OPERATION MANUAL

Date: 3/17/08

Revision: Original

This manual covers:

SPS Series 3.3kW ~ 45kW Programmable DC Switching Power Supplies

K-Type Front Panel

AMERICAN RELIANCE, INC.
3445 Fletcher Ave., El Monte, CA 91731
Ph: (626) 443-6818 E-mail:ariinfo@amrel.com
Website: www.amrel.com

WARRANTY INFORMATION

CERTIFICATION

American Reliance certifies that this product met its published specifications at time of shipment from the factory.

THREE-YEAR LIMITED WARRANTY

American Reliance warrants to the original user or purchaser that your unit is free from any defects in material or workmanship for a period of three years from the date of purchase. If any defect is discovered within the warranty period, American Reliance will repair or replace the unit, subject to verification of the defect or malfunction, upon delivery or prepaid shipment to American Reliance.

IMPORTANT:

(1) Unless a problem is discovered upon initial inspection after purchase of the unit, please do not return the product to the distributor where it was purchased. American Reliance Inc. accepts the responsibility of keeping the customer satisfied.

(2) If the customer's product requires troubleshooting, warranty service or need a RMA number for return, contact your merchant. Or if you are unable to contact your merchant, or the merchant is unable to provide service, contact American Reliance Inc. directly at:

Phone:	**626-443-6818**
Toll Free #:	**1-800-654-9838**
Fax:	**626-443-8600**
Email:	**ariinfo@amrel.com**

This warranty does not apply to defects or to physical damage resulting from abuse, neglect, accident, improper repair, alteration, or unreasonable use of the unit, resulting in (but not limited to) cracked or broken cases or parts, or to units damaged by excessive heat. Except upon initial purchase, this warranty does not cover finish or appearance items nor does it cover items damaged in shipment to American Reliance for repair or calibration. American Reliance assumes no responsibility for shipping and handling. However, repaired units will be shipped back to the customer with return shipping charges paid by American Reliance.

To receive service under this warranty, you must include proof of purchase; including date and place of purchase (a copy of your purchase receipt) or American Reliance will not be responsible for repairs or replacement of the unit under warranty.

Any applicable implied warranties, including warranties of merchantable and fitness for a particular use, are hereby limited to three years from the date of purchase. Consequential or incidental damages resulting from loss of use, or from a breach of any applicable express or implied warranties are hereby excluded.

This warranty is in lieu of all other agreements and warranties, general or specific, express or implied. No representative or person is authorized to assume for American Reliance any other liability in connection with the sale or use of this American Reliance product. Some states do not allow limitations on how long implied warranties last and do not allow exclusion of incidental or consequential damages, so the above limitations and exclusions may not apply to the customer. This warranty gives the customer specific legal rights, which may vary from state to state.

NON-WARRANTY SERVICE

Any American Reliance out-of-warranty instrument that is thought to be defective, but is repairable, may be sent in for non-warranty service. Please contact our service department at (800) 654-9838 for current repair charges.

Instrument to American Reliance, should follow the instruction under the heading "Shipping Instructions" in this section.

EXCLUSIVE REMEDIES

Remedies provided herein are the customer's sole and exclusive remedies. American Reliance Inc. shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any legal theory.

RMA RETURNS

Products returned for warranty and non-warranty service to American Reliance must be shipped, freight prepaid (COD will not be accepted).

American Reliance Inc.
3445 Fletcher Ave
El Monte, CA 91731
Attn: RMA # _____

- ***Please call our service department at 1-800-654-9838 to obtain a return authorization (RMA #) from AMREL before returning any product.***

The instrument must be carefully packed, preferably in its original carton, and should be accompanied by a letter or note containing the following information:

User's Name	Proof of Purchase
User's Address	Description of problem
Model number	Serial number

If service is desired, such as calibration, it must be stated in the enclosed letter. For non-warranty repairs, and for calibration, the correct service charge must accompany the unit in the form of a check or money order payable to American Reliance Inc. Please do not send cash. Contact our service department at (800) 654-9838. American Reliance will return the serviced instrument, with freight paid by American Reliance, via UPS ground service unless otherwise requested.

***NOTE: ALL INSTRUMENTS WHICH ARE RETURNED FOR REPAIR OR CALIBRATION MUST HAVE AN ASSIGNED R.M.A. NUMBER WRITTEN ON THE FRONT OF THE PACKAGE. THIS NUMBER MAY BE OBTAINED BY OUR SERVICE DEPARTMENT. ANY INSTRUMENT DELIVERED WITHOUT THIS NUMBER WILL BE REFUSED, AND RETURNED.**

TABLE OF CONTENTS

1.0 GENERAL INFORMATION

1.1 Description

This manual contains operation and maintenance instructions for AMREL's SPS Series, current fed power supplies. These power supplies are constant voltage/constant current sources suitable for a wide range of applications.

1.2 Features

AMREL's SPS Series combines the best of dc power processing with multiprocessor embedded control. A combination of high and medium frequency power processing technologies improves response, shrinks package size, and reduces cost. SPS Series power supplies are current fed and are more tolerant to abusive loads than conventional switching power supplies.

SPS Series power supplies can operate as a voltage source or current source depending on the control settings and load conditions. If the power supply is operating as a voltage source and the load increases to a point beyond the current command setting, the power supply automatically crosses over to current mode control and operates as a current source at that setting.

SPS Series power supplies incorporate an optically isolated feedback system. The result is, all user interface circuitry is referenced to earth ground -- not the negative terminal of the power supply. This enables users to connect external circuitry without concern of ground loops or voltage breakdown.

SPS Series power supplies offer both master/slave parallel and series operation. This enables two or more power supplies to be placed in parallel for increased output current or in series for increased output voltage. With master/slave operation, power supplies operate at near equal voltage and current.

SPS Series power supplies can be configured through the front panel for different applications. The power supply can be programmed to have its control functions accessible from the front panel, rear connector, or with RS232, optional IEEE-488, or optional Ethernet communications. External RS485 to RS232 and external USB to RS232 converters are also available to echo commands over the communications network. SPS Series power supplies support a full set of SCPI commands. Drivers are available for LabWindows/CVI and LabVIEW.

Sensing can be connected at the output terminal of the power supply or through a rear terminal block for sensing at the load. A smart remote sense detector checks whether or not sense leads are present eliminating the potential of uncontrolled operation. An

external interlock can be set to enable operation only when an external connection is made. Calibration is done electronically.

SPS Series power supplies have three levels of over voltage/current protection: shutdown of controlling insulated gate bipolar transistors (IGBT's), disconnect of main power, and input fuses. After an OV/OC Trip condition, the SPS must be reset.

SPS Series power supplies utilize user-friendly keypad and encoder for navigation and programmability. These controls are tied to a mechanical contactor which operates with the electronic switches to break the ac mains when OUTPUT OFF is commanded. Unlike competing products, an off means both an electrical and mechanical break in the power circuit — not a break in an electronic switch. Safety comes first at AMREL.

SPS Series power supplies are available with an all digital panel, keypad, encoder and VFD Display. With simple configuration changes, voltage, current, over voltage trip, and over current trip may be programmed from the rear connector or with RS232, IEEE-488, or optional Ethernet communications. Via the Keypad and Encoder, the voltage, current, OVP and OCP settings can be programmed. Through the Menu Options and local key strokes, interface configurations, V_{LIST}, I_{LIST} and other features such as Interlock and External Control capabilities. SPS Series models are well suited for laboratory applications requiring sophisticated control or industrial applications utilizing programmatic interfaces for ATE configurations.

The SPS Supplies provide 4 memory locations, each storing up to 20 voltage or current points for the V_{LIST} & I_{LIST} auto sequence function. Set points can be auto sequenced with preprogrammed dwell times or via external triggering, and can be repeated continuously to create a powerful function generator. In addition, over voltage , over current, interface, remote sense, external control & interlock parameters can be stored.

The SPS Series power supplies offer an analog input to modulate voltage/current setting using piecewise linear approximation. This feature enables the voltage/current setting to be adjusted by a sensor input, i.e. thermistor or monitoring its own voltage/current. Modulation allows output to be tailored for advanced process control applications, battery charging, and source emulation.

SPS Series models have extensive diagnostic functions -- all of which when activated take command to shut down the system and power supply will latch in protection mode, until it is cleared. Diagnostic functions include phase loss, excessive thermal conditions, over voltage trip, over current trip, fuse clearing, and program line. Program line monitors externally applied analog set point signals to insure they are within the specified range. Upon a diagnostic fault condition, main power is disconnected and the diagnostic condition is latched into memory. All diagnostic functions can be monitored through a rear connector. Furthermore, control functions can also be set through the rear connector to allow simultaneous control of one or more SPS Series units.

1.3 IEC Symbols Used in Manual

The following IEC symbols are used in this manual.

 Caution, risk of electric shock

 Caution, risk of danger

 Protective conductor terminal

 Three-phase alternating current

1.4 Power Requirements

SPS Series power supplies are manufactured to operate on 208/240 V, 380/415 V, or 440/480 V 50 to 400 Hz mains.

