California Instruments

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P/N 7000-963

i Series AC Power Source
User Manual

User's Manual
AC Power Source
California Instruments
Models :

- 3001i
- 5001i
- 5001i-400
- 10001i
- 10001i-400
- 15001i
- 15001i-400
- 15003i
- 15003i-400

SAFETY SUMMARY

This power source contains high voltage and current circuits which are potentially lethal. Because of its size and weight, mechanical stability must be ensured. The following safety guidelines must be followed when operating or servicing this equipment. These guidelines are not a substitute for vigilance and common sense. California Instruments assumes no liability for the customer's failure to comply with these requirements. If the power source is used in a manner not specified by California Instruments the protection provided by the equipment may be impaired.

BEFORE APPLYING POWER

1. Verify the correct voltage is applied to the unit (for example 240V).

2. The chassis and cabinet of this power source must be grounded to minimize shock hazard. A chassis ground is provided at the input terminal block. This is located at the back of the cabinet on the lower right hand side. The chassis ground must be connected to an electrical ground through an insulated wire of sufficient gauge.

FUSES

Use only fuses of the specified current, voltage, and protection speed (slow blow, normal blow, and fast blow) rating. Do not short out the fuse holder or use a repaired fuse.

DO NOT OPERATE IN A VOLATILE ATMOSPHERE

Do not operate the power source in the presence of flammable gases or fumes.

DO NOT TOUCH ENERGIZED CIRCUITS

Disconnect the power cable before servicing this equipment. Even with the power cable disconnected, high voltage can still exist on some circuits. Discharge these voltages before servicing. Only qualified service personnel may remove covers, replace components or make adjustments.

DO NOT SERVICE ALONE

Do not remove covers, replace components, or make adjustments unless another person, who can administer first aid, is present.

DO NOT EXCEED INPUT RATINGS

Do not exceed the rated input voltage or frequency. Additional hazards may be introduced because of component failure or improper operation.

DO NOT MODIFY INSTRUMENT OR SUBSTITUTE PARTS

Do not modify this instrument or substitute parts. Additional hazards may be introduced because of component failure or improper operation.

MOVING THE POWER SOURCE

When moving the power source, observe the following:

1. Remove all AC power to unit.

2. Use two people to prevent injury.

SAFETY SYMBOLS:

THIS SYMBOL INDICATES DIRECT CURRENT

THIS SYMBOL INDICATES ALTERNATING CURRENT

THIS SYMBOL INDICATES BOTH DIRECT AND ALTERNATING CURRENT

THIS SYMBOL INDICATES THREE–PHASE ALTERNATING CURRENT

THIS SYMBOL INDICATES EARTH (GROUND) TERMINAL

THIS SYMBOL INDICATES PROTECTIVE CONDUCTOR TERMINAL

THIS SYMBOL INDICATES FRAME OR CHASSIS TERMINAL

THIS SYMBOL INDICATES ON (SUPPLY)

THIS SYMBOL INDICATES OFF (SUPPLY)

THIS SYMBOL INDICATES CAUTION, RISK OF ELECTRIC SHOCK

THIS SYMBOL INDICATES CAUTION (REFER TO ACCOMPANYING DOCUMENTS)

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are fuses and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA number to shipping label. Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS 9689 Towne Centre Drive San Diego, CA 92121. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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1. Introduction

This instruction manual contains information on the installation, operation, calibration and maintenance of all power systems that use the 3001i and 5001i power sources with the programmable controller.

1.1 General Description

The 3001i and 5001i are high efficiency, light weight AC power sources that provide a precise output with low distortion. The output has two ranges, either 0-135V or 0-270V and full power is available at the maximum output voltage. Two or three 5001i units can be connected in parallel as a single-phase system for 10 kVA or 15 kVA respectively. When two or three units are operated in parallel they can only be used in the AC Mode. Three units can be connected as a three-phase system where each unit is a master with its own controller, synchronized using clock and lock, and they can be operated with AC or DC output.

2. Specifications

All specifications are for a single i-Series chassis and 25± 1°C unless noted otherwise.

2.1 Electrical

2.1.1 Input

Line Voltage:	
3001i	208-240 ±10% VAC, single phase
5001i	208-240 V_{LL} ±10% , 400-440 V_{LL} ±10%
	or 400-480 V_{LL} ±10%
	3 phase, 3 wire + ground
Line VA: :	
3001i	5000VA
5001i	8000VA
Line Current:	
3001i	25 A RMS max.
5001i	23 A RMS max. at 208-240 VAC
	12 A RMS max. at 400-440 VAC and 400-480 VAC
Line Frequency:	50-60 Hz ±10%
Efficiency:	80% (typical) depending on line and load
Power Factor:	
3001i	0.7 (typical)
5001i	0.9 (typical)
Inrush Current:	100 A_{pk} for 100 μs at 208-240V
	50 A_{pk} for 100 μs 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 & DC UNLESS NOTED OTHERWISE)

Voltage Range:	0 to 135 or 270
Voltage Resolution:	0.1 volt
Voltage Accuracy:	±0.5% or range, 16 to 400 Hz.
Voltage Distortion:	1% max THD at 50/60 Hz, 2% max THD at 400 Hz (linear load)
Load Regulation:	± 0.5% DC to 100 Hz.
Load Regulation	± 2.2% to 500 Hz (135 range)
Load Regulation	± 0.6% to 500 Hz (270 range)
Line Regulation:	0.1% for 10% input line change
Power:	
3001i	3000 VA maximum at full scale voltage, either range, AC only (1500W DC)
5001i	5000 VA maximum at full scale voltage, either range, AC only (2500W DC)
10001i	10000 VA maximum at full scale voltage, either range, AC only
15001i	15000 VA maximum at full scale voltage, either range, AC only
15003i	15000 VA maximum total at full scale voltage, either range, AC only
	5000 VA maximum per phase
Current, max.:	
3001i	22.2 arms for 135 VAC range
	11.1 arms for 270 VAC range
5001i	37 arms for 135 VAC range
	18.5 arms for 270 VAC range
	(Derated linearly from 50% of voltage to 10% of specified current at 5% of voltage range)

Current Limit:	AC 135V range:	AC 270V range:	DC 135V range:	DC 270V range:
3001i	0 to 22.2	0 to 11.1	0 to 11.1	0 to 5.56
5001i & 15003i	0 to 37	0 to 18.5	0 to 18.5	0 to 9.25
10001i	0 to 74	0 to 37	n/a	n/a
15001i	0 to 111	0 to 55.5	n/a	n/a

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 program value
DC Offset Voltage:	Less than 20 mV with linear load.

Output Noise:	400 mV RMS on 135 range, 800 mV RMS on 270 range
Peak Rep AC Current:	110 A for 135 V range, 92 A for 270 V range
Crest Factor:	Up to 5:1

2.1.3 Measurements

(ALL SPECIFICATIONS ARE FOR AC & DC UNLESS NOTED OTHERWISE)

Voltage (TRMS)	0.1 volt resolution, ± 0.5 volts accuracy.
Current (TRMS)	
5001i, 15003i	± 0.5 amp Accuracy, 0.1 amp Resolution
10001i, 15001I	± 5 amp Accuracy, 1 amp Resolution
Peak Current:	
5001i, 15003i	± 0.5 amp Accuracy, 0.1 amp Resolution
10001i, 15001i	± 5 amp Accuracy, 1 amp Resolution
True Power:	
5001i, 15003i	± 0.05 kW AC, ± 0.15 kW DC Accuracy, 0.01 kW Resolution
10001i, 15001i	± 0.5 kW AC Accuracy, 0.1 kW Resolution:
Apparent Power(VA):	
5001i, 15003i	0.20 kVA Accuracy, 0.01 kVA Resolution
10001i, 15001i	2.0 kVA Accuracy, 0.1 kVA Resolution
Frequency:	
16.00 - 99.99 Hz	± 0.02 Hz Accuracy, 0.01 Hz Resolution
100.0 - 500.0 Hz	± 0.2 Hz Accuracy, 0.1 Hz Resolution

2.1.4 System Specification

External Modulation:	10 volt input for 30% change in output.
Synchronization Input:	Isolated TTL input for external frequency control. Requires 5V at 5 ma for logic high.
Trigger Output:	400 μs high pulse for voltage or frequency change. Isolated output that requires a pull-up resistor, 22K, to ± 5 VDC.
Non volatile memory storage:	8 complete instrument setups and transient lists, 32 events per list.
Transient types:	Voltage drop, voltage step, voltage sweep

	Voltage sag/surge, Frequency sweep, Frequency step
	Voltage and frequency sweep
IEEE-488 Interface:	SH1, AH1, T6, L3, SR1, RL2, DC1, DT1
	IEEE 488.2 & 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: 1200, 2400, 4800, 9600
	IEEE 488.2 and SCPI
Current Limit Modes:	Two selectable modes of operation.
	Constant current and constant voltage with hold-off time and trip.

2.1.5 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 at 10% +/- TBD% above programmed value.
Output Overvoltage:	220 V +/- 10 volt peak for 135 volt range
	420 V +/- 20 volt peak for 270 volt range.
Output Short Circuit:	Peak current limit. Foldback with automatic recovery.
Overtemperature:	Automatic shutdown and recovery.

2.2 Mechanical

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

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/Overvoltage:	
Category:	II
Pollution Degree:	2
Indoor Use Only	
Vibration:	Designed to meet NTSA 1A transportation levels.
Shock:	Designed to meet NTSA 1A transportation levels.

2.4 Regulatory

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 to meet UL3111 and EN61010-1 European safety standards as required for the “CE” mark.

2.5 Front Panel Controls

Controls:	
Shuttle knob:	Allows continuos 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 allow 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.

Displays:

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 Overtemperature lamp illuminates when internal heatsink 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 and Options

Parallel Operation: Can parallel up to three units in a single phase configuration (with one master controller and one or two slave units in AC mode only).

Three Phase Output: Can connect three units (all with controllers) in a three phase configuration using CLOCK and LOCK connections.

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.

3. Unpacking and Installation

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.

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

3.2 Power Requirements

The 3001i AC Power Source has been designed to operate from a single phase 208 to 240 volt AC line. The 5001i AC Power Source and its systems have been designed to operate from a three phase AC line voltage. Two three phase input models are available. One model operates from 208V to 240V input line and the other model operates from 400V to 480V line.

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

Figure 3-1: The 5001i Power Source

3.3 Mechanical Installation

The 3001i and 5001i are a 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. See Figure 3-1.

3.4 Input Wiring

The input terminal block, TB1, is located at the rear of the unit. Ground or 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.

3.5 Output Connections

3.5.1 Output Wiring

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 Figure 3-2 for all connections.

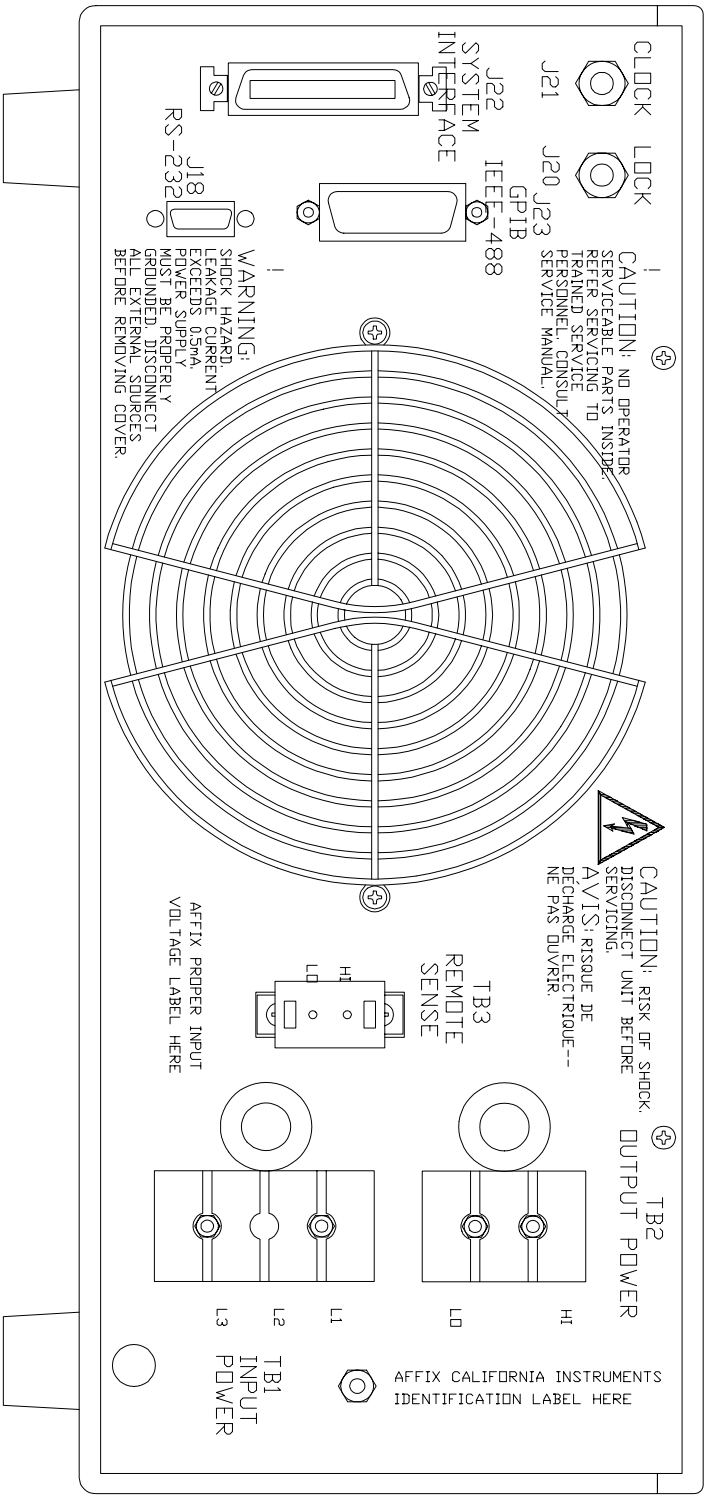
The output of the power source may be grounded or left floating.

3.5.2 System Interface, Clock and Lock Connectors

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.

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.

Figure 3-2: Rear Panel View



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 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 X DISTANCE X CABLE RESISTANCE PER FT. X CURRENT = VOLT DROP

Table 1: Wire Sizes

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

3.5.3 Single-Phase and Three-Phase Multiple Box System Configurations

Three Phase System:

The three phase system will be configured ready for use when ordered as such from the factory. One unit will be identified as the master and the other two units will be identified as slaves. The master will control the frequency of the two slaves but the frequency range switch must be in the same position on all units. The voltage of each phase is independently controlled from the control on the front of each box.

The three units must be interconnected using the ***clock and lock cables*** and the three **LO** outputs must also be connected together before applying power. ***Do not connect the system interface cable.***

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 power-on light.

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 block's 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 1 for cable sizing.

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

3.6 Output Voltage Ranges

The power source has two standard ranges 0-135V and 0-270V. The operator may switch from one range to the other at will with no special precautions except to remember that the output voltage will go to zero voltage when changing from the low range to the high range.

3.7 Functional Test

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

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

1. Connect an oscilloscope, voltmeter and/or distortion analyzer to the AC source output at the output terminal block (L2).

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 (L1). 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 with 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 = 135 volts, frequency = 60 Hz, voltage range = 135 volts, and current limit = 22.2 amps (3001i) or 37 amps (5001i). 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 135 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 135 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 18 amps. The system should go into current limit. Return the current value to 22.2 amps (3001i) or 37 amps (5001i) 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 = 270 volts, output range = 270 volts, current limit = 11.1 amps (3001i) or 18.5 amps (5001i). For step 7, the current limit value can be set to 9 amps.

In the unlikely event the power source does not pass the functional test, refer to the calibration procedure on page 6-1 or call California Instrument’s customer satisfaction department for further assistance.

