Model 5100 AC/DC Source

Hardware Reference Manual

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TABLE OF CONTENTS

1. MODEL 5100 AC/DC SOURCE

1.1 Introduction

The NH Research Model 5100 AC/DC Source was designed to provide 3000 Watts of output from a single phase 240V input with the ability to provide peak currents up to 200 Amps. Its operation is unique from most PWM sources in that the output is DC coupled to the load (no output transformer), both in the AC and DC modes of operation.

1.2 Features

The AC/DC Source uses input power factor correction to pull maximum rated power from a single-phase line supply varying from 90 - 265 VAC RMS. In AC mode, the large peak current output capacity allows testing of switching supplies with input current crest factors of up to eight to one. In DC mode, the four quadrant output capability allows discharge of capacitive DC loads much faster than traditional sources. The source has multiple output voltage ranges and a constant power envelope to provide a wide variety of maximum current and voltage capabilities.

Another feature is remote sense capability (true RMS volts in AC, average volts in DC) to compensate for losses in fixture wiring and give an accurate match between the programmed set value and the voltage seen by the UUT. The source also has a programmable current limit for AC RMS current and DC average current, as well as staged hardware current limits to allow peak current delivery to the UUT while protecting the unit from damage.

The output waveform generation and RMS value calculations are performed by an onboard DSP device for fast measurement and command response times. All the microcode for the DSP and the communication microcontroller is stored in FLASH memory so that firmware upgrades can be performed in the field by downloading over the serial interface.

Separate safety interlock inputs are provided for AC and DC operation. If the interlock signal loop becomes open, the Source output power bridge will be tri-stated immediately and the source output will then perform the normal output off sequence.

The output of the source is completely isolated from the line supply and chassis ground. Control communication with the source is over the NH S6000 family serial bus, which provides isolation between the host computer and any source or load outputs.

1.3 Software Commands

Several output commands are available to control the output of the source and perform measurements using the internal metering circuits. The operations available are;

- Reset the source
- Turn the output on or off
- Set the operating mode to AC or DC output
- Set output voltage and current limit
- Set current measurement range
- Set output voltage range
- Set output voltage frequency
- Set frequency and voltage sweep rates
- Set turn on/turn off phase angle
- Set peak clamping voltage with associated cycle count
- Enable/disable remote sense
- Enable/disable output sync pulse

- Set trigger control
- Set fast (reduced accuracy) or normal (specified accuracy mode)
- Set current trip level and delay
- Read output voltage, current, and real power
- Read peak output current with cycle of occurrence
- Read status and configuration

See the Powerflex Notebook Users Manual - NH document 09-0208 for more detail on the command set.

1.4 Safety Features

1.4.1 Hardware Interlocks

The source has separate safety interlock inputs for AC and DC mode of operation, as well as an S6000 family system interlock input. The AC/DC interlock inputs are on the front panel connector. Each interlock signal has a pair of pins which must remain connected by switch or relay contact for the Source output to be enabled. In AC mode, the AC interlock pins must remain connected to enable output and the DC interlock pin connection has no effect. In DC mode, the DC interlock pins must be connected and the AC interlock pins are ignored.

The S6000 system interlock pins are on the rear panel Comm In connector. These pins must remain connected for output to be enabled, regardless of the operating mode of the source.

Because the Source will provide AC and DC voltage on the same output pins, it is important to use the appropriate AC or DC interlock connection in any UUT fixturing to avoid damage from applying the wrong type of voltage. Using the front panel interlocks also provides a safety feature in preventing lethal voltage to be present on output pins which can be operator accessible.

Note: For safety, always use front panel interlock connections in fixture wiring.

Opening an interlock connection while the output is on will immediately disable the output of the source and set an error status. The output will not be re-enabled by re-connecting the interlock pins after opening. The Source must be sent an Output Off command before output can be re-enabled after an interlock open event.

1.5 Switches and Indicators

1.5.1 Indicators

The Power On indicator light on the front panel will light whenever the output relay is closed, enabling voltage to the output connector pins. An LED device is used for long life, however failure is always a possibility. When the light is on, output voltage is present, however voltage cannot be guaranteed to be absent if the light is off, since it may be due to failure of the LED.

The front panel on/off switch is also a circuit breaker. The switch is a rocker design which is turned OFF by pushing in at the bottom. If the breaker is tripped, the switch will go to the off position.

There are four LEDs viewable from the rear of the Source for diagnostic purposes;

Status indicator - yellow	Error indicator - red
Talk indicator - green	Listen indicator - green

The Status indicator will blink about once per second while the source is powered on to indicate normal operation of the command execution microcontroller. If this LED stops blinking, the microcontroller is not running correctly and a power on reset will be required.

