115V RMS, 400 Hz		FTAC101
TAC102		Steady State Limits for Voltage (Including Unbalance) and Frequency			
	1	Balanced Phases	108V to 118V RMS, 393 to 407 Hz	Apply for 30 mins each test	FTAC102-1
	2	Unbalanced Phases	108V to 118V RMS, +/- 3V Unbalance	Apply for 30 mins each test	FTAC102-2
TAC103		Voltage Phase Difference	Phase B 116 to 124 degrees	Apply for 30 mins each test	FTAC103
TAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FTAC104-1
	2	109V Nominal Test	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FTAC104-2
	3	117V Nominal Test	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FTAC104-3
TAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, 4 Hz mod	Apply for 10+ mins	FTAC105-1
	2	395 Hz Nominal Test	395 Hz, 4 Hz mod	Apply for 10+ mins	FTAC105-2
	3	405 Hz Nominal Test	405 Hz, 4 Hz mod	Apply for 10+ mins	FTAC105-3
TAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
TAC107		Total Voltage Distortion	Voltage Distortion Factor 0.05	Apply for 30 mins	FTAC107
TAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	FTAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	FTAC108-2
TAC109		Normal Voltage Transients	180V RMS to 80V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table TAC109-3 AA-GG	FTAC109-1
	2	Undervoltage Transients	Low voltage 80V RMS	Table TAC109-3 HH-LL	FTAC109-2
	3	Combined Transient	180V RMS to 80V RMS	Table TAC109-3 MM	FTAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	FTAC109-4
TAC110		Normal Frequency Transients	375 Hz to 425 Hz		
	1	Overfrequency Transients	High Frequency 425 Hz	Table TAC110-3 AA-DD	FTAC110-1
	2	Underfrequency Transients	Low Frequency 375 Hz	Table TAC110-3 EE-HH	FTAC110-2
	3	Combined Transient	375 Hz to 425 Hz	Table TAC110-3 II	FTAC110-3
TAC201		Power Interrupt	0V for 50 msec	Table TAC201-2 A-L	FTAC201
TAC301		Abnormal Steady State Limits for Voltage and Frequency	100V RMS to 125V RMS, 380 Hz to 420 Hz	Apply for 30 mins	FTAC301
TAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table TAC302-3 AA-GG	FTAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table TAC302-3 HH-NN	FTAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table TAC302-3 OO	FTAC302-3
TAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table TAC303-3 AA-EE	FTAC303
TAC401		Emergency Steady State Limits for Voltage and Frequency	Perform Test TAC102		
TAC501		No Tests		N/A to AC Utilization Equipment	
TAC601		Power Failure (Three Phase)	0V for 7 seconds	Table TAC601-2 A-D	FTAC601

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TAC602		One Phase and Two Phase Power Failures			
	1	One Phase Power Failures	0V for 7 seconds	Table TAC602-2 A-F	FTAC602-1
	2	Two Phase Power Failures	0V for 30 mins	Table TAC602-2 G-J	FTAC602-2
TAC603		Phase Reversal		Phase reversal done physically	FTAC603

**Table SVF:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SVF101		Load and Current Harmonic Measurements	115V RMS, 360-800 Hz		FSVF101
SVF102		Steady State Limits for Voltage and Frequency	108-118V RMS, 360-800 Hz	Apply for 30 mins each test	FSVF102
SVF103		No Test, Done so numbers coincide			
SVF104		Voltage Modulation			
	400-1	115V RMS, 400 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-400-1
	400-2	109V RMS, 400 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-400-2
	400-3	117V RMS, 400 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-400-3
	360-1	115V RMS, 360 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-360-1
	360-2	109V RMS, 360 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-360-2
	360-3	117V RMS, 360 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-360-3
	600-1	115V RMS, 600 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-600-1
	600-2	109V RMS, 600 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-600-2
	600-3	117V RMS, 600 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-600-3
	800-1	115V RMS, 800 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-800-1
	800-2	109V RMS, 800 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-800-2
	800-3	117V RMS, 800 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FSVF104-800-3
SVF105		Frequency Modulation			
	400-1	115V RMS, 400 Hz nominal settings	400 Hz, 4 Hz mod	Apply for 30+ mins	FSVF105-400-1
	360-1	115V RMS, 360 Hz nominal settings	360 Hz, 4 Hz mod	Apply for 30+ mins	FSVF105-360-1
	600-1	115V RMS, 600 Hz nominal settings	600 Hz, 4 Hz mod	Apply for 30+ mins	FSVF105-600-1
	800-1	115V RMS, 800 Hz nominal settings	800 Hz, 4 Hz mod	Apply for 30+ mins	FSVF105-800-1
SVF106		Voltage Distortion Spectrum		Requires Additional Equipment	
SVF107		Total Voltage Distortion			
	400-1	115V RMS, 400 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FSVF107-400-1
	360-1	115V RMS, 360 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FSVF107-360-1
	600-1	115V RMS, 600 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FSVF107-600-1
	800-1	115V RMS, 800 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FSVF107-800-1
SVF108		DC Voltage Component			
	400-1	400 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FSVF108-400-1
	400-2	400 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FSVF108-400-2
	360-1	360 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FSVF108-360-1
	360-2	360 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FSVF108-360-2
	600-1	600 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FSVF108-600-1
	600-2	600 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FSVF108-600-2
	800-1	800 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FSVF108-800-1

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SVF109	800-2	800 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FSVF108-800-2
		Normal Voltage Transients			
	400-1	400 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF109-2	FSVF109-400-1
	400-2	400 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table SVF109-2	FSVF109-400-2
	400-3	400 Hz, Combined Transient	180V to 80V RMS	Table SVF109-2	FSVF109-400-3
	400-4	400 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure SVF109-2	FSVF109-400-4
	360-1	360 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF109-2	FSVF109-360-1
	360-2	360 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table SVF109-2	FSVF109-360-2
	360-3	360 Hz, Combined Transient	180V to 80V RMS	Table SVF109-2	FSVF109-360-3
	360-4	360 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure SVF109-2	FSVF109-360-4
	600-1	600 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF109-2	FSVF109-600-1
	600-2	600 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table SVF109-2	FSVF109-600-2
	600-3	600 Hz, Combined Transient	180V to 80V RMS	Table SVF109-2	FSVF109-600-3
	600-4	600 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure SVF109-2	FSVF109-600-4
	800-1	800 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF109-2	FSVF109-800-1
	800-2	800 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table SVF109-2	FSVF109-800-2
	800-3	800 Hz, Combined Transient	180V to 80V RMS	Table SVF109-2	FSVF109-800-3
	800-4	800 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure SVF109-2	FSVF109-800-4
SVF110		Normal Frequency Transients			
	1	Overfrequency Transients	High Frequency 800 Hz	Table SVF110-2	FSVF110-1
	2	Underfrequency Transients	Low Frequency 360 Hz	Table SVF110-2	FSVF110-2
	3	Combined Transient	360 Hz to 800 Hz	Table SVF110-2	FSVF110-3
SVF201		Power Interrupt			
	400-1	115V RMS, 400 Hz nominal settings	0V for 50 msec	Table SVF201-2	FSVF201-400-1
	360-1	115V RMS, 360 Hz nominal settings	0V for 50 msec	Table SVF201-2	FSVF201-360-1
	600-1	115V RMS, 600 Hz nominal settings	0V for 50 msec	Table SVF201-2	FSVF201-600-1
	800-1	115V RMS, 800 Hz nominal settings	0V for 50 msec	Table SVF201-2	FSVF201-800-1
SVF301		Abnormal Steady State Limits for Voltage and Frequency	100V to 125V RMS, 360Hz to 800 Hz	Apply for 30 mins	FSVF301
SVF302		Abnormal Voltage Transients			
	400-1	400 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF302-2 A-G	FSVF302-400-1
	400-2	400 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table SVF302-2 H-N	FSVF302-400-2
	400-3	400 Hz, Combined Transient	45V RMS to 180V RMS	Table SVF302-2 O	FSVF302-400-3
	360-1	360 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF302-2 A-G	FSVF302-360-1
	360-2	360 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table SVF302-2 H-N	FSVF302-360-2
	360-3	360 Hz, Combined Transient	45V RMS to 180V RMS	Table SVF302-2 O	FSVF302-360-3
	600-1	600 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF302-2 A-G	FSVF302-600-1
	600-2	600 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table SVF302-2 H-N	FSVF302-600-2
	600-3	600 Hz, Combined Transient	45V RMS to 180V RMS	Table SVF302-2 O	FSVF302-600-3
	800-1	800 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table SVF302-2 A-G	FSVF302-800-1
	800-2	800 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table SVF302-2 H-N	FSVF302-800-2
	800-3	800 Hz, Combined Transient	45V RMS to 180V RMS	Table SVF302-2 O	FSVF302-800-3
SVF303		Abnormal Frequency Transients			

Test No.	Section	Subject	Test Limits	Comment	File Ref.
	1	Overfrequency Transients	High Frequency 800 Hz	Table SVF303-2 A-D	FSVF303-1
	2	Underfrequency Transients	Low Frequency 360 Hz	Table SVF303-2 E-H	FSVF303-2
	3	Combined Transient	360 Hz to 800 Hz	Table SVF303-2 I	FSVF303-3
SVF401		Emergency Limits for Voltage and Frequency	Perform Test SVF102		
SVF501		No Tests		N/A to AC Utilization Equipment	
SVF601		Power Failure (Single Phase)			
	400-1	115V RMS, 400 Hz nominal settings	0V for 7 seconds	Table SVF601-2	FSVF601-400-1
	360-1	115V RMS, 360 Hz nominal settings	0V for 7 seconds	Table SVF601-2	FSVF601-360-1
	600-1	115V RMS, 600 Hz nominal settings	0V for 7 seconds	Table SVF601-2	FSVF601-600-1
	800-1	115V RMS, 800 Hz nominal settings	0V for 7 seconds	Table SVF601-2	FSVF601-800-1
SVF602		No Test, Done so numbers coincide			
SVF603		Phase Reversal		Phase reversal done physically	FSVF603

**Table TVF:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TVF101		Load and Current Harmonic Measurements	115V RMS, 360-800 Hz		FTVF101
TVF102		Steady State Limits for Voltage (Including Unbalance) and Frequency			
	1	Balanced Phases	108V to 118V RMS, 360 to 800 Hz	Apply for 30 mins each test	FTVF102-1
	2	Unbalanced Phases	108V to 118V RMS, +/- 3V Unbalance	Apply for 30 mins each test	FTVF102-2
TVF103		Voltage Phase Difference			
	400-1	115V RMS, 400 Hz nominal settings	Phase B 116 to 124 degrees	Apply for 30 mins each test	FTVF103-400-1
	360-1	115V RMS, 360 Hz nominal settings	Phase B 116 to 124 degrees	Apply for 30 mins each test	FTVF103-360-1
	600-1	115V RMS, 600 Hz nominal settings	Phase B 116 to 124 degrees	Apply for 30 mins each test	FTVF103-600-1
	800-1	115V RMS, 800 Hz nominal settings	Phase B 116 to 124 degrees	Apply for 30 mins each test	FTVF103-800-1
TVF104		Voltage Modulation			
	400-1	115V RMS, 400 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-400-1
	400-2	109V RMS, 400 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-400-2
	400-3	117V RMS, 400 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-400-3
	360-1	115V RMS, 360 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-360-1
	360-2	109V RMS, 360 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-360-2
	360-3	117V RMS, 360 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-360-3
	600-1	115V RMS, 600 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-600-1
	600-2	109V RMS, 600 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-600-2
	600-3	117V RMS, 600 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-600-3
	800-1	115V RMS, 800 Hz nominal settings	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-800-1
	800-2	109V RMS, 800 Hz nominal settings	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-800-2
	800-3	117V RMS, 800 Hz nominal settings	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FTVF104-800-3
TVF105		Frequency Modulation			
	400-1	115V RMS, 400 Hz nominal settings	400 Hz, 4 Hz mod	Apply for 30+ mins	FTVF105-400-1
	360-1	115V RMS, 360 Hz nominal settings	360 Hz, 4 Hz mod	Apply for 30+ mins	FTVF105-360-1
	600-1	115V RMS, 600 Hz nominal settings	600 Hz, 4 Hz mod	Apply for 30+ mins	FTVF105-600-1

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TVF106	800-1	115V RMS, 800 Hz nominal settings	800 Hz, 4 Hz mod	Apply for 30+ mins	FTVF105-800-1
		Voltage Distortion Spectrum		Requires Additional Equipment	
		Total Voltage Distortion			
TVF107	400-1	115V RMS, 400 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FTVF107-400-1
	360-1	115V RMS, 360 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FTVF107-360-1
	600-1	115V RMS, 600 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FTVF107-600-1
	800-1	115V RMS, 800 Hz nominal settings	Voltage Distortion Factor 0.05	Apply for 30 mins	FTVF107-800-1
		DC Voltage Component			
TVF108	400-1	400 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FTVF108-400-1
	400-2	400 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FTVF108-400-2
	360-1	360 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FTVF108-360-1
	360-2	360 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FTVF108-360-2
	600-1	600 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FTVF108-600-1
	600-2	600 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FTVF108-600-2
	800-1	800 Hz, Positive DC Offset	115V RMS + .10 DC offset	Apply for 30 mins	FTVF108-800-1
	800-2	800 Hz, Negative DC Offset	115V RMS - .10 DC offset	Apply for 30 mins	FTVF108-800-2
		Normal Voltage Transients			
	400-1	400 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF109-2	FTVF109-400-1
TVF109	400-2	400 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table TVF109-2	FTVF109-400-2
	400-3	400 Hz, Combined Transient	180V to 80V RMS	Table TVF109-2	FTVF109-400-3
	400-4	400 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure TVF109-2	FTVF109-400-4
	360-1	360 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF109-2	FTVF109-360-1
	360-2	360 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table TVF109-2	FTVF109-360-2
	360-3	360 Hz, Combined Transient	180V to 80V RMS	Table TVF109-2	FTVF109-360-3
	360-4	360 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure TVF109-2	FTVF109-360-4
	600-1	600 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF109-2	FTVF109-600-1
	600-2	600 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table TVF109-2	FTVF109-600-2
	600-3	600 Hz, Combined Transient	180V to 80V RMS	Table TVF109-2	FTVF109-600-3
	600-4	600 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure TVF109-2	FTVF109-600-4
	800-1	800 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF109-2	FTVF109-800-1
	800-2	800 Hz, Undervoltage Transients	Low Voltage 80V RMS	Table TVF109-2	FTVF109-800-2
	800-3	800 Hz, Combined Transient	180V to 80V RMS	Table TVF109-2	FTVF109-800-3
	800-4	800 Hz, Repetitive Normal Voltage Transient Test	90V to 140V RMS	Figure TVF109-2	FTVF109-800-4
TVF110		Normal Frequency Transients			
	1	Overfrequency Transients	High Frequency 800 Hz	Table TVF110-2	FTVF110-1
	2	Underfrequency Transients	Low Frequency 360 Hz	Table TVF110-2	FTVF110-2
	3	Combined Transient	360 Hz to 800 Hz	Table TVF110-2	FTVF110-3
TVF201		Power Interrupt			
	400-1	115V RMS, 400 Hz nominal settings	0V for 50 msec	Table TVF201-2	FTVF201-400-1
	360-1	115V RMS, 360 Hz nominal settings	0V for 50 msec	Table TVF201-2	FTVF201-360-1
	600-1	115V RMS, 600 Hz nominal settings	0V for 50 msec	Table TVF201-2	FTVF201-600-1
	800-1	115V RMS, 800 Hz nominal settings	0V for 50 msec	Table TVF201-2	FTVF201-800-1

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TVF301		Abnormal Steady State Limits for Voltage and Frequency	100V to 125V RMS, 360Hz to 800 Hz	Apply for 30 mins	FTVF301
TVF302		Abnormal Voltage Transients			
	400-1	400 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF302-2 A-G	FTVF302-400-1
	400-2	400 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table TVF302-2 H-N	FTVF302-400-2
	400-3	400 Hz, Combined Transient	45V RMS to 180V RMS	Table TVF302-2 O	FTVF302-400-3
	360-1	360 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF302-2 A-G	FTVF302-360-1
	360-2	360 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table TVF302-2 H-N	FTVF302-360-2
	360-3	360 Hz, Combined Transient	45V RMS to 180V RMS	Table TVF302-2 O	FTVF302-360-3
	600-1	600 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF302-2 A-G	FTVF302-600-1
	600-2	600 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table TVF302-2 H-N	FTVF302-600-2
	600-3	600 Hz, Combined Transient	45V RMS to 180V RMS	Table TVF302-2 O	FTVF302-600-3
	800-1	800 Hz, Overvoltage Transients	Peak Voltage 180V RMS	Table TVF302-2 A-G	FTVF302-800-1
	800-2	800 Hz, Undervoltage Transients	Low Voltage 45V RMS	Table TVF302-2 H-N	FTVF302-800-2
	800-3	800 Hz, Combined Transient	45V RMS to 180V RMS	Table TVF302-2 O	FTVF302-800-3
TVF303		Abnormal Frequency Transients			
	1	Overfrequency Transients	High Frequency 800 Hz	Table TVF303-2 A-D	FTVF303-1
	2	Underfrequency Transients	Low Frequency 360 Hz	Table TVF303-2 E-H	FTVF303-2
	3	Combined Transient	360 Hz to 800 Hz	Table TVF303-2 I	FTVF303-3
TVF401		Emergency Limits for Voltage and Frequency	Perform Test TVF102		
TVF501		No Tests		N/A to AC Utilization Equipment	
TVF601		Power Failure (Single Phase)			
	400-1	115V RMS, 400 Hz nominal settings	0V for 7 seconds	Table TVF601-2	FTVF601-400-1
	360-1	115V RMS, 360 Hz nominal settings	0V for 7 seconds	Table TVF601-2	FTVF601-360-1
	600-1	115V RMS, 600 Hz nominal settings	0V for 7 seconds	Table TVF601-2	FTVF601-600-1
	800-1	115V RMS, 800 Hz nominal settings	0V for 7 seconds	Table TVF601-2	FTVF601-800-1
TVF602		One Phase and Two Phase Power Failures			
	400-1	One Phase Power Failures	0V for 7 seconds	Table TVF602-2 A-F	FTVF602-400-1
	400-2	Two Phase Power Failures	0V for 30 mins	Table TVF602-2 G-J	FTVF602-400-2
	360-1	One Phase Power Failures	0V for 7 seconds	Table TVF602-2 A-F	FTVF602-360-1
	360-2	Two Phase Power Failures	0V for 30 mins	Table TVF602-2 G-J	FTVF602-360-2
	600-1	One Phase Power Failures	0V for 7 seconds	Table TVF602-2 A-F	FTVF602-600-1
	600-2	Two Phase Power Failures	0V for 30 mins	Table TVF602-2 G-J	FTVF602-600-2
	800-1	One Phase Power Failures	0V for 7 seconds	Table TVF602-2 A-F	FTVF602-800-1
	800-2	Two Phase Power Failures	0V for 30 mins	Table TVF602-2 G-J	FTVF602-800-2
TVF603		Phase Reversal		Phase reversal done physically	FTVF603