Table 2: System Interface Connector (J22)

J22	Description
1	Analog Common
2	Not used
3	Analog Common
4	Not used
5	CT Common, Current Transformer Common
6	Not used
7	Analog Common
8	Not used
9	Not used
10	$\overline{\text{OVR TEMP}}$ Overtemperature indication
11	$\overline{\text{CNF}}$, Output relay
12	Not used
13	FLT A, Phase A current limit fault
14	F STB LO, Function Sync output LO
15	EX SYNC LO, External Sync input LO
16	No connection
17	No connection
18	No connection
19	Not used
20	MR A, Phase A amplifier input signal
21	Not used
22	CS A, Phase A current sum
23	Not used
24	OS A, Oscillator Phase A output
25	Not used
26	CL A, Phase A DC current limit
27	D COM, Digital Common
28	$\overline{\text{RNG HI}}$, High Voltage range
29	
30	Not used
31	TRIGGER OUTPUT
32	EX SYNC HI, External Sync input HI
36	REMOTE SHUTDOWN

J22-1 ANALOG COMMON: This is the common for all analog signals on the connector.

J22-3 ANALOG COMMON: See J22-1.

J22-5 CT COMMON:

J22-7 ANALOG COMMON: See J22-1.

J22-10 $\overline{\text{OVR TEMP}}$: A logic low output to indicate an overtemperature condition. Make no connection to the pin.

J22-11 $\overline{\text{CNF}}$: Output relay control indication. This is an output logic line that indicates the state of the output relay. A logic low indicates the output relay is open. Make no connection to the pin.

J22-13 FLT A: Make no connections.

J22-14 F STB LO: Function Sync 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.

J22-15 EX SYNC LO: External Sync Low signal. This is the ground return for the TTL external sync input. It connects to the cathode of an LED at the input of an optocoupler. Refer to J22-32.

J22-16 No connection.

J22-17 No connection.

J22-18 No connection.

J22-20 MR A: This is the input signal to the phase A amplifier from the internal oscillator drive signal. Do not make any connection to this pin except for troubleshooting.

J22-22 CS A: Current sum for the phase A output. Make no connection to this pin.

J22-24 OS A: This is the output from the internal phase A oscillator. Use this pin as an input if an oscillator is not installed. 5.0 VRMS on this pin will generate a full-scale output voltage.

J22-26 CL A: A DC level from the oscillator used to set the current limit for phase A. Make no connection to the pin.

J22-27 D COM: Digital common.

J22-28 $\overline{\text{RNG HI}}$: A logic output from the internal oscillator to control the ramp relays. A logic low on this pin indicates the high voltage range. If the power system is used without an oscillator, this pin is a logic input.

J22-29 Make no connection.

J22-31 TRIGGER OUTPUT: 400μs high pulse for voltage or frequency change. Isolated output that requires a pull-up resistor, 22KΩ, to ± 5 VDC.

J22-32 EX SYNC HI: External High signal. 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 ±30%. J22-15 is the common input. The External Sync input is optically isolated. It must also be enabled from the SNC screen.

J22-36 REMOTE SHUTDOWN: 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.

Figure 3-3: Functional Test Setup

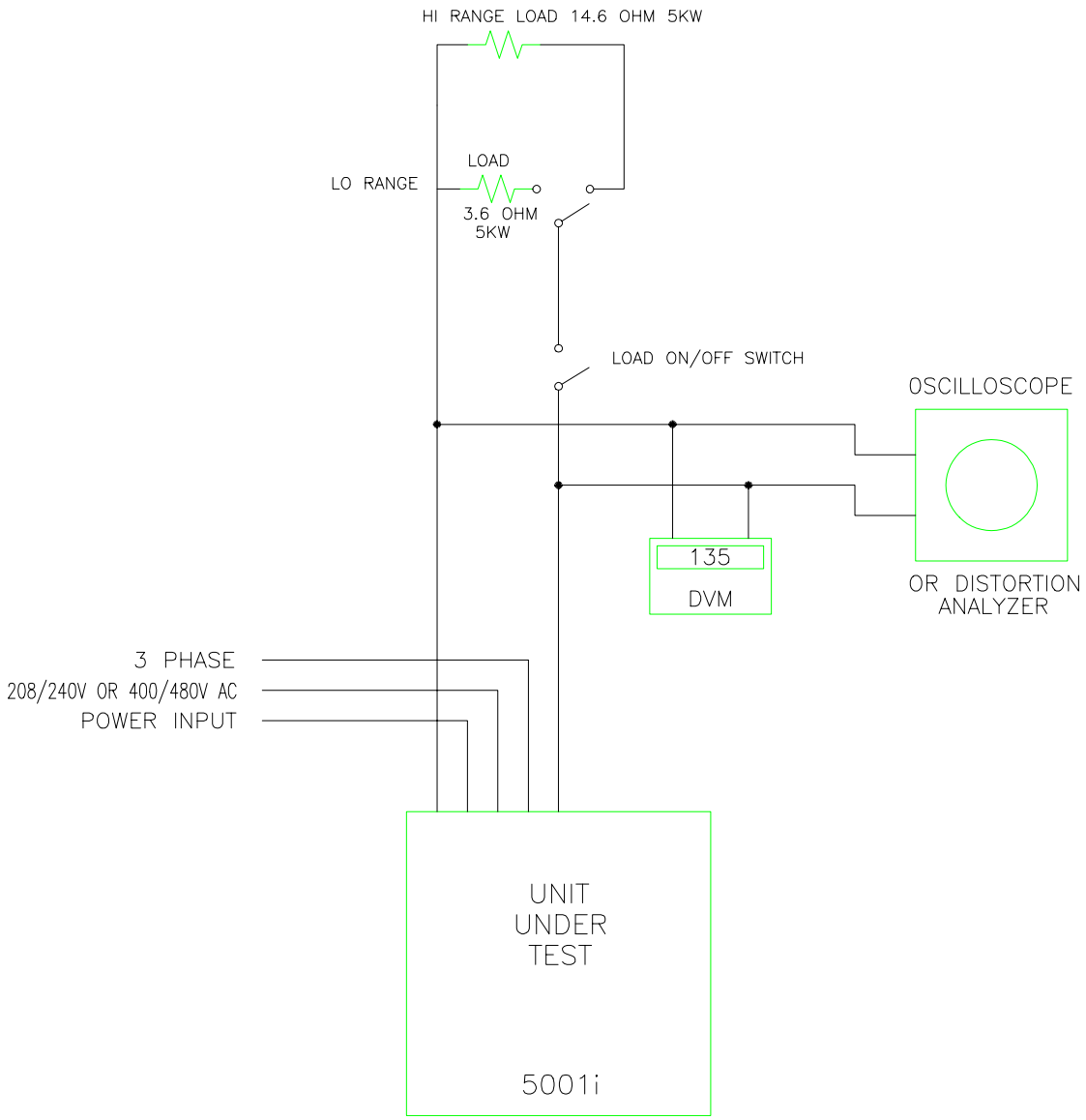


Figure 3-4: Three Phase 15000 VA System

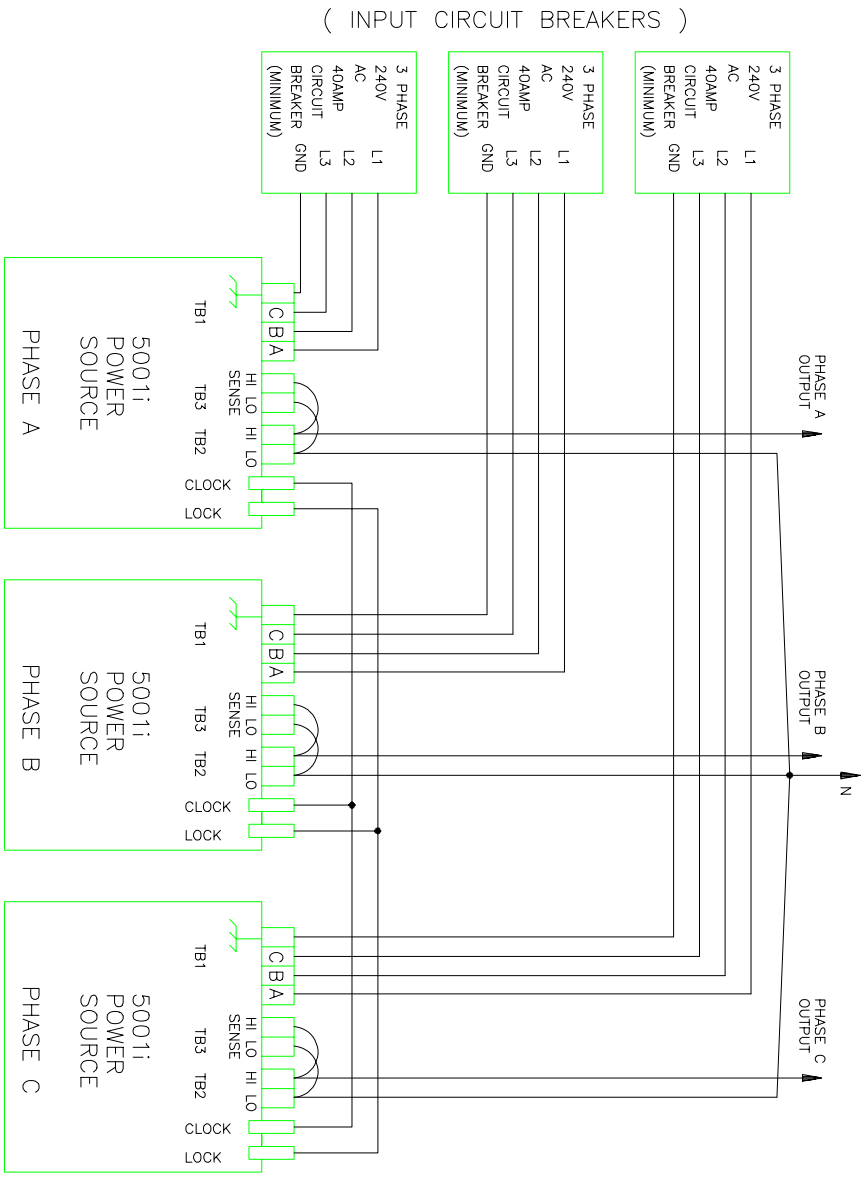
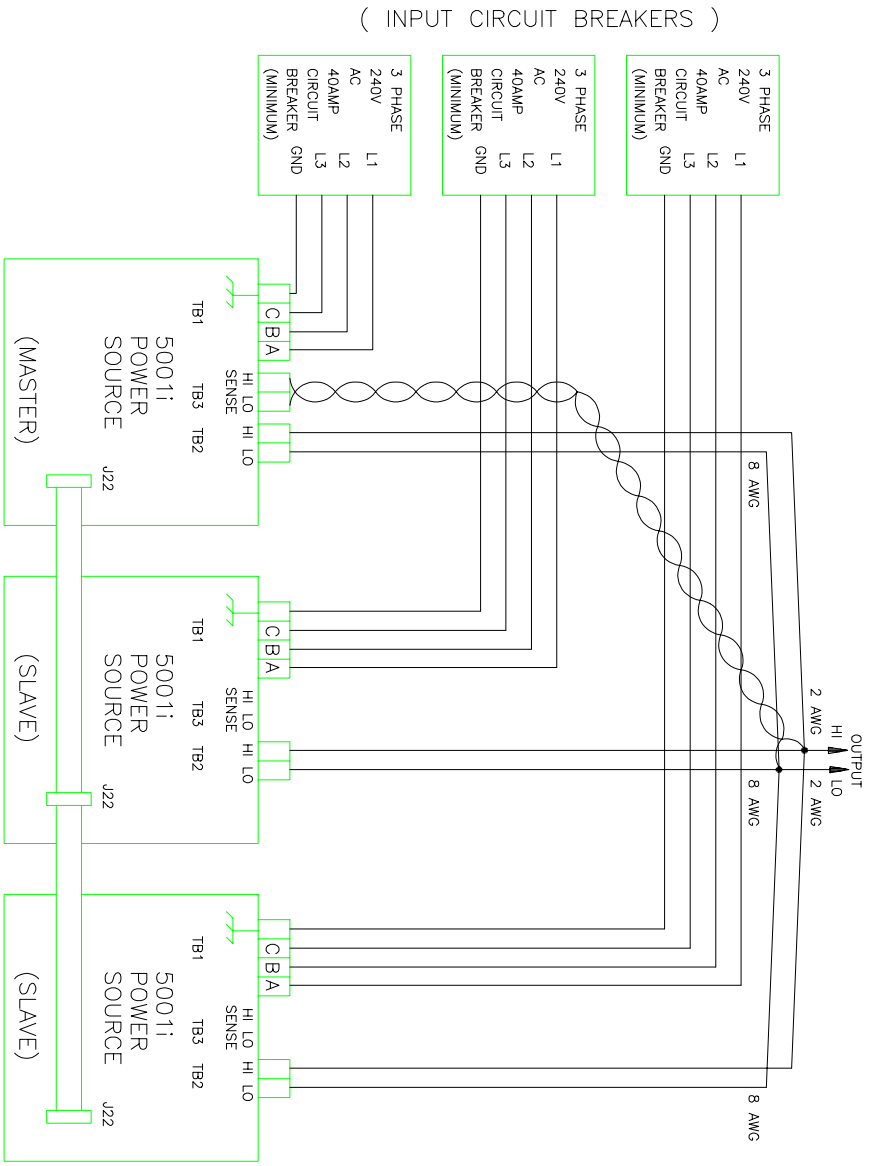


Figure 3-5: Single Phase 15000 VA System



4. Front Panel Operation

4.1 Front Panel Guided Tour

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

- Main circuit breaker
- Status Indicator lights
- Shuttle knob.
- LCD display

- FUNCTION keypad
- DATA ENTRY keypad

4.1.1 Mains Circuit Breaker

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

4.1.2 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 asserted 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.
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 i-Series unit. This is an abnormal condition which will cause the unit to shut off. Check the air flow exhaust at the rear of the unit to make sure it is not obstructed.

4.1.3 The Shuttle Knob

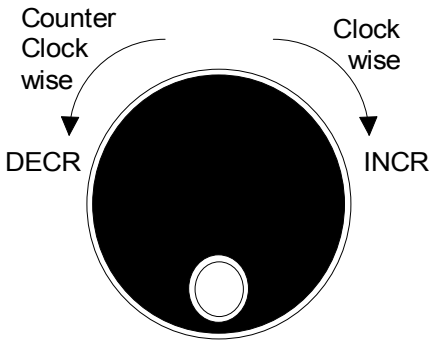


Figure 4-1: Shuttle Knob

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 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.

4.1.4 FUNCTION Keypad

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

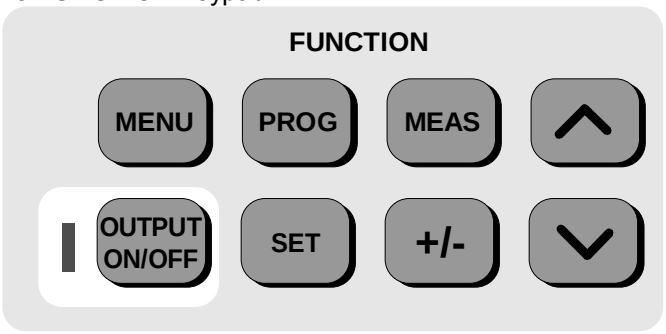


Figure 4-2: Function Keypad

KEY	DESCRIPTION
MENU	The top level menu is accessed by pressing the MENU key. Two shortcut keys are provided to provide direct access to the PROGRAM and MEASUREMENT screens as these are among the most frequently used screens. Thus instead of going through the main menu to reach the PROGRAM and MEASUREMENT screens, they can be accessed directly by pressing the PROG and MEAS keys respectively.
PROG	The PROG key is a shortcut to access the PROGRAM menu directly. The PROGRAM menu is on of the most frequently used menu. Thus instead of going through the main menu to reach the PROGRAM menu, it can be accessed directly by pressing the PROG key.
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.
CURSOR UP	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 right hand column, no action takes place. Figure 4-3 depicts the cursor movement through a two column menu.

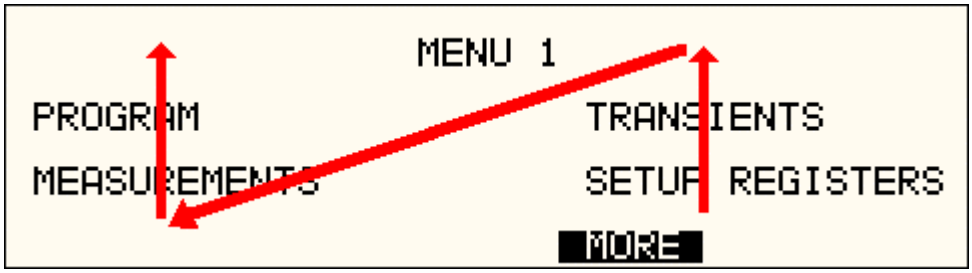


Figure 4-3: Cursor "up " Key Movement

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, no action takes place. Figure 4-4 depicts the cursor movement through a two column menu.