The Error indicator is lit when the command execution microcontroller detects any of several errors, either in hardware, DSP communication, or command execution. The Error LED will usually remain lit until a Reset or Mode Change command is executed by the Source.

The Listen and Talk LEDs flash when commands or data are received, or responses sent.

1.5.2 Switch Settings

The address switch on the rear of the AC/DC Source unit is used to set a unique communication address for the Source on the S6000 family serial interface (see figure of rear panel below). Six switch positions are used to set the S6000 family module address. The seventh switch position is used for factory diagnostic purposes. Switch position eight is unused.

Switch position 7 should always be in the on/closed position for normal operation of the unit, otherwise errors may go unreported!

The connectors accessible from the rear of the base model AC/DC Source are all on, or cabled to, the Digital Control Board - with the exception of the line input terminal block. If the optional GPIB interface CPU board is installed, the connectors nearest the side of the chassis are mounted on that board.

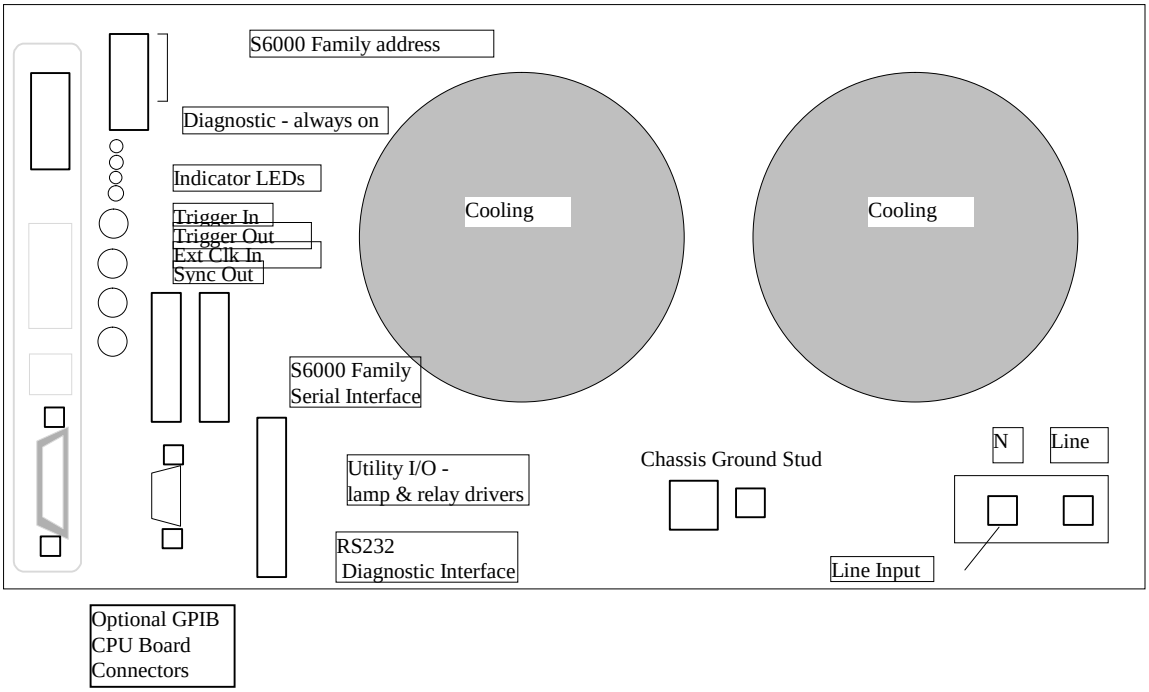

Figure 1.1 Rear View of Model 5100 AC/DC Source

Rack Mount Dimensions:

24.0 Inch depth requirement

8.75 inch rack height

19.0 inch wide rack requirement

Weight 80 lbs

Air cooled - 4 inch rear exhaust zone and unrestricted front intake zone

1.6 Connector Pinouts

1.6.1 Input Terminal Block

The line input terminal block and grounding stud are used to supply power to the AC/DC Source. The terminal block should be connected to a single phase input from 90-280 VAC RMS, 50-60 Hz. The line input has no polarity and can be connected to the terminal block lugs in any orientation. The chassis grounding stud should be returned to earth ground.