**Table SXF:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SXF101		Load and Current Harmonic Measurements	115V RMS, 60 Hz		FSXF101
SXF102		Steady State Limits for Voltage and Frequency	105V to 125V RMS, 59.75 to 60.25 Hz	Apply for 30 mins each test	FSXF102
SXF103		No Test, Done so test numbers coincide			



Test No.	Section	Subject	Test Limits	Comment	File Ref.
SXF104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 2.5V RMS mod	Apply for 10+ mins	FSXF104-1
	2	109V Nominal Test	109V RMS, 2.5V RMS mod	Apply for 10+ mins	FSXF104-2
	3	117V Nominal Test	117V RMS, 2.5V RMS mod	Apply for 10+ mins	FSXF104-3
SXF105		Frequency Modulation			
	1	60 Hz Nominal Test	60 Hz, .5 Hz mod	Apply for 10+ mins	FSXF105-1
	2	59.75 Hz Nominal Test	59.75 Hz, .5 Hz mod	Apply for 10+ mins	FSXF105-2
	3	60.75 Hz Nominal Test	60.75 Hz, .5 Hz mod	Apply for 10+ mins	FSXF105-3
SXF106		Voltage Distortion Spectrum		Requires Additional Equipment	
SXF107		Total Voltage Distortion	Voltage Distortion Factor 0.05	Apply for 30 mins	FSXF107
SXF108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	FSXF108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	FSXF108-2
SXF109		Normal Voltage Transients	152V RMS to 31V RMS		
	1	Overvoltage Transients	Peak voltage 152V RMS	Table SXF109-3 A-D	FSXF109-1
	2	Undervoltage Transients	Low voltage 31V RMS	Table SXF109-3 E-H	FSXF109-2
	3	Combined Transient	130V RMS to 70V RMS	Table SXF109-3 I	FSXF109-3
	4	Repetitive Normal Voltage Transient Test	100V RMS to 128V RMS	Run transient for 30 mins	FSXF109-4
SXF110		Normal Frequency Transients	59 Hz to 61 Hz		
	1	Overfrequency Transients	High Frequency 61 Hz	Table SXF110-3 A-B	FSXF110-1
	2	Underfrequency Transients	Low Frequency 59 Hz	Table SXF110-3 C-D	FSXF110-2
	3	Combined Transient	59 Hz to 61 Hz	Table SXF110-3 E	FSXF110-3
SXF201		Power Interrupt	0V for 50 msec	Table SXF201-2 A-L	FSXF201
SXF301		Abnormal Steady State Limits for Voltage and Frequency	100V RMS to 128V RMS, 59.5 Hz to 60.5 Hz	Apply for 30 mins	FSXF301
SXF302		Abnormal Voltage Transients	50V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SXF302-3 A-E	FSXF302-1
	2	Undervoltage Transients	Low voltage 50V RMS	Table SXF302-3 F-J	FSXF302-2
	3	Combined Transient	50V RMS to 180V RMS	Table SXF302-3 K	FSXF302-3
SXF303		Abnormal Frequency Transients	50 Hz to 61 Hz	Table SXF303-3 A-E	FSXF303
SXF401		Emergency Steady State Limits for Voltage and Frequency	Perform Test SXF102		
SXF501		No Tests		N/A to AC Utilization Equipment	
SXF601		Power Failure (Single Phase)	0V for 2 seconds	Table SXF601-2 A-C	FSXF601
SXF602		Power Failure	No test, done so numbers coincide		
SXF603		Phase Reversal		Phase reversal done physically	FSXF603

**Table LDC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
LDC101		Load Measurements	28V DC		FLDC101
LDC102		Steady State Limits for Voltage	22V to 29V DC	Apply for 30 mins	FLDC102
LDC103		Voltage Distortion Spectrum		Requires Additional Equipment	
LDC104		Total Ripple		Requires Additional Equipment	

Test No.	Section	Subject	Test Limits	Comment	File Ref.
LDC105		Normal Voltage Transients	18V to 50V DC		
	1	Overvoltage Transients	Peak Voltage 50V DC	Table LDC105-3 AA-JJ	FLDC105-1
	2	Undervoltage Transients	Low Voltage 18V DC	Table LDC105-3 KK-PP	FLDC105-2
	3	Combined Transients	18V to 50V DC	Table LDC105-3 QQ-RR	FLDC105-3
	4	Repetitive Normal Voltage Transient Test	18V to 45V DC	Repeat transient for 30 mins	FLDC105-4
LDC201		Power Interrupt	0V for 50 msec	Table LDC201-2 A-L	FLDC201
LDC301		Abnormal Steady State Limits for Voltage	20V to 31.5V DC	Apply each test for 30 mins	FLDC301
LDC302		Abnormal Voltage Transients	7V to 50V DC		
	1	Overvoltage Transients	Peak Voltage 50V DC	Table LDC302-4 AAA-FFF	FLDC302-1
	2	Undervoltage Transients	Low Voltage 7V DC	Table LDC302-4 GGG-LLL	FLDC302-2
	3	Combined Transients	7V to 50V DC	Table LDC302-4 MMM-NNN	FLDC302-3
LDC401		Emergency Limits for Voltage	18V to 29V DC	Apply each test for 30 mins	FLDC401
LDC501		Starting Voltage Transients	12V to 29V DC	Table LDC501-3 AA	FLDC501
LDC601		Power Failure	0V for 7 seconds	Table LDC601-2 A-D	FLDC601
LDC602		Polarity Reversal		Polarity reversal done physically	FLDC602

**Table HDC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
HDC101		Load Measurements	270V DC		FHDC101
HDC102		Steady State Limits for Voltage	250V to 280V DC	Apply for 30 mins	FHDC102
HDC103		Voltage Distortion Spectrum		Requires Additional Equipment	
HDC104		Total Ripple		Requires Additional Equipment	
HDC105		Normal Voltage Transients	200V to 330V DC		
	1	Overvoltage Transients	Peak Voltage 330V DC	Table HDC105-2 AA-JJ	FHDC105-1
	2	Undervoltage Transients	Low Voltage 200V DC	Table HDC105-2 KK-PP	FHDC105-2
	3	Combined Transients	200V to 330V DC	Table HDC105-2 QQ-RR	FHDC105-3
	4	Repetitive Normal Voltage Transient Test	215V to 315V DC	Repeat transient for 30 mins	FHDC105-4
HDC201		Power Interrupt	0V for 50 msec	Table HDC201-2 A-L	FHDC201
HDC301		Abnormal Steady State Limits for Voltage	240V to 290V DC	Apply each test for 30 mins	FHDC301
HDC302		Abnormal Voltage Transients	180V to 350V DC		
	1	Overvoltage Transients	Peak Voltage 350V DC	Table HDC302-4 AAA-FFF	FHDC302-1
	2	Undervoltage Transients	Low Voltage 180V DC	Table HDC302-4 GGG-LLL	FHDC302-2
	3	Combined Transients	180V to 350V DC	Table HDC302-4 MMM-NNN	FHDC302-3
HDC401		Emergency Limits for Voltage	250V to 280V DC	Apply each test for 30 mins	FHDC401
HDC501		Starting Voltage Transients	115V to 280V DC	Table HDC501-3 AA	FHDC501
HDC601		Power Failure	0V for 7 seconds	Table HDC601-2 A-D	FHDC601
HDC602		Polarity Reversal		Polarity reversal done physically	FHDC602

**Rev E:** This test should be performed using the firmware version of the –704 option.

**Rev D:** This test should be performed using the firmware version of the –704 option.

**Rev C:****Table SAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SAC101		Load and Current Harmonic Measurements	115V RMS, 400 Hz		CSAC101
SAC102		Steady State Limits for Voltage and Frequency	108V to 118V RMS, 393 to 407 Hz	Apply for 30 mins each test	CSAC102
SAC103		No Test, Done so test numbers coincide			
SAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 2.5V RMS mod	Apply for 10+ mins	CSAC104-1
	2	109V Nominal Test	109V RMS, 2.5V RMS mod	Apply for 10+ mins	CSAC104-2
	3	117V Nominal Test	117V RMS, 2.5V RMS mod	Apply for 10+ mins	CSAC104-3
SAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, +/-5 Hz mod	Apply for 10+ mins	CSAC105-1
	2	395 Hz Nominal Test	395 Hz, +/-5 Hz mod	Apply for 10+ mins	CSAC105-2
	3	405 Hz Nominal Test	405 Hz, +/-5 Hz mod	Apply for 10+ mins	CSAC105-3
SAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
SAC107		Total Voltage Distortion	Voltage Distortion Factor 0.05	Apply for 30 mins	CSAC107
SAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	CSAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	CSAC108-2
SAC109		Normal Voltage Transients	180V RMS to 80V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SAC109-3 AA-GG	CSAC109-1
	2	Undervoltage Transients	Low voltage 80V RMS	Table SAC109-3 HH-LL	CSAC109-2
	3	Combined Transient	180V RMS to 80V RMS	Table SAC109-3 MM	CSAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	CSAC109-4
SAC110		Normal Frequency Transients	375 Hz to 425 Hz		
	1	Overfrequency Transients	High Frequency 425 Hz	Table SAC110-3 AA-DD	CSAC110-1
	2	Underfrequency Transients	Low Frequency 375 Hz	Table SAC110-3 EE-HH	CSAC110-2
	3	Combined Transient	375 Hz to 425 Hz	Table SAC110-3 II	CSAC110-3
SAC201		Power Interrupt	0V for 50 msec	Table SAC201-2 A-L	CSAC201
SAC301		Abnormal Steady State Limits for Voltage and Frequency	100V RMS to 125V RMS, 380 Hz to 420 Hz	Apply for 30 mins	CSAC301
SAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SAC302-3 AA-GG	CSAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table SAC302-3 HH-NN	CSAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table SAC302-3 OO	CSAC302-3
SAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table SAC303-3 AA-EE	CSAC303
SAC401		Emergency Steady State Limits for Voltage and Frequency	104V to 122V RMS, 360 to 440 Hz	Apply for 30 mins each test	CSAC401
SAC501		No Tests		N/A to AC Utilization Equipment	
SAC601		Power Failure (Single Phase)	0V for 7 seconds	Table SAC601-2 A-D	CSAC601
SAC602		Power Failure	No test, done so numbers coincide		

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SAC603		Phase Reversal	N/A to Rev C		

**Table TAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TAC101		Three Phase Load and Current Harmonic Measurements	115V RMS, 400 Hz		CTAC101
TAC102		Steady State Limits for Voltage (Including Unbalance) and Frequency			
	1	Balanced Phases	108V to 118V RMS, 393 to 407 Hz	Apply for 30 mins each test	CTAC102-1
	2	Unbalanced Phases	108V to 118V RMS, +/- 3V Unbalance	Apply for 30 mins each test	CTAC102-2
TAC103		Voltage Phase Difference	Phase B 116 to 124 degrees	Apply for 30 mins each test	CTAC103
TAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 2.5V RMS mod	Apply for 10+ mins	CTAC104-1
	2	109V Nominal Test	109V RMS, 2.5V RMS mod	Apply for 10+ mins	CTAC104-2
	3	117V Nominal Test	117V RMS, 2.5V RMS mod	Apply for 10+ mins	CTAC104-3
TAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, +/-5 Hz mod	Apply for 10+ mins	CTAC105-1
	2	395 Hz Nominal Test	395 Hz, +/-5 Hz mod	Apply for 10+ mins	CTAC105-2
	3	405 Hz Nominal Test	405 Hz, +/-5 Hz mod	Apply for 10+ mins	CTAC105-3
TAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
TAC107		Total Voltage Distortion	Voltage Distortion Factor 0.05	Apply for 30 mins	CTAC107
TAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	CTAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	CTAC108-2
TAC109		Normal Voltage Transients	180V RMS to 80V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table TAC109-3 AA-GG	CTAC109-1
	2	Undervoltage Transients	Low voltage 80V RMS	Table TAC109-3 HH-LL	CTAC109-2
	3	Combined Transient	180V RMS to 80V RMS	Table TAC109-3 MM	CTAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	CTAC109-4
TAC110		Normal Frequency Transients	375 Hz to 425 Hz		
	1	Overfrequency Transients	High Frequency 425 Hz	Table TAC110-3 AA-DD	CTAC110-1
	2	Underfrequency Transients	Low Frequency 375 Hz	Table TAC110-3 EE-HH	CTAC110-2
	3	Combined Transient	375 Hz to 425 Hz	Table TAC110-3 II	CTAC110-3
TAC201		Power Interrupt	0V for 50 msec	Table TAC201-2 A-L	CTAC201
TAC301		Abnormal Steady State Limits for Voltage and Frequency	100V RMS to 125V RMS, 380 Hz to 420 Hz	Apply for 30 mins	CTAC301
TAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table TAC302-3 AA-GG	CTAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table TAC302-3 HH-NN	CTAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table TAC302-3 OO	CTAC302-3
TAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table TAC303-3 AA-EE	CTAC303
TAC401		Emergency Steady State Limits for Voltage and Frequency	104V to 122V RMS, 360 to 440 Hz	Apply for 30 mins each test	CTAC401
TAC501		No Tests		N/A to AC Utilization Equipment	
TAC601		Power Failure (Three Phase)	0V for 7 seconds	Table TAC601-2 A-D	CTAC601
TAC602		One Phase and Two Phase Power Failures			

Test No.	Section	Subject	Test Limits	Comment	File Ref.
	1	One Phase Power Failures	0V for 7 seconds	Table TAC602-2 A-F	CTAC602-1
	2	Two Phase Power Failures	0V for 30 mins	Table TAC602-2 G-J	CTAC602-2
TAC603		Phase Reversal	N/A to Rev C		

**Table LDC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
LDC101		Load Measurements	28V DC		CLDC101
LDC102		Steady State Limits for Voltage	22V to 29V DC	Apply for 30 mins	CLDC102
LDC103		Voltage Distortion Spectrum		Requires Additional Equipment	
LDC104		Total Ripple		Requires Additional Equipment	
LDC105		Normal Voltage Transients	18V to 50V DC		
	1	Overvoltage Transients	Peak Voltage 50V DC	Table LDC105-3 AA-JJ	CLDC105-1
	2	Undervoltage Transients	Low Voltage 18V DC	Table LDC105-3 KK-PP	CLDC105-2
	3	Combined Transients	18V to 50V DC	Table LDC105-3 QQ-RR	CLDC105-3
	4	Repetitive Normal Voltage Transient Test	18V to 45V DC	Repeat transient for 30 mins	CLDC105-4
LDC201		Power Interrupt	0V for 50 msec	Table LDC201-2 A-L	CLDC201
LDC301		Abnormal Steady State Limits for Voltage	20V to 31.5V DC	Apply each test for 30 mins	CLDC301
LDC302		Abnormal Voltage Transients	7V to 50V DC		
	1	Overvoltage Transients	Peak Voltage 50V DC	Table LDC302-3 AA-FF	CLDC302-1
	2	Undervoltage Transients	Low Voltage 7V DC	Table LDC302-3 GG-LL	CLDC302-2
	3	Combined Transients	7V to 50V DC	Table LDC302-3 MM-NN	CLDC302-3
LDC401		Emergency Limits for Voltage	16V to 30V DC	Apply each test for 30 mins	CLDC401
LDC501		Starting Voltage Transients	16V to 30V DC	Table LDC501-2 A	CLDC501
LDC601		Power Failure	0V for 7 seconds	Table LDC601-2 A-D	CLDC601
LDC602		Polarity Reversal	N/A to Rev B		

**Table HDC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
HDC101		Load Measurements	270V DC		CHDC101
HDC102		Steady State Limits for Voltage	250V to 280V DC	Apply for 30 mins	CHDC102
HDC103		Voltage Distortion Spectrum		Requires Additional Equipment	
HDC104		Total Ripple		Requires Additional Equipment	
HDC105		Normal Voltage Transients	125V to 475V DC		
	1	Overvoltage Transients	Peak Voltage 475V DC	Table HDC105-1 A-J	CHDC105-1
	2	Undervoltage Transients	Low Voltage 125V DC	Table HDC105-1 K-P	CHDC105-2
	3	Combined Transients	125V to 475V DC	Table HDC105-1 Q-R	CHDC105-3
	4	Repetitive Normal Voltage Transient Test	215V to 315V DC	Repeat transient for 30 mins	CHDC105-4
HDC201		Power Interrupt	0V for 50 msec	Table HDC201-2 A-L	CHDC201
HDC301		Abnormal Steady State Limits for Voltage	245V to 285V DC	Apply each test for 30 mins	CHDC301
HDC302		Abnormal Voltage Transients	65V to 475V DC		
	1	Overvoltage Transients	Peak Voltage 475V DC	Table HDC302-2 A-F	CHDC302-1
	2	Undervoltage Transients	Low Voltage 65V DC	Table HDC302-2 G-L	CHDC302-2