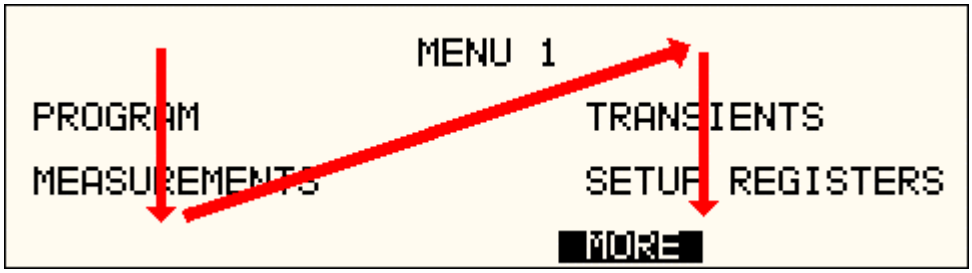


Figure 4-4: Cursor "down" Key Movement

OUTPUT ON/OFF

The OUTPUT ON/OFF key toggles the output relay on or off. The present 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 Neutral and Line 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.

SET

The SET key is used select the mode of operation of the shuttle. Refer to section 4.1.3 for details on its operation and the use of the SET key.

+/-

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.

4.1.5 Data ENTRY Keypad

The data ENTRY keypad is used to enter parameter values. Any decimal value can be entered, including a fractional part. The BACKSPACE key (<-) located to the left to the ENTER key can be used to erase one digit at a time. While parameter values are entered in a field, the field will blink to indicate the pending change of value. When the ENTER key is pressed, the entered values takes effect and the field stops blinking.
Note that only the field on which the cursor (reverse bar) is located can be changed.

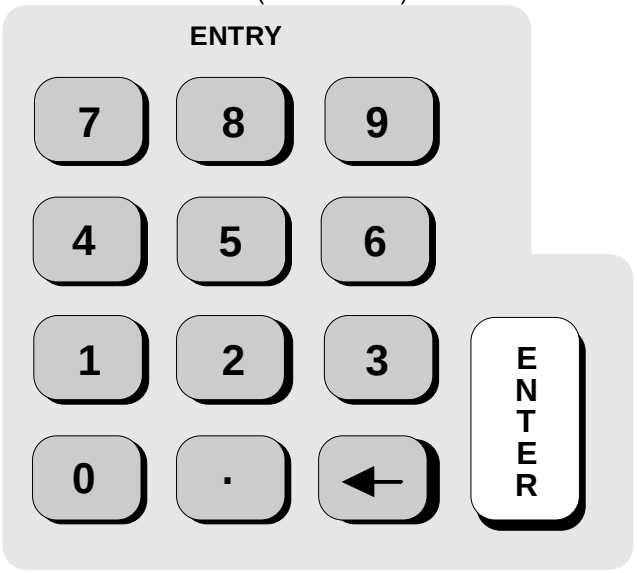


Figure 4-5: Data Entry Keypad

4.1.6 LCD Display

The LCD display of the i 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, all screens are widely spaced. A sample of the main menu 1 screen that appears when the 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 two parts, part 1 and part 2. The MORE selection located at the bottom right hand side provides access to menu choice 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.
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 FUNCTION keypad.

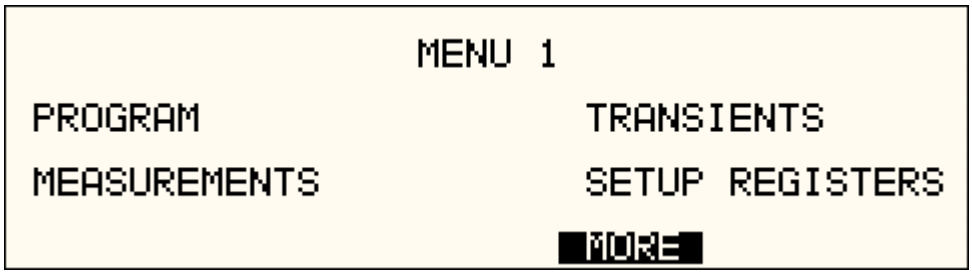


Figure 4-6: Main Menu 1 Screen

4.2 Menu Structure

The i Series AC power source is operated by means of a collection of hierarchical menus that address the various aspects of setup, measurement and transient programming. This chapter provides an overview of the overall menu structure to help the user in finding his way around the instrument. The menu structure tree shown in Figure 4-8 can be used as a guide.

4.2.1 Menu Levels

The number of nested menu levels is limited to only three for virtually all areas of operation. The only exception to this rule is the MIL-STD 704D and RTCA-DO160C tests located in the APPLICATIONS menu. These tests require an additional nested level. The MIL-STD 704D and RTCA-DO160C are firmware options and may or may not be installed in your unit.
The menu levels are shown at the top of Figure 4-8 for reference. Level 1 is the main menu that appears when the i Series unit is first turned on or any time the MENU key is pressed.

4.2.2 MAIN Menu

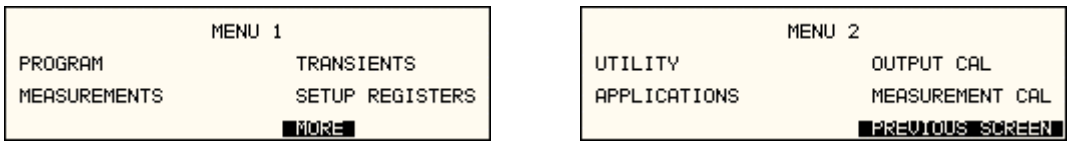
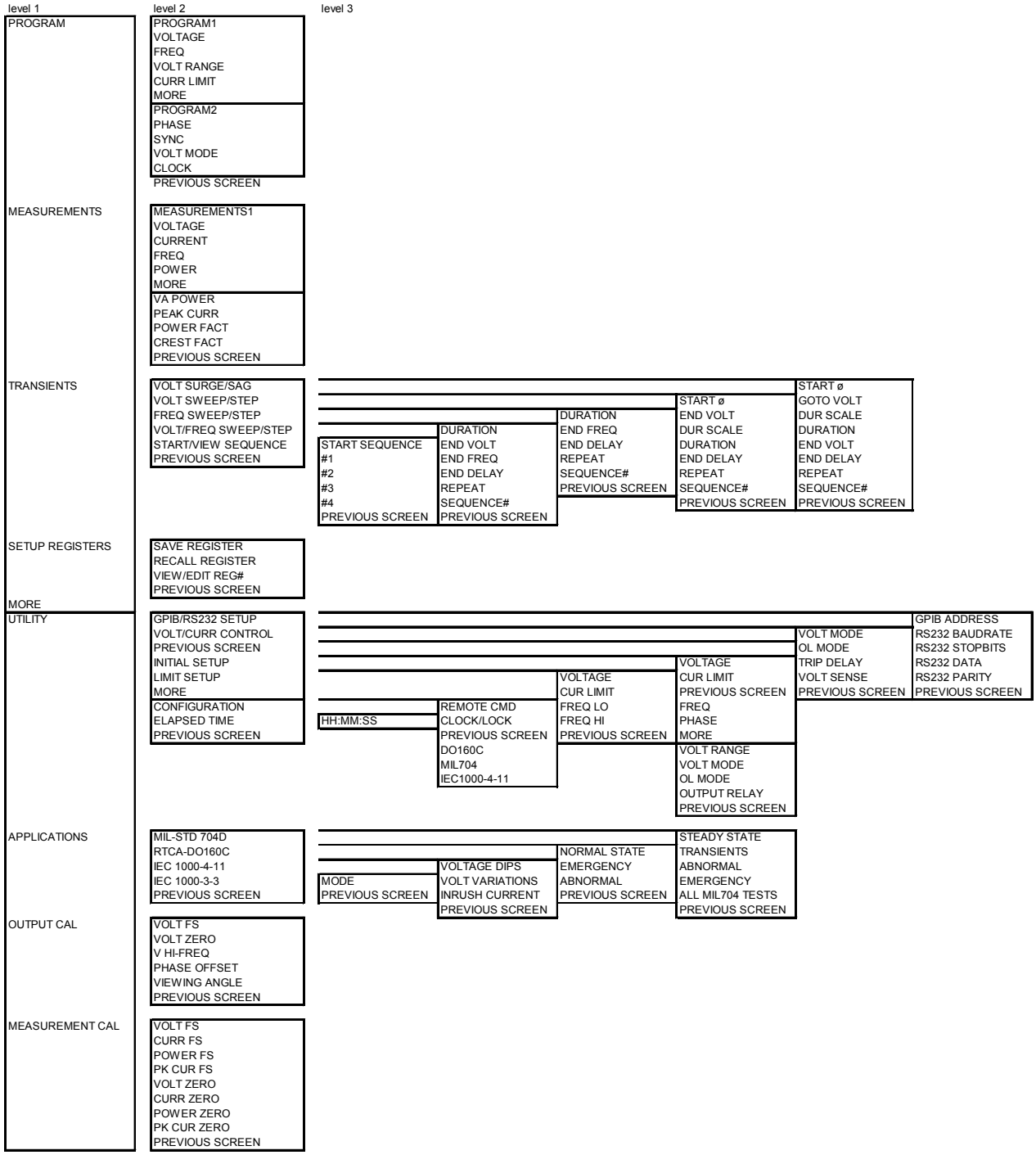


Figure 4-7: Main Menu 1 and 2

The top level menu is split in two parts, MENU 1 and MENU 2 to allows spacing between menu entries. MENU 2 can be reached from MENU 1 by selecting the MORE entry. The division of menu choices between the two screens is graphically illustrated in Figure 4-8 by the box in level 1. Each box represents one screen. The division is immediately following the MORE entry.
The top level menu offers the following level 2 menu choices:

Entry	Description
PROGRAM	The PROGRAM menu allows output parameters the be changed.
MEASUREMENTS	The MEASUREMENT screens are not menus in that no user entries are required. The MEASUREMENT screens show up to four output measurements at a time.
TRANSIENTS	The TRANSIENTS menu allows output transients to be programmed.
SETUP REGISTERS	The SETUP REGISTERS menu allows complete instrument settings or transient list programs to be saved to non volatile memory.
MORE	The MORE selection causes the second part of the MENU screen to be displayed. (MENU 2)
UTILITY	The UTILITY menu provides access to less commonly used setup screen such as those for the GPIB and RS232C interface settings, initial startup values etc.

Figure 4-8: i Series Structure Menu



Entry	Description
APPLICATIONS	The APPLICATIONS menu provides access to optionally installed firmware options that address specific applications. There may be no entries in the APPLICATIONS menu if no options are installed.
OUTPUT CAL	The OUTPUT CAL menu allows the output of the i Series AC source to be calibrated.
MEASUREMENT CAL	The MEASUREMENT CAL screen allows the measurement functions of the i-Series AC source to be calibrated.

4.2.2.1 PROGRAM Menu

Figure 4-9: Program Menu

The PROGRAM menu is shown in Figure 4-9 it can be reached in one of two ways:
1. by selecting the PROGRAM entry in the MENU menu 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 menu 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 PROGRAM 1 using the MORE selection.
The following choices are available in the PROGRAM menu:

Entry	Description
VOLTAGE	Programs the output voltage in rms. when in AC mode or absolute volt 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 135V or 270V 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.
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).

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.
SYNC	Selects the synchronization mode. When INT (internal) is selected, the AC source's internal clock oscillator is free running. When EXT (external) is selected, the AC source clock is synchronized with an externally provided SYNC signal.
VOLT MODE	Selects the output voltage mode. AC for AC mode, DC for DC mode. In DC mode, no frequency selection is possible and all maximum current and power ratings are divided by two.
CLOCK	Selects internal or external clock source. The i Series uses an open air crystal timebase with an accuracy of 100 ppm. To improve out frequency stability and accuracy, an external clock generator may be used.
STARTø	Selects the starting phase angle for external clock mode operation. When external clock mode is selected, the phase angle of the AC source output is offset with respect to the external clock input signal by the value entered in this field.

4.2.2.2 MEASUREMENTS Screen

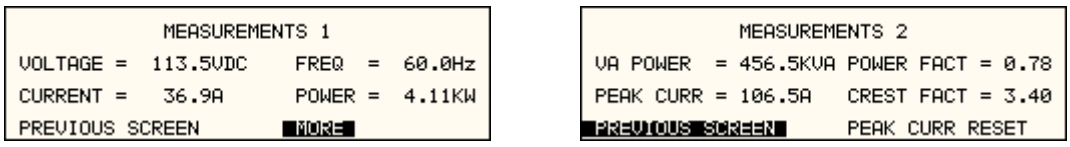


Figure 4-10: Measurements Screen

The two Measurement screens are not menus in that no changes can be made anywhere. These two screens provide load parameter readouts. The following parameters are available :

Entry	Description
VOLTAGE	When in AC mode, this value is the true rms. output voltage measured at the output sense lines. In DC mode, the voltage is the DC voltage including polarity.
CURRENT	When in AC mode, this value is the true rms. output current drawn by the load. In DC mode, the current is the DC current including polarity
FREQ	When in AC mode, the output frequency is measured at the sense lines. When in DC mode, this value always reads 0 Hz.
POWER	In both AC and DC mode, this value is the real rms. power consumed by the load.
VA POWER	In AC 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.

4.2.2.3 SETUP REGISTERS Menu

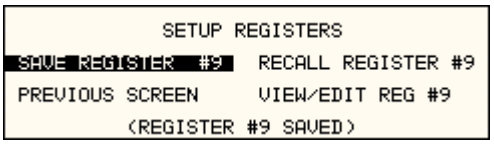


Figure 4-11: Setup Registers Menu

The SETUP REGISTERS menu allows the user to store and recall complete instrument setups, including transient program lists. A total of 12 non volatile setup registers is available, numbered sequentially from 1 through 12.
The following entries can be found in the SETUP REGISTERS menu:

Entry	Description
SAVE REGISTER	Save present instrument setups 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 setups 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.

4.2.2.4 TRANSIENTS Menu

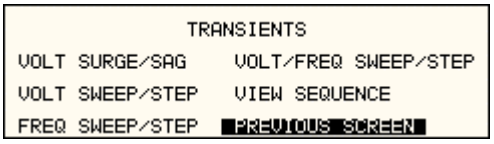


Figure 4-12: Transients Menu

The transient menu provides access to the transient list data. The i Series has 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 submenu will be shown. The four available submenu's can be found in Figure 4-12. The START/EDIT SEQUENCE submenu 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 a 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 sag 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 identical to a voltage sweep/step. Refer to the previous paragraph.
VOLT/FREQ SWEEP/STEP	This transient type combined the previous two types into a single step. The effect is that of slewing or 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.

4.2.2.5 UTILITY Menu

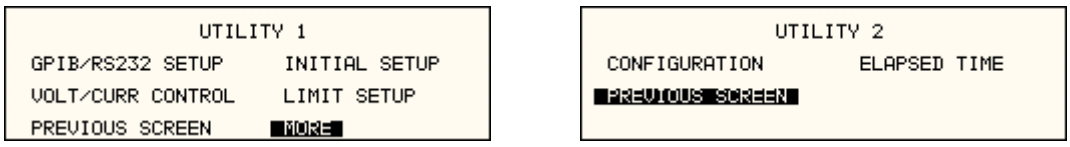


Figure 4-13: Utility Menu

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

Entry	Description
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 their is rarely a need to change these values.
VOLT/CURR CONTROL	The voltage and current control menu can be used to select the voltage sense source and current limit method used by the AC source. Voltage sense can be internal or external. For best output voltage regulation, select external sense and make sure to connect the sense lines to the load to compensate for voltage drops in the load cables. The two current limit choices available 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 set at which time the voltage will be dropped to zero. This effectively shuts off the AC source in case of an overload condition. This mode has a user programmable trip delay which is located in the same menu. 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 reduces from the set level down to zero depending on the load requirement. This mode is useful for starting up inductive or capacitive loads that may require a high inrush current. The trip delay has no effect in this mode of current limiting.
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.