1.6.2 Front Panel Output Power/Interlock Connector

Pin	Signal	Description
A1	Output Voltage +	0 to 280 VAC RMS, 0 to 400 VDC, 40 A maximum per pin continuous
A2	Output Voltage +	0 to 280 VAC RMS, 0 to 400 VDC, 40 A maximum per pin continuous
1	Remote Voltage Sense +	0 to 420 V Peak input maximum
2-3	No Connect	Reserved to maintain voltage isolation
4	DC Interlock	TTL input with 10K Ohm pull up resistor to chassis-referenced 5V supply (not isolated)
5	DC Interlock Return	Logic ground, chassis-referenced (not isolated)
6-8	No Connect	Reserved to maintain voltage isolation
9	Remote Voltage Sense -	0 to -420 V Peak input maximum
10-12	No Connect	Reserved to maintain voltage isolation
13	AC Interlock	TTL input with 10K Ohm pull up resistor to chassis-referenced 5V supply (not-isolated)
14	AC Interlock Return	Logic ground, chassis-referenced (not isolated)
15-17	No Connect	Reserved to maintain voltage isolation
A3	Output Voltage -	0-280 VAC RMS, 0-400 VDC, 40 A maximum per pin continuous
A4	Output Voltage -	0-280 VAC RMS, 0-400 VDC, 40 A maximum per pin continuous

Wiring to the power pins should be AWG 8 maximum to AWG 12 minimum.

For output to be enabled in AC mode, AC Interlock and AC Interlock Return must be connected together through a relay or switch contact. For output to be enabled in DC mode, DC Interlock and DC Interlock Return must be connected through a relay or switch contact

Note: The remote sense leads must be connected to the supply outputs. They should be connected to the supply outputs at the load connection terminals to compensate for voltage drop over fixture wiring. They can be connected at the source outputs if compensation is not required.

Mating Connector type is:

NH Part	Description	Commercial Part #	Manufacturer
6200527	DSUB 17 - 4 coax	DCM-21 WA4P	ITT CANNON
6200561	DSUB contact 40 A	DM 53745-1	ITT CANNON
6200927	DSUB shell	DCM 24660	ITT CANNON
6201309	DSUB Screw Lock	D20419-21	ITT CANNON

1.6.3 S6000 Master/Slave Connections - Digital Control Board J5/J6 - DB15

	COMM OUT - FEMALE		COMM IN - MALE
1	TX_IN-	1	TX_IN-
2	TRIGIN+	2	TRIGIN+
3	No Connect	3	GND
4	TX_IN+	4	TX_IN+
5	INTLKIN+	5	INTLKIN+
6	INTLKIN-	6	INTLKIN-
7	LCLOUT0+	7	LCLIN0+
8	LCLOUT-	8	LCLIN0-
9	RX_IN-	9	RXOUT-
10	TRGOUT+	10	TRGOUT+
11	TRGOUT-	11	TRGOUT-
12	RX_IN+	12	RXOUT+
13	TRIGIN-	13	TRIGIN-
14	LCL1OUT+	14	LCLIN1+
15	LCL1OUT-	15	LCLIN1-

Signal levels on this connector are differential with levels conforming to RS422 specification.

Mating connector type is:

NH Part	Description	Commercial Part #	Manufacturer
6200844	DSUB 15 Socket (COMM IN)	DA15S	ITT CANNON
6200799	DSUB 15 Plug (COMM OUT)	DA15P	ITT CANNON
6200800	DSUB Shell	DA24658	ITT CANNON
6201309	DSUB Screw Lock	D20419-21	ITT CANNON

The COMM IN connector should have a jumper between pins 3 and 5 to close the system interlock.

1.6.4 RS232C Connector - Digital Control Board J7 - DB9

Pin	Description
1	No Connect
2	TX
3	RX
7	RTS
5	GND - logic

Signal levels on this connector conform to RS232C signal levels.

Mating Connector type is:

NH Part	Description	Commercial Part #	Manufacturer
6202014	DSUB 9 Plug	DE9P	ITT CANNON
6201698	DSUB Shell	DE24657	ITT CANNON
6201309	DSUB Screw Lock	D20419-21	ITT CANNON

This connector pin out will mate with a PC compatible nine pin RS232 port if a one-to-one four wire cable is used. This connection is normally used for factory configuration and diagnostic operations, not for control of the source in a test system. Jumpers inside the source must be set to enable RS232 control.