The standard operating voltage is 208 V, 3ϕ, 50 to 400 Hz unless otherwise specified at time of order. For conversion from 208 V to 240 V operation, two internal wiring changes must be made to each power module. The locations are not accessible to the user and the power supply must be returned to the factory for modification.

SPS power supplies are optionally available to operate on 380 V or 480 V, 3ϕ, 50 to 400 Hz mains. For conversion from 380 V to 415 V or from 480 V to 440 V operation, two internal wiring changes must be made to each power module. The locations are not accessible to the user and the power supply must be returned to the factory for modification.

1.5 Specifications

The following specifications describe the published operational characteristics of the SPS Series power supplies.

Input voltage:
208/240 Vac, 50-400 Hz, 3ϕ;
380/415 Vac, 50-400 Hz, 3ϕ;
440/480 Vac, 50-400 Hz, 3ϕ.

Line regulation:
Voltage Mode: ±.004% of full scale,

Current Mode: ±.02% of full scale.

Load regulation:
Voltage Mode: ±.01% of full scale,
Current Mode: ±.04% of full scale.

Stability: 0.10 % for 8 hours after 30 minute warm up.

Load transient response:
2 ms to recover within ±1% of regulated output with a 50% to 100% or 100% to 50% step load change.

Efficiency: greater than 86%, see Model and Ratings tables for details.

Temperature coefficient: 0.04 %/°C of maximum output current.

Isolation:
Maximum input voltage to ground: ±2500 Vac,
Maximum output voltage to ground: ±1000 Vdc,
User inputs and outputs: referenced to earth ground.

Power Factor: greater than 92% at maximum power.

Ambient Temperature: 0 to 50°C.

Water Cooling:
Inlet temperature: 25˚C maximum,
Flow rate:
- 1.5 GPM minimum for 15 kW units,
- 3.0 GPM minimum for 20 to 30 kW units,
- 4.5 GPM minimum for 45 kW units.

Pressure: 80 PSI maximum,
Pipe size: 1/4" NPT female.

Storage Temperature: -25 to +85°C.

Remote sense limits: 3% maximum voltage drop from output terminals to load.

Remote analog programming limits:
Voltage set point: 0-2.0 Vdc,
Current set point: 0-2.0 Vdc,
Over voltage trip set point: 0 to 2.2 Vdc,
Over current trip set point: 0 to 2.2 Vdc,
Modulation: 0 to 2.0 Vdc (D Version models only).

Remote analog programming accuracy of full scale:
Voltage set point: ±.50%,
Current set point: ±.75%,
Over voltage trip set point: ±.50%,
Over current trip set point: ±.75%.

Analog monitoring accuracy of full scale:
Output voltage: ±.50%,
Output current: ±.75%.

Digital programming accuracy of full scale:
Voltage set point: ±.50%,
Current set point: ±.75%,
Over voltage trip set point: ±.50%,
Over current trip set point: ±.75%.

Digital readback accuracy of full scale:
Output voltage: ±.50%,
Output current: ±.75%.

Period programming limits:
Minimum period: 10 msec,
Maximum period: 9997 sec or 2.77 hours.

Digital control inputs and outputs limits:
Input voltage: 0 to 5 Vdc;
Output voltages: 0 to 5 Vdc, 5 mA drive capacity per line;
5 V supply: 25 mA.

User interface connectors details:
EXT PRG Connector: 37 pin D-Subminiature, female;
JS2: 2 terminal 6-32 screw connector;
RS-232: 9 pin D-Subminiature, female.
GPIB: 24 pin IEEE-488, female.
LAN: optional 8 pin RJ45, female.

RS-232 interface:
Baud Rate: 19200 Baud,
Data Size: 8-bit,
Parity: None,
Stop bits: 1.

Size and Weight: See page 1-7 to 1-17

Agency Approvals:
CE-marked units meet the following standards (note: optional EMI filter must be installed to meet EMC requirements)

EN61010-1:2001-02 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

EN61326-1:1997 Electrical Equipment for Measurement, Control, and Laboratory Use EMC Requirements

- EN55022:1998 Radiated, Class A, Group 1
- EN55022:1998 Conducted, Class A, Group 1
- EN61000-4-2:1999 Electrostatic Discharge
- EN61000-4-3:1999 Radiated Susceptibility
- EN61000-4-6:1999 Conducted Susceptibility

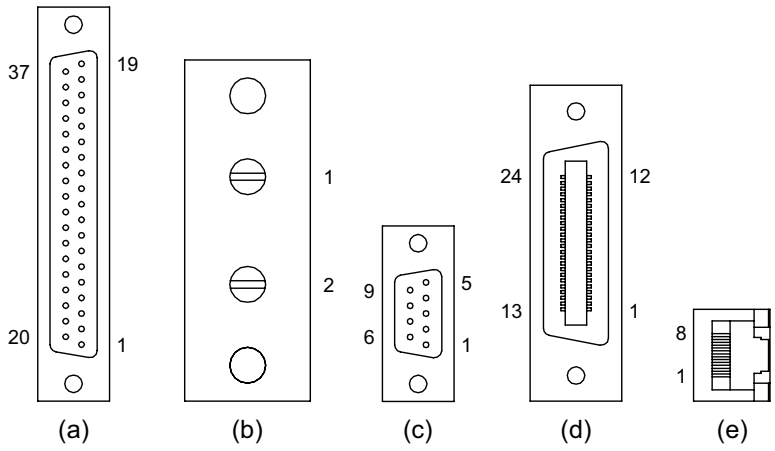


Figure 1.1 Connector (a) remote interface (EXT PRG); (b) remote sense (JS2); (c) RS232; (d) IEEE-488; and (e) Ethernet (LAN)

MODEL ORDERING SYSTEM – Example SPS500-30-K0XX

SPS	500	-	30	-	K	0	X	X
SERIES NAME	**OUTPUT VOLTAGE**		**OUTPUT CURRENT**		**FRONT PANEL**		**INTERFACE**	**INPUT AC**
SPS	See Tables		See Tables		**K** Keypad Encoder		**1:** RS232 **2:** GPIB/RS232 **E:** Ethernet GPIB/RS232	1 - 240 1Φ 2 - 208 3Φ 3 - 380 3Φ 4 - 440 3Φ 5 - 240 3Φ 6 - 415 3Φ 7 - 480 3Φ

SIZE AND WEIGHT MATRIX

POWER kW	SIZE H" x W" x D"	WEIGHT LBS
3.3	5¼"H x 19"W x 24"D	74
6.6	5¼"H x 19"W x 24"D	95
10.0	5¼"H x 19"W x 24"D	125
15.0	5¼"H x 19"W x 24"D	125
20.0	10½"H x 19"W x 24"D	195
25.0	10½"H x 19"W x 24"D	220
30.0	10½"H x 19"W x 24"D	245
45.0	15¾"H x 19"W x 24"D	265

PIN DEFINITIONS FOR EXT PRG CONECTOR (REMOTE INTERFACE)

TERM	PARAMETER	TERM	PARAMETER	TERM	PARAMETER
1	REF GND	14	EXT CTL	27	PGL
2	REF GND	15	FUSE (FSE)	28	STANDBY
3	VREF EXT	16	RESERVE	29	PHL
4	TVREF EXT	17	START	30	VOLT CTL
5	VO2	18	CLEAR	31	RESERVE
6	REF CAL	19	STOP	32	OCT
7	GND	20	REF GND	33	INT CTL
8	POWER	21	REF	34	OVT
9	OTT	22	IREF EXT	35	RESERVE
10	LOC	23	TIREF EXT	36	ARM
11	CUR CTL	24	IO2	37	INTERLOCK SET
12	STANDBY/FLT	25	VMOD		
13	FAULT	26	+5B		

TERMINAL DEFINITIONS FOR CONNECTOR JS2, REMOTE SENSE

TERM	PARAMETER
1	VO1REM-
2	VO1REM+

TERMINAL DEFINITIONS FOR RS232 CONNECTOR

TERM	PARAMETER
1	NC
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	NC

TERMINAL DEFINITIONS FOR IEEE-488/GPIB CONNECTOR

TERM	PARAMETER	TERM	PARAMETER
1	DIO1/Data line	13	DIO5/Data line
2	DIO2/Data line	14	DIO6/Data line
3	DIO3/Data line	15	DIO7/Data line
4	DIO4/Data line	16	DIO8/Data line
5	EOI/End or Identify	17	REN/Remote Enable
6	DAV/Data Valid	18	DAV/Gnd
7	NRFD/Not Ready For Data	19	NRFD/Gnd
8	NDAC/Not Data Accepted	20	NDAC/Gnd
9	IFC/Interface Clear	21	IFC/Gnd
10	SRQ/Service Request	22	SRQ/Gnd
11	ATN/Attention	23	ATN/Gnd
12	Shield	24	Ground

TERMINAL DEFINITIONS FOR ETHERNET/LAN CONNECTOR

TERM	PARAMETER
1	TX+
2	TX-
3	RX+
4	NC
5	NC
6	RX-
7	NC
8	NC

3.3 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
SPS5-600	5	600	50	86	12	6
SPS8-400	8	400	40	86	12	6
SPS10-300	10	300	40	86	12	6
SPS16-200	16	200	35	86	12	6
SPS20-165	20	165	40	86	12	6
SPS32-100	32	100	40	86	12	6
SPS40-82	40	82	40	87	12	6
SPS50-65	50	65	50	87	12	6
SPS80-41	80	41	60	87	12	6
SPS100-33	100	33	60	87	12	6
SPS125-26	125	26	100	87	12	6
SPS160-20	160	20	120	87	12	6
SPS200-16	200	16	125	87	12	6
SPS250-13	250	13	130	88	12	6
SPS375-8	375	8	170	88	12	6
SPS500-6	500	6	220	88	12	6
SPS600-5	600	5	250	88	12	6
SPS800-4	800	4	300	88	12	6
SPS1000-3	1000	3	350	88	12	6

Notes:
1) Rating specified at 208 and 440 V input.
2) Specifications subject to change without notice.