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	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 inception. This value is read only and cannot be changed by the user.

4.2.2.6 APPLICATIONS Menu

Figure 4-14: Applications Menu

The APPLICATIONS menu provides access to the optional application specific pre-programmed test sequences. Since these test sequences are optional, this menu can 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.
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.

4.2.2.7 OUTPUT CAL Menu

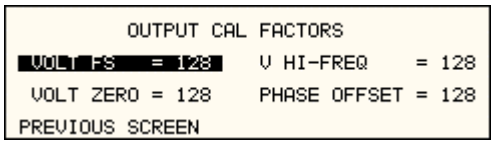


Figure 4-15: OUTPUT CAL Menu

The OUTPUT CAL 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. Refer to the i Series user manual for information on calibration procedures.

4.2.2.8 MEASUREMENT CAL Menu

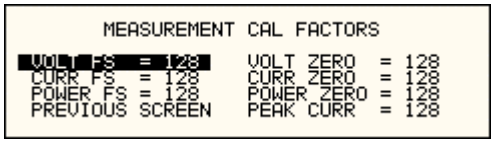


Figure 4-16: MEASUREMENT CAL Menu

The MEASUREMENT CAL menu provides access to the measurement calibration parameters. These parameters are password protected and can only be changed after the calibration password has been entered. Refer to the i Series user manual for information on calibration procedures.

4.3 How to...

This chapter covers some common tasks that are often performed with an AC power source. These examples are written in a How to... format and provide step by step instructions on how to set up the i Series source for a specific task.

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

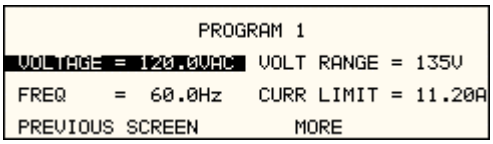
1. Use the PROG key to directly bring up the PROGRAM menu.

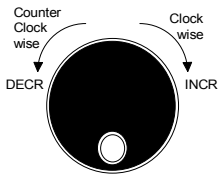
There are two methods for programming output parameters:

IMMEDIATE mode
SET mode

4.3.1.1 Slewing Output Values With the Knob in IMMEDIATE Mode

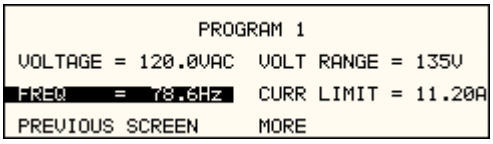
The default mode of operation is an immediate mode in which changes to output parameters made with the knob or the entry keypad are immediately reflected at the output.
To change the output voltage

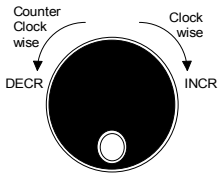




1. Place the cursor on the VOLTAGE entry
2. Rotate the knob clock wise to increase the value, counter clockwise to decrease the value

These changes take effect immediately.
To change the output frequency



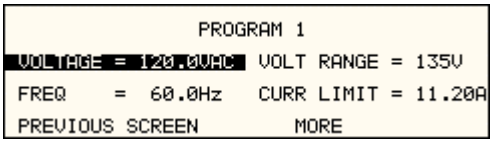


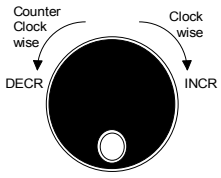
1. Place the cursor on the FREQ entry
2. Rotate the knob clock wise to increase the value, counter clockwise to decrease the value

These changes take effect immediately.

4.3.1.2 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 are 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 clock wise to increase the value, counter clockwise 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 clock wise to increase the value, counter clockwise 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.

4.3.1.3 Change Output Value With the Decimal Keypad

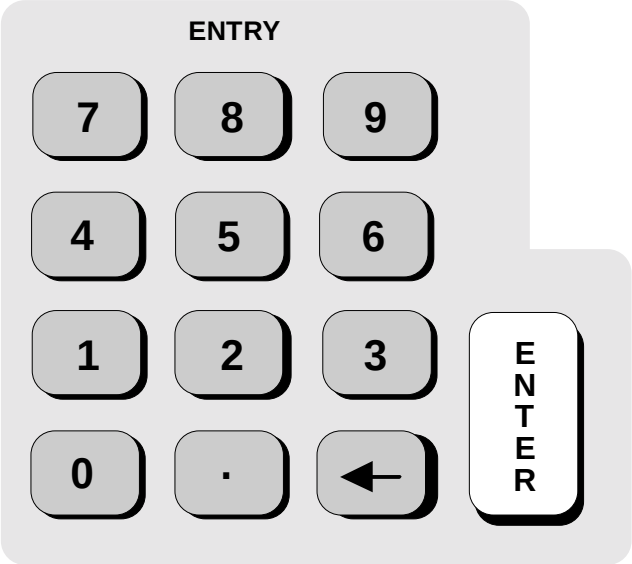


Figure 4-17: Entering Value from Decimal Keypad

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.

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

4.3.2 Set Power Up Defaults

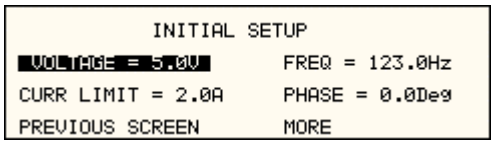


Figure 4-18: Initial Setup Menu

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 menu.
To access the INITIAL SETUP menu, proceed as follows:

1. Press the MENU key
2. Move the cursor down to the MORE field
3. Press the ENTER key
4. Move the cursor down to the INITIAL SETUP entry
5. Press the ENTER key
6. Move the cursor to the field you wish to change.
7. Enter a new value with the shuttle knob or the decimal keypad
8. Press ENTER to confirm your entry

9. Repeat steps 6 through 8 for all parameters. You can access additional initial setting parameters by selecting the MORE entry and pressing ENTER.
10. Turn the unit off
11. Wait a few seconds and turn the unit back on.
12. Press the PROG key and verify that the INITIAL settings are present in the PROGRAM menu.

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 the operator. It is recommended that the initial voltage be set low and / or the output relay be programmed to OFF for most situations.

4.3.3 View Measurements

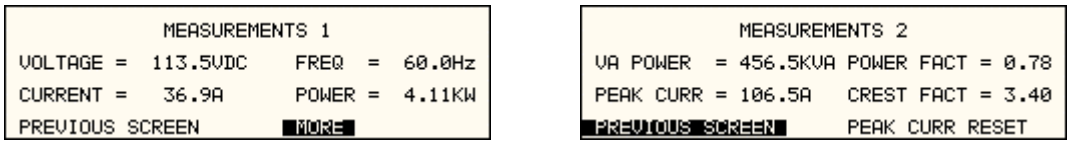


Figure 4-19: Measurements Screen

The MEASUREMENTS screen can be called up in one of two ways :

1. Press the MENU key to select the MAIN menu.
2. Scroll down to the MEASUREMENTS entry using the Up and Down cursor keys.
3. Press the ENTER key to bring up the MEASUREMENTS menu.

or

1. Use the MEAS key to directly bring up the MEASUREMENTS menu.

Note that the measurement menu is broken down in two parts, MEASUREMENTS 1 and MEASUREMENTS 2. The second screen can be selected by moving the cursor to the MORE entry and pressing the ENTER key.

4.3.3.1 Measure Inrush Current

The peak current reading will always show the maximum peak current value found so far. To determine the inrush current of a load, proceed as follows:

1. Turn off the output relay with the OUTPUT ON/OFF switch.
2. Move the cursor in the MEASUREMENTS 2 screen to the PEAK CURR RESET field at the end of the screen.
3. Press the ENTER key to reset the PEAK CURR reading.
4. Turn the output on with the OUTPUT ON/OFF switch.
5. Read the inrush current value in the PEAK CURR field.

4.4 Transient Programming

The TRANSIENT screen can be called from the MAIN menu screen:
1. Press the MENU key to select the MAIN menu
2. Scroll to the TRANSIENTS entry using the up and down cursor keys.
3. Press the ENTER key to bring up the TRANSIENTS menu.

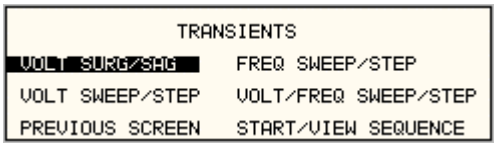


Figure 4-20: Transient Menu

The TRANSIENT screen shown in
9 has the following selections:
1. VOLT SURG/SAG
2. VOLT SWEEP/STEP
3. FREQ SWEEP/STEP
4. FREQ SWEEP/STEP
5. VOLT/FREQ SWEEP/STEP
6. START/VIEW SEQUENCE

Selection one through five will allow the user to setup the transient type parameters. Selection six will show a list of available transient events presently in memory. The same screen will allow the transient program to be executed.

4.4.1 Voltage Surge and Sags

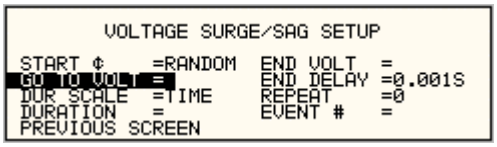


Figure 4-21: Surge sag Screen

The VOLTAGE SURGE AND SAGS screen shown in Figure 4-21 can be reached from the TRANSIENT screen as follows:

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

The VOLT SURG/SAG screen has several data fields. All data fields that are blank to the right to 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:

1. 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.

2. GO TO VOLT

This field will set the voltage level during the transient duration in volts

3. 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 milliseconds. Thus, for 50 Hz applications, no rounding errors occur but for 60 Hz, the 16.666666666666..... ms period will cause a rounding error when converted. The Duration scale selection affects both the DURATION and END DELAY parameters.

4. 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

4. END VOLT

This is the output voltage level at the end of the transient EVENT and after a time specified by the DURATION

5. 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.

6. 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.

7. 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 # to allow insertion of an EVENT later if needed. (For example, space then by 5) Entry of a sequence EVENT# number will cause the display to return to the TRANSIENT screen.

4.4.2 Voltage Sweep/Step

Figure 4-22: Voltage Sweep/Step Screen

The VOLTAGE SWEEP AND STEP screen shown in Figure 4-22 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 to 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:

1. 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.

2. END VOLT

This is the output voltage level at the end of the transient event in volts.

3. 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 milliseconds. Thus, for 50 Hz applications, no rounding errors occur but for 60 Hz, the 16.666666666666..... ms period will cause a rounding error when converted. The Duration scale selection affects both the DURATION and END DELAY parameters.

4. 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

5. 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.

6. 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.

7. 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 # to allow insertion of an EVENT later if needed. (For example, space then by 5) Entry of a sequence EVENT# number will cause the display to return to the TRANSIENT screen.

4.4.3 Frequency Sweep/Step

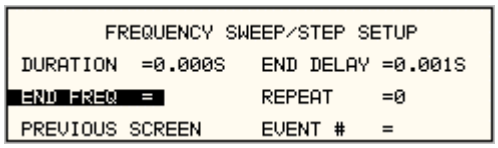


Figure 4-23: Frequency Sweep/Step Screen

The VOLTAGE SWEEP AND STEP SCREEN shown in Figure 4-23 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 to 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:

1. 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 both the output frequency for the event. A duration of 0 seconds will cause the output frequency to reach the end frequency immediate.

2. END FREQ

This is the output frequency at the end of the transient event in Hz.

3. 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.

4. 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.

5. 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 # to allow insertion of an EVENT later if needed. (For example, space then by 5) Entry of a sequence EVENT# number will cause the display to return to the TRANSIENT screen.

4.4.4 Volt/Freq Sweep/Step

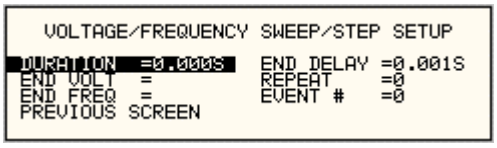


Figure 4-24: VOLT/FREQ SWEEP/STEP screen

The VOLT/FREQ SWEEP/STEP screen shown in Figure 4-24 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 to 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:

1. 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 events. A duration of 0 seconds will cause the output voltage and frequency to reach the end frequency immediate.

2. END FREQ

This is the output frequency at the end of the transient event in Hz.

3. END VOLT

This is the output voltage at the end of the transient event in volts.

4. END DELAY

This is the time delay the output frequency and voltage will stay at END FREQ and END VOLT before it proceeds with the next transient event or completes the transient.

5. REPEAT

This is the number of times it will repeat the VOLTAGE/FREQUENCY SWEEP/STEP transient 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.

6. 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 # to allow insertion of an EVENT later if needed. (For example, space then by 5) Entry of a sequence EVENT# number will cause the display to return to the TRANSIENT screen.

4.4.5 View and Execute Transients

Transient events can be viewed for further editing before execution. This can be accomplished form the START/VIEW SEQUENCE screen.

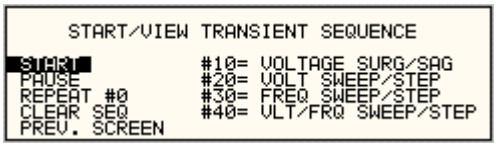


Figure 4-25: Start/view transient sequence

The START/VIEW SEQUENCE screen shown in Figure 4-25 can be reached from the TRANSIENT screen as follows:

1. Scroll to the START/VIEW SEQUENCE entry using the up and down cursor keys.
2. Press the ENTER key to bring up the START/VIEW SEQUENCE screen.

The START/VIEW SEQUENCE screen has the following data field:

1. START/ABORT

This field is used to start or abort the transient. Scroll down or up to the START entry using the up and down cursor keys. Press the ENTER key to start the transient. This field will become an ABORT when the transient is in progress. Press down the enter key will abort the transient immediate. The steady output voltage and frequency is the voltage and frequency level at the time of abort.

2. PAUSE/RESUME

This field is used to PAUSE the transient. This field is only active when the transient is in progress. To activate the PAUSE key, scroll down or up to the PAUSE entry using the up and down cursor keys. Press the ENTER key to pause the transient while the transient is in progress. The transient will pause immediately. Both voltage and frequency will stay at the last values before the pause. The field will indicate RESUME. Pressing the RESUME key will cause the transient to continue from the point at which it was paused.

3. REPEAT

This field will accept a number from 0 to 999,999. The REPEAT field will allow the transient sequence to run the number times entered plus one. Note this repeat is different from the repeat associated with each transient event. This is a global sequence repeat as opposed to an individual program event repeat. To select the REPEAT field, scroll to the REPEAT entry using the up and down cursor keys. Use the numeric key pad to enter the number desired.

4. CLEAR SEQ

This field will delete all transient events. Care must be taken to avoid accidental selection of this field. To select the CLEAR SEQ field, scroll to the CLEAR SEQ entry using the up and down cursor keys. To clear all events press the ENTER key.

5. VIEW TRANSIENT EVENTS

All fields on the right hand side of the display will show the events that make up the transients sequence or program. The transient events are sorted by their sequence numbers. Each field shows the event number followed by the event type. A maximum of five events can be visible on the screen. Scroll up or down to select an event that is not visible in the screen. To view an event scroll up or down to the event and press the ENTER key. Now you can view and edit the event.