Test No.	Section	Subject	Test Limits	Comment	File Ref.
	3	Combined Transients	65V to 475V DC	Table HDC302-2 M-N	CHDC302-3
HDC401		Emergency Limits for Voltage	240V to 290V DC	Apply each test for 30 mins	CHDC401
HDC501		Starting Voltage Transients	155V to 280V DC	Table HDC501-2 A	CHDC501
HDC601		Power Failure	0V for 7 seconds	Table HDC601-2 A-D	CHDC601
HDC602		Polarity Reversal	N/A to Rev B		

**Rev B:****Table SAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SAC101		Load and Current Harmonic Measurements	115V RMS, 400 Hz		BSAC101
SAC102		Steady State Limits for Voltage and Frequency			
	1	Regular Test	108V to 118V RMS, 395 to 405 Hz	Apply for 30 mins each test	BSAC102-1
	2	Helicopter Test	108V to 118V RMS, 380 to 420 Hz	Apply for 30 mins each test	BSAC102-2
SAC103		No Test, Done so test numbers coincide			
SAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 2.5V RMS mod	Apply for 10+ mins	BSAC104-1
	2	109V Nominal Test	109V RMS, 2.5V RMS mod	Apply for 10+ mins	BSAC104-2
	3	117V Nominal Test	117V RMS, 2.5V RMS mod	Apply for 10+ mins	BSAC104-3
SAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, +/-5 Hz mod	Apply for 10+ mins	BSAC105-1
	2	395 Hz Nominal Test	395 Hz, +/-5 Hz mod	Apply for 10+ mins	BSAC105-2
	3	405 Hz Nominal Test	405 Hz, +/-5 Hz mod	Apply for 10+ mins	BSAC105-3
SAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
SAC107		Total Voltage Distortion	Voltage Distortion Factor 0.05	Apply for 30 mins	BSAC107
SAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	BSAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	BSAC108-2
SAC109		Normal Voltage Transients	180V RMS to 80V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SAC109-3 AA-GG	BSAC109-1
	2	Undervoltage Transients	Low voltage 80V RMS	Table SAC109-3 HH-LL	BSAC109-2
	3	Combined Transient	180V RMS to 80V RMS	Table SAC109-3 MM	BSAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	BSAC109-4
SAC110		Normal Frequency Transients	375 Hz to 425 Hz		
	1	Overfrequency Transients	High Frequency 425 Hz	Table SAC110-3 AA-DD	BSAC110-1
	2	Underfrequency Transients	Low Frequency 375 Hz	Table SAC110-3 EE-HH	BSAC110-2
	3	Combined Transient	375 Hz to 425 Hz	Table SAC110-3 II	BSAC110-3
SAC201		Power Interrupt	0V for 50 msec	Table SAC201-2 A-L	BSAC201
SAC301		Abnormal Steady State Limits for Voltage and Frequency	100V RMS to 125V RMS, 375 Hz to 425 Hz	Apply for 30 mins	BSAC301
SAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SAC302-3 AA-GG	BSAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table SAC302-3 HH-NN	BSAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table SAC302-3 OO	BSAC302-3
SAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table SAC303-3 AA-EE	BSAC303
SAC401		Emergency Steady State Limits for Voltage and Frequency	102V to 124V RMS, 360 to 440 Hz	Apply for 30 mins each test	BSAC401
SAC501		No Tests		N/A to AC Utilization Equipment	
SAC601		Power Failure (Single Phase)	0V for 7 seconds	Table SAC601-2 A-D	BSAC601
SAC602		Power Failure	No test, done so numbers coincide		

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SAC603		Phase Reversal	N/A to Rev B		

**Table TAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TAC101		Three Phase Load and Current Harmonic Measurements	115V RMS, 400 Hz		BTAC101
TAC102		Steady State Limits for Voltage (Including Unbalance) and Frequency			
	1	Balanced Phases	108V to 118V RMS, 395 to 405 Hz	Apply for 30 mins each test	BTAC102-1
	2	Helicopter Test	108V to 118V RMS, 380 to 420 Hz	Apply for 30 mins each test	BTAC102-2
	3	Unbalanced Phases	108V to 118V RMS, +/- 3V Unbalance	Apply for 30 mins each test	BTAC102-3
TAC103		Voltage Phase Difference	Phase B 116 to 124 degrees	Apply for 30 mins each test	BTAC103
TAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 2.5V RMS mod	Apply for 10+ mins	BTAC104-1
	2	109V Nominal Test	109V RMS, 2.5V RMS mod	Apply for 10+ mins	BTAC104-2
	3	117V Nominal Test	117V RMS, 2.5V RMS mod	Apply for 10+ mins	BTAC104-3
TAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, +/-5 Hz mod	Apply for 10+ mins	BTAC105-1
	2	395 Hz Nominal Test	395 Hz, +/-5 Hz mod	Apply for 10+ mins	BTAC105-2
	3	405 Hz Nominal Test	405 Hz, +/-5 Hz mod	Apply for 10+ mins	BTAC105-3
TAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
TAC107		Total Voltage Distortion	Voltage Distortion Factor 0.05	Apply for 30 mins	BTAC107
TAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	BTAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	BTAC108-2
TAC109		Normal Voltage Transients	180V RMS to 80V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table TAC109-3 AA-GG	BTAC109-1
	2	Undervoltage Transients	Low voltage 80V RMS	Table TAC109-3 HH-LL	BTAC109-2
	3	Combined Transient	180V RMS to 80V RMS	Table TAC109-3 MM	BTAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	BTAC109-4
TAC110		Normal Frequency Transients	375 Hz to 425 Hz		
	1	Overfrequency Transients	High Frequency 425 Hz	Table TAC110-3 AA-DD	BTAC110-1
	2	Underfrequency Transients	Low Frequency 375 Hz	Table TAC110-3 EE-HH	BTAC110-2
	3	Combined Transient	375 Hz to 425 Hz	Table TAC110-3 II	BTAC110-3
TAC201		Power Interrupt	0V for 50 msec	Table TAC201-2 A-L	BTAC201
TAC301		Abnormal Steady State Limits for Voltage and Frequency	100V RMS to 125V RMS, 375 Hz to 425 Hz	Apply for 30 mins	BTAC301
TAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table TAC302-3 AA-GG	BTAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table TAC302-3 HH-NN	BTAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table TAC302-3 OO	BTAC302-3
TAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table TAC303-3 AA-EE	BTAC303
TAC401		Emergency Steady State Limits for Voltage and Frequency	102V to 124V RMS, 360 to 440 Hz	Apply for 30 mins each test	BTAC401
TAC501		No Tests		N/A to AC Utilization Equipment	
TAC601		Power Failure (Three Phase)	0V for 7 seconds	Table TAC601-2 A-D	BTAC601



Test No.	Section	Subject	Test Limits	Comment	File Ref.
TAC602		One Phase and Two Phase Power Failures			
	1	One Phase Power Failures	0V for 7 seconds	Table TAC602-2 A-F	BTAC602-1
	2	Two Phase Power Failures	0V for 30 mins	Table TAC602-2 G-J	BTAC602-2
TAC603		Phase Reversal	N/A to Rev B		

**Table LDC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
LDC101		Load Measurements	28V DC		BLDC101
LDC102		Steady State Limits for Voltage	22V to 29V DC	Apply for 30 mins	BLDC102
LDC103		Voltage Distortion Spectrum		Requires Additional Equipment	
LDC104		Total Ripple		Requires Additional Equipment	
LDC105		Normal Voltage Transients	18V to 50V DC		
	1	Overvoltage Transients	Peak Voltage 50V DC	Table LDC105-3 AA-JJ	BLDC105-1
	2	Undervoltage Transients	Low Voltage 18V DC	Table LDC105-3 KK-PP	BLDC105-2
	3	Combined Transients	18V to 50V DC	Table LDC105-3 QQ-RR	BLDC105-3
	4	Repetitive Normal Voltage Transient Test	18V to 45V DC	Repeat transient for 30 mins	BLDC105-4
LDC201		Power Interrupt	0V for 50 msec	Table LDC201-2 A-L	BLDC201
LDC301		Abnormal Steady State Limits for Voltage	20V to 31.5V DC	Apply each test for 30 mins	BLDC301
LDC302		Abnormal Voltage Transients	7V to 50V DC		
	1	Overvoltage Transients	Peak Voltage 50V DC	Table LDC302-3 AA-FF	BLDC302-1
	2	Undervoltage Transients	Low Voltage 7V DC	Table LDC302-3 GG-LL	BLDC302-2
	3	Combined Transients	7V to 50V DC	Table LDC302-3 MM-NN	BLDC302-3
LDC401		Emergency Limits for Voltage	18V to 29V DC	Apply each test for 30 mins	BLDC401
LDC501		Starting Voltage Transients	16V to 30V DC	Table LDC501-2 A	BLDC501
LDC601		Power Failure	0V for 7 seconds	Table LDC601-2 A-D	BLDC601
LDC602		Polarity Reversal	N/A to Rev B		

**Table HDC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
HDC101		Load Measurements	270V DC		BHDC101
HDC102		Steady State Limits for Voltage	250V to 280V DC	Apply for 30 mins	BHDC102
HDC103		Voltage Distortion Spectrum		Requires Additional Equipment	
HDC104		Total Ripple		Requires Additional Equipment	
HDC105		Normal Voltage Transients	125V to 475V DC		
	1	Overvoltage Transients	Peak Voltage 475V DC	Table HDC105-1 A-J	BHDC105-1
	2	Undervoltage Transients	Low Voltage 125V DC	Table HDC105-1 K-P	BHDC105-2
	3	Combined Transients	125V to 475V DC	Table HDC105-1 Q-R	BHDC105-3
	4	Repetitive Normal Voltage Transient Test	215V to 315V DC	Repeat transient for 30 mins	BHDC105-4
HDC201		Power Interrupt	0V for 50 msec	Table HDC201-2 A-L	BHDC201
HDC301		Abnormal Steady State Limits for Voltage	245V to 285V DC	Apply each test for 30 mins	BHDC301
HDC302		Abnormal Voltage Transients	65V to 475V DC		
	1	Overvoltage Transients	Peak Voltage 475V DC	Table HDC302-2 A-F	BHDC302-1

Test No.	Section	Subject	Test Limits	Comment	File Ref.
	2	Undervoltage Transients	Low Voltage 65V DC	Table HDC302-2 G-L	BHDC302-2
	3	Combined Transients	65V to 475V DC	Table HDC302-2 M-N	BHDC302-3
HDC401		Emergency Limits for Voltage	240V to 290V DC	Apply each test for 30 mins	BHDC401
HDC501		Starting Voltage Transients	155V to 280V DC	Table HDC501-2 A	BHDC501
HDC601		Power Failure	0V for 7 seconds	Table HDC601-2 A-D	BHDC601
HDC602		Polarity Reversal	N/A to Rev B		

**Rev A:****Table SAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
SAC101		Load and Current Harmonic Measurements	115V RMS, 400 Hz		ASAC101
SAC102		Steady State Limits for Voltage and Frequency	108V to 118V RMS, 380 to 420 Hz	Apply for 30 mins each test	ASAC102
SAC103		No Test, Done so test numbers coincide			
SAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 3.5V Vp-v mod	Apply for 10+ mins	ASAC104-1
	2	109V Nominal Test	109V RMS, 3.5V Vp-v mod	Apply for 10+ mins	ASAC104-2
	3	117V Nominal Test	117V RMS, 3.5V Vp-v mod	Apply for 10+ mins	ASAC104-3
SAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, +/-4 Hz mod	Apply for 10+ mins	ASAC105-1
	2	395 Hz Nominal Test	395 Hz, +/-4 Hz mod	Apply for 10+ mins	ASAC105-2
	3	405 Hz Nominal Test	405 Hz, +/-4 Hz mod	Apply for 10+ mins	ASAC105-3
SAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
SAC107		Total Voltage Distortion	Voltage Distortion Factor 0.08	Apply for 30 mins	ASAC107
SAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	ASAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	ASAC108-2
SAC109		Normal Voltage Transients	160V RMS to 58V RMS		
	1	Overvoltage Transients	Peak voltage 160V RMS	Table SAC109-2 A-G	ASAC109-1
	2	Undervoltage Transients	Low voltage 58V RMS	Table SAC109-2 H-N	ASAC109-2
	3	Combined Transient	160V RMS to 58V RMS	Table SAC109-2 O	ASAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	ASAC109-4
SAC110		Normal Frequency Transients	350 Hz to 450 Hz		
	1	Overfrequency Transients	High Frequency 425 Hz	Table SAC110-2 A-D	ASAC110-1
	2	Underfrequency Transients	Low Frequency 350 Hz	Table SAC110-2 E-H	ASAC110-2
	3	Combined Transient	350 Hz to 450 Hz	Table SAC110-2 I	ASAC110-3
SAC201		Power Interrupt	0V for 50 msec	Table SAC201-2 A-L	ASAC201
SAC301		Abnormal Steady State Limits for Voltage and Frequency	102V RMS to 124V RMS, 370 Hz to 430 Hz	Apply for 30 mins	ASAC301
SAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table SAC302-2 A-G	ASAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table SAC302-2 H-N	ASAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table SAC302-2 O	ASAC302-3
SAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table SAC303-2 A-E	ASAC303
SAC401		Emergency Steady State Limits for Voltage and Frequency	104V to 122V RMS, 360 Hz to 440 Hz	Apply for 30 mins	ASAC401
SAC501		No Tests		N/A to AC Utilization Equipment	
SAC601		Power Failure (Single Phase)	0V for 7 seconds	Table SAC601-2 A-D	ASAC601
SAC602		Power Failure	No test, done so numbers coincide		
SAC603		Phase Reversal	N/A to rev A		

**Table TAC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TAC101		Three Phase Load and Current Harmonic Measurements	115V RMS, 400 Hz		ATAC101
TAC102		Steady State Limits for Voltage (Including Unbalance) and Frequency			
	1	Balanced Phases	108V to 118V RMS, 380 to 420 Hz	Apply for 30 mins each test	ATAC102-1
	2	Unbalanced Phases	108V to 118V RMS, +/- 3V Unbalance	Apply for 30 mins each test	ATAC102-2
TAC103		Voltage Phase Difference	Phase B 116 to 124 degrees	Apply for 30 mins each test	ATAC103
TAC104		Voltage Modulation			
	1	115V Nominal Test	115V RMS, 3.5V Vp-v mod	Apply for 10+ mins	ATAC104-1
	2	109V Nominal Test	109V RMS, 3.5V Vp-v mod	Apply for 10+ mins	ATAC104-2
	3	117V Nominal Test	117V RMS, 3.5V Vp-v mod	Apply for 10+ mins	ATAC104-3
TAC105		Frequency Modulation			
	1	400 Hz Nominal Test	400 Hz, +/- 4 Hz mod	Apply for 10+ mins	ATAC105-1
	2	395 Hz Nominal Test	395 Hz, +/- 4 Hz mod	Apply for 10+ mins	ATAC105-2
	3	405 Hz Nominal Test	405 Hz, +/- 4 Hz mod	Apply for 10+ mins	ATAC105-3
TAC106		Voltage Distortion Spectrum		Requires Additional Equipment	
TAC107		Total Voltage Distortion	Voltage Distortion Factor 0.08	Apply for 30 mins	ATAC107
TAC108		DC Voltage Component			
	1	Positive DC Offset	115V RMS + .10V DC	Apply for 30 mins	ATAC108-1
	2	Negative DC Offset	115V RMS - .10V DC	Apply for 30 mins	ATAC108-2
TAC109		Normal Voltage Transients	160V RMS to 58V RMS		
	1	Overvoltage Transients	Peak voltage 160V RMS	Table TAC109-2 A-G	ATAC109-1
	2	Undervoltage Transients	Low voltage 58V RMS	Table TAC109-2 H-N	ATAC109-2
	3	Combined Transient	160V RMS to 58V RMS	Table TAC109-2 O	ATAC109-3
	4	Repetitive Normal Voltage Transient Test	90V RMS to 140V RMS	Run transient for 30 mins	ATAC109-4
TAC110		Normal Frequency Transients	350 Hz to 450 Hz		
	1	Overfrequency Transients	High Frequency 450 Hz	Table TAC110-2 A-D	ATAC110-1
	2	Underfrequency Transients	Low Frequency 350 Hz	Table TAC110-2 E-H	ATAC110-2
	3	Combined Transient	350 Hz to 450 Hz	Table TAC110-2 I	ATAC110-3
TAC201		Power Interrupt	0V for 50 msec	Table TAC201-2 A-L	ATAC201
TAC301		Abnormal Steady State Limits for Voltage and Frequency	102V RMS to 124V RMS, 370 Hz to 430 Hz	Apply for 30 mins	ATAC301
TAC302		Abnormal Voltage Transients	45V RMS to 180V RMS		
	1	Overvoltage Transients	Peak voltage 180V RMS	Table TAC302-2 A-G	ATAC302-1
	2	Undervoltage Transients	Low voltage 45V RMS	Table TAC302-2 H-N	ATAC302-2
	3	Combined Transient	45V RMS to 180V RMS	Table TAC302-2 O	ATAC302-3
TAC303		Abnormal Frequency Transients	320 Hz to 480 Hz	Table TAC303-2 A-E	ATAC303
TAC401		Emergency Steady State Limits for Voltage and Frequency	104V to 122 V, 360 to 440 Hz	Apply for 30 mins	ATAC401
TAC501		No Tests		N/A to AC Utilization Equipment	
TAC601		Power Failure (Three Phase)	0V for 7 seconds	Table TAC601-2 A-D	ATAC601
TAC602		One Phase and Two Phase Power Failures			
	1	One Phase Power Failures	0V for 7 seconds	Table TAC602-2 A-F	ATAC602-1
	2	Two Phase Power Failures	0V for 30 mins	Table TAC602-2 G-J	ATAC602-2