6.6 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
SPS8-800	8	800	40	86	24	12
SPS10-600	10	600	40	86	24	12
SPS16-400	16	400	35	86	24	12
SPS20-330	20	330	40	86	24	12
SPS32-200	32	200	40	86	24	12
SPS40-165	40	165	40	87	24	12
SPS50-130	50	130	50	87	24	12
SPS80-82	80	82	60	87	24	12
SPS100-66	100	66	60	87	23	12
SPS125-53	125	53	100	87	23	12
SPS160-41	160	41	120	87	23	12
SPS200-33	200	33	125	87	23	12
SPS250-26	250	26	130	88	23	12
SPS375-17	375	17	170	88	23	12
SPS500-13	500	13	220	88	23	12
SPS600-10	600	10	250	88	23	12
SPS800-8	800	8	270	88	23	12
SPS1000-6	1000	6	350	88	23	12

Notes:
1) Rating specified at 208 and 440 V input.
2) Specifications subject to change without notice.

10 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
SPS10-900	10	900	40	86	36	18
SPS16-600	16	600	35	86	36	18
SPS20-500	20	500	40	86	36	18
SPS32-300	32	300	40	86	36	18
SPS40-250	40	250	40	87	36	18
SPS50-200	50	200	50	87	36	18
SPS80-125	80	125	60	87	36	18
SPS100-100	100	100	60	87	35	17
SPS125-80	125	80	100	87	35	17
SPS160-62	160	62	120	87	35	17
SPS200-50	200	50	125	87	35	17
SPS250-40	250	40	130	88	35	17
SPS375-27	375	27	170	88	35	17
SPS500-20	500	20	220	88	35	17
SPS600-16	600	16	250	88	35	17
SPS800-12	800	12	270	88	35	17
SPS1000-10	1000	10	350	88	35	17

Notes:
1) Rating specified at 208 and 440 V input.
2) Specifications subject to change without notice.

15 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF %	INPUT CURRENT (Aac)		
					208/240 V	380/415 V	440/480 V
SPS16-900	16	900	35	86	54	30	27
SPS20-750	20	750	40	86	54	30	27
SPS32-450	32	450	40	86	54	30	27
SPS40-375	40	375	40	87	54	30	27
SPS50-300	50	300	50	87	54	30	27
SPS80-186	80	186	60	87	54	30	27
SPS100-150	100	150	60	87	53	29	26
SPS125-120	125	120	100	87	53	29	26
SPS160-93	160	93	120	87	53	29	26
SPS200-75	200	75	125	87	53	29	26
SPS250-60	250	60	130	88	53	29	26
SPS375-39	375	39	170	88	53	29	26
SPS500-30	500	30	220	88	53	29	26
SPS600-24	600	24	250	88	53	29	26
SPS800-18	800	18	300	88	53	29	26
SPS1000-15	1000	15	350	88	53	29	26

Notes:
1) Rating specified at 208, 380, and 440 V input.
2) Specifications subject to change without notice.

20.0 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)		
					208/240 V	380/415 V	440/480 V
SPS10-1800	10	1800	40	86	72	40	36
SPS16-1200	16	1200	35	86	72	40	36
SPS32-600	32	600	40	86	72	40	36
SPS50-400	50	400	50	87	72	40	36
SPS80-248	80	248	60	87	72	40	36
SPS125-160	125	160	100	87	70	40	35
SPS200-100	200	100	125	87	70	39	35
SPS250-80	250	80	130	88	70	39	35
SPS375-54	375	54	170	88	70	39	35
SPS500-40	500	40	220	88	70	39	35
SPS600-32	600	32	250	88	70	39	35
SPS800-24	800	24	300	88	70	39	35
SPS1000-20	1000	20	350	88	70	39	35

Notes:
1) Rating specified at 208, 380 and 440 V input.
2) Specifications subject to change without notice.

25 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF %	INPUT CURRENT (Aac)		
					208/240 V	380/415 V	440/480 V
SPS16-1500	16	1500	35	86	90	50	45
SPS20-1250	20	1250	40	86	90	50	45
SPS32-750	32	750	40	86	90	50	45
SPS40-625	40	625	40	87	90	50	45
SPS50-500	50	500	50	87	90	50	45
SPS80-310	80	310	60	87	90	50	45
SPS100-250	100	250	60	87	89	49	44
SPS125-200	125	200	100	87	89	49	44
SPS160-155	160	155	120	87	89	49	44
SPS200-125	200	125	125	87	89	49	44
SPS250-100	250	100	130	88	89	49	44
SPS375-65	375	65	170	88	89	49	44
SPS500-50	500	50	220	88	89	49	44
SPS600-40	600	40	250	88	89	49	44
SPS800-30	800	30	300	88	89	49	44
SPS1000-25	1000	25	350	88	89	49	44

Notes:
1) Rating specified at 208, 380, and 440 V input.
2) Specifications subject to change without notice.

30 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF %	INPUT CURRENT (Aac)		
					208/240 V	380/415 V	440/480 V
SPS16-1800	16	1800	35	86	108	60	54
SPS20-1500	20	1500	40	86	108	60	54
SPS32-900	32	900	40	86	108	60	54
SPS40-750	40	750	40	87	108	60	54
SPS50-600	50	600	50	87	108	60	54
SPS80-372	80	372	60	87	108	60	54
SPS100-300	100	300	60	87	106	58	52
SPS125-240	125	240	100	87	106	58	52
SPS160-186	160	186	120	87	106	58	52
SPS200-150	200	150	125	87	106	58	52
SPS250-120	250	120	130	88	106	58	52
SPS375-78	375	78	170	88	106	58	52
SPS500-60	500	60	220	88	106	58	52
SPS600-48	600	48	250	88	106	58	52
SPS800-36	800	36	300	88	106	58	52
SPS1000-30	1000	30	350	88	106	58	52

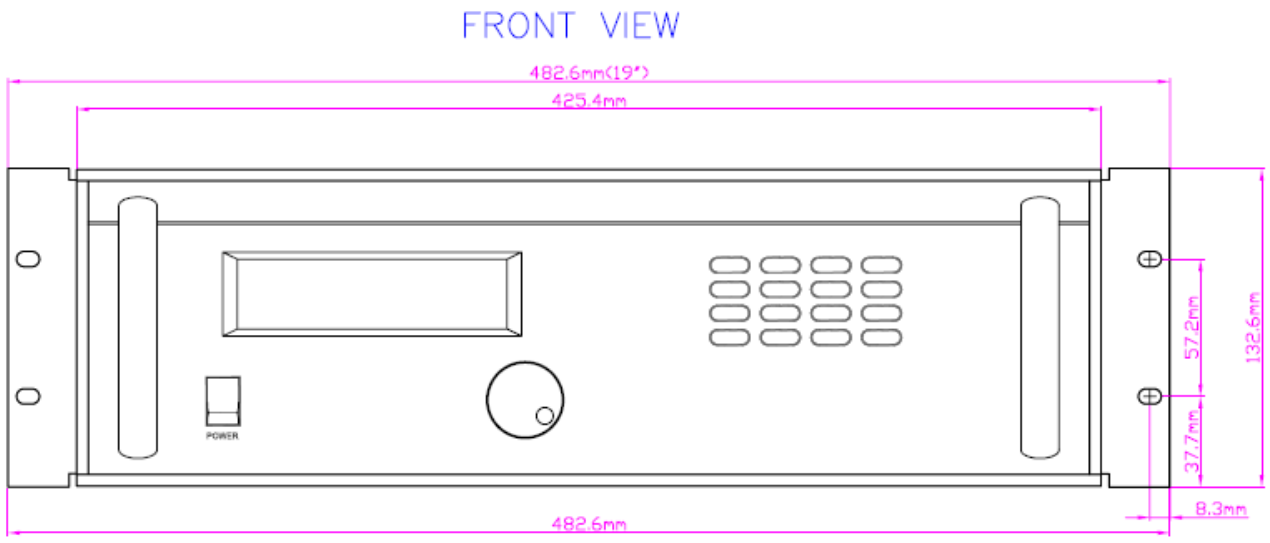
Notes:
1) Rating specified at 208, 380, and 440 V input.
2) Specifications subject to change without notice.