6. CLEAR TRANSIENT EVENTS

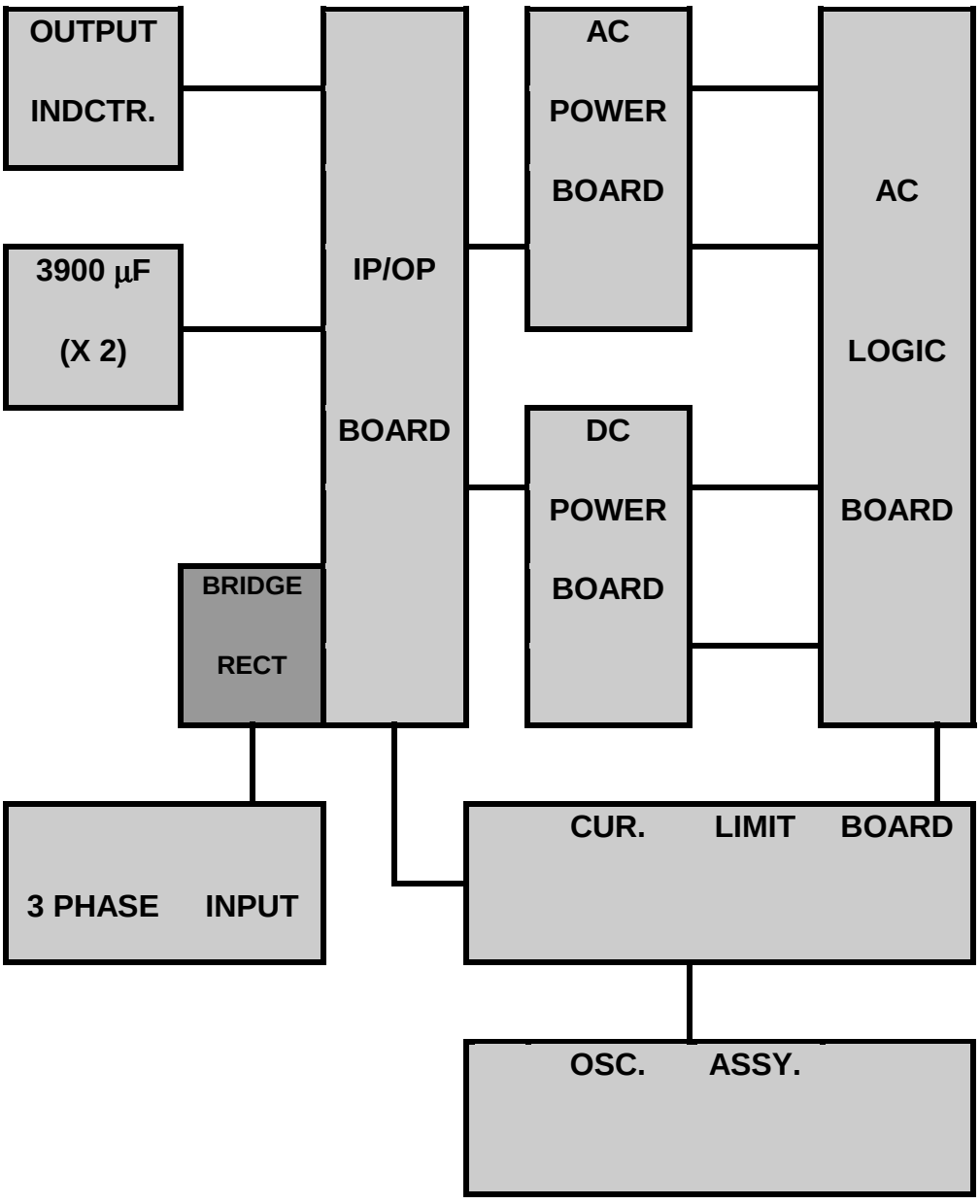
Scroll to the transient event you want to delete using the up and down cursor keys. Use the back space key ← to delete the transient event.

5. Principle of Operation

5.1 General

An explanation of the circuits in the 3001i and 5001i is given in this section. Refer to Figure 5-1 for a block diagram of the system. Figure 5-6 shows the system interconnect.

Figure 5-1: AC Power System Block Diagram



5.2 Overall Description

Three 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 aux. PS supplies low voltage logic level power to the control logic board, the oscillator board, the AC power board as well as the fan. The output of the DC converter is fed to two 3900 μF 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 VAC output and 400 volts for the 270 V AC output.

The oscillator assembly generates the sine wave signal and provides frequency and amplitude 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 5-2 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 Waveform Board

This board assembly, A8, consists of the components for generating the input signal for the power amplifier. 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.

The waveform 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)									
	W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**	**W10**
Standard, CLK & LK Master	+	-	-	+	-	+	+	-	-	+
CLK & LK Slave	+	-	-	-	+	-	-	+	+	-
External Modulation, % Program value	-	+	-	See above for CLK & LK Options						
External Modulation, ± 15VRMS	-	-	+	See above for CLK & LK Options						

5.3.2 Keyboard/ Display Board

The keyboard/ display assembly is assembly A9. It is mounted to the front panel and holds the 21 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 CPU Board

This assembly, A7, has the CPU and all memory devices. It also has a nonvolatile RAM for storage of calibration, configuration and setup data. The RAM has a 10 year life expectancy.

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.

Figure 5-2: Oscillator Power Module Block Diagram

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 sinusoidal 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 sinusoidal constant current mode.

5.5 Auxiliary Power Supply

The aux. PS is mounted on the DC-DC power board. The auxiliary power supply generates nine low voltage outputs. These outputs from the aux. PS 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.

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 and runs at 37.5 kHz. The control logic supply for the DC-DC converter is derived from the aux. PS so the DC-DC converter does not start switching until after the aux. PS has started up and comes into regulation. This feature ensures a smooth start up.

The output of the DC converter is automatically selected for 250V dc or 400V dc output depending on whether the low range output (135 Vac) or high range output (270 Vac) is selected. The 250/400V dc 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 input and output 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 capacitor 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 optocouplers that provide the necessary isolation.

Figure 5-3: 5001i Internal Layout

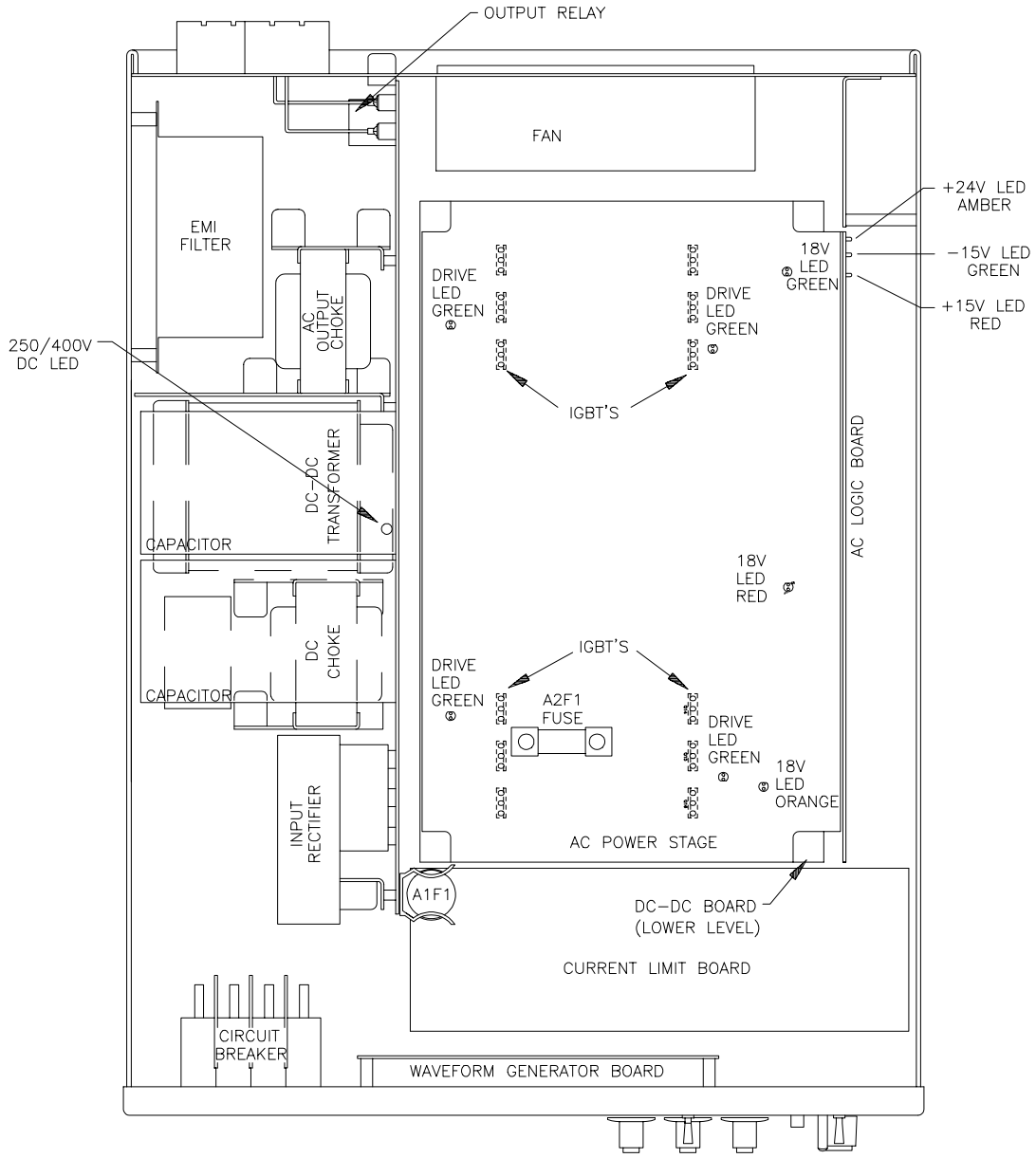
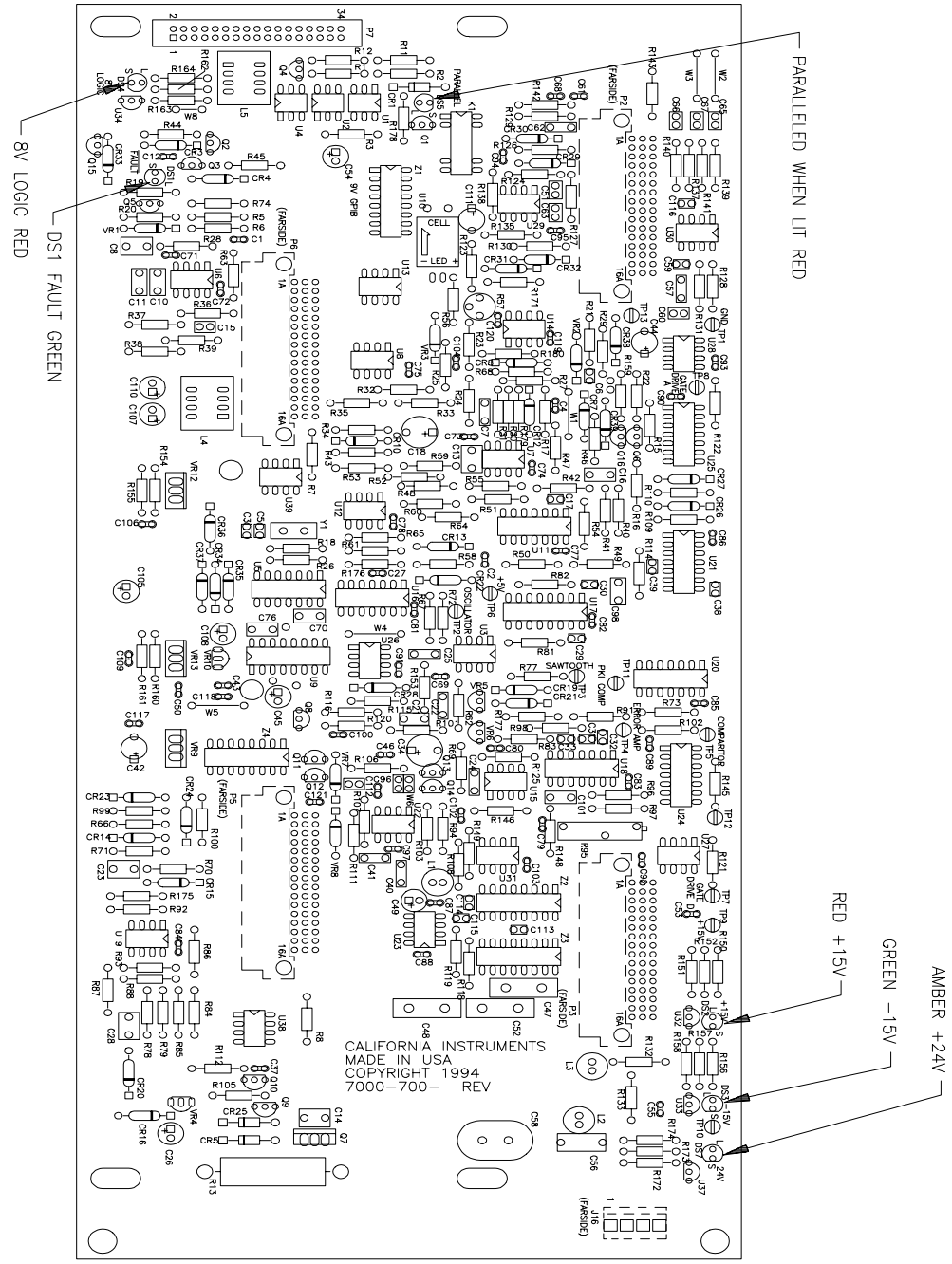


Figure 5-4: Logic Board LED's



There are six LED indicators on the logic board. Their positions are shown in Figure 5-4. The functions in Table 3.

Table 3: 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/400V DC input and generates a 135V/270V 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