Test No.	Section	Subject	Test Limits	Comment	File Ref.
TAC603		Phase Reversal	N/A to rev A		

**Table LDC:**

Test No.	Section	Subject	Test Limits	Comment	File Ref.
LDC101		Load Measurements	28V DC		ALDC101
LDC102		Steady State Limits for Voltage	24V to 28.5V DC	Apply for 30 mins	ALDC102
LDC103		Voltage Distortion Spectrum		Requires Additional Equipment	
LDC104		Total Ripple		Requires Additional Equipment	
LDC105		Normal Voltage Transients	8V to 70V DC		
	1	Overvoltage Transients	Peak Voltage 70V DC	Table LDC105-2 A-J	ALDC105-1
	2	Undervoltage Transients	Low Voltage 8V DC	Table LDC105-2 K-T	ALDC105-2
	3	Combined Transients	8V to 70V DC	Table LDC105-2 U-V	ALDC105-3
	4	Repetitive Normal Voltage Transient Test	18V to 45V DC	Repeat transient for 30 mins	ALDC105-4
LDC201		Power Interrupt	0V for 50 msec	Table LDC201-2 A-L	ALDC201
LDC301		Abnormal Steady State Limits for Voltage	22.5V to 30V DC	Apply each test for 30 mins	ALDC301
LDC302		Abnormal Voltage Transients	6V to 80V DC		
	1	Overvoltage Transients	Peak Voltage 80V DC	Table LDC302-2 A-J	ALDC302-1
	2	Undervoltage Transients	Low Voltage 6V DC	Table LDC302-2 K-T	ALDC302-2
	3	Combined Transients	6V to 80V DC	Table LDC302-2 U-V	ALDC302-3
LDC401		Emergency Limits for Voltage	16V to 24V DC	Apply each test for 30 mins	ALDC401
LDC501		Starting Voltage Transients	16V to 28.5V DC	Table LDC501-2 A	ALDC501
LDC601		Power Failure	0V for 7 seconds	Table LDC601-2 A-D	ALDC601
LDC602		Polarity Reversal	N/A to rev A		

### 9.8.2.13 704 Option Related Error Messages

The CIGui32 program will monitor the power source on a regular basis for any run time errors. If an error is reported by the power source, any test step execution will be aborted. Possible errors and error sources are:

No	Description	Potential cause
2	Current Limit Fault	EUT may require more current than the programmed current limit setting. This is possible on constant power loads during reduced voltage (low line) type test steps. If the power source is set to Constant Voltage (CV) mode, the output will trip off when the current limit is exceeded and a Current Limit fault is generated. In Constant Current (CC) mode, the output voltage will be reduced to reduce the current to the set limit. In this case, no error message will be generated.
-113	Undefined Header	Generally caused by a communication problem between the PC and the power source.  If the RS232 interface is used and these problems persist, try using the GPIB interface instead. (Requires National Instruments GPIB controller).
15	Slew exceeds dwell	The power source transient system was programmed to slew to a voltage and/or frequency value that would take longer to accomplish than the slew time set. This error can result in single step mode if the steps are executed out of order or one or more steps are skipped. The voltage/frequency values may no longer line up. Try running the test from the first step.
16	Illegal during transient	A transient step is still in progress. Try using the Abort button to abort any test in progress. If other CIGui32 screens other than the Main GUI screen are open, they may have initiated a transient, which conflicts with the 704 option. Try closing all other CIGui32 windows.

Great efforts have been made to check all test sequence files provided as part of the –704 option. However, due to the breadth and complexity of the 704 database, an occasional error may occur while using these files. If an error cannot be resolved, turn on the CIGui32 bus monitor window and rerun the test that yields the error and save the bus trace to a text file using the File, Save All menu in the bus monitor window. This file can be emailed to [support@calinst.com](mailto:support@calinst.com) along with a description of the error.

Furthermore, test files were developed making reasonable assumptions concerning the intent of the MIL-STD-704 directive. The user is free to modify, edit, revise or otherwise update any of these tests to match his/her own requirements. In this case, we recommend you copy the supplied MS704\_RevF subdirectory and use this copy to make modifications to. This will preserve the original data provided.

## 9.9 ABD Option: Airbus ABD0100.1.8 Test

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Use of this option requires the following:

- i/iX Series power source with firmware revision 3.02 or higher.
- -ABD option. Options installed are listed on unit's serial tag.
- Windows XP/2000 PC with RS232C or National Instruments GPIB controller interface. California Instruments recommends the use of the GPIB interface for best performance.
- CIGui32 Windows software revision 1.24 or higher. Provided on CI P/N CIC496 CD ROM or available for download from California Instruments' website.

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### ***Table of Contents - ABD Option Manual Section.***

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### **9.9.1 General**

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The -ABD option support Airbus ABD0100.1.8 voltage and frequency immunity tests in either of the AC or DC mode. This option can only be used in conjunction with the provided CIGui32 Windows application software only due to the amount of selections and data presentation involved. As such, these tests require the use of a PC running Windows XP / 2000 and cannot be operated from the front panel.

The -ABD option is based on Airbus Directive 0100, Part 1, Chapter 8, Section 2 (ABD0100.1.8) dated August 2002. Section 1 refers to wiring, installation and connectors and is outside the scope of the -ABD option for the i/iX Series.

Future revisions of the ABD0100.1.8 directive may be issued over time and updates may be made available to cover any changes in test levels, durations, procedures etc. Furthermore, the -ABD option is completely data file driven to allow a large degree of customization by the end-user if needed so many changes can be supported without the need for software updates.

This section of the manual covers operation of the -ABD option using the CIGui32 program. Version 1.24 or higher of the CIGui32 program is required. The CIGui32 program is supplied with all i/iX systems free of charge on CD ROM CIC496. It can also be downloaded from the California Instruments web site ([www.calinst.com](http://www.calinst.com)).

The information provided in this user manual is aimed at guiding the operator in the use of the ABD option through the use of the CIGui32 program. Much of the same information can be found in the on-line help system of the CIGui32.

This manual is **not** intended to elaborate on the intent or purpose of the immunity tests and the expected behavior of the EUT as described in the ABD0100.1.8 documents. It is assumed that the end-user is familiar with the content of the ABD test standard.

## 9.9.2 Test Coverage

The comprehensiveness of the test that can be performed with the –ABD options is determined primarily by the capabilities of the power source used. Tests that are outside the hardware capabilities of the power source used will not be enabled and cannot be selected. For these tests, additional equipment may be required as indicated. The extent of coverage of the –ABD option as implemented on the i/iX Series platform is shown in the table below. Tests marked with an 'x' generally require additional hardware to be used.

No.	Description	Table A	Table B	Table C	No.	Description	Table D	No.	Description	Table E
1	Steady State Voltage	√	√	√	1	Steady State Voltage	√	1	Steady State Voltage	√
2	Abnormal Steady State Voltage	√	√	√	2	Abnormal Steady State Voltage	√	2	Voltage Surge - Normal	√
3	Voltage Surge - Normal	√	√	√	3	Voltage Surge - Normal	√	3	Voltage Surge - Abnormal	√
4	Voltage Surge - Abnormal	√	√	√	4	Voltage Surge - Abnormal	√	4	Voltage Spikes	X
5	Voltage Spikes	X	X	X	5	Voltage Spikes	X	5	Switching Transients – Appendix 1	√
6	Switching Transients – Appendix 1	√	√	√	6	Switching Transients – Appendix 1	√	6	Ripple Voltage	X
7	Voltage Modulation	√	√	√	7	Square Wave	√	7	Starting Current	√
8	Normal Frequency Variations	√	√	√	8	Ripple Voltage	X			
9	Frequency Modulation	√	√	√						
10	Distorted Voltage	√		√						

Table 9-23: -ABD Option Test Coverage



### 9.9.3 General Test Procedure

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Generally, the following steps are needed to perform an ABD test on an EUT.

1. Connect the EUT to the power source.
2. Select the correct mode of operation for the EUT, AC or DC mode, single or three-phase mode.
3. Program the relevant nominal voltage and frequency using the CIGui32 main screen.
4. Apply power by closing the output relay. This can be done at a later stage or will be done automatically after prompting the operator when a test is started.
5. Open the ABD0100.1.8 Tables control screen from the toolbar of Applications menu.
6. Select the correct airframe directory or use the default ABD\_Dbase.
7. Select the correct Power Group table A through E.
8. Select a test from the test table displayed in the bottom part of this screen. You can select a test by clicking on a row. The selected row will be highlighted.
9. Switch to the **Test Control** tab (middle tab along the top of the screen).
10. Verify that the test sequence and description shown in the table on the Test Control screen is indeed the desired test.
11. Click the Start button to initiate the test.
12. Observe the test progress monitor at the top of the window and observe the EUT.
13. Wait for test completion. You can Abort a test in progress by clicking the Abort button.
14. Select the **EUT Performance Measurements** tab.(Right tab along top of the screen.)
15. Click the **Update Meas.** Button located in the top center of the screen. This will initiate a measurement cycle. Measurements in three-phase mode may take some time to complete.
16. Use the tabs located along the top of the measurement tab (**Parameters, Waveforms, Curr Graph and Curr Spectrum**) to review the EUT data. Any anomalies can be noted in the observations tab located on the **Parameters** screen. This information will be included in the test report.
17. Click on the **Print** button or use File, Print to print a test report for this test.
18. Return to step 8 as needed.

The following chapters provide details on the various screens, menus, displays and controls available to the operator to manage the test process.

#### 9.9.4 Initial Setup

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The –ABD option supports both AC and DC modes of operation. The correct mode is a function of the EUT to be tested and the operation must select the corresponding operating mode first. This can be done from the front panel if needed or using the CIGui32 program. Use of the CIGui32 program for all settings will be assumed for the remainder of this chapter.

Five power groups are covered in the ABD0100.1.8 directive:

Group	Description
A	115VAC / 400 Hz (CF)
B	26 VAC / 400 Hz
C	115VAC / Variable Frequency (VF), 360 – 800 Hz.
D	28VDC, Conventional DC network.
E	28VDC, No Break Power Transfer (NBPT) DC network.

The required steady state output settings for each power group must be selected based on the type of EUT to be tested. These settings can be made from the front panel of the I/IX Series power source or from the main CIGui32 control screen.

9.9.5 CIGui32 ABD Control Window

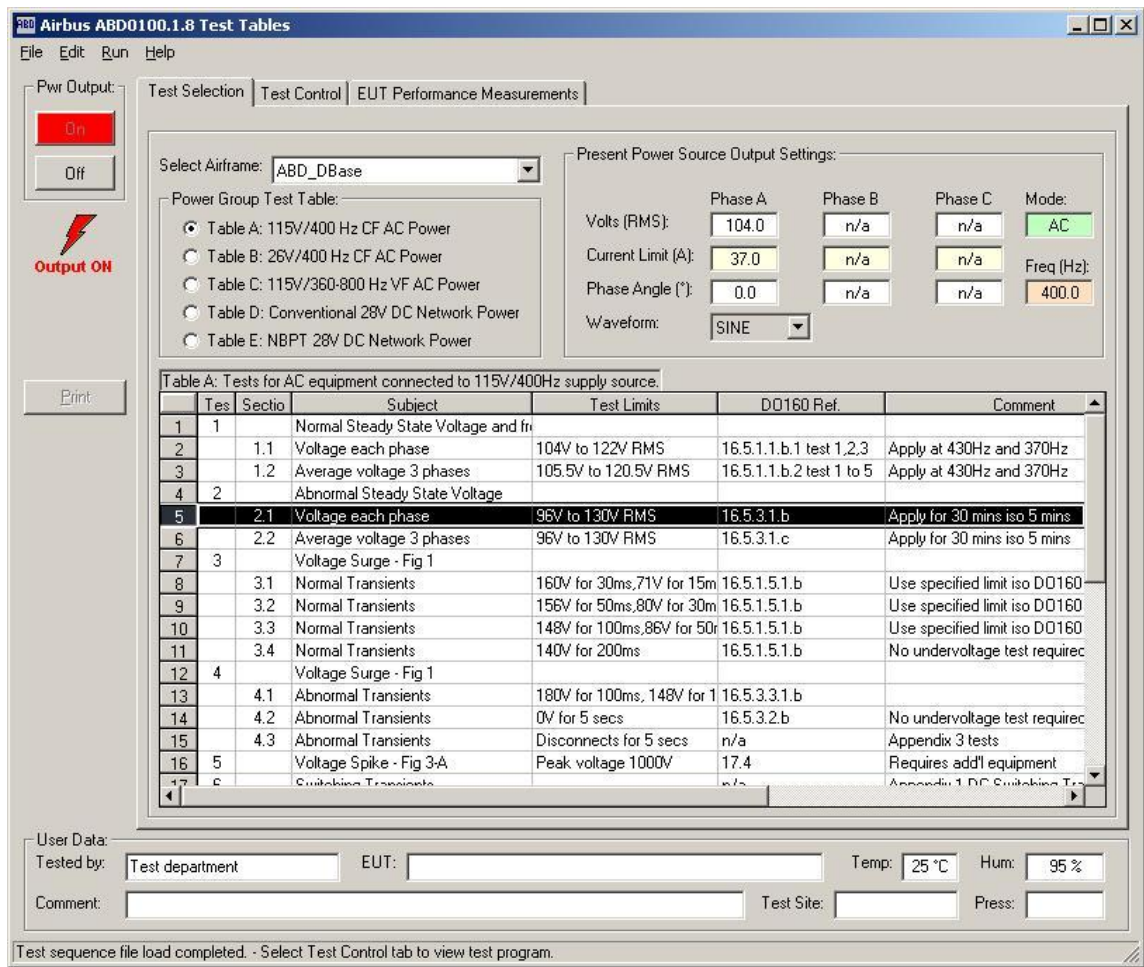


Figure 9-66: ABD Option Test Selection Screen.

To access the –ABD option, select the Airbus ABD Tables from the Applications menu of the CIGui32 main screen or click on the ABD button in the toolbar. The ABD Tables control window will open selecting the power group that most closely matches the steady state values set. It may still be necessary to select the desired power group first however. Also verify that the selected power group in the ABD screen is the correct one for the EUT being tested.

The ABD tests can be operated from the ABD test screen. This screen contains three main tabs located along the top edge of the window. The following tabs are available. Click on the tab name for additional help on how to use each tab.

Tab	Description
Test Selection	This tab allows the operator to select the library of test files to use (Select Airframe) and the relevant Power group. It also displays the AC power source settings that are in effect on the right hand side. Available power group selections are A,B and C for AC products and D and E for DC products. The table shown at the bottom of this tab shows the available test sections that can be selected. This table matches the test tables A through E of the ABD0100.1.8 test standard.
Test Control	This tab provides information on the test sequence that is presently selected and also contains the execution controls. It shows the progress of any test that is executing.

Tab	Description
EUT Performance Measurements	This tab may be used to display EUT performance data as measured by the power source's advanced data acquisition system. If the source used does not support advanced measurement function such as waveform capture and FFT, some of the information in this tab may not be displayed.

In addition to the three tab controls, the left pane of the ABD windows contains a set of output on/off control buttons and a print button. The on/off buttons may be used to open or close the output relay of the power source at any time. If the output relay is opened during a test run, the test is automatically aborted when the operator clicks on the Off button. The ON button will be shown in red while the output relay is closed. The Off button is shown in green if the output relay is open. The report print function can be invoked by either clicking on the Print button or using the File, Print menu.

If the GUI program is used in demo mode, the "DEMO MODE ONLY!!!" banner will be displayed in this area as well. In Demo mode, all test runs and all measurements are simulated. This mode may be used to develop new test sequences off-line but any run-time errors will not be detected until executed with an actual power source.

## 9.9.6 ABD Menus

The top of the ABD window contains a standard Windows menu bar. Available menus are:

Menu	Sub Menu	Description
File	New	The selected clears all data from the Test Control data grid. This operation is not normally recommended unless a complete new test sequence is to be entered manually.
	Open	Opens a specific test sequence file. This menu may be used to directly select a test file without using the Test Selection table tab.
	Save	Saves the contents of the test sequence data grid to the selected test file.
	Save As...	Saves the contents of the test sequence data grid to a user defined file name. A file dialog box will appear enabling selection of the directory and file name under which to store the contents of the test sequence data grid.
	Print	Prints a test report using MS Word format. Only data for the presently selected test sequence is printed. The test reports also include EUT performance measurement data. Note: To print reports, the MS Word report format selection must be made from the Main GUI, Options menu → Report Format menu before opening the ABD0100.1.8 test screen. If not, an error prompt will indicate that no supported report format is selected.
	Exit	Closes the ABD test window.
Edit	Cut	Cuts the selected row from either the Test selection data grid or the Test sequence data grid. The data in the row cut is available for a Paste operation.
	Copy	Copies the selected row from either the Test selection data grid or the Test sequence data grid. Copied rows can be pasted to the same grid at a different location.
	Paste	Pastes a copied row from to either the Test selection data grid or the Test sequence data grid.
	Insert Row	Inserts a new blank row at the selected data grid location.
	Delete Row	Deletes the selected row from either the Test selection data grid or the Test sequence data grid. The row contents are permanently discarded.
Run	All	Run selected test
	Stop	Abort test in progress
Help		Opens the on-line help file.