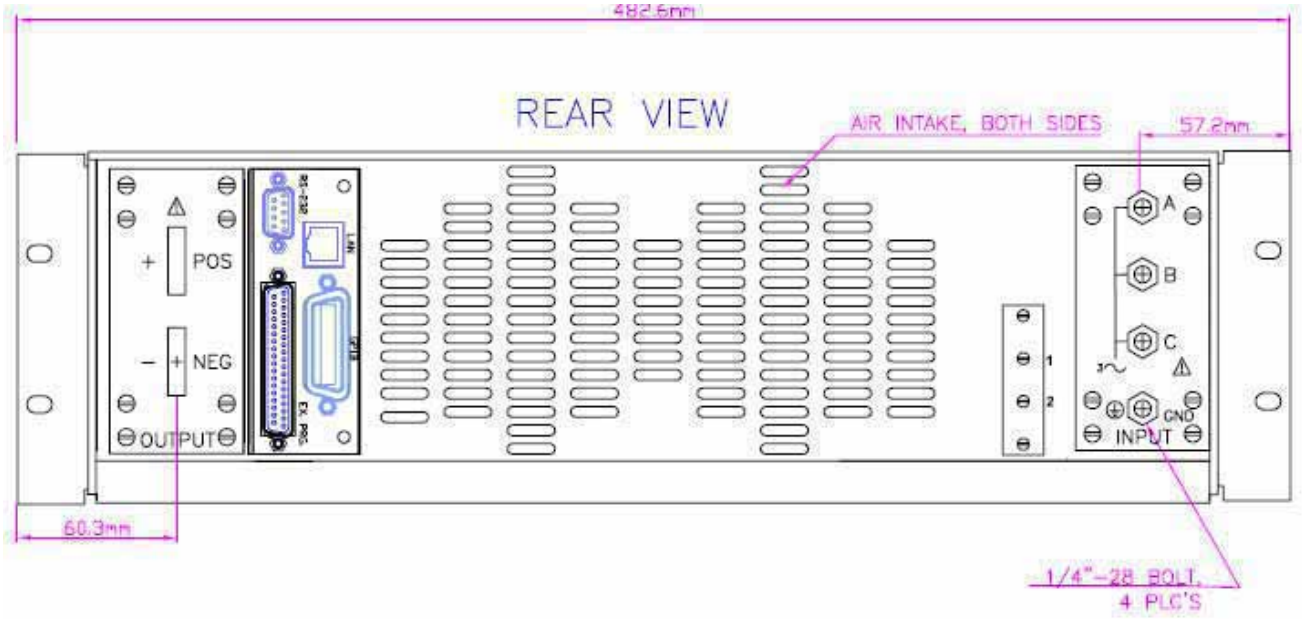
45 KW MODELS AND RATINGS

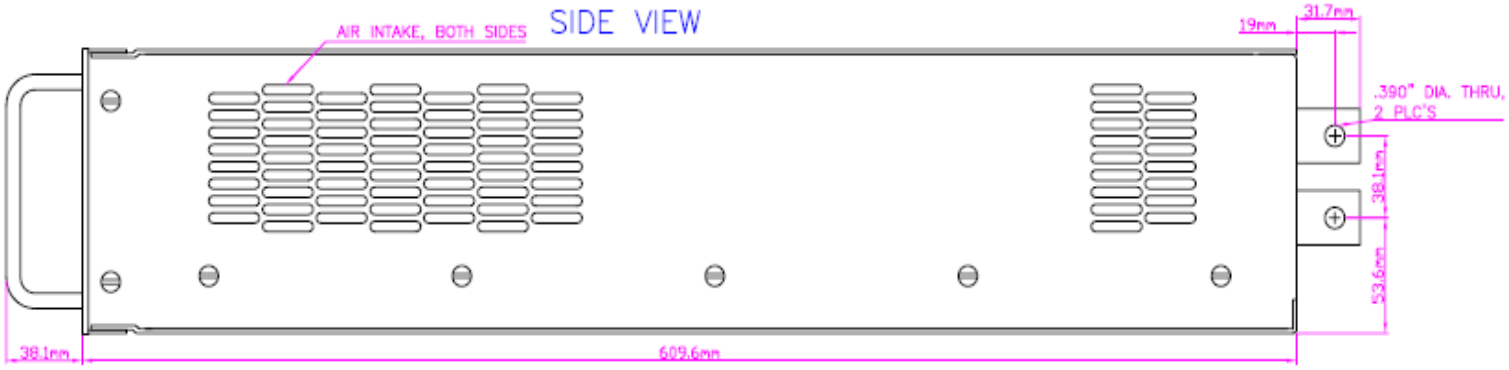
MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF %	INPUT CURRENT (Aac)		
					208/240 V	380/415 V	440/480 V
SPS16-2700	16	2700	35	86	162	90	81
SPS20-2250	20	2250	40	86	162	90	81
SPS32-1350	32	1350	40	86	162	90	81
SPS40-1125	40	1125	40	87	162	90	81
SPS50-900	50	900	50	87	162	90	81
SPS80-558	80	558	60	87	162	90	81
SPS100-450	100	450	60	87	159	87	78
SPS125-360	125	360	100	87	159	87	78
SPS160-279	160	279	120	87	159	87	78
SPS200-225	200	225	125	87	159	87	78
SPS250-180	250	180	130	88	159	87	78
SPS375-117	375	117	170	88	159	87	78
SPS500-90	500	90	220	88	159	87	78
SPS600-72	600	72	250	88	159	87	78
SPS800-54	800	54	300	88	159	87	78
SPS1000-45	1000	45	350	88	159	87	78

Notes:
1) Rating specified at 208, 380, and 440 V input.
2) Specifications subject to change without notice.