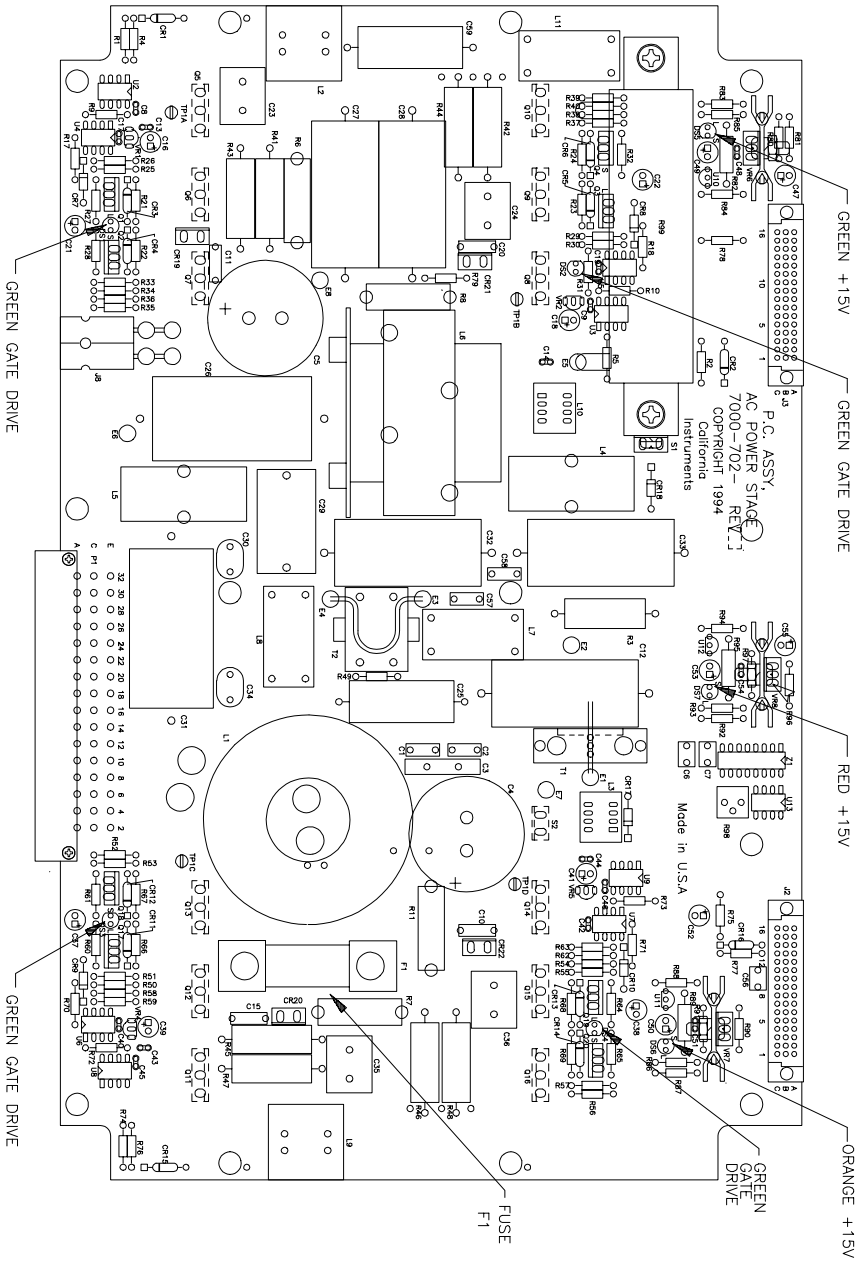
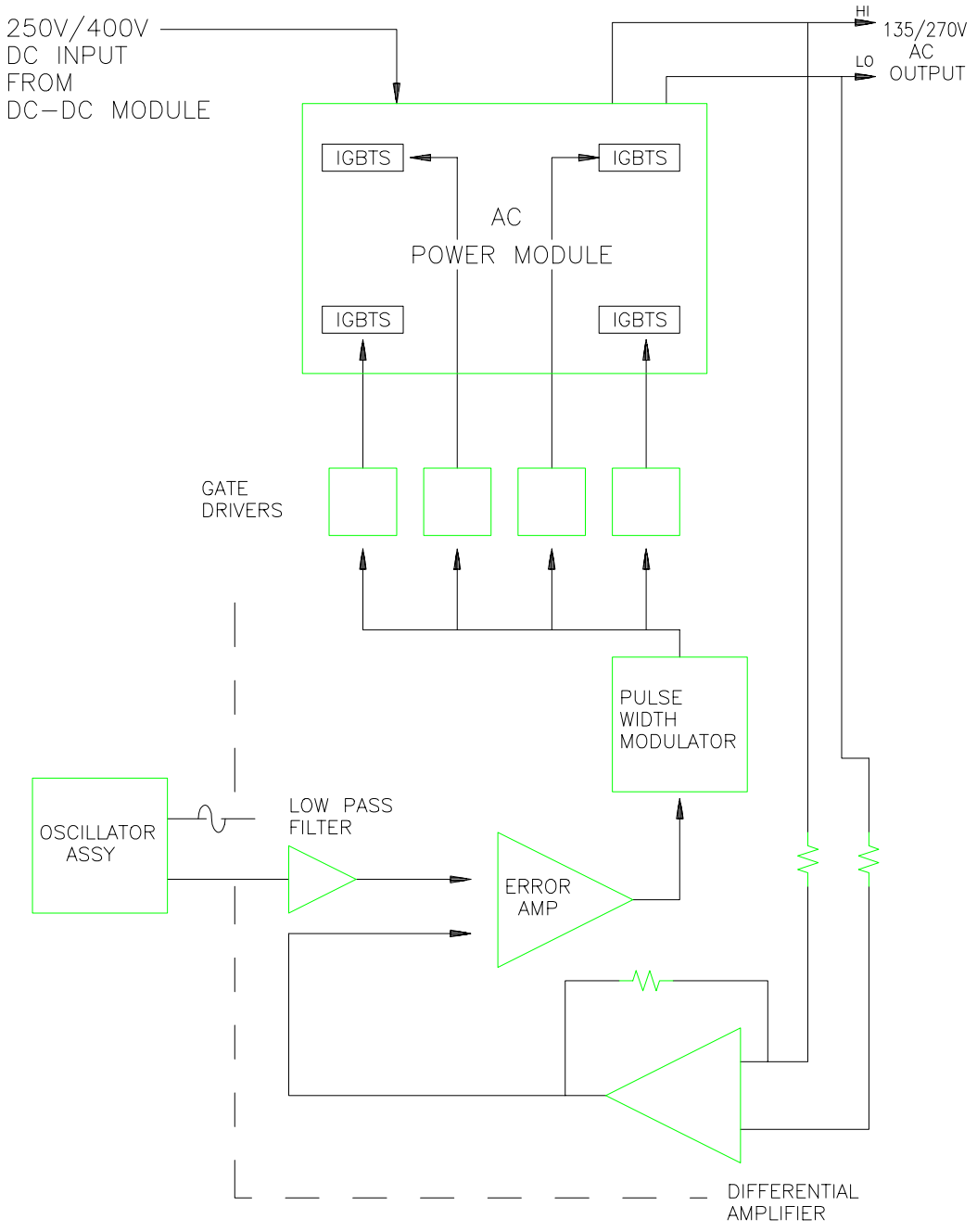
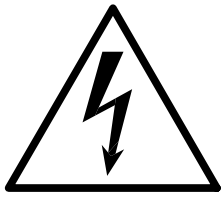


Figure 5-6: AC Control Logic Block Diagram





CAUTION

VOLTAGES UP TO 480 VAC AND 650 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.

6.1 Calibration Equipment

Digital Multimeter:	Fluke 8506A or HP 34401A
10 milliohm Current Shunt:	Isotek Model RUG-Z-R010-0.1 or equivalent
1 milliohm Current Shunt: (10001i-1 & 15001i-1):	Isotek Model RUG-Z-R001-0.1
Load Bank:	Various high power load resistors will be needed.

6.2 The Output Calibration Screen

To show the OUTPUT CALIBRATION screen for the first time press the MENU key. Press the ↑ or ↓ key several times to highlight MORE. Press the ENTER key to show the MENU 2 screen. Select OUTPUT CAL and press ENTER. Type 5000 and press the ENTER key to show the OUTPUT CALIBRATION screen.

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.

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

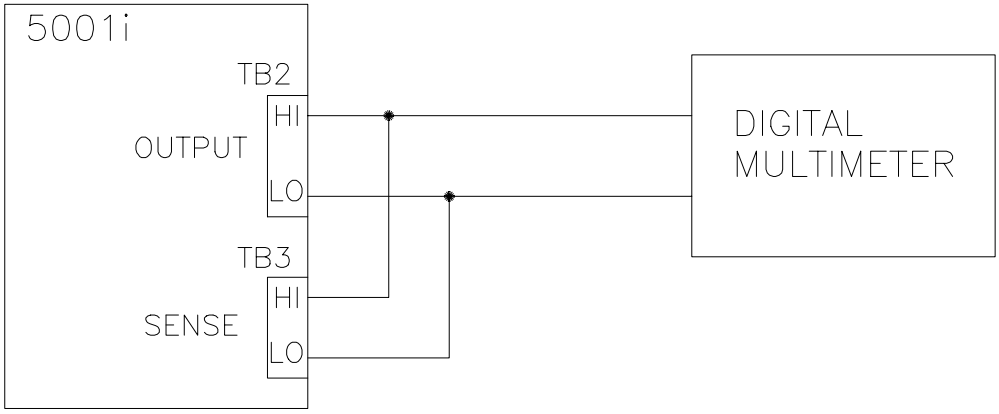


FIGURE 6-1

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

135 VAC Range DC Zero:
Press the PROGRAM key and select the 135 Range with the shuttle. Program the output to 0.0 volts. Go the Output Calibration 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 ± 0.005 VDC.

135 VAC Range Full-scale:
Press the PROGRAM key and program 120.0 volts and 60 Hz. Go to the OUTPUT CALIBRATION screen by choosing the PREVIOUS screen selection. Select the VOLT FS parameter and adjust the output to 120.0 ±0.05 volts.

135 VAC Range HI Freq:
Press the PROGRAM key and program the output to 120.0 volts and 300 Hz. Go the CALIBRATION screen and select the V HI FREQ parameter. Adjust the output with the shuttle for an output of 120.0 ±0.05 volts. Repeat the 60 Hz and 300 Hz adjustments until the output is within ±0.05 volts of the programmed value.

270 VAC Range DC Zero:
Program the output to the 270 VAC Range by pressing and selecting the 270 Range with the shuttle. Go the CALIBRATION screen, select the VOLT ZERO parameter and adjust the output to 0.0 ±0.005 VDC.

270 VAC Range Volt Full-scale:
Program the output to 240.0 volts and 60 Hz. Go to the CALIBRATION screen and adjust VOLT FS parameter for an output of 240.0 ±0.05 volts.

270 VAC Range Volt HI Freq:
Program the output to 240.0 volts and 300 Hz. Go to the CALIBRATION screen and select the V HI FREQ parameter. Adjust the output with the shuttle for an output of 240.0 ±0.05 volts. Repeat the 60 and 300 Hz adjustments until the output is within ±0.05 volts of the programmed value.

135 VDC Range Volt Zero:
Press the PROGRAM key. Select the MORE option to go to the PROGRAM 2 screen. Highlight the VOLTAGE MODE parameter and select the DC Mode by moving the shuttle. Press the PROGRAM key and program the 270 Range and 0.0 volts. Go to the Measurement Calibration by pressing the MENU key followed by pressing the ENTER key to display the MENU 2 screen. Select the MEASUREMENT screen and adjust the VOLT ZERO for 0.0 ±0.005 volts DC.

135 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 ±0.05 volts DC.

135 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 ±0.05 volts DC.

270 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 ±0.05 volts DC.

270 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 ±0.05 volts DC.

Program the following values in the table and make the adjustments in the OUTPUT CALIBRATION screen.

Table 4: Output Calibration Table

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

6.5 Routine Measurement Calibration

Connect the test equipment to the power source as shown in Figure 6-2. If the Current, Peak Current or Power Measurement can't be successfully performed, adjust the Current Measurement Pot. This adjustment is described in the Non-routine Calibration section of this manual.

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 the relays in the load bank from being damaged.

To calibrate all measurement functions the desired value 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. The value for Power is in kW.

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

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

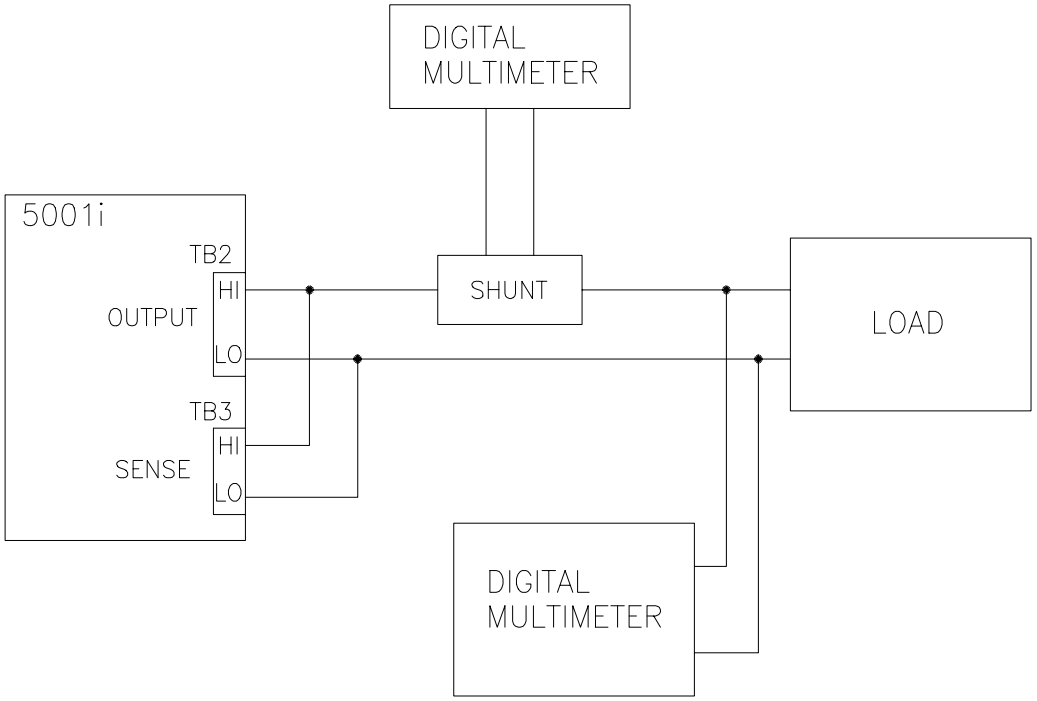


FIGURE 6-2

AC Volt Zero:
Program the output to the 270 volt range and 0.0 volts. Close the output relay. Go the MEASUREMENT CALIBRATION screen and select the VOLT ZERO parameter. Observe the AC output voltage on the AC Digital Multimeter (DVM). Enter the value of the output voltage for the VOLT ZERO parameter and press the ENTER key.

AC Volt Full-scale:
Program the output to 240 volts. Go to the MEASUREMENT CALIBRATION screen. Enter the actual AC output voltage for the VOLT FS parameter and press the ENTER key.

AC Current Zero:
Program the output to the 135 range, 135 volts and 60 Hz. Apply a 27 ohm load to the output. This load will draw approximately 5 amps from the output. Observe the actual output current by measuring the voltage from the current shunt 5 amps will be represented by 0.050 VRMS. Go to the MEASUREMENT CALIBRATION screen. Enter the value of the load current for the CURR ZERO parameter and press the ENTER key.

AC Power Zero:
Multiply the values for the actual voltage and load current. This value represents the output power. Enter this value in Kilowatts for the POWER ZERO parameter. (ex. 675 watts = 0.68 kW)

AC Peak Current Zero:
Multiply the load current by 1.414. Enter this value for the PK CUR ZERO parameter and press the ENTER key.

AC Current Full-scale:
Apply a 3.8 ohm, 5000 watt load resistor (6.3 ohm, 3000 watt for 3001i) to the output. Observe the actual output current and enter this value for the CURR FS parameter. Press the ENTER key.

AC Power Full-scale:
Multiply the values for the actual output voltage and load current. Enter this value in kilowatts for the POWER FS parameter and press the ENTER key.

AC Peak Current Full-scale:
Multiply the load current by 1.414. Enter this value for the PK CUR FS parameter and press the ENTER key.

DC Volt Zero:
Go to the PROGRAM 2 screen and program the DC mode. Go the PROGRAM screen and program the 270 range and 0.0 volts. Go to the MEASUREMENT CALIBRATION screen and enter the value of 0 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 for the VOLT FS parameter and press the ENTER key.

DC Volt -Full-scale:
Program the output to -240 volts. Enter the actual DC output voltage for the VOLT FS parameter in the MEASUREMENT CALIBRATION screen. Remember to press the +/- key for the negative voltage.

DC Current Zero:
Program the output voltage to 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.

DC Power Zero:

Multiply the value of the actual output voltage and the load current. Enter this value in kilowatts for the POWER ZERO parameter in the CALIBRATION screen.

DC Current Full-scale:
Program the output to 0 volts. Apply an 8 ohm , 2500 watt load resistor to the output. Program 135 volts. Enter the actual output current for the CURR FS parameter in the MEASUREMENT CALIBRATION screen.

DC Power Full-scale
Multiply the value of the actual output voltage and load current. Enter this value in kilowatts for the POWER FS parameter.

The value indicated by the External DVM is called Vac or V_{DC}. The current measured by the current shunt is called I_{ac} or I_{DC}.

Table 5: Measurement Calibration Table

TITLE	PROGRAM/LOAD PARAMETERS	PARAMETER	ADJUST TO
AC Volt Zero	270 Range, 0.0 volts	VOLT ZERO	V_{ac}
AC Volt Full-scale	240 VAC, 60 Hz	VOLT FS	V_{ac}
AC Current Zero	135 Range, 135 VAC, 27 ohm load	CURR ZERO	I_{ac}
AC Power Zero	135 Range, 135 VAC, 27 ohm load	POWER ZERO	I_{ac} x V_{ac}
AC Peak Curr Zero	135 Range, 135 VAC, 27 ohm load	PK CUR ZERO	I_{ac} x $\sqrt{2}$
AC Current Full-scale	135 Range, 135 VAC, 3.8 ohm load	CURR FS	I_{ac}
AC Power Full-scale	135 Range, 135 VAC, 3.8 ohm load	POWER FS	I_{ac} x V_{ac} x 0.001
AC Peak Curr. Full-scale	135 Range, 135 VAC, 3.8 ohm load	PK CUR FS	I_{ac} x $\sqrt{2}$
DC Volt Zero	270 Range, 0.0 VDC	VOLT ZERO	0
DC Volt + Full - scale	+240 VDC	VOLT FS	V_{DC}
DC Volt - Full - scale	-240 VDC	VOLT FS	V_{DC}
DC Current Zero	135 Range, 135 VDC, 67 ohm load	CURR ZERO	I_{DC}
DC Power Zero	135 Range, 135 VDC, 67 ohm load	POWER ZERO	I_{DC} x V_{DC} x 0.001
DC Current Full-scale	135 Range, 135 VDC, 8 ohm load	CURR FS	I_{DC}
DC Power Full-scale	135 Range, 135 VDC, 8 ohm load	POWER FS	I_{DC} x V_{DC} x 0.001

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.