### 9.9.7 ABD Test Selection

The Test Selections tab in the ABD tests window contains the following controls and displays.

Control / Display	Description														
Select Airframe.	This drop down control allows the operator to select from one or more libraries of test sequences grouped by airframe. This allows multiple sets of test sequences to be organized by application. The GUI program is supplied with a generic ABD_Dbase set of test sequences, which conform to the ABD0100.1.8 document.														
Power Group Test Table	<p>A library can contain up to five power group test tables numbers A through E. These table letters correspond to the Power Groups identified in the ABD0100.1.8 standard. Note that groups A, B and C are AC powered where as groups D and E are DC powered. The operator cannot select a group that is not supported by the present mode of operation of the power source. Thus, if the power source is in AC mode, an error message will be display when trying to select group D or E. Operating modes such as AC or DC must be changed from the main GUI screen. The ABD screen can remain open while switching back to the main screen. Upon return to the ABD screen, the relevant power groups can be selected.</p> <p>Available power groups are:</p> <table> <tr> <td>Table A</td><td>115V / 400 Hz constant frequency (CF) AC Power tests.</td></tr> <tr> <td>Table B</td><td>26V / 400 Hz constant frequency (CF) AC Power tests.</td></tr> <tr> <td>Table C</td><td>115V / 360 to 800 Hz variable frequency (VF) AC Power tests.</td></tr> <tr> <td>Table D</td><td>Conventional 28 VDC Network Power tests.</td></tr> <tr> <td>Table E</td><td>No Break Power Transfer 28 VDC Network Power tests.</td></tr> </table> <p>The operator needs to determine what the relevant power group selection is for the unit under test. (EUT). When switching power groups, the table data shown at the bottom of this tab will be updated to reflect the new selection. The first test section of the table will automatically be selected when switching power groups.</p>	Table A	115V / 400 Hz constant frequency (CF) AC Power tests.	Table B	26V / 400 Hz constant frequency (CF) AC Power tests.	Table C	115V / 360 to 800 Hz variable frequency (VF) AC Power tests.	Table D	Conventional 28 VDC Network Power tests.	Table E	No Break Power Transfer 28 VDC Network Power tests.				
Table A	115V / 400 Hz constant frequency (CF) AC Power tests.														
Table B	26V / 400 Hz constant frequency (CF) AC Power tests.														
Table C	115V / 360 to 800 Hz variable frequency (VF) AC Power tests.														
Table D	Conventional 28 VDC Network Power tests.														
Table E	No Break Power Transfer 28 VDC Network Power tests.														
Present Power Source Output Settings	This section displays the programmed steady state settings that are in effect. This information is updated each time the ABD from regains focus. The mode of operation (AC, DC or AC+DC) is display for reference but cannot be changed from this screen. When in DC mode, the frequency setting will show "DC". Note that changes in steady state settings can only be made from the main GUI screen. The operator can toggle between the main screen and the ABD screen for this purpose as needed.														
Table Header	The table header is shown against a blue background and contains the table reference designator and a description of the selected power group.														
Test Table Display	<p>The data grid at the bottom of the tab displays the selected power group test table. It is also used to select the specific test section and number to be executed. Thus, every test starts by selecting the desired test step from this table. Clicking on the desired ROW does this. The selected row will be highlighted and the associated file shown in the File Ref. Field will be loaded in the Test Control tab.</p> <p>For better readability, the user can adjust the column widths by dragging the dividers between columns. If the window is too small to display all rows and columns, scroll bars will appears at the bottom and/or right of the data grid.</p> <p>The following fields are displayed in the test data tables.</p> <table> <tr> <td>Test</td><td>Number of the test from the ABD0100.1.8 standard. For sub sections of a test number, this field will be blank.</td></tr> <tr> <td>Section</td><td>Test section. Some tests may only have one section in which case this field is blank.</td></tr> <tr> <td>Subject</td><td>Description of the type of test.</td></tr> <tr> <td>Test Limits</td><td>A summary of the test limits that will be applied by this test.</td></tr> <tr> <td>DO160 Reference</td><td>A cross-reference to the relevant RTCA/DO-160 Section 16 tests after which this test is patterned. Generally, ABD tests deviate in one or more ways from these specific RTCA/DO-160 tests. If there is no equivalent DO-160 test, this field will be blank.</td></tr> <tr> <td>Comment</td><td>Comments concerning this test or its parameters.</td></tr> <tr> <td>File</td><td>The test sequence file that is used to implement this test section</td></tr> </table>	Test	Number of the test from the ABD0100.1.8 standard. For sub sections of a test number, this field will be blank.	Section	Test section. Some tests may only have one section in which case this field is blank.	Subject	Description of the type of test.	Test Limits	A summary of the test limits that will be applied by this test.	DO160 Reference	A cross-reference to the relevant RTCA/DO-160 Section 16 tests after which this test is patterned. Generally, ABD tests deviate in one or more ways from these specific RTCA/DO-160 tests. If there is no equivalent DO-160 test, this field will be blank.	Comment	Comments concerning this test or its parameters.	File	The test sequence file that is used to implement this test section
Test	Number of the test from the ABD0100.1.8 standard. For sub sections of a test number, this field will be blank.														
Section	Test section. Some tests may only have one section in which case this field is blank.														
Subject	Description of the type of test.														
Test Limits	A summary of the test limits that will be applied by this test.														
DO160 Reference	A cross-reference to the relevant RTCA/DO-160 Section 16 tests after which this test is patterned. Generally, ABD tests deviate in one or more ways from these specific RTCA/DO-160 tests. If there is no equivalent DO-160 test, this field will be blank.														
Comment	Comments concerning this test or its parameters.														
File	The test sequence file that is used to implement this test section														

Control / Display	Description	
	Reference	on the power source.
User Data	The area at the bottom of this tab may be used to enter general information regarding the unit under test, the test location and operator and environmental conditions in effect during the test. This information will be incorporated in the test reports generated by the GUI.	

## 9.9.8 ABD Test Control

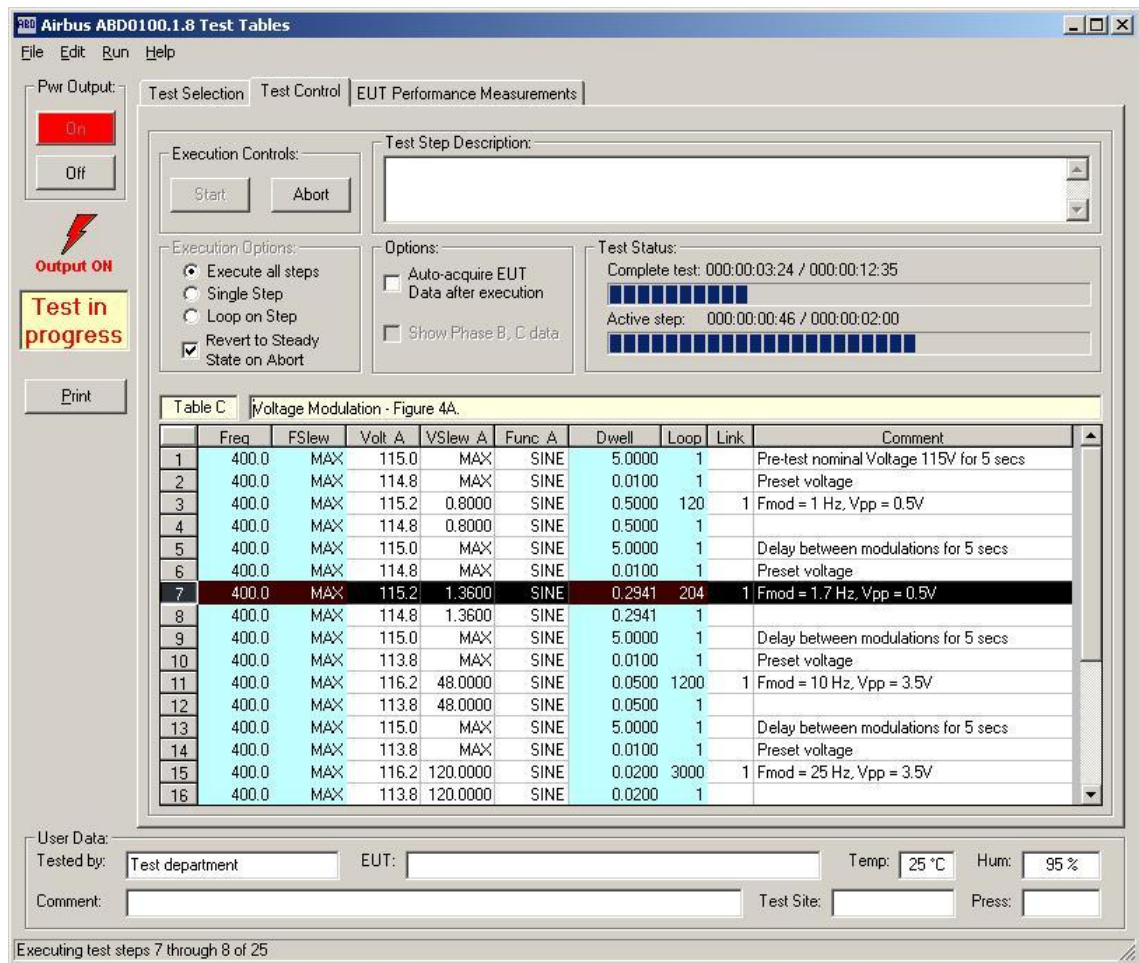


Figure 9-67: ABD Option Test Control Screen.

The Test Control tab in the ABD tests window is used to display and execute a selected ABD test. This tab contains the following controls and displays.

Control / Display	Description						
Execution Controls	The Start and Abort buttons are used to start and stop the selected test step. The execution mode that will be used is determined by the Execution Options setting. The same can be accomplished using the Run menu entries. When operating in Single Step or Loop mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab as this will be the one used by the program.						
Execution Options	The execution options determine the mode of operation when the Start button is clicked. Available execution modes and settings are: <table border="1"> <tr> <td>Execute all steps</td><td>In this mode, all steps in the test sequence will be executed sequentially until the end of the table is reached.</td></tr> <tr> <td>Single Step</td><td>Runs only the selected test step. When operating in Single Step mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab before clicking on the Start button.</td></tr> <tr> <td>Loop on Step</td><td>In this mode, the same step will be executed repeatedly until the operator clicks on the Abort button. In this mode, the Complete test progress status bar may run</td></tr> </table>	Execute all steps	In this mode, all steps in the test sequence will be executed sequentially until the end of the table is reached.	Single Step	Runs only the selected test step. When operating in Single Step mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab before clicking on the Start button.	Loop on Step	In this mode, the same step will be executed repeatedly until the operator clicks on the Abort button. In this mode, the Complete test progress status bar may run
Execute all steps	In this mode, all steps in the test sequence will be executed sequentially until the end of the table is reached.						
Single Step	Runs only the selected test step. When operating in Single Step mode, make sure the desired test step is selected in the test sequence table at the bottom of this tab before clicking on the Start button.						
Loop on Step	In this mode, the same step will be executed repeatedly until the operator clicks on the Abort button. In this mode, the Complete test progress status bar may run						

Control / Display	Description	
		past is maximum and will no longer update as the total test time is determined by the operator now and not the program.
	Revert to Steady State on Abort	When selected, the output of the power source will be set back to the steady state settings in effect before the start of the test when the operator aborts a test. Normally, the output of the source at the end of a test run is determined by the settings in the test sequence file loaded.
Options	This section contains additional options that can be set by the operator as needed. The following options are available:	
	Auto Acquire EUT Data after execution	When set, this option causes the GUI program to initiate an EUT performance data measurement sequence automatically at the end of a test (normal mode) or test step (single step mode).
	Show Phase B, C data	For three-phase EUT's, data for phases B and C can be displayed as well. In most cases, the settings for all three phases are the same and there is no need to display them all as it takes up screen space. However, this is not the case for voltage imbalance tests. This is a display feature only and has no effect on the actual test. Note however, that if the power source is in single-phase mode, settings for phase B and C will be ignored. The phase mode of the power source can only be changed from the main GUI screen.
Test Status	This area of the Test Control tab displays test execution status for each individual test step as well as the complete test. The top section shows the complete test time and what part has been completed so far. The bottom section shows the same information for the present test step.	
Test Description	The area at the top of the Test Control tab is used to display additional information about the selected test tab. It is for information purposes only and has no effect on the actual test execution.	
Table Header	The table header is shown against a yellow background and shows the table from which this test sequence was selected.	
Test Sequence Data Grid	The test sequence data grid displays the specific parameters used to program the power source. This data implements the required tests. The parameters are loaded for the referenced ini file in the test table on the Test Selection tab. It is possible to edit this information if needed which allows variations on any of these tests to be made. Any changes can be saved to a new file. The standard provided test files are write protected however and should not be overwritten. The following columns/data fields are available in this table for each test step (row).	
	Step number	Sequential number from 1 through end of sequence.
	Freq	Test frequency in Hz
	FSlew	Frequency slew rate in Hz/sec
	Volt A	Test voltage for phase/output A in Vrms or Vdc depending on mode.
	VSlew A	Voltage slew rate in V/sec
	Func A	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.
	Volt B	Test voltage for phase/output B in Vrms or Vdc depending on mode.
	VSlew B	Voltage slew rate in V/sec
	Func B	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this capability is supported by the power source.
	Volt C	Test voltage for phase/output C in Vrms or Vdc depending on mode.
	VSlew C	Voltage slew rate in V/sec
	Func C	Waveform function. Default is SINE for AC mode and DC for DC mode. Arbitrary waveform can be used in AC mode if this



Control / Display	Description	
		capability is supported by the power source.
	Dwell	Dwell time in seconds.
	Loop	Repeat count for each step. Default is 1.
	Link	Number of subsequent rows that are linked to this step. This function is required to implement complex transients that require multiple steps with zero time skew. When set to a value other than blank or "1", subsequent rows are considered part of the same test step for single step or loop on step execution modes.
	Comment	A comment about the specific test step.

### 9.9.9 ABD EUT Performance Measurements

**Airbus ABD0100.1.8 Test Tables**

File Edit Run Help

Pwr Output: On Off

**Output ON**

Print

Test Selection Test Control **EUT Performance Measurements**

Parameters Waveforms Curr Graph Curr Spectrum Update Meas. Settings

	Phs A	Phs B	Phs C	Hz		
Volt RMS (V):	115.10	0.0	0.0	399.8		
Curr RMS (A):	0.018	0.0	0.0	Total VA		
App. Power (VA):	0.0	0.0	0.0	0.0	0.0	
Inrush Current (A):	0.06	0.0	0.0	Limits:		
Power Factor:	0.240	0.00	0.00	0.20 -0.20	Pass/Fail	Pass
Current Distortion (%):	0.00	0.00	0.00			Pass

Test Frequency: 400\_Hz Acquire data at all frequencies Abort Meas. Read Meas. Data from File

Observations:

User Data:  
 Tested by: Test department EUT: Temp: 25 °C Hum: 95 %  
 Comment: Test Site: Press:

Test Completed.

Figure 9-68: ABD Option EUT Measurement Data Screen.

The EUT Performance Measurements tab in the ABD tests window provides measurement data taken by the power source's data acquisition system. It also analyzes the data where applicable and compares against performance limits set by the ABD test standard. This tab contains four sub-tabs that each present different aspects of the EUT measurement data. Additional user controls for measurement updates and graph scaling are provided right next to the four sub tabs. The following sub tabs are available for selection.

Sub-Tab	Description	
Parameters	This tab displays the parametric measurement data in tabular form. This includes voltage, current, power, power factor, distortion etc. For three-phase EUT's data is shown for all three phases. For single phase EUT, data is shown for phase A only as long as the power source is in single-phase mode.	
	The top half of the Parameters tab displays all parametric measurement data. The following data is available:	
	Volt RMS (V)	Displays source voltage per phase in Volt RMS or DC depending on power source mode of operation.
	Curr RMS (A)	Displays EUT current per phase in amps RMS or DC depending on power source mode of operation.
	App. Power (VA)	Displays the apparent power for each phase as well as the total power for all three phases.