1.6.5 Utility I/O Connector - Digital Control Board J8 - DB25

Pin	Description	Signal Type
1	AC On Lamp Res.	Relay/lamp driver - 200 mA sink to GND with 10 ohm series resistor
2	DC On Lamp	Relay/lamp driver - 500 mA sink to GND
3	Range 1 Lamp	Relay/lamp driver - 500 mA sink to GND
4	8V	Chassis referenced regulated 500 mA 8V source - not isolated
5	GND	Logic ground (chassis referenced/non-isolated)
6	AC Present -	Isolated open collector NPN emitter
7	DC Present -	Isolated open collector NPN emitter
8	Voltage monitor	Isolated amplifier output, ± 10V full scale, 10 ma drive
9	Current Monitor	Isolated amplifier output, ± 5V full scale, 10 ma drive
10	No connect	
11	RS_ TX+	RS232 Differential positive
12	I Loop RX	Not used
13	I Loop 5V	Not used
14	SPARE	
15	AC On Lamp	Relay/lamp driver - 500 mA sink to GND
16	Range 2 Lamp	Relay/lamp driver - 500 mA sink to GND
17	5V	Chassis referenced regulated 500 mA 5V source - not isolated
18	GND	Logic ground (chassis referenced/non-isolated)
19	AC Present +	Isolated open collector NPN collector with 10.0K pull-up to +5V
20	DC Present +	Isolated open collector NPN collector with 10.0K pull-up to +5V
21	GND	Logic ground (chassis referenced/non-isolated)
22	GND	Logic ground (chassis referenced/non-isolated)
23	No connect	
24	RS_ TX-	RS232 Differential negative
25	I Loop RTN	Not used

Mating Connector type is:

NH Part	Description	Commercial Part #	Manufacturer
6200644	DSUB 25 Plug	DB25P	ITT CANNON
6201298	DSUB Shell	DB24659	ITT CANNON
6201309	DSUB Screw Lock	D20419-21	ITT CANNON

1.6.6 Clock and Trigger Connectors - Digital Control Board J1-J4 - SMB

Connector	Description
Trigger In	Positive true TTL level signal with 1K Ohm pull-down to logic ground
Trigger Out	Positive true TTL level output, 74ACT244 driver with 50 Ohm series resistor
Ext Clock In	Positive true TTL level signal with 1K Ohm pull-down to logic ground
Sync Out	Positive true TTL level output, 74ACT244 driver with 50 Ohm series resistor

Mating Connector type is:

NH Part	Description	Commercial Part #	Manufacturer
6200262	SMB coax 50 Ohm	131-1403-016	EF JOHNSON

This connector is used with RG178 type 50 ohm coaxial cable.

1.7 AC Source Specs

1.7.1 Output Voltage Waveform

Description	Specification	Note
PARD RMS (30kHz to 20MHz)	-60db FS Max	
Distortion	1% THD Typ @ 60Hz	
Frequency Range	40 to 500Hz	2
Frequency Resolution 40-326Hz	0.01Hz	
Frequency Resolution 327-500Hz	0.02Hz	
Frequency Accuracy	0.01%	
Frequency Slew Rate Range	0.5 to 16383 Hz/Sec	1
Frequency Slew Rate Resolution	0.5 Hz/Sec	1
Frequency Slew Rate Accuracy	1%	1
Turn-on Phase Angle Range	0 to 360 deg	1
Turn-on Phase Angle Resolution	2 degrees	1
Turn-on Phase Angle Accuracy	5 degrees ±0.05 deg/Hz	1
Envelope Slew Rate Range	10 to 327670 V/Sec	1
Envelope Slew Rate Resolution	10V/Sec	1

Envelope Slew Rate Accuracy	5%	
Cycle Dropout	1 to 10	
Load Power Factor	0 to 1 Lead or Lag	
Isolation	1000VDC	

1.7.2 Output Power

Description	Specification	Note
Power Limit 180-265VAC in	4.5kVA, 3kW	
Power Limit 90 -180VAC in	3kVA, 1.5kW	
Power Capability Transient	24kVA, Max, 1/2 cycle	3
Power Metering Range	Volt Range times Amp Range	
Power Metering Resolution	50mW	1
Power Metering Accuracy	0.1% + 0.1% Typical	4

1.7.3 Output Voltage

Description	Specification	Note
Set Voltage 140V range	0 to 140V	
Set Voltage 280V range	0 to 280V	
Set Voltage 350V range	0 to 350V	7
Set Voltage Resolution	12mV	1, 7
Set Voltage Accuracy	0.1% + 0.1%	4, 7
Set Voltage Accuracy with Remote Regulation Enabled	0.1% + 0.1%	4
Load Regulation 140V range	1%	
Load Regulation 140V range Remote Regulation Enabled	0.05%	
Load Regulation 280V range	0.5%	
Load Regulation 280V range Remote Regulation Enabled	0.05%	
Load Regulation 350V range Remote Regulation Enabled	1%	7
Line Regulation 140V range	0.05%	
Line Regulation 280V range	0.05%	
Line Regulation 350V range	1%	7
Meter Voltage 140V range	0 to 140V True RMS	
Meter Voltage 280V range	0 to 280V True RMS	
Meter Voltage 350V range	0 to 350V True RMS	7
Meter Resolution 280V range	12mV	1
Meter Accuracy 280V range	0.05% + 0.1%	4