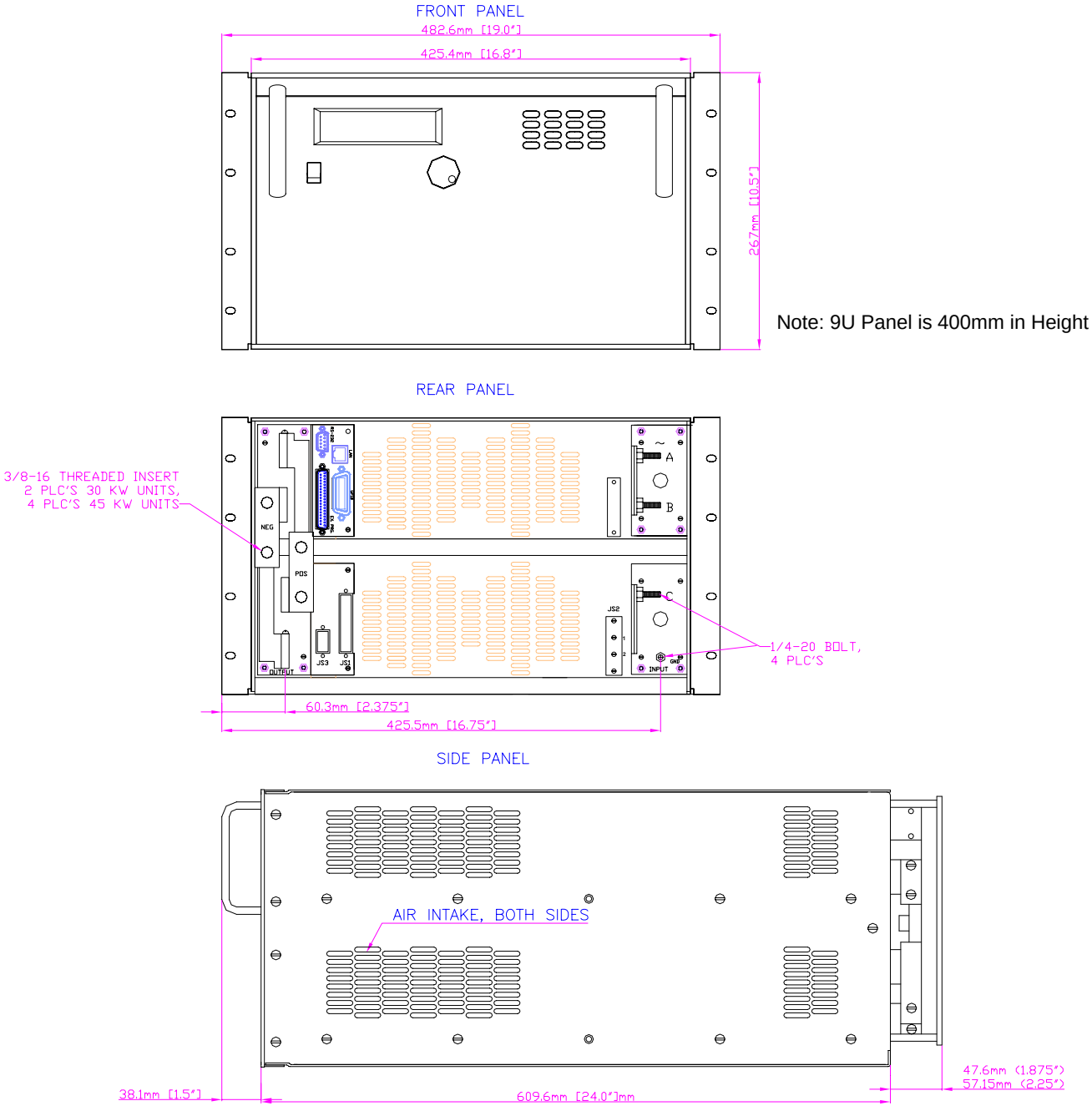
3U (Air-Cooled) 3-View Diagram





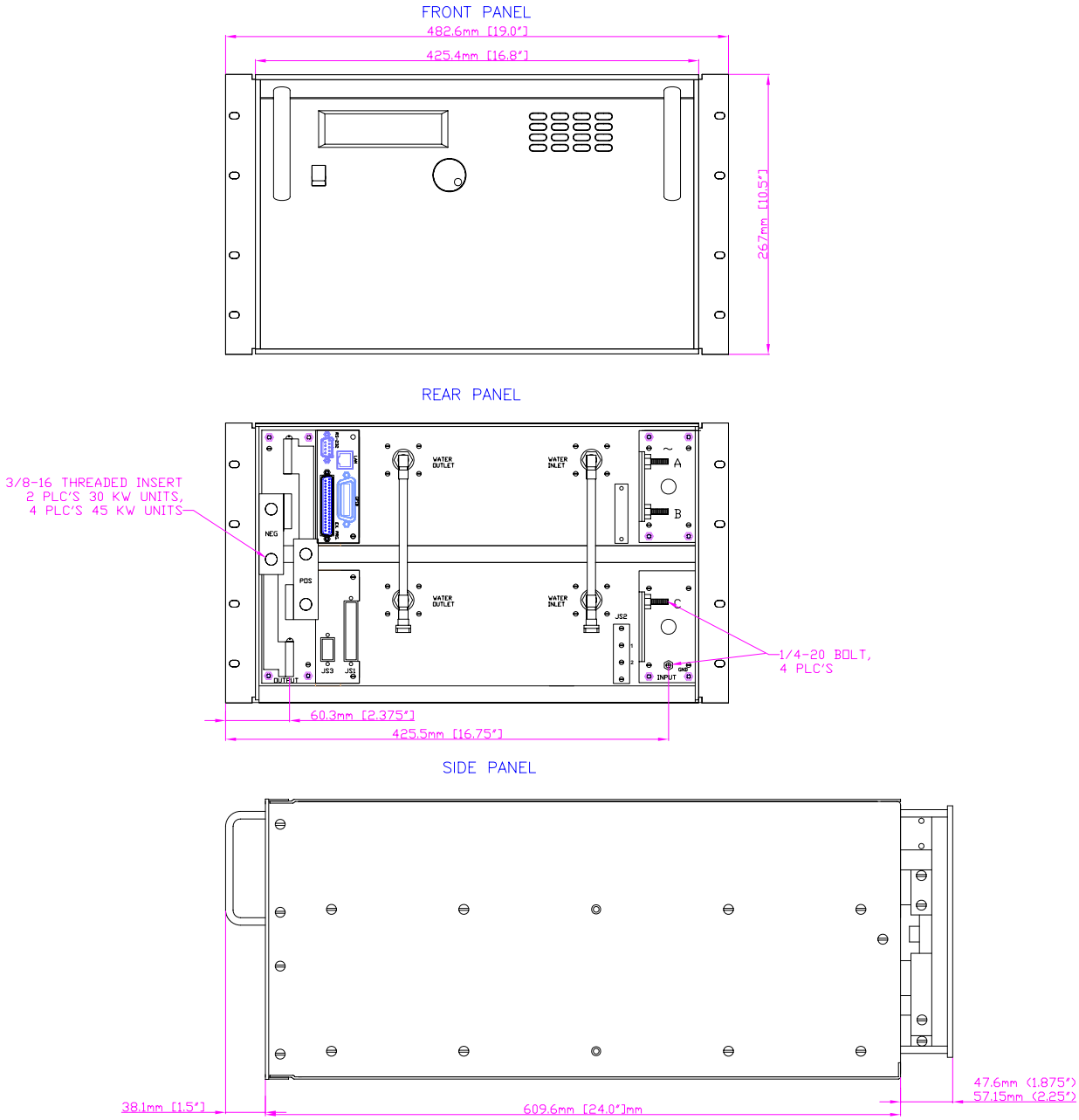


6U & 9U (Air-Cooled) 3-View Diagram



Note: 9U Panel is 400mm in Height

6U & 9U (Water-Cooled) 3-View Diagram



2.0 INSTALLATION AND POWER ON CHECK

SPS Series power supplies are intended for rack mount installations only and are designed to fit in a standard 19" equipment racks. Additional support, other than that provided by the front panel, is required. Angle slides or cross beam supports securely fastened to the rack are recommended for supporting the weight of the power supply. The unit should be horizontally mounted.

Caution: The power supply is too heavy for one person to safely lift and mount. To avoid injury, ask a co-worker for assistance.

2.1 Cooling

SPS Series power supplies are cooled by air or water. Air cooled power supplies are for general use. Water cooled power supplies are for use in corrosive environments such as plating applications or in densely packaged system cabinets where heat removal by air cooling presents a problem. The method of cooling must be specified at time of order.

2.1.1 Air Cooling

Each power supply enclosure is cooled by suitable blowers exhausting warm air to the rear of the cabinet. Fresh air intake is from the sides of the cabinet allowing two or more SPS Series supplies to be stacked. Equipment racks should be equipped with fans or blowers to remove heat generated by the power supplies. The manufacturer recommends fresh air intake at the bottom of the cabinet and exhaust at the top. Fans and blowers should be rated at 400 CFM for each 15 kW unit, 800 CFM for each 20 kW to 30 kW unit, and 1200 CFM for each 45 kW unit.

Caution: blocking ventilation will cause the power supply to overheat.

2.1.2 Water Cooling

Water cooling is accomplished with chill plates and an integrated central heat exchanger. The chill plates provides a thermal conduction path for heat sensitive components and the central heat exchanger removes heat from air internal to the enclosure. Water cooled SPS Series models have enclosures without vent holes and are basically sealed the unit from the environment. An internal solenoid valve enables water flow when the chill plate reaches 60˚C. Operation of the solenoid prevents internal condensation.

water flow when the chill plate reaches 60˚C. Operation of the solenoid prevents internal condensation.

Caution: water cooled power supplies are not water tight. Allowing water penetration is a safety hazard and will damage the power supply.

Each 15 kW module has a 1/4" NPT female inlet and outlet for water flow. For models greater than 15 kW, external plumbing interconnects power supply modules. A minimum of 2.50" is recommended behind the enclosure for this hardware and user connections. For systems requiring more than one power supply, plumbing connections must be paralleled; that is, water should not flow from one power supply into another.

2.2 AC Input Connections

Caution: disconnect AC power from the mains before attempting any installation procedure.

Caution: a safety ground wire must be connected to the unit as indicated by the protective ground symbol at the rear of the power supply.

AC power is wired to the power supply by attaching three cables plus ground. The manufacture recommends cables, as specified in Tables 2.1 or 2.2, be crimped to ring terminals and securely fastened to the four studs at the rear of the power supply. After connections are made, screw the four standoffs into the back panel and place the protective shield over the connections.

This power supply is designed to be permanently connected to the power source requiring a readily accessible disconnect device incorporated into the fixed wiring.

2.3 DC Output Connections

Caution: disconnect AC power from the mains before attempting any installation procedure.