Power Zero Adjustment:

1. Program the DC voltage mode, 270 range and 0.0 VDC. Go to the MEASUREMENT CALIBRATION screen. By enabling the CALIBRATION screen, the measured value will show ± values for AC parameters. This is necessary to perform the Power Zero Adjustment.
2. Press the MEASURE key and record the measurement value for POWER. Program 270 VDC and adjust R23 on the I/O Board for the same Power measurement value as the one recorded in step 2.

Power Source Gain Adjustment:

Program 120 VAC on the 135 volt range and 300 Hz. Adjust R14 on the Current Limit Board for an output of 120 ±0.05 VAC.

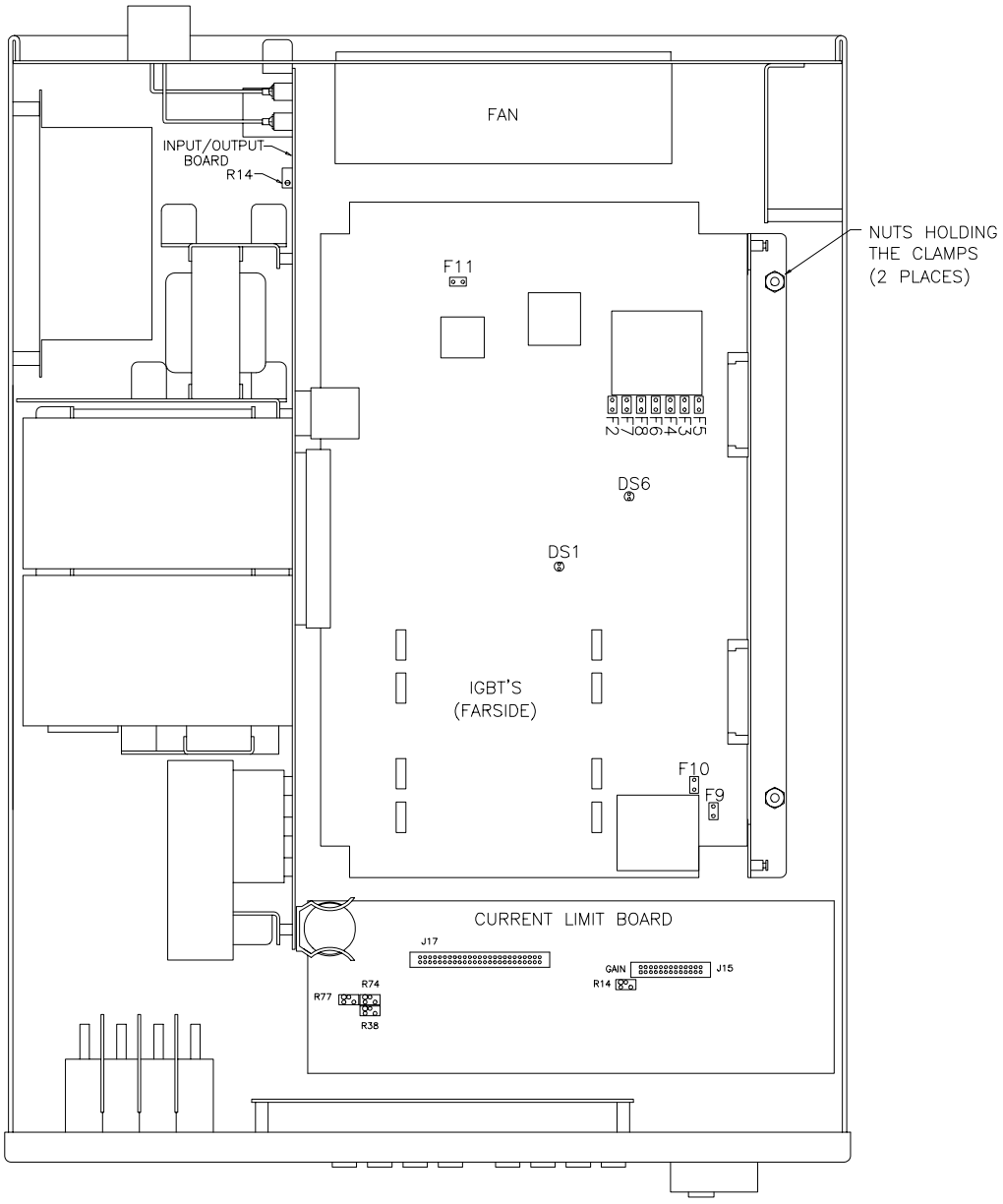
Current Amplifier Gain Adjustment:

Monitor the output load current with the shunt and AC DVM. Program 135 VAC on the 135 volt range and 60 Hz. Apply a load current between 33 and 37 amps (between 19.8 and 22.2 amps for 3001i). Go to the CURRENT MEASUREMENT screen. Adjust R74 on the Current Limit Board for a CURRENT measurement display equal to the load current.

Current Limit Adjustments:

Program the output to the 135 VAC range the current limit to 30 amps (18 amps for 3001i). Program the output to the constant current mode (CC). Apply a 3 ohm load to the output and adjust the output voltage for an output current of 33 amps (19.8 amps for 3001i). Adjust R38 on the Current Limit Board for an output current of 32 amps (19.2 amps for 3001i).
Program 0 VAC and remove the load. Monitor the voltage at TP9 on the Current Limit Board. Use TP1 as the ground. Adjust R77 on the Current Limit Board for the lowest DC voltage on TP9. Cycle the input power off and then on again.

Figure 6-3: Location of Internal Adjustments



7. Service

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 6: Basic Symptoms

PARAGRAPH	PROBLEM
7.2.1	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

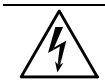
WARNING: Do not connect 400-480V into the 208-240V unit, the result could be a severely damaged unit.

CAUTION: VOLTAGES UP TO 480 VAC AND 650 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.

Select 60 Hz on the frequency controls, turn the amplitude control fully counterclockwise and the current limit to approximately 25% clockwise. Do not apply any load at this time as running the unit at high loads with the cover off will cause overheating of some components.

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-red, DS6-amber, and DS7-blue, 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 before attempting to disassemble the unit to allow for the capacitors to discharge.*** 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 for fuse functions). Replace any blown fuses. Always replace fuses with same type and rating. (See Table 5).

Table 7: Auxiliary Power Supply Fuse Ratings

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	1 amp
F11	Auxiliary power supply input fuse.	3 amp

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/400V 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 aux. PS LED's are lit, then check F2 on the DC-DC board. See Table 7 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 a) and c).

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 the amplitude knob on the front panel. If no reading is present check the output at the Waveform Generator Board. Check the signal between TP6 and TP1 (return) on the Waveform Generator Board. ***Switch power to the unit off before relocating probes.***

If a signal is present at the Waveform Generator 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 TP6 then recheck the inhibit at paragraph 7.3.7 a) and c). 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 5-6.

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, please contact the factory for assistance.

7.4.6 Disassembly Procedure

Disconnect mains power to the source and ***wait 10 minutes before attempting to disassemble the unit to allow for the capacitors to discharge.*** 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: 7000-412-1 3001i
7000-406-1 5001i, 240 VAC INPUT
7000-406-2 5001i, 480 VAC INPUT

Table 8: Replaceable Parts

SEQ#	CI PART #	DESCRIPTION	VENDOR	QTY.
A1	7000-703-1	240V - I/O PC ASSEMBLY, 5001i	CI	1
A1	7000-703-2	240V - I/O PC ASSEMBLY, 3001i	CI	1
A1	7000-706-1	480V - I/O PC ASSEMBLY, 5001i	CI	1
A2	7000-402-1	AC POWER MODULE	CI	1
A3	7000-401-1	240V - DC - DC POWER MODULE	CI	1
A3	7000-405-1	480V - DC - DC POWER MODULE	CI	1
A4	7000-700-1	LOGIC BOARD PC ASSEMBLY	CI	1
A6	7000-707-1	CURRENT LIMIT PC ASSEMBLY	CI	1
2	7000 404-1	PROGRAMMABLE OSC. FRONT PANEL ASSY.	CI	1
A10	7000-713-1	IEEE 488 BOARD	CI	1
B1	241183	FAN 6 INCH--JD24B2	Rotron	1
F1	270184	FUSE 30A 700V I/O & AC BOARDS	Bussman-KPB30	1
K1	245217	RELAY ON CHASSIS. KUHP-5DT1-24	Potter&Brumfield	1
F_{MISC}	270183	P.C. FUSES ON DC-DC BD, 3A F_6,F_{10},F_{11}	Bussman PCC-3	3
F_{MISC}	270174	P.C. FUSES ON DC-DC BD, 1A F_2-F_5, F_7-F_9	Bussman PCC-1	6
CB1	270186	INPUT CIRCUIT BREAKER 35A (240V), 5001i	AIRPAX 205-1111-28051-2	1
CB1	270196	INPUT CIRCUIT BREAKER 35A (250V), 3001i	AIRPAX IELK21-28851-1-V	1
CB1	270187	INPUT CIRCUIT BREAKER 15A (480V), 5001i	AIRPAX 205-1111-28051-2	1

SEQ#	CI PART #	DESCRIPTION
DC - DC POWER ASSY. 7000-701 AND 7000-706		
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
F12	270182	10 amp, 250 vac, time lag
AC POWER ASSY. 7000-702		
F1	270184	30 amp, 700 vac, very quick acting
240 VOLT I/O ASSY. 7000-703		
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
400 VOLT I/O ASSY, 7000-706		
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

9. Options

9.1 Omni Option

9.1.1 General

The OMNI option is an impedance network adds resistive and inductive impedance to the output of 5001I power source. These addendum describe how to Bypass or Engage the OMNI form the 5001I source. For Specification and additional information refer to the OMNI user manual.

9.1.2 Front Panel Control

Select the APPLICATIONS screen from the MENU2 screen. The following screen will appear as shown in Figure 9-1

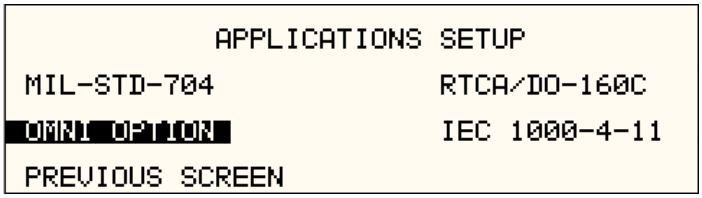


Figure 9-1: Applications Screen

Scroll to the OMNI OPTION entry using the up and down courser key. Press the ENTER key. The following MENU will appear as shown in Figure 9-2

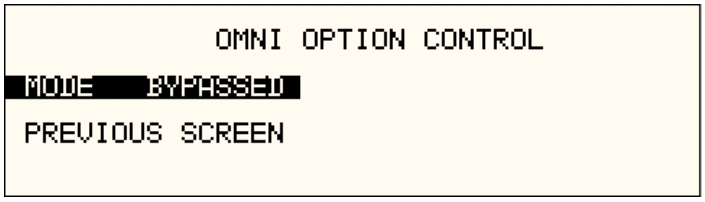


Figure 9-2: OMNI Control Screen

Scroll to the MODE entry using the up and down courser key. USE the Shuttle Knob to engage the OMNI. The display will indicate that the OMNI mode as shown in Figure 9-3

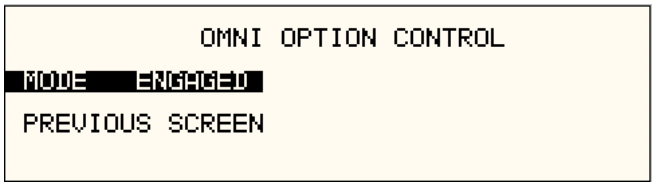


Figure 9-3: OMNI Control Screen

Note: The output of the AC source will drop for about 50 msec when the OMNI MODE changes state.

To Bypass the OMNI, turn the Shuttle Knob counter clock wise.

9.1.3 Remote Programming

The OMNI remote programming syntax is part of the Output subsystem.

Subsystem Syntax

```
OUTPut
    [:STATe] <bool>          Enable/disable the output voltage, current,power, etc.
    :TTLTrg
        [:STATe] <bool>      Enable/disable trigger out drive
        :SOURce<source>      Select a TTLTrg source(BOT|EOT|LIST)
    :OMNI
        [:STATe]<state>      Select the OMNI state (BYPassed|ENGaged)
```

OUTPut:OMNI[:STATe]

This command will engage or bypass the OMNI impedance network. The output voltage will drop when the state changes.

Command Syntax	OUTPut:OMNI[:STATe]<state>
Parameters	BYPassed | ENGaged
*RST Value	BYPassed
Examples	OUTP:OMNI ENG
Query Syntax	OUTPut:OMNI[:STATe]?
Returned Parameters	BYP|ENG
Related Commands	None

9.2 RTCA/DO-160C - Option

9.2.1 General

The RTCA/DO-160C option is capable of performing all sections of RTCA/DO-160C for the AC Source signal. This option is available in single phase AC source units only. In three phase AC Source, this option is available from the GUI (Graphical user interface) with the IEEE488 interface. Version 1.7 or later of the CIGUI is required to operate the DO160 option in three phase mode.

9.2.2 Initial Setup

Nominal parameters for the AC Power source are as follows:

Output Voltage	115V L-N
Output Frequency	400 Hz

9.2.3 Tests Performed

9.2.3.1 Normal State

1. Normal State Voltage and Frequency test
2. Waveform Distortion test
3. Voltage Modulation test
4. Frequency Modulation test
5. Momentary Power Interrupt (Undervoltage) test
6. Voltage Surge (Overvoltage) test

9.2.3.2 Emergency Test

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

9.2.3.3 Abnormal Test

1. Abnormal Voltage minimum
2. Abnormal Voltage maximum
2. Voltage Drop
3. Voltage Surge

9.2.4 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 9-4

Figure 9-4: Application Menu

Scroll to the RTCA/DO-160C entry using the up and down cursor keys. Press the ENTER key to select the RTCA/DO 160C main menu. The screen will appear as shown in Figure 9-5. **The output voltage will be set to 115 volts and frequency to 400 Hz.***

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

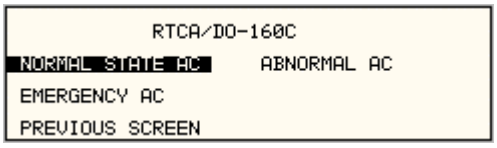


Figure 9-5: DO160 Main Menu

9.2.4.1 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 9-6

Figure 9-6: 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

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.

9.2.4.1.1 VOLT FREQ MIN

This test will change the output voltage from 115V to 104V and the output frequency from 400 Hz to 380 Hz. The test will last for 30 minutes. The ← Key (backspace) will terminate the test at any time.

9.2.4.1.2 VOLT FREQ MAX

This test will change the output voltage from 115V to 122V and the output frequency from 400 Hz to 420 Hz.. The test will last for 30 minutes. The ← Key (backspace) will terminate the test at any time.

9.2.4.1.3 VOLT UNBALANCE

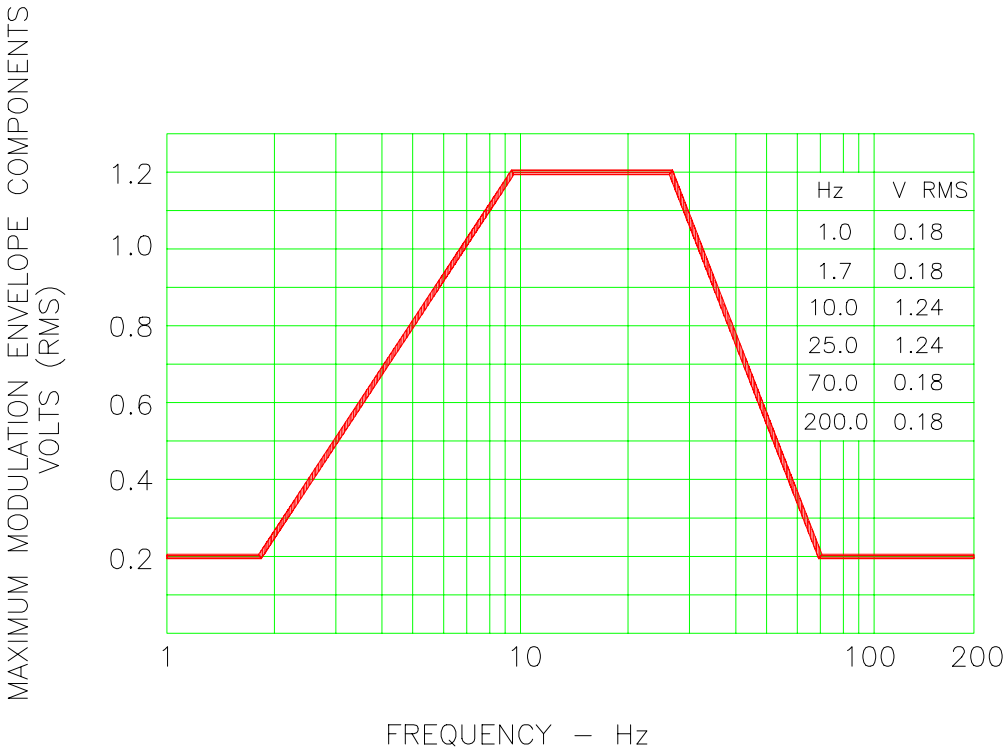
This test will set the output voltage to 112 volts for 5 minutes and to 118 volts for another 5 minutes before it returns to 115 volts. This test requires a three phase supply such as the 15003i, and not applicable for single phase. The ← Key will terminate the test at any time.