1.7.4 Output Current

Description	Specification	Note
Meter Current 2A range	0 to 2A True RMS	
Meter Current 5A range	0 to 5A True RMS	
Meter Current 12.5A range	0 to 12.5A True RMS	7
Meter Current 25A range	0 to 25A True RMS	
Meter Resolution 2A range	0.5mA	1
Meter Resolution 5A range	1mA	1
Meter Resolution 12.5A range	2mA	1
Meter Resolution 25A range	6mA	1
Meter Accuracy 2A range	0.1% + 0.1%	4, 7
Meter Accuracy 5A range	0.1% + 0.1%	4, 7
Meter Accuracy 12.5A range	0.1% + 0.1%	4, 7
Meter Accuracy 25A range	0.1% + 0.1%	4
Peak Metering 15A Range	0 to 15A	1
Peak Metering 30A Range	0 to 30A	1
Peak Metering 75A Range	0 to 75A	1
Peak Metering 200Range	0 to 200A	1
Peak Resolution 15A Range	0.5mA	1
Peak Resolution 30A Range	1mA	1
Peak Resolution 75A Range	2mA	1
Peak Resolution 200Range	6mA	1
Peak Accuracy 15A Range	1% range	1, 7
Peak Accuracy 30A Range	1% range	1, 7
Peak Accuracy 75A Range	1% range	1, 7
Peak Accuracy 200Range	1% range	1
RMS Current Limit	0.2% + 0.2%	6, 7

1.8 DC Source Specs

1.8.1 Output Power

Description	Specification	Note
Power Capability 180 - 265VAC in	3kW Max	
Power Capability 90 -180VAC in	1.5kW Max	
Power Capability Transient	24kW, 5mS	3
Power Metering Range	Volt Range times Amp Range	
Power Metering Resolution	50mW	1
Power Metering Accuracy	0.1% + 0.1% Typical	4

1.8.2 Output Voltage

Description	Specification	Note
Set Voltage ±100V Range	±100V	
Set Voltage ±200V Range	±200V	
Set Voltage ±400V Range	±400V	
Set Resolution ±100V Range	3mV	1
Set Resolution ±200V Range	6mV	1
Set Resolution ±400V Range	12mV	1
Set Accuracy ±100V Range	0.1% + 0.1%	4
Set Accuracy ±100V Range with Remote Regulation Enabled	0.1% + 0.1%	4
Set Accuracy ±200V Range	0.1% + 0.1%	4
Set Accuracy ±200V Range with Remote Regulation Enabled	0.1% + 0.1%	4
Set Accuracy ±400V Range	0.1% + 0.1%	4
Set Accuracy ±400V Range with Remote Regulation Enabled	0.1% + 0.1%	4
Load Regulation ±100V Range	2%	
Load Regulation ±100V Range with Remote Regulation Enabled	0.05%	
Load Regulation ±200V Range	1%	
Load Regulation ±200V Range with Remote Regulation Enabled	0.05%	
Load Regulation ±400V Range	0.5%	
Load Regulation ±400V Range with Remote Regulation Enabled	0.05%	
Line Regulation ±100V Range	0.05%	
Line Regulation ±200V Range	0.05%	

Description	Specification	Note
Line Regulation ±400V Range	0.05%	
Meter Voltage ±100V Range	±100V	
Meter Voltage ±200V Range	±200V	
Meter Voltage ±400V Range	±400V	
Meter Resolution ±100V Range	3mV	1
Meter Resolution ±100V Range	6mV	1
Meter Resolution ±100V Range	12mV	1
Meter Accuracy ±100V Range	0.05% + 0.1%	4
Meter Accuracy ±200V Range	0.05% + 0.1%	4
Meter Accuracy ±400V Range	0.05% + 0.1%	4
Output Isolation	1000VDC	
Dynamic response	90% 10mS set accuracy 100mS	
PARD RMS (20Hz to 20mhz) ±100V Range	-70db	
PARD RMS (20Hz to 20mhz) ±200V Range	-70db	
PARD RMS (20Hz to 20mhz) ±400V Range	-70db	

1.8.3 Output Current

Description	Specification	Note
Meter Current ±5A Range	±5A	
Meter Current ±12.5A Range	±12.5A	
Meter Current ±25A Range	±25A	
Meter Current ±50A Range	±50A	
Meter Resolution ±5A Range	0.5mA	1
Meter Resolution ±12.5A Range	1mA	1
Meter Resolution ±25A Range	2mA	1
Meter Resolution ±50A Range	6mA	1
Meter Accuracy ±5A Range	0.1% + 0.1%	4
Meter Accuracy ±12.5A Range	0.1% + 0.1%	4
Meter Accuracy ±25A Range	0.1% + 0.1%	4
Meter Accuracy ±50A Range	0.1% + 0.1%	4
Meter Peak ±5A Range	±15A	1
Meter Peak ±12.5A Range	±30A	1
Meter Peak ±25A Range	±75A	1
Meter Peak ±50A Range	±200A	1
Meter Peak Accuracy ±5A Range	1% range	1
Meter Peak Accuracy ±12.5A Range	1% range	1
Meter Peak Accuracy ±25A Range	1% range	1
Meter Peak Accuracy ±50A Range	1% range	1
Average Current Limit	0.2% + 0.2%	6