Sub-Tab	Description	
		For three-phase EUT's, any imbalance in power between the three phases is calculated by the GUI program and compared against Figure 9 of the ABD0100.1.8 specification. The amount of imbalance is displayed in % of total VA to the right of the power readings.
	Inrush Current (A)	Displays peak current detected per phase in Amps since last measurement was taken.
	Power Factor	Displays power factor for each phase. Power factor measurement data is compared against Figure 10 of the ABD0100.1.8 specification for both leading and lagging power factors. If one or more phases is outside the allowable limits, a Fail indication is displayed.
	Current Distortion (%)	Displays Total Current Distortion for each phase in percent of fundamental current. No limits are applied although the user can set a maximum limit for this parameter if needed in the "ABD010018_Distortion_Limits.ini" setting file by adding "lthd = n.n" in either TABLE_F or TABLE_G sections..
	The bottom half of the Parameters tab contains user controls and a text entry field for entering observations regarding the EUT operation.	
	Test Frequency Dropdown control	The frequency selection drop down control is active only for Table C mode (Variable Frequency) and can be used to set the frequency at which data from the EUT is to be acquired. For all other modes, it is fixed to either 400 Hz or DC.
	Acquire Data at all frequencies	This button caused data to be acquired at all frequencies available in the Test Frequency Dropdown control. For all tables other than C, this button functions like the Update Meas. Button located above the subtabs.
	Abort Meas.	This button aborts measurements in progress. In case of Table C, acquiring data at all 12 frequency settings can take a long time. This button allows this process to be aborted.
	Read Meas. Data from File	This button reads measurement data from disk. Each time measurement data is acquired by the GUI, it is saved to an ASCII text file. A separate file is used for each frequency or DC setting. To recall data taken at a specific frequency setting, select the desired frequency using the Test Frequency Dropdown control before clicking on this button. Note that all measurement data files are saved in the Reports subdirectory of the GUI application directory using file name convention "MeasData_ABD01008_nnn_Hz.txt" where 'nnn' is the frequency setting or DC.
Waveforms	This tab displays the voltage and current waveform (time domain) for each phase. The sample rate is automatically set to display about 20 msec of time.	
Cur Graph	This tab displays the Current harmonics in a bar graph format. Up to 50 harmonics are displayed.	
Cur Spectrum	This tab displays the same current harmonics as the Current Graph tab except in a tabular format. Data is shown in both absolute and relative form (percent of fundamental current). A limit table is applied and a pass or fail indication is shown in the last column. Values that exceed the allowable limits are shown with a red background in the Pass/Fail column.	
	No.	Harmonic number, 1 through 50
	Freq (Hz)	Frequency of harmonic in Hz.
	Curr (A)	Absolute current (rms) in Amps.
	% Fund.	Relative current in percent of the fundamental current (I1).
	Limit	Allowable current harmonic limits per Table F for single-phase EUT's or Table G for three-phase EUT's of ABD0100.1.8. Distortion limits per tables F and G are contained in the "ABD010018_Distortion_Limits.ini" file located in the "ABD_Dbase" directory or the selected airframe directory.
	P/F	Pass or Fail indication.
	A phase selection is available to the left of the graphs and table, which allows each	

Sub-Tab	Description
	phase to be displayed, one at a time.

Additional user controls located on the EUT Performance Measurements Tab:

Control / Display	Description
Update Meas.	Triggers a new acquisition cycle and updates measurement data for all tabs. For table C mode (Variable Frequency), data will be acquired at the frequency set by the Test Frequency Dropdown control. This button is always available regardless of what sub tab is selected.
Settings	Brings up a dialog box that allows scaling and color changes for the Waveform or Current harmonics graphs. Note that setting changes will apply to graphs for all phases. For current harmonics graphs, only the absolute bar settings apply. The ABD measurement screen does not display relative current harmonic bar charts but relative data is available in tabular format on the Cur Spectrum tab. This button is available only if either the Waveforms or Cur Graph sub tab is selected

9.9.10 Appendix 1: ABD Switching Transients Test Window

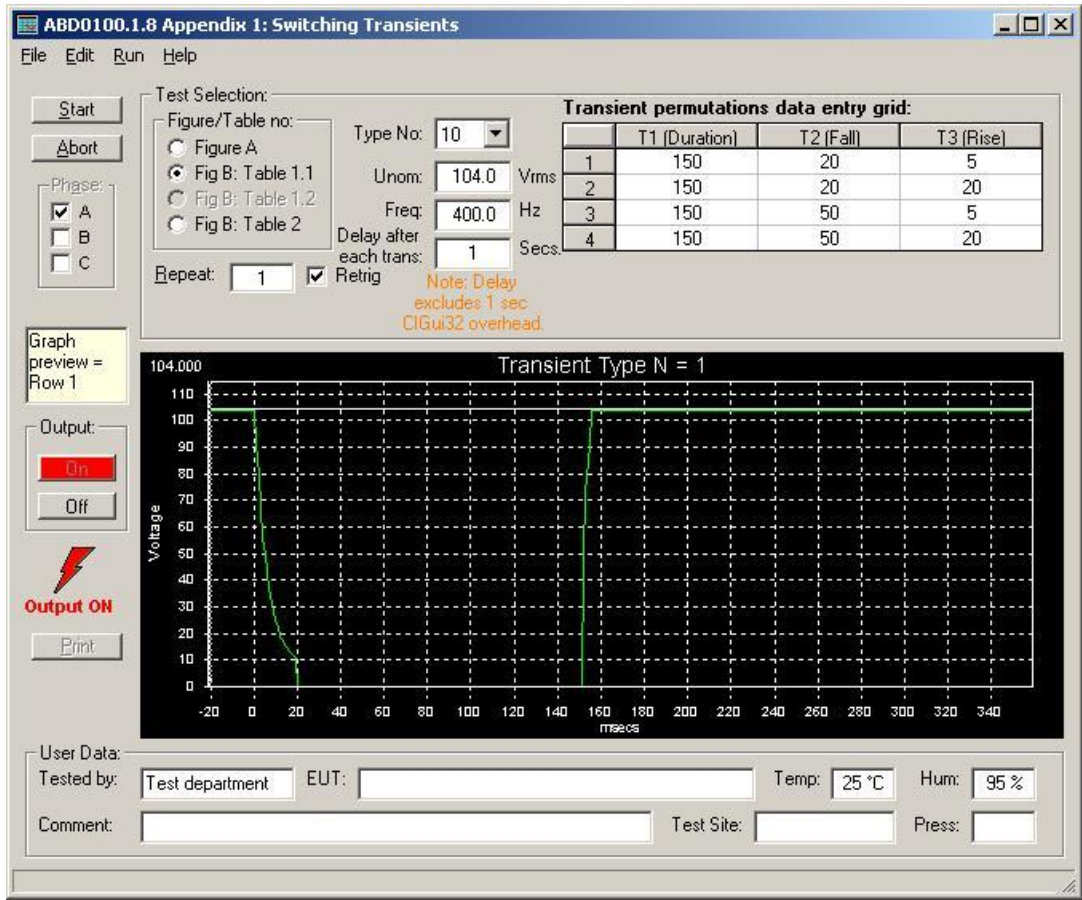
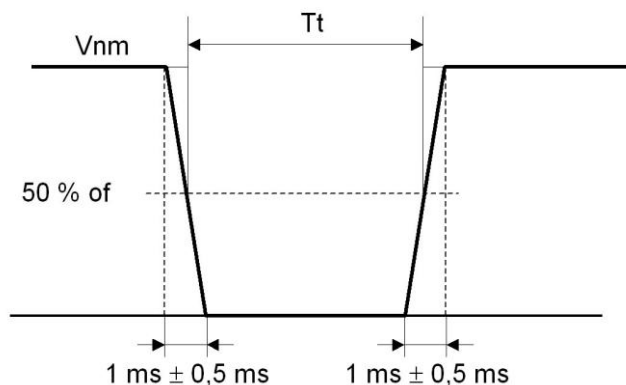


Figure 9-69: ABD0100.1.8 Switching Transient Control Window

The ABD0100.1.8 Switching Transients screen provides a high level of control for performing AC or DC transient tests according to appendix 1 of the ABD0100.1.8. The switching transient tests are also incorporated in the ABD Table test screen but the parameters for these tests are pre-set by the test sequence files provided. Using the ABD0100.1.8 Switching Transient control window, transient parameters can be set interactively and resulting transient timing is displayed graphically.

Both Figure A (Transparency Tests) and Figure B type transients (Transient Tests) can be selected and parameter permutations for Figure B tests are automatically generated and displayed in the transient permutations table above the time domain display.

Switching Transients conform Figure A (Transparency).  $T_t$  is shown in the T1 column of the table. This transient is repeated 5 times with a delay of 1 second (default) between transients.



Switching Transients conform Figure B. The T1, T2 and T3 values are shown on screen in the table above the graph. Each permutation shown is repeated one time with a 1 second delay (default) between transients.

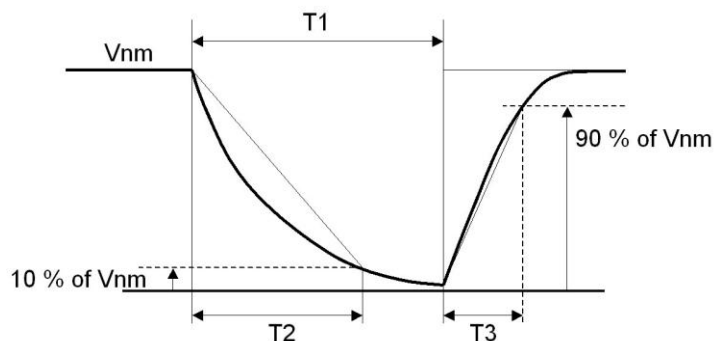
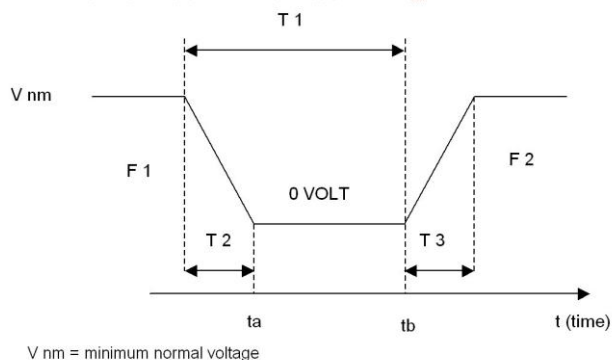


Table 2 transients with roman numerals I through VI are supported as well be selection Figure B, Table 2. F1 and F2 represent the test frequencies before and after the transient.

F1 = frequency of equipment voltage supply when  $t \leq t_a$   
 F2 = frequency of equipment voltage supply when  $t \geq t_b$



## Controls

The following controls and displays are available in this window:

Control / Display	Description	
Start button	Start selected transient test. This button will be disabled while a test is running and re-enabled at the end of a test.	
Abort button	Aborts a test in progress. This button will be disabled unless a test is running and enabled as soon as a test is started.	
Phase Checkbox	The Phase selections may be used to include one or more or all phases in a test run. Only phases with a check mark will be included in a test. Phases that are not checked remain unchanged during the test.	
Graph Preview indicator.	This text field displays the currently selected Row from the Transient permutations grid that is shown in the graph display in the lower half of the window. Normally, this is the row that is highlighted in the grid and/or the row that is presently executing.	
Output On/Off	Indicates the status of the output relay of the power source. Normally, the output relay should remain closed during and between tests. To toggle the state of the output relay, the main GUI screen must be used.	
Test Selection	This section contains the settings and control to determine the type and duration of the transient tests to be run.	
	Figure / Table no.	This selection sets the type of transient to be run as either conform Figure A or Figure B of Appendix 1. In case Figure B is selected, the parameter table to be used can be selected as well. Some choices may not be available depending on the mode of operation of the power source. For examples, Table 1.2 applies only to DC transients and will be grayed out if the power source is in AC mode. Mode changes can only be made from the main GUI screen. Note that the size of the Transient permutations table will vary depending on the Figure and Table selection made in this control.
	Type No.	<p><u>For Figure A Transparency Transients:</u> This drop down list control contains drop times in msec. Select the desired drop time from this list. Rise and fall times will be set to &lt;1 msec. Each transient will be run 5 times with a 1 second delay between transients per ABD0100.1.8 Appendix 1.</p> <p><u>For Figure B Switching Transients:</u> This drop down list contains the numbers from the selected table 1.1, 1.2 or 2. Select the number for the transient you want to run. The GUI will automatically load all available permutations for the selected table entry. For tables 1.1 and 1.2, these numbers are Arabic. For table 2, they are Roman numerals.</p>
	Unom	Sets the nominal voltage at which these transients are to be run. Recommended nominal voltages to use per Appendix 1 are shown here.
	Network Type	Voltage applied at equipment terminals (Unom)
	115 VAC	104 Vrms
	26 VAC	23 Vrms
	Conventional DC	25.5 Vdc
	NBPT DC	24 Vdc
	Delay after each transient	This field sets the time delay between transients in seconds. Default value is 1 second. Note that there is a small amount of overhead from the GUI program as it reprograms the power source between transients. This time is small compared to the 1 second delay itself however.
	Repeat	Sets the number of times each transient is run. Default value is 1. For most situations, this value should be set to 1.
	Retrig.	If repeat count greater than 1 is used and external trigger source is selected, setting this check box will require only a

Control / Display	Description	
		single trigger input. Subsequent repeats will trigger automatically.
	Freq F1 < ta	Sets the frequency before the transient (ta) for Table 2 type transients. Normally this value is set automatically per Appendix A, but the operator can change it in this field.
	Freq F2 > tb	Sets the frequency after the transient (tb) for Table 2 type transients. Normally this value is set automatically per Appendix A, but the operator can change it in this field.
Transient permutations data entry grid. (Table)	This data grid displays the T1, T2 and T3 values used for each permutation of the table values from Appendix A. These values are normally loaded automatically when selecting a table number using the Type No. drop down list. It is possible however to edit these values and save them to disk. User defined transients can be recalled using the File, Open menu. See Menu help below.	
Graph	The graph shows each transient type on a time scale from –20 msec to 350 msec. Note that for AC mode, only the envelope of the AC waveform is shown for clarity. Thus, the type of display is the same for AC and DC modes. The graph can be zoomed using the left mouse button. Double click on the graph to unzoom.	
User Data	The area at the bottom of this tab may be used to enter general information regarding the unit under test, the test location, operator, and environmental conditions in effect during the test. This information will be incorporated in the test reports generated by the GUI.	

## Menus

The top of the ABD Transients window contains a standard Windows menu bar. Available menus are:

Menu	Sub Menu	Description
File	New	The selected resets all data from the Transient permutations data entry grid to the selected Type No entry. This operation may be used to undo any edits made by the user.
	Open	Opens a specific transient test file with ABD0100_1_8 extension. This menu may be used to directly select a test file without using the Type No. drop down list.
	Save	Saves the contents of the Transient permutations data entry grid to the selected test file. The ABD0100_1_8 file extension is automatically appended.
	Save As...	Saves the contents of the Transient permutations data entry grid to a user defined file name. A file dialog box will appear enabling selection of the directory and file name under which to store the contents of the test sequence data grid. The ABD0100_1_8 file extension is automatically appended.
	Print	Prints a test report using MS Word format. Only data for the presently selected test sequence is printed. Note: To print reports, the MS Word report format selection must be made from the Main GUI, Options menu → Report Format menu before opening the ABD0100.1.8 test screen. If not, an error prompt will indicate that no supported report format is selected.
	Exit	Closes the ABD Transients test window.
Edit	Cut	Cuts the selected row from the Transient permutations data entry grid. The data in the row cut is available for a Paste operation.
	Copy	Copies the selected row from the Transient permutations data entry grid. Copied rows can be pasted to the same grid at a different location.
	Paste	Pastes a copied row from to the Transient permutations data entry grid.
Run	All	Run selected test
	Stop	Abort test in progress
Help		Opens this help file.



### 9.9.11 Test Description Files – Creating Custom Tests

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The ABD option uses a set of configuration files that contain the relevant test descriptions. These files are contained in the ABD\_Dbase subdirectory of the CIGUI32 application directory.

The contents of these tables is defined by the “ABD\_Structure\_Tbl\_X.ini” configuration files located in the ABD\_Dbase directory. “X” references the relevant table.

The test description files used to perform a specific test are listing in the last column labeled “Test File”. These files must be present in the ABD\_Dbase directory or the user directory.

For customer created tests, these file names can be renamed as needed as long as they are correctly referenced in the ABD\_Structure\_Tbl\_X.ini configuration files.

Tests can be customized as needed by editing these table configuration and test sequence files. To do so, create a new subdirectory under the application directory. To access any new sub directory from within the ABD test window, the directory name must be added to the “ABDUserTestLibraries.txt” file located in the CIGui32 application directory. This is a simple text file listing all test description directories available.

Example “ABDUserTestLibraries.txt” file content:

```
A350_DBase  
Dummy_Dir_Entry
```

Directories listed will be available for selection from the AirFrame selection in the ABD Test Setup screen.

To facilitate creating new test directories, it is easiest to create a copy of the ABD\_Dbase first and rename it as required.

### 9.9.12 Test Tables

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The tables shown on the next few pages list the test sections covered by the –ABD option. Where relevant, the numbering used matches that of the ABD0100.1.8 document. The notes in the right hand column indicate tests that are either not directly supported or require additional external test equipment. Test tables are listed by power groups A through E.