Table 2.1 SUGGESTED AMPACITIES OF 4-CONDUCTOR TYPE S OR SO CABLE

Wire Size (AWG)	Maximum Current (A)	Wire Size (AWG)	Maximum Current (A)
18	7	8	35
16	10	6	45
14	15	4	60
12	20	2	80
10	25		

Table 2.2 SUGGESTED AMPACITIES OF CONDUCTORS AS RECOMMENDED BY THE NATIONAL ELECTRICAL CODE

	Temperature Rating of Copper Conductor			
	60 ˚C	75˚C	85˚C	90˚C
	Types	Types	Types	Types
Wire Size (AWG)	RUW, T, TW	FEPW, RH, RHW, RUH, THW, THWN, XHHW, ZW	V, MI	TA, TBS, SA, AVB, SIS, FEP, FEPB, RHH, THHN, XHHW
14	25	30	30	35
12	30	35	40	40
10	40	50	55	55
8	60	70	75	80
6	80	95	100	105
4	105	125	135	140
3	120	145	160	165
2	140	170	185	190
1	165	195	215	220
1/0	195	230	250	260
2/0	225	265	290	300
3/0	260	310	335	350
4/0	300	360	390	405
250 MCM	340	405	440	455
300 MCM	375	445	485	505
350 MCM	420	505	550	570

Single conductors in free air, based on ambient temperature of 30˚C

DC power is wired to the power supply by attaching two cables to the output bus bars. The manufacture recommends cables, as specified in Tables 2.2 or 2.3, be crimped to ring terminals and securely fastened to bus bars using 3/8" bolts, lock washers, and mating nuts. After connections are made, screw the four standoffs into the back panel and place the protective shield over the connections.

⚠ **Caution:** Make sure connections are tight to avoid overheating of the bus bars.

Table 2.3 SUGGESTED AMPACITIES OF WELDING CABLE

Wire Size (AWG)	Maximum Current (A)	Wire Size (AWG)	Maximum Current (A)
6	85	1/0	200
4	110	2/0	235
3	130	3/0	275
2	150	4/0	315
1	170	*	315+

* Contact factory for assistance

2.4 General Operation

As shipped, SPS Series power supplies are configured for local sensing, local control, internal programming, and voltage input as specified on the rear label. From the front panel, voltage and current settings are programmed via the keypad or encoder. The impedance of the load determines whether the unit is voltage or current controlled, and will display on the VFD screen as CV or CC. The correct Voltage/Current values must be entered for proper operation.

2.5 Controls and Indicators

The controls and indicators are shown in figure 2.1, 2.2 and 3.1.

2.6 Preparation for Use

2.6.1 Unpacking

Carefully unpack the power supply saving all packing materials and included enclosures. Inspect power supply for possible shipping damage. Check that there are no broken knobs or connectors, the external surface is not scratched or dented, the meter faces are not damaged, and all controls move freely. Any external damage may be an indication of internal damage. Please take extreme caution when handling or lifting the units, the units are extremely heavy. It is recommended to use hydraulic-type lifts with “reversed eye slings/straps” for moving the SPS units.

2.6.2 Electrical Check.

2.6.2.1 SPS Series Models

With the power supply off, disconnect the load. Connect the power supply to a suitable source of ac voltage. (For this test, only 50% of rated ac current is required.) Turn the power switch on, observe the VFD screen and listen for the boot-up sequence. During

the startup sequence, the power supply should beep. After initialization, the VFD display will light up. This is the default configuration from the factory. It is recommended that the following brief electrical check be made shortly after unpacking the supply.

Program the voltage set point to maximum and turn output on. Dc voltage should increase smoothly from minimum to maximum. With output still enabled, program the voltage set point to the minimum, the voltage reading on the VFD will decrease to a minimum. Disable the output.

To check over voltage trip, press the “9" key to enter the OVP set point. Using the keypad, enter an over voltage trip set point at half the rating of the power supply. Once the over voltage trip set point has been entered, press the enter key to save the information. Press the “2" key to enable OVP Detection Trip.

Program a voltage setting higher than the OVP Set point and enable the power supply output. Once the power supply output turns on, the Over voltage trip should engage. The over voltage trip (OVT) indicator will display on the VFD screen, the supply will shut down and latch in protection mode. If the BUZZER is enabled during the protection trip, the power supply will beep continuously. Press the clear key as a protection clear. Now set the over voltage trip set point to maximum which is 110% the full scale rating of the power supply. With the maximum over voltage trip set point entered, again start the supply and observe that the power supply operates normally.

With the main power disconnected, connect a short to the power output studs on the rear panel. Reconnect the main power and turn the power switch on.

Program the voltage set point to 10% of Vmax, and the current to maximum via the key pad. Now enable the power supply output and the current reading on the VFD display should increase to the maximum set point. With the power supply still on, program the current value to 0Adc, the current reading on the VFD display will decrease accordingly. Disable the power supply output.

To check over current trip, press the “6" key to enter the OCP set point. Using the keypad, enter an over current trip set point at half the rating of the power supply. Once the over current trip setting has been entered, press the enter key to save the information.

Check to verify the voltage set point is still at 10% of Vmax, and then enable the power supply output. Program the current setting to greater than the OCP set point. The over current trip should engage and the power supply output will disable. The over current trip (OCT) indicator should display on the VFD screen, the power will latch in protection mode and if the BUZZER is enabled, the supply will continuously beep. Press the clear key. Now set the over current trip set point to maximum which is 110% the full scale rating of the power supply. With the maximum over current trip set point entered, again start the supply and observe that the power supply operates normally.

If any of these events do not occur, the supply is defective and should not be operated. Depending on the circumstances, either warranty service or trouble shooting, as described in Section 7.2, is required.

FRONT PANEL DESCRIPTION:

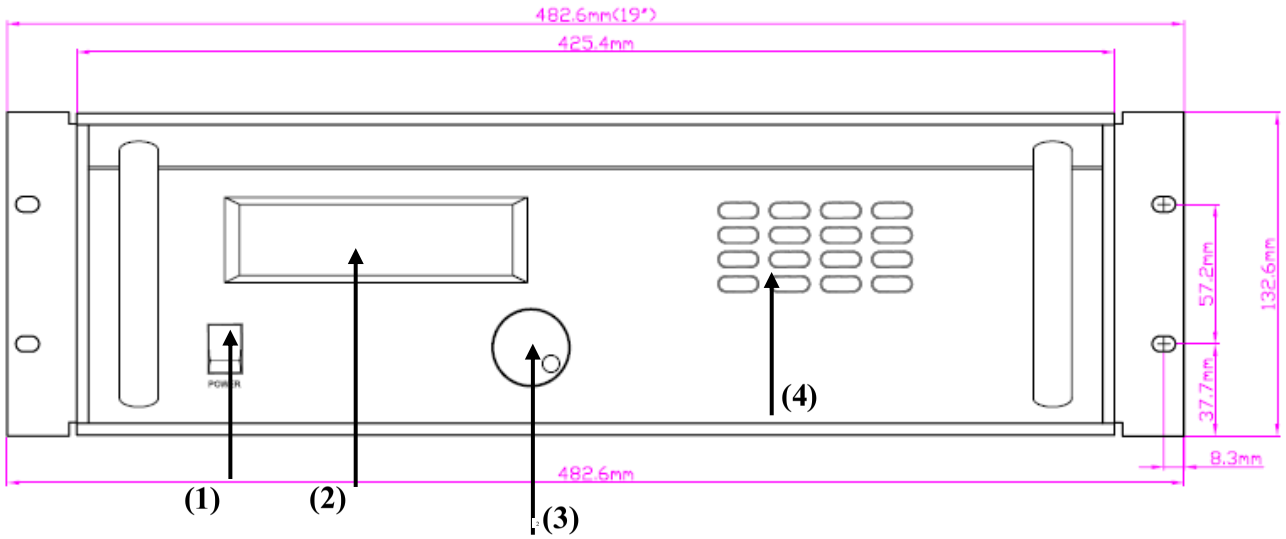


FIGURE 2.1 Front Panel Controls and Description

1) **Power Switch:** Powers the SPS Unit on and off.

2) **20 X 2 (40 character) VFD display**: The screen displays different menus, functions, system information, settings, and protection messages.

3) **Encoder:** The knob is an alternative to the scrolling, enter, and clear buttons that is used when selecting menu choices and setting different system values (fine tuning).

4) **Front Panel Keypad:** The keypad is used to control output on/off, select different menus, set system values, navigate the SPS user interface, setup V_{LIST} and $I_{LIST,}$ and configure and activate other system functions.