1.9 Common Specifications

1.9.1 Input Power

Description	Specification	Note
3000W out	180-265VAC, 1∅	
1500W out	90-180VAC, 1∅	
Input Current	22A	5
Inrush Current	50A peak	
Power Factor	>0.99	
Frequency	47 to 63Hz	
EMI	Mil Std 461C	
Leakage Current	10mA Max	

1.9.2 Other Features

Description	Specification	Note
Voltage Monitor Range	±10VDC or 7.07V RMS	
Voltage Monitor Accuracy	5% FS	
Current Monitor Range	±10VDC or 7.07V RMS	
Current Monitor Accuracy	5% FS	

1.10 Notes

1. Guaranteed by design.
2. Source will operate over frequency range, but is only specified at 50 and 60Hz.
3. Peak power was not directly measured, but implied by peak current and voltage measurements.
4. Accuracies are specified as % of reading + % of range at 23°C ± 5°C. Voltage set and metering accuracy is not guaranteed. It is only accurate when operated at the temperature calibrated. May be off as much as 0.5% when operated at 50°C.
5. With nominal input line, up to 30A peak with low input line.
6. Current limit Range and Resolution is the same as metered current. Hardware current limit tested at >200A peak and >50A continuous with no failures.
7. Voltage Range 0 to 350VAC only available with NHR5100A ordered with “High Voltage Boost” (NHR Part N0. 15-1311)
   All Voltage and Current Set Points and all Voltage, Current, VA and Power readback in this range have tolerances of +/- 1 % of reading plus +/- 1 % of full scale except Peak current metering accuracy in this voltage range is +/- 2 % of reading plus +/- 2 % of full scale.
   Maximum current limit available in this voltage range is 10 Amps.
   Maximum current trip available in this voltage range is 11 Amps.
8. Noncondensing humidity < 75% R.H.