**Table A:**

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
1							
2		1.1	Voltage each phase	104V to 122V RMS	16.5.1.1.b.1 test 1,2,3	Apply at 430Hz and 370Hz	A1P1_NSSVF
3		1.2		105.5V to 120.5V RMS	16.5.1.1.b.2 test 1 to 5	Apply at 430Hz and 370Hz	A1P3_NSSVF
4	2		Abnormal Steady State Voltage				
5		2.1	Voltage each phase	96V to 130V RMS	16.5.3.1.b	Apply for 30 mins iso 5 mins	A2P1_ABN_SSV
6		2.2	Average voltage 3 phases	96V to 130V RMS	16.5.3.1.c	Apply for 30 mins iso 5 mins	A2P3_ABN_SSV
7	3		Voltage Surge - Fig 1				
8		3.1	Normal Transients	160V for 30ms, 71V for 15ms	16.5.1.5.1.b	Use specified limit iso DO160	A3P0_NORMVSURGE1
9		3.2	Normal Transients	156V for 50ms, 80V for 30ms	16.5.1.5.1.b	Use specified limit iso DO160	A3P0_NORMVSURGE2
10		3.3	Normal Transients	148V for 100ms, 86V for 50ms	16.5.1.5.1.b	Use specified limit iso DO160	A3P0_NORMVSURGE3
11		3.4	Normal Transients	140V for 200ms	16.5.1.5.1.b	No undervoltage test required	A3P0_NORMVSURGE4
12	4		Voltage Surge - Fig 1				
13		4.1	Abnormal Transients	180V for 100ms, 148V for 1 sec	16.5.3.3.1.b		A4P0_ABNVSURGE1
14		4.2	Abnormal Transients	0V for 5 secs	16.5.3.2.b	No undervoltage test required	A4P0_ABNVSURGE2
15		4.3	Abnormal Transients	Disconnects for 5 secs	n/a	Appendix 3 tests	A4P3_APPENDIX3
16	5		Voltage Spike - Fig 3-A	Peak voltage 1000V	17.4	Requires add'l equipment	
17	6		Switching Transients		n/a	Appendix 1 DC Switching Transients	
18		6.1	Appendix 1: Figure A	Table 1.1 - T1 $\geq$ 10 msec			A6P0_APP1TransientsA
19		6.2.1	Appendix 1: Figure 1.B	Table 1.1 - N = 1			A6P0_APP1TransientsB_N1
20		6.2.2	Appendix 1: Figure 1.B	Table 1.1 - N = 2			A6P0_APP1TransientsB_N2
21		6.2.3		Table 1.1 - N = 3			A6P0_APP1TransientsB_N3
22		6.2.4	Appendix 1: Figure 1.B	Table 1.1 - N = 4			A6P0_APP1TransientsB_N4
23		6.2.5	Appendix 1: Figure 1.B	Table 1.1 - N = 5			A6P0_APP1TransientsB_N5
24		6.2.6	Appendix 1: Figure 1.B	Table 1.1 - N = 6			A6P0_APP1TransientsB_N6
25		6.2.7	Appendix 1: Figure 1.B	Table 1.1 - N = 7			A6P0_APP1TransientsB_N7
26		6.2.8	Appendix 1: Figure 1.B	Table 1.1 - N = 8			A6P0_APP1TransientsB_N8
27		6.2.9	Appendix 1: Figure 1.B	Table 1.1 - N = 9			A6P0_APP1TransientsB_N9
28		6.2.10	Appendix 1: Figure 1.B	Table 1.1 - N = 10			A6P0_APP1TransientsB_N10

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
29		6.2.11		Table 1.1 - N = 11			A6P0_APP1TransientsB_N11
30	7		Voltage Modulation	Fig 4-A	16.5.1.2	Replace DO160 Fig 16.1 with Fig 4-A	A7P0_VMOD
31	8		Frequency excursions abnormal	Fig 5, limits 1 and 4	n/a	Appendix 2 tests	A8P0_ABNFEXCURS
32	9		Frequency modulation	Fig 6	16.5.3.1		A9P0_FMOD
33	10		Distorted Voltage	Par 2.4.2.6.1	n/a	Test conditions 1 & 2	A10P0_VDIST

**Table B:**

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
1					16.5.1.1.b.1 test 1,2,3	Apply at 430Hz and 370Hz, Replace 100V & 122V with 23V & 28V	B1P0_NSSVF
2	2		Abnormal Steady State Voltage	21V to 30V RMS	16.5.3.1.b	Apply for 30 mins iso 5 mins	B2P0_ABN_SSV
3	3						
4		3.1	Normal Transients	36.5V for 30ms, 16.1V for 15ms	16.5.1.5.b	Use specified limit iso DO160	B3P0_NORMVSURGE1
5		3.2	Normal Transients	35.6V for 50ms, 18.2V for 30ms	16.5.1.5.b	Use specified limit iso DO160	B3P0_NORMVSURGE2
6		3.3	Normal Transients	33.8V for 19.5ms, 86V for 50ms	16.5.1.5.b	Use specified limit iso DO160	B3P0_NORMVSURGE3
7		3.4	Normal Transients	32V for 200ms	16.5.1.5.b	No undervoltage has to be applied	B3P0_NORMVSURGE4
8	4		Voltage Surge - Fig 1				
9		4.1	Abnormal Transients	41.1V for 100ms, 33.8V for 1 sec	16.5.3.3.1.b		B4P0_ABNVSURGE1
10		4.2	Abnormal Transients	0V for 5 secs	16.5.3.2.b		B4P0_ABNVSURGE2
11		4.3	Abnormal Transients	Disconnects for 5 secs	n/a	Appendix 3 tests	B4P3_APPENDIX3
12	5		Voltage Spike - Fig 3-B	Peak voltage 250V	17.4	Requires add'l equipment	
13	6		Switching Transients		17.4		
14		6.1	Appendix 1: Figure A	Table 1.1 - T1 = 10 msec			B6P0_APP1TransientsA
15		6.2.1	Appendix 1: Figure 1.B	Table 1.1 - N = 1			B6P0_APP1TransientsB_N1
16		6.2.2	Appendix 1: Figure 1.B	Table 1.1 - N = 2			B6P0_APP1TransientsB_N2
17		6.2.3	Appendix 1: Figure 1.B	Table 1.1 - N = 3			B6P0_APP1TransientsB_N3
18		6.2.4	Appendix 1: Figure 1.B	Table 1.1 - N = 4			B6P0_APP1TransientsB_N4
19		6.2.5	Appendix 1: Figure 1.B	Table 1.1 - N = 5			B6P0_APP1TransientsB_N5
20		6.2.6	Appendix 1: Figure 1.B	Table 1.1 - N = 6			B6P0_APP1TransientsB_N6
21		6.2.7		Table 1.1 - N = 7			B6P0_APP1TransientsB_N7
22		6.2.8	Appendix 1: Figure 1.B	Table 1.1 - N = 8			B6P0_APP1TransientsB_N8
23		6.2.9	Appendix 1: Figure 1.B	Table 1.1 - N = 9			B6P0_APP1TransientsB_N9
24		6.2.10	Appendix 1: Figure 1.B	Table 1.1 - N = 10			B6P0_APP1TransientsB_N10
25		6.2.11	Appendix 1: Figure 1.B	Table 1.1 - N = 11			B6P0_APP1TransientsB_N11
26	7		Voltage Modulation	Fig 4-B	16.5.1.2	Replace DO160 Fig 16.1 with Fig 4-B	B7P0_VMOD
27	8		Frequency excursions abnormal	Fig 5, limits 1 and 4	n/a	Refer to Appendix 2 for test description	B8P0_ABNFEXCURS
28	9		Frequency modulation	Fig 6	16.5.3.1		B9P0_FMOD

**Table C:**

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
1							
2		1.1	Voltage each phase	104V to 122V RMS	16.5.1.1.d.1 test 1 and 2	Apply at 800Hz and 360Hz	C1P1_NSSVF
3		1.2		105.5V to 120.5V RMS	16.5.1.1.d.2 test 1 to 4	Apply at 800Hz and 360Hz	C1P3_NSSVF
4	2		Abnormal Steady State Voltage				
5		2.1	Voltage each phase	96V to 130V RMS	16.5.3.1.b	Apply for 30 mins iso 5 mins	C2P1_ABN_SSV
6		2.2	Average voltage 3 phases	96V to 130V RMS	16.5.3.1.c	Apply for 30 mins iso 5 mins	C2P3_ABN_SSV
7	3		Voltage Surge - Fig 1				
8		3.1	Normal Transients	160V for 30ms, 71V for 15ms	16.5.1.5.1.b	Use specified limit iso DO160	C3P0_NORMVSURGE1
9		3.2	Normal Transients	156V for 50ms, 80V for 30ms	16.5.1.5.1.b	Use specified limit iso DO160	C3P0_NORMVSURGE2
10		3.3	Normal Transients	148V for 100ms, 86V for 50ms	16.5.1.5.1.b	Use specified limit iso DO160	C3P0_NORMVSURGE3
11		3.4	Normal Transients	140V for 200ms	16.5.1.5.1.b	No undervoltage test required	C3P0_NORMVSURGE4
12	4		Voltage Surge - Fig 1				
13		4.1	Abnormal Transients	180V for 100ms, 148V for 1 sec	16.5.3.3.1.b		A4P0_ABNVSURGE1
14		4.2	Abnormal Transients	0V for 5 secs	16.5.3.2.b	No undervoltage test required	A4P0_ABNVSURGE2
15		4.3	Abnormal Transients	Disconnects for 5 secs	n/a	Appendix 3 tests	A4P3_APPENDIX3
16	5		Voltage Spike - Fig 3-A	Peak voltage 1000V	17.4	Requires add'l equipment	
17	6		Switching Transients		n/a		
18		6.1	Appendix 1: Figure A	Table 1.1 - T1 = 10 msec		At 360Hz and 800Hz	C6P0_APP1TransientsA
19		6.2.1	Appendix 1: Figure 1.B	Table 1.1 - N = 1		Run transient at 360Hz.	C6P0_APP1TransientsB_N1_360
20		6.2.2	Appendix 1: Figure 1.B	Table 1.1 - N = 2		Run transient at 360Hz.	C6P0_APP1TransientsB_N2_360
21		6.2.3		Table 1.1 - N = 3		Run transient at 360Hz.	C6P0_APP1TransientsB_N3_360
22		6.2.4	Appendix 1: Figure 1.B	Table 1.1 - N = 4		Run transient at 360Hz.	C6P0_APP1TransientsB_N4_360
23		6.2.5	Appendix 1: Figure 1.B	Table 1.1 - N = 5		Run transient at 360Hz.	C6P0_APP1TransientsB_N5_360
24		6.2.6	Appendix 1: Figure 1.B	Table 1.1 - N = 6		Run transient at 360Hz.	C6P0_APP1TransientsB_N6_360
25		6.2.7	Appendix 1: Figure 1.B	Table 1.1 - N = 7		Run transient at 360Hz.	C6P0_APP1TransientsB_N7_360
26		6.2.8	Appendix 1: Figure 1.B	Table 1.1 - N = 8		Run transient at 360Hz.	C6P0_APP1TransientsB_N8_360
27		6.2.9	Appendix 1: Figure 1.B	Table 1.1 - N = 9		Run transient at 360Hz.	C6P0_APP1TransientsB_N9_360
28		6.2.10	Appendix 1: Figure 1.B	Table 1.1 - N = 10		Run transient at 360Hz.	C6P0_APP1TransientsB_N10_360

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
29		6.2.11		Table 1.1 - N = 11		Run transient at 360Hz.	C6P0_APP1TransientsB_N11_360
30		6.2.1	Appendix 1: Figure 1.B	Table 1.1 - N = 1		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N1_800
31		6.2.2	Appendix 1: Figure 1.B	Table 1.1 - N = 2		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N2_800
32		6.2.3	Appendix 1: Figure 1.B	Table 1.1 - N = 3		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N3_800
33		6.2.4	Appendix 1: Figure 1.B	Table 1.1 - N = 4		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N4_800
34		6.2.5	Appendix 1: Figure 1.B	Table 1.1 - N = 5		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N5_800
35		6.2.6	Appendix 1: Figure 1.B	Table 1.1 - N = 6		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N6_800
36		6.2.7	Appendix 1: Figure 1.B			Repeat transient at 800Hz.	C6P0_APP1TransientsB_N7_800
37		6.2.8	Appendix 1: Figure 1.B	Table 1.1 - N = 8		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N8_800
38		6.2.9	Appendix 1: Figure 1.B	Table 1.1 - N = 9		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N9_800
39		6.2.10	Appendix 1: Figure 1.B	Table 1.1 - N = 10		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N10_800
40		6.2.11	Appendix 1: Figure 1.B	Table 1.1 - N = 11		Repeat transient at 800Hz.	C6P0_APP1TransientsB_N11_800
41		6.3.1	Appendix 1: Table 2	Table 2 - N = I		Run transient at 360Hz and 800Hz.	C6P0_APP1TransientsT2_I
42		6.3.1	Appendix 1: Table 2	Table 2 - N = II		Run transient at 360Hz and 800Hz.	C6P0_APP1TransientsT2_II
43		6.3.1	Appendix 1: Table 2	Table 2 - N = III		Run transient at 360Hz and 800Hz.	C6P0_APP1TransientsT2_III
44		6.3.1	Appendix 1: Table 2	Table 2 - N = IV		Run transient at 360Hz and 800Hz.	C6P0_APP1TransientsT2_IV
45		6.3.1	Appendix 1: Table 2	Table 2 - N = V		Run transient at 360Hz and 800Hz.	C6P0_APP1TransientsT2_V
46		6.3.1	Appendix 1: Table 2	Table 2 - N = VI		Run transient at 360Hz and 800Hz.	C6P0_APP1TransientsT2_VI
47	7		Voltage Modulation	Fig 4-A	16.5.1.2	Replace DO160 Fig 16.1 with Fig 4-A	A7P0_VMOD
48	8		Frequency variations				
49		8.1	Normal Frequency variations	Fig 5, limits 1 and 4	16.5.1.6	Slew at 100Hz/sec	C8P0_NORMFREQVARS
50		8.2	Emergency Frequency variations	Fig 5, limits 1 and 4	16.5.1.6	Slew at 500Hz/sec	C8P0_EMERFREQVARS
51	9		Frequency modulation	Fig 6	16.5.3.1		C9P0_FMOD
52	10		Distorted Voltage				
53		10.1	Distorted Voltage 10% - Normal	Par 2.4.2.6.2	n/a	Test condition 2 Normal	C10P0_VDIST10
54		10.2	Distorted Voltage 15% - Emergency	Par 2.4.2.6.2	n/a	Test condition 2 Emergency	C10P0_VDIST15
55		10.3	Distorted Voltage 25% - Emergency	Par 2.4.2.6.2	n/a	Test condition 3 Emergency	C10P0_VDIST25

**Table D:**

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
1							
2		1.1	Maximum Voltage - Norm and Emer	30.3V DC	16.5.2.1.b (1)		D1P0_NORM_MAXV
3		1.2		25.5V DC	16.5.2.1.b (2)		D1P0_NORM_MINV
4		1.3	Minimum voltage - Emergency operation	17V DC	16.5.2.1.b (3)		D1P0_EMER_MINV
5	2		Abnormal Steady State Voltage				
6		2.1	Maximum	32.5V DC	16.5.4.1.b (1)	Apply for 30 mins iso 5 mins	D2P0_ABN_MAXV
7		2.2	Minimum	23.5V DC	16.5.4.1.b (2)	Apply for 30 mins iso 5 mins	D2P0_ABN_MINV
8	3		Voltage Surge - Fig 2				
9		3.1	Normal Transients	40V for 30ms, 17V for 15ms	16.5.2.4.b	Replace DO160 28V with 28.8V	D3P0_NORMVSURGE1
10		3.2	Normal Transients	39V for 50ms, 19.5V for 30ms	16.5.2.4.b	Replace DO160 28V with 28.8V	D3P0_NORMVSURGE2
11		3.3	Normal Transients	37V for 100ms, 21V for 50ms	16.5.2.4.b	Replace DO160 28V with 28.8V	D3P0_NORMVSURGE3
12		3.4	Normal Transients	35V for 200ms, 23.5V 100ms	16.5.2.4.b	Replace DO160 28V with 28.8V	D3P0_NORMVSURGE4
13	4		Voltage Surge - Fig 2				
14		4.1	Abnormal Transients	46V for 100ms, 38V for 1 sec	16.5.4.4.c	Apply also Appendix 3 test	D4P0_ABNVSURGE1
15		4.2	Abnormal Transients	0V for 5 secs	16.5.4.3.b	Apply also Appendix 3 test	D4P0_ABNVSURGE2
16		4.3	Abnormal Transients	Disconnects for 5 secs	n/a	Appendix 3 tests for multiple power input equipment.	D4P3_APPENDIX3
17	5		Voltage Spike - Fig 3-C	Peak voltage 600V	17.4	Requires additional equipment	
18	6		Switching Transients	Appendix 1	n/a	Appendix 1 DC Switching Transients	
19		6.1	Cf Figure A	Table 1.1 - T1 >= 10 msec	n/a		D6P0_APP1TransientsA
20		6.2.1	Cf Figure B	Table 1.1 - N=1	n/a		D6P0_APP1TransientsB_N1
21		6.2.2		Table 1.1 - N=2	n/a		D6P0_APP1TransientsB_N2
22		6.2.3	Cf Figure B	Table 1.1 - N=3	n/a		D6P0_APP1TransientsB_N3
23		6.2.4	Cf Figure B	Table 1.1 - N=4	n/a		D6P0_APP1TransientsB_N4
24		6.2.5	Cf Figure B	Table 1.1 - N=5	n/a		D6P0_APP1TransientsB_N5
25		6.2.6	Cf Figure B	Table 1.1 - N=6	n/a		D6P0_APP1TransientsB_N6
26		6.2.7	Cf Figure B	Table 1.1 - N=7	n/a		D6P0_APP1TransientsB_N7
27		6.2.8	Cf Figure B	Table 1.1 - N=8	n/a		D6P0_APP1TransientsB_N8

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
28		6.2.9	Cf Figure B	Table 1.1 - N=9	n./a		D6P0_APP1TransientsB_N9
29		6.2.10		Table 1.1 - N=10	n./a		D6P0_APP1TransientsB_N10
30		6.2.11	Cf Figure B	Table 1.1 - N=11	n./a		D6P0_APP1TransientsB_N11
31	7		Square wave DC load variations	Fig 7-A and 7-B	n/a	Apply Fig 7-A or 7-B depending on distribution bus bar	
32		7.1	Square wave DC load variations	Figure 7-A	n/a	A380 Version	D7P0_DCFIG7A_A380
33		7.1	Square wave DC load variations	Figure 7-A	n/a	Other Airbus	D7P0_DCFIG7A_AIRB
34		7.2	Square wave DC load variations	Figure 7-B	n/a	A380 Version	D7P0_DCFIG7B_A380
35		7.2	Square wave DC load variations	Figure 7-B	n/a	Other Airbus	D7P0_DCFIG7B_AIRB
36	8		Ripple Voltage		16.5.2.2	Requires additional equipment	