9.2.4.1.4 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 30 minutes. The ← Key (backspace) will terminate the test at any time.

9.2.4.1.5 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 9-7 . This test will last for 2 minutes.



FREQUENCY CHARACTERISTICS OF AC VOLTAGE MODULATION ENVELOPE

Figure 9-7: Voltage Modulation

9.2.4.1.6 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 9-8. This test will last for 2 minutes.

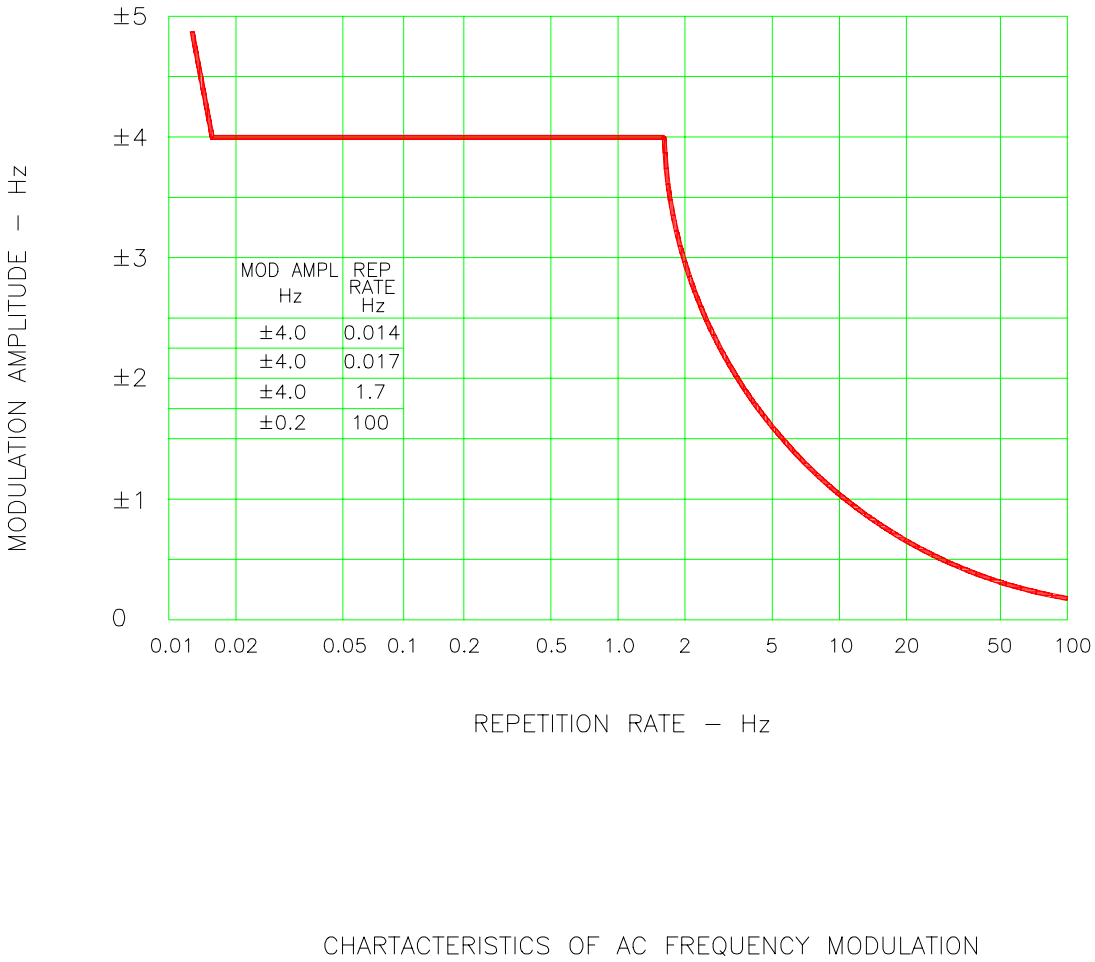
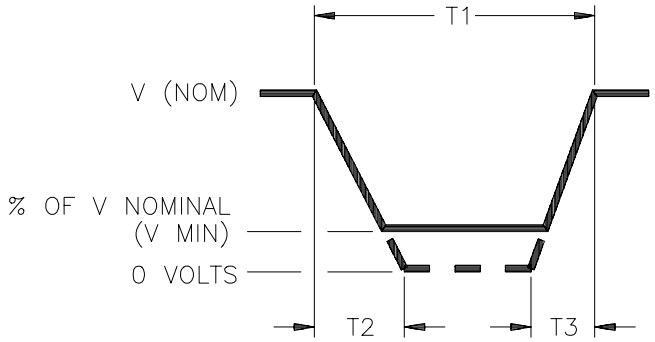


Figure 9-8: Frequency Modulation

9.2.4.1.7 POWER INTERRUPT

This test requires numeric data entry from 1 through 15. This value represent the test number. Refer to Figure 9-9 for characteristic of each test.



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 appliedvoltage 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 and V MIN = ±10%

TEST CONDITION NO.	1	2	3	1	5	6	7	8	9	10	11	12	13	14	15
T1 (MILLISECONDS)	2	10	25	50	75	100	200	1000	10	25	50	75	100	200	1000
T2 (MILLISECONDS)	<1	20*	20	20	20	20	20	20	50*	50*	50	50	50	50	50
T3 (MILLISECONDS)	<1	5	5	5	5	5	5	5	20	20	20	20	20	20	20
% OF V NOMINAL (V MIN)	0	50	15	10	5	0	0	0	20	50	0	15	5	0	0

* VOLTAGE WILL NOT REACH ZERO IN THIS TEST CONDITION.

Figure 9-9: Power Interrupt

9.2.4.1.8 VOLTAGE SURGE

This test require 160 volt output voltage. 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 automatticaly

The output voltage will remain at 115 volts for 5 minutes before the output voltage surges to 160 volts for 30 msec. The output voltage will remain at 115 volts for 5 seconds before it drops to 60 volts for 30 msec. The output voltage will remain at 115 volts for another 5 seconds. The above sequence will be repeated 2 more times before completion of the test. The ← Key will terminate the test at any time.

9.2.4.2 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 9-10.

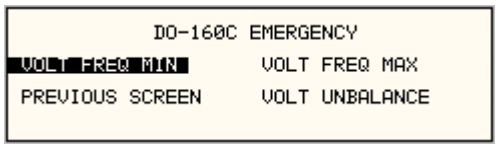


Figure 9-10: Emergency Screen

The EMERGENCY SCREEN has the following test:

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.

9.2.4.2.1 VOLT FREQ MIN

This test will set the output voltage to 104 volts and the output frequency to 360 Hz. The test will last for 30 minutes before it returns to 115 volts and 400 Hz. The ← Key (backspace) will terminate the test at any time.

9.2.4.2.2 VOLT FREQ MAX

This test will set the output voltage to 122 volts and the output frequency to 440 Hz. The test will last for 30 minutes before it returns to 115 volts and 400 Hz. The ← Key (backspace) will terminate the test at any time.

9.2.4.2.3 VOLT UNBALANCE

This test will set the output voltage to 111 volts for 5 minutes and to 119 volts for another 5 minutes before it return to 115 volts. This test requires a three phase supply and not applicable for single phase.

9.2.4.3 Abnormal Test

Form 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 9-11.

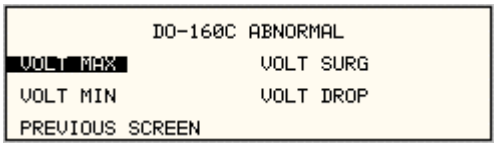


Figure 9-11: Abnormal Screen

The ABNORMAL SCREEN has the following test:

1. VOLT MAX
2. VOLT MIN
3. VOLT SURG
4. VOLT DROP

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.

9.2.4.3.1 VOLT MAX

This test will set the output voltage to 135 volts for 5 minutes before it returns to 115 volts. The ← Key (backspace) will terminate the test at any time.

9.2.4.3.2 VOLT MIN

This test will set the output voltage to 97 volts for 5 minutes before it returns to 115 volts. The ← Key (backspace) will terminate the test at any time.

9.2.4.3.3 VOLT SURGE

This test requires 180 volt output voltage. 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 msec. 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.

9.2.5 Remote Control

The following are the remote commands set for DO-160C. ABORt command will terminate the test in progress at any time. Status checking via *OPC?; using *OPC 1 after DO160 command. This may be relevent for ATE applications in view of long test times.

DO160:NORMal:VOLT_FREQ :MINinum
DO160:NORMal:VOLT_FREQ :MAXimum
DO160:NORMal :WAVeform :DISTortion
DO160:NORMal:VOLTage :MODulation <numeric>
DO160:NORMal:FREQency :MODulation <numeric>
DO160:NORMal:VOLTage :INTerrupt <numeric>
DO160:NORMal:VOLTage :SURG

DO160:EMERgency :VOLT_FREQ :MINimum
DO160:EMERgency :VOLT_FREQ :MAXimum
DO160:EMERgency :VOLTage :UNBalance

DO160:ABNormal stage :VOLTage :MINimum
DO160:ABNormal state :VOLTage :MAXimum
DO160:ABNormal stage :VOLTage :UNDer
DO160:ABNormal state :VOLTage :OVER

9.3 IEC1000-4-11 - Option

9.3.1 General

The IEC411 option is capable of performing IEC1000-4 section 11 Voltage dips, short interruptions and voltage variations immunity tests. This option is available in single phase AC Source. In three phase AC Source, this option is available from the GUI (Graphical user interface) with the IEEE488 interface. When used in a three phase system (15003I) through the GUI, a slight delay will occur between transitions on each individual phase. The user can select one, two or all three phases to be active during the IEC1000-4-11 tests in this configuration.

9.3.2 Initial Setup

The user must set the operating frequency and voltage as well as close the output relay prior to the start of test. It is possible to change the normal voltage (Ut) from the IEC1000-4-11 menu's before running each test.

9.3.3 Tests Performed

9.3.3.1 Dips and Interruptions

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

9.3.3.2 Voltage Variations

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

9.3.4 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 9-12.

Figure 9-12: 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 9-13.

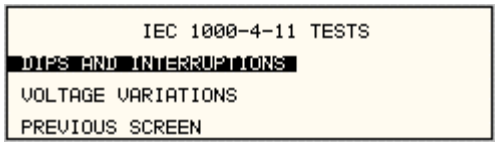


Figure 9-13: IEC1000-4-11 Menu

9.3.4.1 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 Figure 9-14.

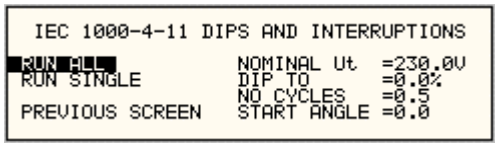


Figure 9-14: IEC Dips and Interrupts

9.3.4.1.1 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 ø	10
4	0	5	45,90,135	3 at diff ø	10
5	0	10	90,135,180	3 at diff ø	10
6	0	25	180,225,270	3 at diff ø	10
7	0	50	270,315,0	3 at diff ø	10
8	40	0.5	0	3	10
9	40	0.5	180	3	10
10	40	1	0,45,90	3 at diff ø	10
11	40	5	45,90,135	3 at diff ø	10
12	40	10	90,135,180	3 at diff ø	10
13	40	25	180,225,270	3 at diff ø	10
14	40	50	270,315,0	3 at diff ø	10
15	70	0.5	0	3	10
16	70	0.5	180	3	10
17	70	1	0,45,90	3 at diff ø	10
18	70	5	45,90,135	3 at diff ø	10
19	70	10	90,135,180	3 at diff ø	10
20	70	25	180,225,270	3 at diff ø	10
21	70	50	270,315,0	3 at diff ø	10

The user can change the NOMINAL Ut 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.

9.3.4.1.2 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 seconds delay is inserted.

9.3.4.2 Voltage Variation Tests

From the IEC1000-4-11 Main Menu screen shown in Figure 9-13. Scroll to 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 9-15.

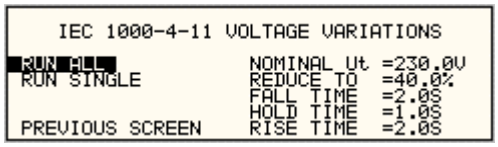


Figure 9-15: Voltage Variation screen

9.3.4.2.1 RUN ALL

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

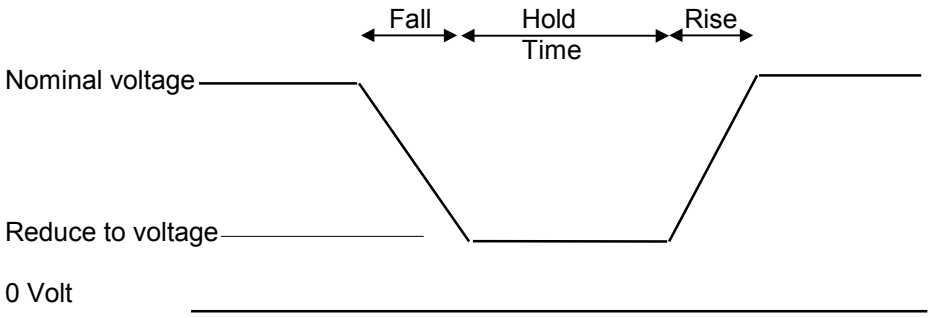
Step	Type	Start V in % of U_T	Dwell time	End V in % of U_T	Delay between steps (s)
1	VSweep	100	2	40	0
2	Hold	40	1	40	0
3	VSweep	40	2	100	10
4	VSweep	100	2	40	0
5	Hold	40	1	40	0
6	VSweep	40	2	100	10
7	VSweep	100	2	40	0
8	Hold	40	1	40	0
9	VSweep	40	2	100	10
10	VSweep	100	2	0	0
11	Hold	0	1	0	0
12	VSweep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

The user can change the NOMINAL Ut 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.

9.3.4.2.2 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.
FALL TIME:	The time in seconds it will take the output to reach the REDUCE TO voltage.
HOLD TIME:	The time in seconds the output will hold at the REDUCE TO voltage.
RISE TIME:	The time in seconds the output will reach the NOMINAL voltage from the REDUCE to voltage



9.3.5 Remote Control

The following are the remote commands set for IEC1000-4-11. The ABORt command will terminate the test in progress at any time. Test completion can be checked using the *OPC? query if the *OPC 1 command is issued immediately after an IEC1000-4-11 command. Upon completion of the test run *OPC? will return a 1. This may be relevant for ATE applications in view of long test times.

```
IEC411:
        [:NOMinal]
                :VOLTage
        :DIPS
                :RUN
                        [:ALL]
                        :SINGle
                :VOLTage
                        [:PERCent]
                :CYCLes
                :ANGLe
        :VARiants
                :RUN
                        [:ALL]
                        :SINGle
                :HOLD
                        :TIME
                        :VOLTage
                                [:PERCent]
                :FALL
                        [:TIME]
                :RISE
                        [:TIME]
```

10. Index - Section 1