1.11 AC/DC Input and DC/DC Converter Block Diagrams

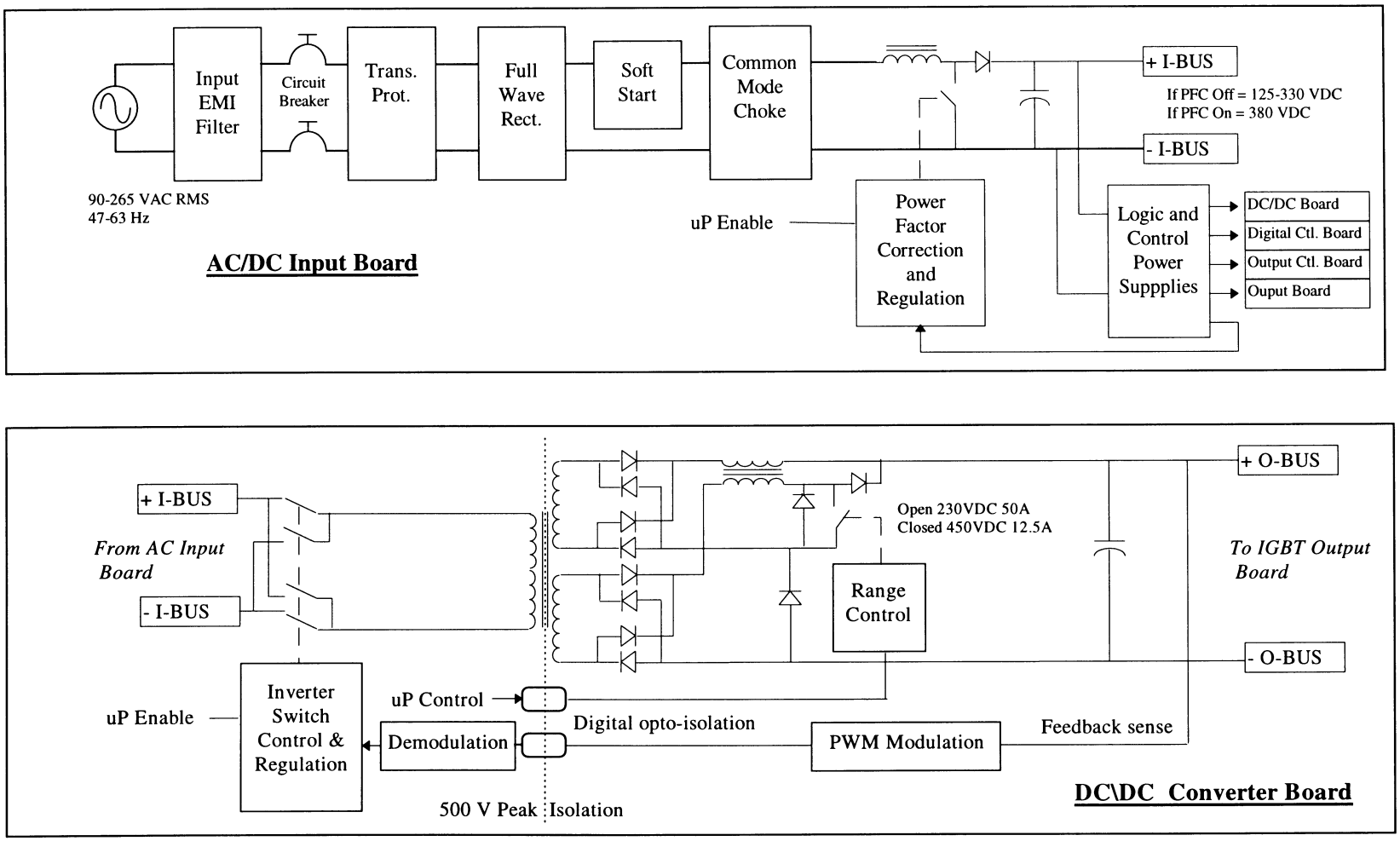

Figure 1.2

1.12 Output Block Diagrams