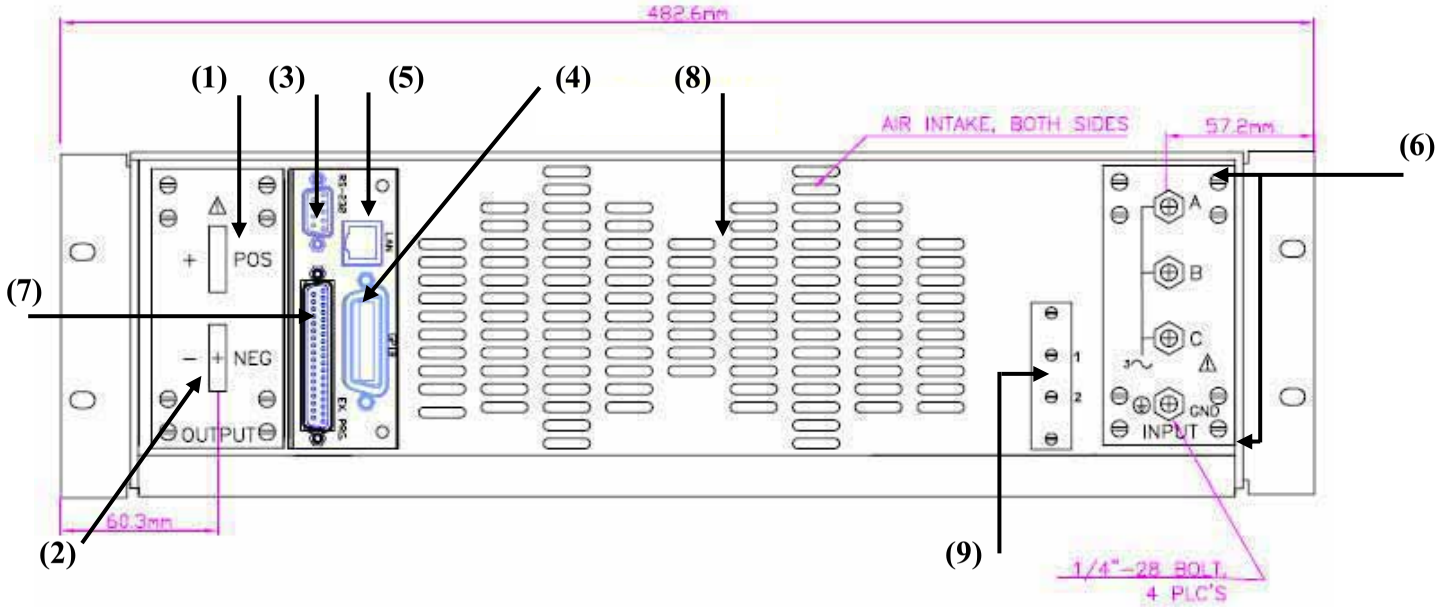


FIGURE 2.2 Rear Panel Controls and Description

1	**Positive Output**	Positive Output Terminal. (Screw: M6X12)
2	**Negative Output**	Negative Output Terminal. (Screw: M6X12)
3	**RS232**	9 pin D-sub male connector for RS232 Interface
4	**GPIB**	Standard IEEE 488 GPIB Interface Connector
5.	**Ethernet Interface**	RJ45 connector for Ethernet interface only.
6.	**AC Input**	AC input terminal strip.
7.	**EXT PRG**	DB-37 I/O connector used for external/analog programming, Monitoring and Protection features (Refer to Table 1.4)
8.	**Air Exhaust**	Cooling Fan Output Vent
9.	**Remote Sense**	Remote Sense Terminal JS2 (Refer to Table 1.5)

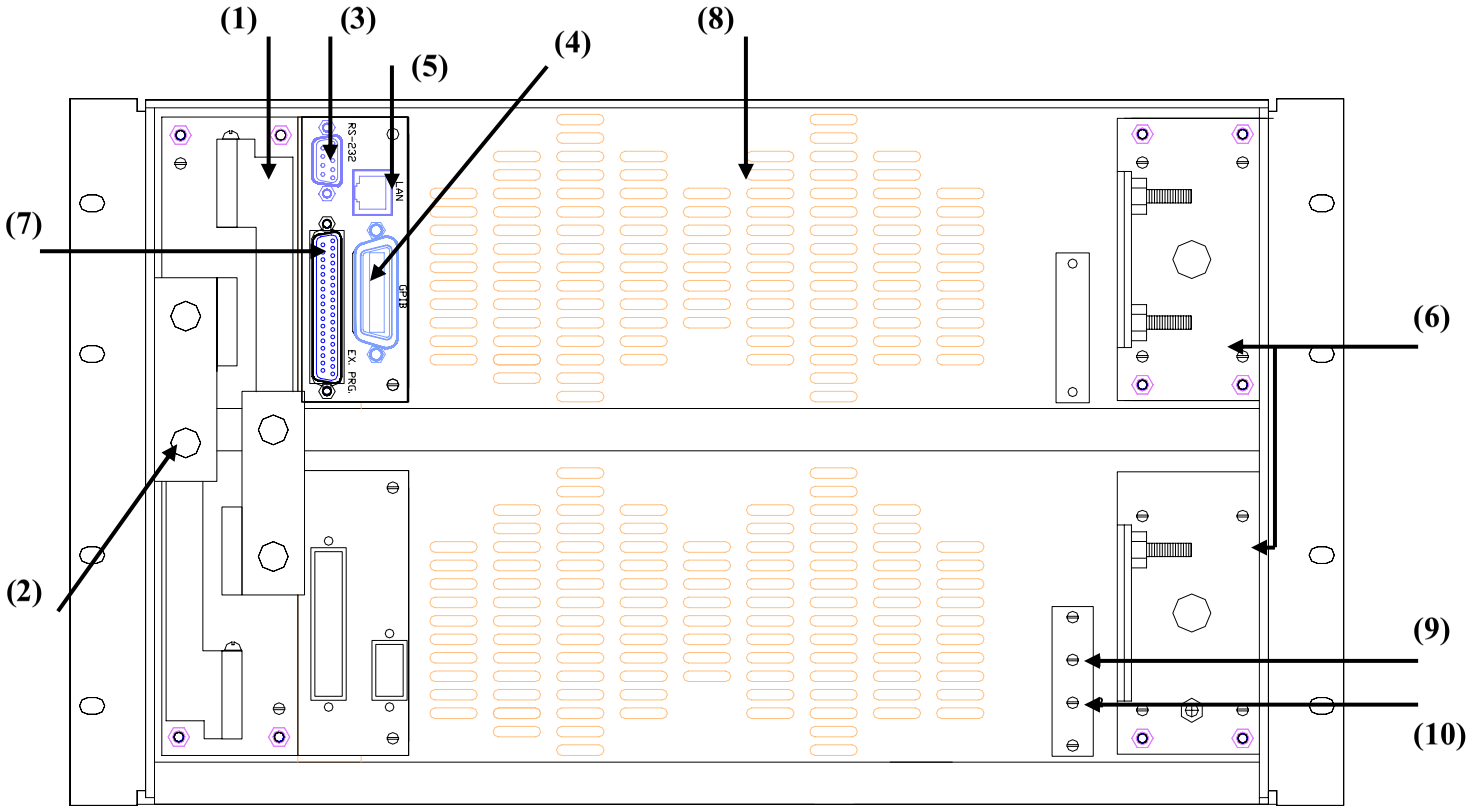


FIGURE 2.2 6U & 9U Rear Panel Controls and Description

1	**Positive Output**	Positive Output Terminal. (Screw: M6X12)
2	**Negative Output**	Negative Output Terminal. (Screw: M6X12)
3	**RS232**	9 pin D-sub male connector for RS232 Interface
4	**GPIB**	Standard IEEE 488 GPIB Interface Connector
5.	**Ethernet Interface**	RJ45 connector for Ethernet interface only.
6.	**AC Input**	AC input terminal strip.
7.	**EXT PRG**	DB-37 I/O connector used for external/analog programming, Monitoring and Protection features (Refer to Table 1.4)
8.	**Air Exhaust**	Cooling Fan Output Vent
9.	**Positive Sense (-)**	Positive Sense Terminal
10.	**Negative Sense (+)**	Negative Sense Terminal (Refer to Table 1.5)

3.0 OPERATION

3.1 Front Panel Description & Navigation

As shipped, SPS Series power supplies are configured for local sensing, local control, internal programming, and voltage input as specified on the rear label. From the front panel, voltage and current settings are programmed via the keypad/encoder. The load impedance determines whether the unit is voltage or current controlled, and will display on the VFD screen as CV or CC. The correct Voltage/Current values must be entered for proper operation. There are 3 types of control schemes for the SPS Series Power Supply - 1) Local Operation, 2) Remote Operation and 3) External Programming Control. Local Operation utilizes the keypad/encoder & menu options to operate different features/functions of the SPS Series Power Supply.