**Table E:**

#	Test	No.	Subject	Test Limits	DO160 Ref.	Comments	Test File
1							
2		1.1	Maximum Voltage - Norm and Emer	32V DC	16.5.2.1.b (1)		E1P0_NORM_MAXV
3		1.2		24V DC	16.5.2.1.b (2)		E1P0_NORM_MINV
4		1.3	Minimum voltage - Emergency operation	18.5V DC	16.5.2.1.b (3)		E1P0_EMER_MINV
5	2		Voltage Surge - Figure 13				
6		2.1	Normal Transients	36V for 100ms	16.5.2.4.b	Use specified limit iso DO160	E2P0_NORMVSURGE1
7		2.2	Normal Transients	35V for 200ms	16.5.2.4.b	Use specified limit iso DO160	E2P0_NORMVSURGE2
8		2.3	Normal Transients	34V for 300ms	16.5.2.4.b	Use specified limit iso DO160	E2P0_NORMVSURGE3
9		2.4	Normal Transients	18.5V for 5 secs	16.5.2.4.b	Use specified limit iso DO160	E2P0_NORMVSURGE4
10	3		Voltage Surge - Figure 13				
11		3.1	Abnormal Transients	36V for 1 sec	16.5.4.4.c	Apply also Appendix 3 test	E3P0_ABNVSURGE1
12		3.2	Abnormal Transients	33V for 3 sec	16.5.4.4.c	Apply also Appendix 3 test	E3P0_ABNVSURGE2
13		3.3	Abnormal Transients	0V for 5 secs	16.5.4.3.b	Apply also Appendix 3 test	E3P0_ABNVSURGE3
14		3.4	Abnormal Transients	Disconnects for 5 secs	n/a	Appendix 3 tests for multiple power input equipment.	E3P3_APPENDIX3
15	4		Voltage Spikes - Fig 3-C	Peak voltage 600V	17.4	Requires additional equipment	
16	5		Switching Transients	Appendix 1	n./a	Appendix 1 DC Switching Transients	
17		5.1	Cf Figure A	Table 1.2 - T1 >= 3 msec	n./a		E5P0_APP1TransientsA
18		5.2.1	Cf Figure B	Table 1.2 - N=1	n./a		E5P0_APP1TransientsB_N1
19		5.2.2	Cf Figure B	Table 1.2 - N=2	n./a		E5P0_APP1TransientsB_N2
20		5.2.3	Cf Figure B	Table 1.2 - N=3	n./a		E5P0_APP1TransientsB_N3
21		5.2.4		Table 1.2 - N=4	n./a		E5P0_APP1TransientsB_N4
22		5.2.5	Cf Figure B	Table 1.2 - N=5	n./a		E5P0_APP1TransientsB_N5
23	6		Ripple Voltage	Figure 8	16.5.2.2 and Figure 18.2	Requires additional equipment	
24	7		Starting inrush current	Figure 14	n/a	Refer to ABD0100.1.8 par 2.4.2.3.2.2	E7P0_DCINRUSH

### 9.9.13 ABD Option Related Error Messages

The CIGui32 program will monitor the power source on a regular bases for any run time errors. If an error is reported by the power source, any test step execution will be aborted. Possible errors and error sources are:

No	Description	Potential cause
2	Current Limit Fault	EUT may require more current than the programmed current limit setting. This is possible on constant power loads during reduced voltage (low line) type test steps. If the power source is set to Constant Voltage (CV) mode, the output will trip off when the current limit is exceeded and a Current Limit fault is generated. In Constant Current (CC) mode, the output voltage will be reduced to reduce the current to the set limit. In this case, no error message will be generated.
-113	Undefined Header	Generally caused by a communication problem between the PC and the power source. If the RS232 interface is used, it may be necessary to increase the command delay setting of the CIGui32 program. (See Interface Settings topic of CIGui32 on-line help.)  If these problems persist, try using the GPIB interface instead. (Requires National Instruments GPIB controller).
15	Slew exceeds dwell	The power source transient system was programmed to slew to a voltage and/or frequency value that would take longer to accomplish than the slew time set. This error can result in single step mode if the steps are executed out of order or one or more steps are skipped. The voltage/frequency values may no longer line up. Try running the test from the first step.
16	Illegal during transient	A transient step is still in progress. Try using the Abort button to abort any test in progress. If other CIGui32 screens other than the Main GUI screen are open, they may have initiated a transient, which conflicts with the ABD option. Try closing all other CIGui32 windows.

Great efforts have been made to check all test sequence files provided as part of the –ABD option. However, due to the breath and complexity of the ABD database, an occasional error may occur while using these files. If an error cannot be resolved, turn on the CIGui32 bus monitor window and rerun the test that yields the error and save the bus trace to a text file using the File, Save All menu in the bus monitor window. This file can be emailed to [support@calinst.com](mailto:support@calinst.com) along with a description of the error.

Furthermore, test files were developed making reasonable assumptions concerning the intent of the Airbus ABD0100 directive. The user is free to modify, edit, revise or otherwise update any of these tests to match his/her own requirements. In this case, we recommend you copy the supplied ABD\_Dbase subdirectory and use this copy to make modifications to. This will preserve the original data provided.

## 9.10 WHM Option

### 9.10.1 General

This section describes the WHM option for the i / iX Series Power Source.

### 9.10.2 Specification

All specifications are the same as the standard i / iX Power Source specifications in addition to the following specifications:

Watt-hour

0-6.000KW	0.01KWH + 0.1% <100Hz
	0.02KWH +0.1% 100-500Hz
>6.000KW	Times three of the above specification

### 9.10.3 Local Operation

- From the Menu screen 2, select the APPLICATIONS SETUP 2 screen. The screen will appear as shown in Figure 9-70. Use the up and down key to position the cursor to the WH METER field. Press the Enter Key.

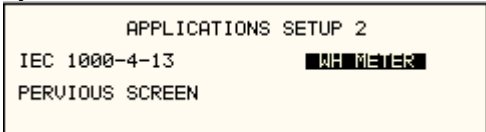


Figure 9-70: Application Screen

- The WATT-HOURS METER screen shown in Figure 9-71 has the following fields:

WATT-HOUR METER		uA
START	WATT HR =	0.000KWH
ETIME =0:00:00	POWER =	0.000KW
PERVIOUS SCREEN	PK CURR =	0.000A

Figure 9-71 Watt-Hour Meter Screen

START: This field will activate the watt-hour measurements. Moving the shuttle clockwise when the field is highlighted will activate the watt hour function and the field will change to STOP as shown in Figure 9-72.

- ETIME: This field will accumulate the time in hours, minutes and seconds.
- WATT HR: This field will accumulate the watt-hour in KWH.
- POWER: This field will report the instantaneous power in KW.
- PK CURR: This field will report the peak current and will hold the maximum reading.

WATT-HOUR METER		ⓐABC
STOP	WATT HR =	2.933KWH
ETIME =1:20:34	POWER =	2.200KW
PREVIOUS SCREEN	PK CURR =	10.000A

*Figure 9-72: WH-Meter Screen With Function Active*

**Note:** Changing from stop to start will stop the measurement and will maintain the last data record for the watt-hour meter. To restart the measurements, the field is toggled to the stop position from the start position and the previous data will be reset to zeros.

WATT HR, POWER and PK CURR will display the data for the phase selected with the phase key. If the phase is selected for all phases in a two or three phase system, the WATT HR and POWER fields will show the sum of all phases. PK CURR will remain at the last selected phase.

**Note:** Changing Mode of operation from single phase to three phases while the Watt-hour meter is in the active state will generate an error: "Input buffer full". This error will halt the measurements. To clear the error, the Watt-hour meter must be switched to the stopped state. It is advised that the Watt-hour meter should be set to the stop state before changing the mode of operation.

#### 9.10.4 Remote PROGRAMMING

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The following SCPI command will be used to control the WHM functions:

WHMeter:

[STATe]	Turn on or of the watt hour function
ETIMe?	Return the elapse time
WHOur?	Return the watt-hour in KWH

##### **WHMeter[:STATe]**

This command will start or stop the watt-hour function.

Command Syntax	WHMeter[:STATe]<bool>
Parameters	0   OFF   1   ON
Examples	WHM ON
Query Syntax	WHM[:STATe]?
Returned Parameters	0   1

##### **WHMeter:ETIMe?**

This command will return the total amount of time the watt-hour meter accumulated. The returned data has four fields separated by commas. These fields are hours, minutes, seconds and milliseconds.

Command Syntax	WHMeter:ETIMe?
Parameters	none
Query Syntax	WHM:ETIM?
Returned Parameters	h,mm,ss,ms

##### **WHMeter:WHOur?**

###### ***Phase Selectable***

This command will return the total accumulated kilowatt-hour for the selected phase. If coupling is set to all, the value returned is the sum of all phases in the system regardless of the selected phase.

Command Syntax	WHMeter:WHOur?
Parameters	none
Query Syntax	WHM:WHO?
Returned Parameters	<numeric value>

**Note:** If the watt-hour meter is active, the total power of all phases in the system will be returned when querying the power.

## 10. Error Messages

Any errors that occur during operation from either the front panel or the remote control interface will result in error messages. Error messages are displayed in the upper left hand corner of the LCD display. They are also stored in the error message queue from which they can be queried using the SYST:ERR? Query. The error queue has a finite depth. If more error messages are generated than can be held in the queue, a queue overflow message will be put in the last queue location. To empty the queue, use the error query until the No Error result is received.

Errors appearing on the LCD will generally remain visible until the user moves to another screen. If multiple error messages are generated in succession, only the last message will be visible as there is only space for one error message on the LCD display.

The same area of the display is also used to display status messages. While error messages always have a negative error number, status messages have a positive number.

The table below displays a list of possible error and status messages along with their possible cause and remedy.

Number	Message String	Cause	Remedy
0	"No error"	No errors in queue	
-100	"Command error"	Unable to complete requested operation	Unit may be in a mode inconsistent with request.
-102	"Syntax error"	Command syntax incorrect.	Misspelled or unsupported command
-103	"Invalid separator"	SCPI separator not recognized	See SCPI section of programming manual.
-104	"Data type error"	Data type invaled.	Check command for supported data types
-108	"Parameter not allowed"	One or more additional parameters were received.	Check programming manual for correct number of parameters
-109	"Missing parameter"	Too few parameters received for requested operation	Check programming manual for correct number of parameters
-110	"Command header error"	Command header incorrect	Check syntax of command.
-111	"header separator error"	Invalid command separator used.	Use semi-colon to separate command headers
-112	"Program mnemonic too long"	Syntax error	Check programming manual for correct command syntax
-113	"Undefined header"	Command not recognized error	Check programming manual for correct command syntax
-120	"Numeric data error"	Data received is not a number	Check programming manual for correct command syntax
-121	"Invalid character in number"	Number received contains non-numeric character(s)	Check programming manual for correct command syntax
-123	"Exponent too large"	Exponent in number exceeds limits	Check programming manual for correct parameter range
-128	"Numeric data not allowed"	Number received when number is not allowed.	Check programming manual for correct command syntax
-168	"Block data not"	Block data was sent.	Check programming manual for

Number	Message String	Cause	Remedy
	allowed"		correct command syntax
-200	"Execution error"	Command could not be executed	Command may be inconsistent with mode of operation such as programming frequency when in DC mode.
-201	"Invalid while in local"	Command issued but unit is not in remote state	Put instrument in remote state before issuing GPIB commands.
-203	"Command protected"	Command is locked out	Some commands are supported by the unit but are locked out for protection of settings and are not user accessible.
-210	"Trigger error"	Problem with trigger system.	Unit could not generate trigger for transient execution or measurement.
-211	"Trigger ignored"	Trigger request has been ignored.	Trigger setup incorrect or unit was not armed when trigger was received. Check transient system or measurement trigger system settings.
-213	"Init ignored"	Initialization request has been ignored	Unit was told to go to armed state but was unable to do so. Could be caused by incorrect transient system or measurement acquisition setup.
-220	"Parameter error"	Parameter not allowed.	Incorrect parameter or parameter value. Check programming manual for allowable parameters
-221	"Setting conflict"	Requested setting conflicts with other setting in effect.	Check other settings. E.g. trying to program a DC offset while in AC mode
-222	"Data out of range"	Parameter data outside of allowable range.	Check programming manual for allowable parameter values
-223	"Too much data"	More data received than expected	Check programming manual for number of parameters or data block size
-224	"Illegal parameter value"	Parameter value is not supported	Check programming manual for correct parameters
-226	"Lists not same length"	One or more transient lists programmed has different length.	All lists must be of same length or transient cannot be compiled and executed.
-241	"Hardware missing"	N/A	N/A
-254	"Media full"	No storage space left to save settings or data.	Delete other settings or data to make room.
-255	"Directory full"	Too many waveform directory entries	Delete one or more waveforms from waveform memory to make room.
-256	"File name not found"	Waveform requested not in directory	Check waveform directory for waveform names present.
-257	"File name error"	Incorrect filename	Too many or non ASCII characters used in waveform file definition.
-283	"Illegal variable name"	Variable name illegal.	Use ASCII characters only
-300	"Device specific error"	Hardware related	Check hardware for proper operation.

Number	Message String	Cause	Remedy
		error	
-311	"Memory error"	Waveform memory checksum error.	May be the result of incomplete user-defined waveform download. Check interface and try downloading waveform again. Successful download may clear this error condition.  Alternatively, use TRAC:DEL ALL command to clear waveform memory.
-314	"Save/recall memory lost"	User setup register contents lost	Store setup in same register again.
-315	"Configuration memory lost"	Hardware configuration settings lost.	Contact CI service department at <a href="mailto:support@calinst.com">support@calinst.com</a> to obtain instructions on restoring configuration data.
-330	"Self-test failed"	Internal error	Contact CI service department at <a href="mailto:support@calinst.com">support@calinst.com</a>
-350	"Queue overflow"	Message queue full.	Too many message. Read status using SYST:ERR query until 0, "No Error" is received indicating queue empty.
-400	"Query error"	Unable to complete query.	Check programming manual for correct query format and parameters
-410	"Query INTERRUPTED"	Query issued but response not read.	Check application program for correct flow. Response must be read after each query to avoid this error.
-420	"Query UNTERMINATED"	Query incomplete.	Check for terminator after query command.
-430	"Query DEADLOCKED"	Query cannot be completed	Check application program for multiple queries
-440	"Query UNTERMINATED"	Query incomplete.	Check for terminator after query command.
1	"Output volt fault"	Output voltage does not match programmed value.	Load exceeds current limit and unit is in Constant Voltage (CV) mode of operation. Reduce load or increase CL setting Output voltage is driven above programmed voltage by external influence (Load, voltage kickback, etc.)
2	"Current limit fault"	Current limit exceeded.	Load exceeds current limit and unit is in Constant Voltage (CV) mode of operation. Reduce load or increase CL setting
3	"Temperature fault"	Temperature of heat sink too high.	Reduce load. Ensure proper air flow and exhaust clearance. Check fan(s) for operation.
4	"External sync. error"	Could not sync to external sync signal.	External sync signal missing, disconnected or out of range.
5	"Initial memory lost"	Power on settings could not be recalled.	Save power on settings again to overwrite old content.



Number	Message String	Cause	Remedy
6	"Limit memory lost"	Hardware configuration settings lost.	Contact CI service department at <a href="mailto:support@calinst.com">support@calinst.com</a> to obtain instructions on restoring configuration data.
7	"System memory lost"	Memory corrupted.	Recycle power.
8	"Calibration memory lost"	Calibration data lost.	Contact CI service department at <a href="mailto:support@calinst.com">support@calinst.com</a> to obtain instructions on restoring calibration data or recalibrate unit.
9	"Start angle must be first sequence"	Start phase angle in wrong place..	Start phase angles can only be programmed at the start of a transient list. Once a transient is in progress, phase angle cannot be changed.
10	"Illegal for DC"	Operation not possible in DC mode.	Switch to AC or AC+DC mode.
11	"Duplicate sequence"	N/A	N/A
12	"Too many sequence"	N/A	N/A
13	"Missing list parameter"	One or more transient list parameters missing.	Check programmed lists.
14	"Voltage peak error "	Peak voltage exceeds internal bus voltage	This error may occur when selecting user defined wave shapes with higher crest factors. Reduce programmed RMS value.
15	"Slew time exceed dwell"	Time needed to slew to final value is less than dwell time.	Check dwell times in transient list settings. Increase dwell time or change slew rate for affected parameter.
16	"Illegal during transient"	Operation requested not available while transient is running.	Wait till transient execution is completed or abort transient execution first.
17	"Output relay must be closed"	Operation not possible with open relay	Close relay before attempting operation. E.g. transient execution requires output relay to be closed.
18	"Trans. duration less than 1msec"	Dwell time below minimum or 1 msec	Increase dwell time to at least 1 msec.
19	"Clock and sync must be internal"	Operation not possible with external clock	Switch to internal sync. (Default)
20	"Input buffer full"	Too much data received.	Break up data in smaller blocks.
21	"EOS Fault"	Hardware error reported by EOS option	Cycle power on EOS to reset error. If error persists, contact Contact CI service department at <a href="mailto:support@calinst.com">support@calinst.com</a> for repair.
22	"Waveform harmonics limit"	Harmonic contents of user defined wave shape is too high and could damage amplifier output stage.	Reduce harmonic content or reduce fundamental frequency programmed.

Number	Message String	Cause	Remedy
23	"ALC or Impedance must be off"	Conflict between ALC and programmable impedance mode.	Turn off ALC to use programmable impedance. Turn off programmable impedance to use ALC.

*Table 10-1: Error Messages.*

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