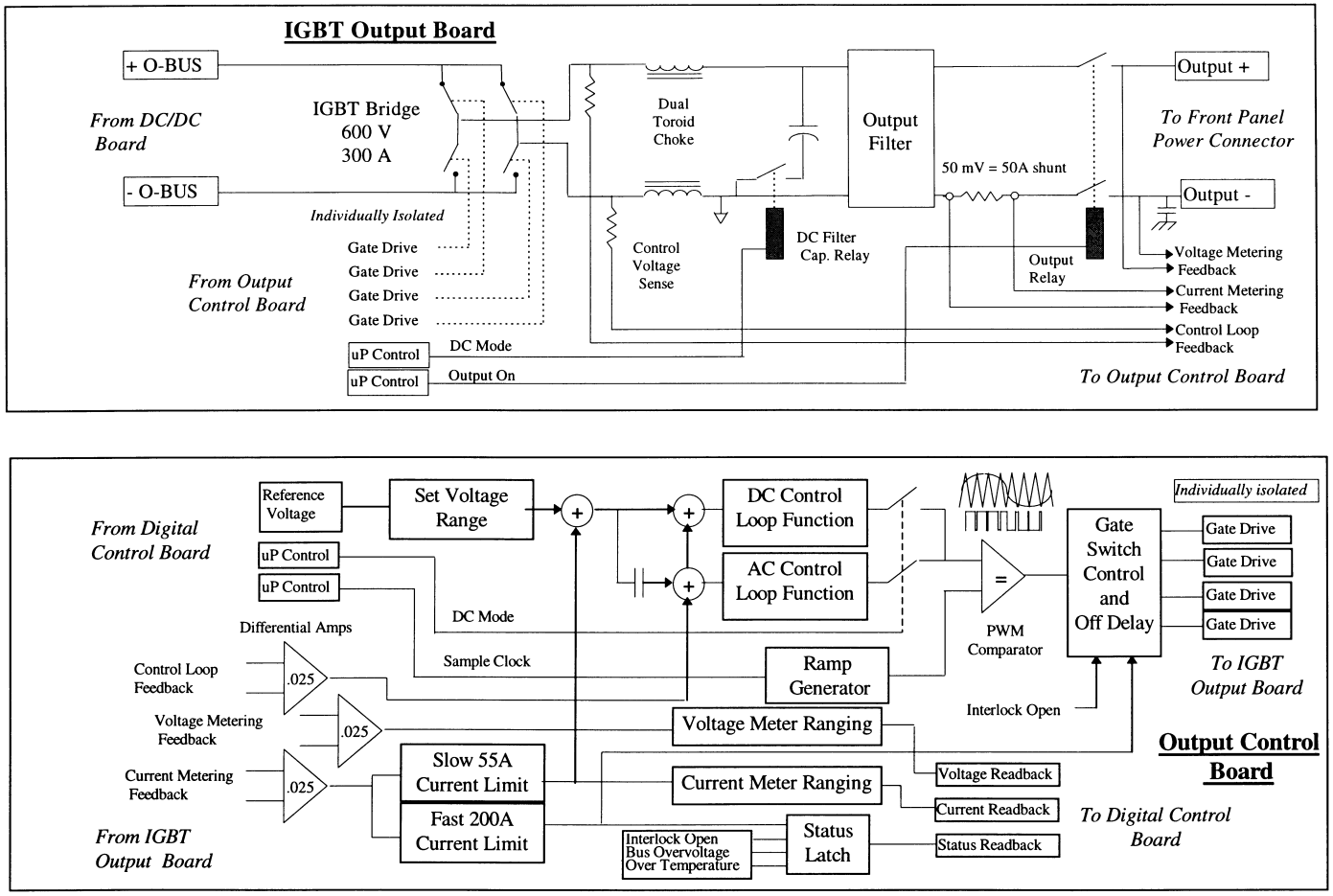

Figure 1.3

1.13 Digital Control Block Diagrams

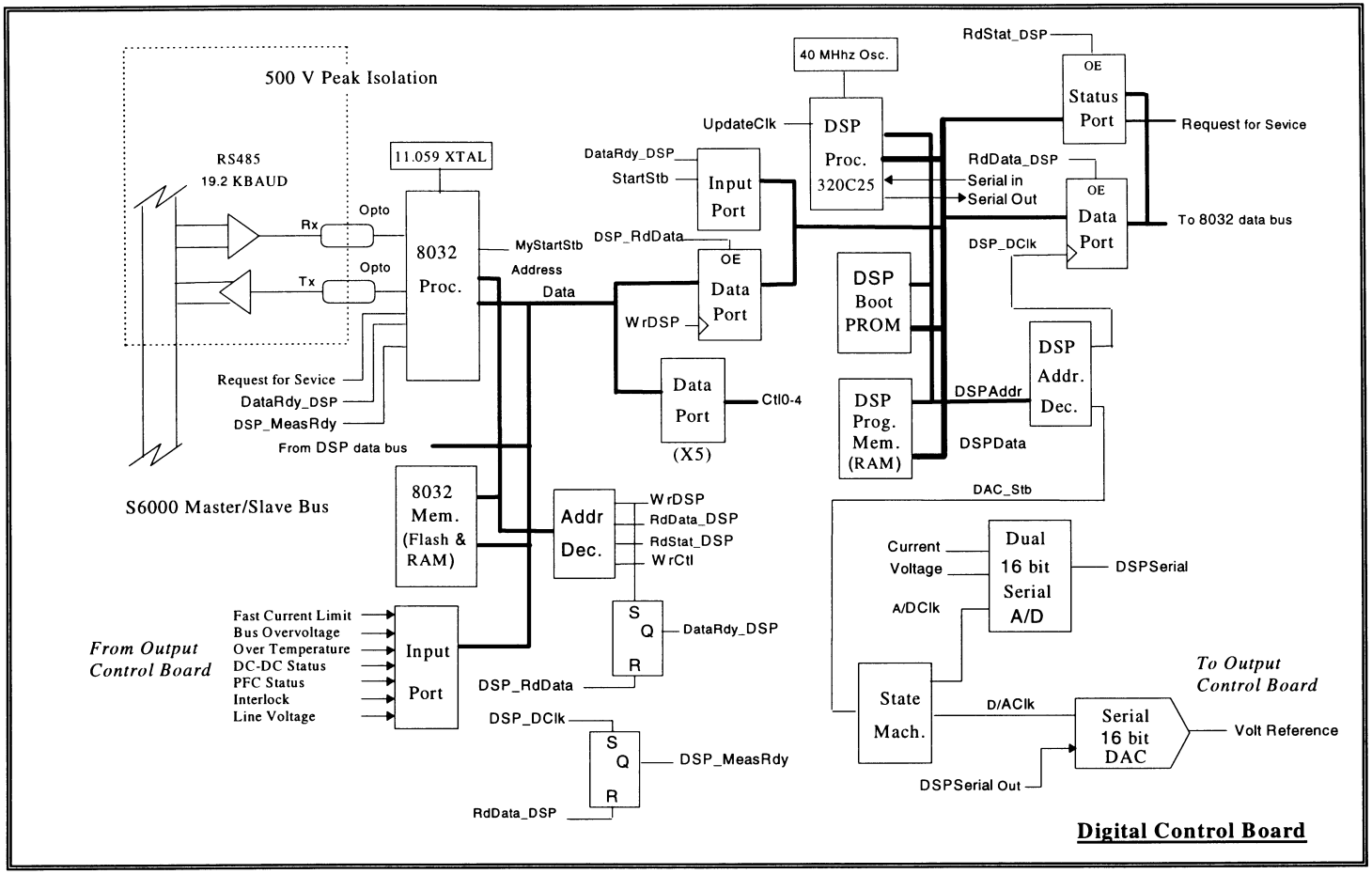

Figure 1.4