Fig 3.1 - KEYPAD DESCRIPTION:

7/VOLT	**8/CURR/ ▲**	**9/OV/TIME**	**LOCAL/UTILITY**
4/VLIST/ ◀	**5/ILIST**	**6/OC/ ▶**	**MODE/LOCKOUT**
1/ILiST ON/OFF	**2/OVP ON/OFF/ ▼**	**3/OCP ON/OFF**	**FUNC/PROFILE**
0/VLIST ON/OFF	**● /OUT ON/OFF**	**CLEAR/PROT**	**ENTER**

Setting Function	
VOLT 7	Sets the Voltage Level
CURR 8	Sets the Current Level
OV/TIME 9	Set the Over Voltage (OV) Level
OC 6	Set the Over Current Level
Additional Key Description	
FNCT	Saves, Recalls and Resets Power Supply Settings to the 4 Memory Locations
MODE	With Panel Lock Enabled, pressing this key will lock the keypad and encoder
Firmware Display	
Press & release CLEAR	Displays current firmware version of the SPS
Toggle On/Off Functions	
OUT ON/OFF ●	Activate/Deactivate Output

VLIST ON/OFF 0	Activate/Deactivate VLIST
ILIST ON/OFF 1	Activate/Deactivate ILIST
OVP ON/OFF 2	Activate/Deactivate OVP
OCP ON/OFF 3	Activate/Deactivate OCP
PROT CLEAR	Protection Clear
Configuring V_{LIST} & I_{LIST} Parameters	
In V_{LIST} Programming Mode (Press 4 key)	
7	Programs the Voltage Set Point
9	Programs the Dwell Time
In I_{LIST} Programming Mode (Press 5 key)	
8	Programs the Current Set Point
9	Programs the Dwell Time
◀ ▶	Use Right and Left Arrows to Navigate Thru the Voltage or Current List Points

Remote Operation is achieved via an extensive set of SCPI commands that is programmed RS-232, GPIB or Optional Ethernet Interface. External Programming uses the 37-pin Ex. PRG. port to operate the SPS Power Supply

Functions such as Local/Remote Sense, External Control, Remote Interlock, OCP, OCP, V_{LIST} and I_{LIST} Programming, Voltage/Current Programming, Interface Configuration, and Panel Lock can be controlled locally and remotely. Please refer to the Keypad description section above for more information on local operation, the Menu Tree below illustrates the navigation required for accessing the different functions of the SPS Series Power Supply and Section 4 for remote programming via SCPI commands.

MENU TREE NAVIGATION:

Press **LOCAL/UTILITY** key

LIST CYCLE		INFINITY	<<
		ONCE	<
REMOTE SENSE		OFF	<<
		ON	<
EXT. CONTROL		OFF	<<
		ON	<
INTERLOCK		OFF	<<
		ON	<
GPIB ADDRESS		0	<
		1	<<
		2	<
		……	<
		30	<
		31	<
DEFAULT OUTPUT		OFF	<<
		ON	<
RS-232 SPEED		2400	<
		4800	<
		9600	<
		19200	<<
EOS CODE		CR+LF	<<
		NULL	<
		CR	<
		LF	<
BUZZER		ON	<<
		OFF	<
PANEL LOCK	PANEL ENABLE	ON	<<
		OFF	<
	PANEL PASSWD	*555555*_____	<
AUTHENTICATE	SERIAL NO.	000B87000XXX	<
	INTERFACE	GPIB ETHER	<
	CODE	_____	<
NETWORK	ADDRESS	0.0.0.0	<
	NETMASK	0.0.0.0	<
	GATEWAY	0.0.0.0	<

Press **MODE/LOCKOUT** Key

CONDITION.1	PANEL ENABLE	ON	Local Lockout Mode has no use.
CONDITION.2	PANEL ENABLE	OFF	Local Control Panel Locked.

(When panel locked, press MODE/LOCKOUT key to enter the PANEL PASSWD, by default “5555555")

Press **FUNC/PROFILE** Key

RECALL FROM	PROFILE #0	<<
	PROFILE #1	<
	PROFILE #2	<
	PROFILE #3	<
(Press FUNC/PROFILE key again)		
SAVE TO	PROFILE #0	<
	PROFILE #1	<
	PROFILE #2	<
	PROFILE #3	<
(Press FUNC/PROFILE key again)		
RESET (CLEAR)	ALL PROFILE	<

Press **5/ILIST** Key

(Press 8/CURR key to enter the current value for specific step)
(Press 9/OV/TIME key to enter the time interval for specific step)

ILIST STEP:	01	<<
	02	<
	……	<
	19	<
	20	<

Press **4/VLIST** Key

(Press 7/VOLT key to enter the voltage value for specific step)
(Press 9/OV/TIME key to enter the time interval for specific step)

VLIST STEP:	01	<<
	02	<
	……	<
	19	
	20	

Note: Profile 0 is the Non-volatile memory location and stores power-on default settings

3.1.1 SPS Series Front Panel Control

Local Operation consists of keypad, encoder and the various menu options, allowing control of Remote sense, local navigation, external control, digital interfaces and interlock functions. To select, press the desirable keys or to deselect, press CLEAR. Remote sense allows the output voltage to be sensed at the load rather than at the output terminals of the power supply. This feature eliminates regulation degradation caused by the voltage drop across the output cables. Details on the physical connections are covered in Section 3.3.

External control enables the start, stop, arm, and clear inputs at terminals 17, 19, 36, and 18 of EXT PRG Connector on the rear panel, respectively. Both internal control and external control may be enabled to allow simultaneous control. Interlock requires a physical short between terminals 26 and 37 of EXT PRG Connector to enable operation. This feature is useful for process control applications when a safety interlock is required. For wiring details, refer to Section 3.6.

In addition, voltage, current, OC, OV, V_{LIST} parameters and I_{LIST} parameters can be programmed via the keypad and encoder or using a digital interface connection and SCPI commands. The numeric keys are used to enter desired values, and the ENTER and CLEAR allow entering or clearing of the values. To exit any menu option or other functions, simply press the CLEAR key.

By selecting external control programming, all reference inputs are set with the analog inputs at terminals 3, 22, 4, and 23 of EXT PRG Connector. See Section 3.4, for connecting external reference inputs. By communicating with the SPS supply over any digital interface (GPIB/RS-232/Ethernet), all reference inputs are set over the corresponding interface network.

3.1.1.1 Calibration

Calibration of the unit is done by re-entering the factory default calibration data. The Calibration Data can be found on the test report and is shipped with each unit. There are 5 parameters to enter, labeled 1 through 5. To enter the values, please follow the sequence below.

1) Press ENTER and Output On/Off Key Simultaneously
2) The OFF indicator on the bottom left hand corner of VFD screen should flash
3) Press ENTER and “0" Key Simultaneously
4) You are now in the Calibration Menu
5) There are 3 Menu Selections - A) EDIT, B) BACKUP and C) RESTORE
    A) EDIT: Allows entry of the Calibration Parameters
    B) BACKUP: Saves Calibration Parameters to NVRAM
    C) RESTORE: Saves Calibration Parameters to NVRAM and Hardware Memory
6) To enter calibration parameters, select the “A) EDIT” menu option and press ENTER
7) Use left and right arrows to navigate parameters 1 thru 5
8) To edit, Press ENTER to begin entry and press ENTER again to confirm entry
9) Once all calibration parameters have been entered, Select C) RESTORE, and all data will be saved. Power Cycle to complete the calibration process

3.1.1.2 Programming Sequential Step Applications

The SPS Series power supplies have the powerful feature of programming output voltage, output current and period for 4 memory states or memory profiles. Other settings such as interface, remote sense, ext. control, OC/CV settings and interlock parameters can be saved into one of the 4 memory profiles. Each memory state provides 20 set points for the V_{LIST} and I_{LIST} operations (programming sequential steps). The different LIST set points can be selected by the user, and to run the sequence, it can be timed stepped, or triggered through the front panel or rear connector. Memory states 0 through 3 are set though the front panel and via digital interfaces - RS232, optional IEEE-488, or optional Ethernet interface. The programming variables are defined as follows:

1. Voltage: output voltage set point. The default state is 0 Vdc and the maximum voltage setting is the rating of the power supply.
2. Current: output current set point. The default state is 0 Adc and the maximum current setting is the rating of the power supply.
3. Period: time period or interval at the current step. The Programmable Range is 0.01 ~ 9997 s (time base is seconds).

To initiate sequential step operation, the power supply must first be programmed with the desired Voltage, Current, Dwell Time and other related settings. Locally, the LIST Function must be enabled in the following sequence. Activate LIST Function by pressing "0 for V_{LIST} and "1 for I_{LIST}"on the front panel and to begin the LIST sequence, press the Output On/Off key. Remotely, the supply must be armed by triggering terminal 36 of EXT PRG Connector located at the rear of the power supply and triggering terminal 17 of EXT PRG Connector will begin the LIST sequence. Once triggered, the power supply will attempt to run through the programmed LIST for each memory step.

With auto sequence / LIST operation, the memory will increment at the end of the time period or by re-pressing the "0" or "1" key on the front panel & activating "output on" or by triggering terminal 17 of EXT PRG Connector. This allows the programmed dwell time to be advanced or auto sequence to continue without time period programming.

The program can be terminated at any point in the program by pressing the $0/V_{LIST}$ or $1/I_{LIST}$ keys or by triggering terminal 19 of EXT PRG Connector. The program can be restarted at the current memory step by pressing the Output On/Off key or by triggering terminal 17 of EXT PRG Connector.

Note: The LIST function must be on (press "0 - V_{LIST} & "1 - I_{LIST}") before enabling Output

3.2 Modes of Operation

3.2.1 Normal Mode

SPS series power supplies are normally shipped with its configuration set for local control, local sensing, and external control disabled. This configuration is set by front panel keypad and menu options described in Section 3.1. With this configuration, the operator can select either a constant voltage or a constant current output using the front panel controls.

3.2.2 Constant Voltage

To select constant voltage output, proceed as follows:

With the supply output off, use the keypad/encoder to program the desired voltage and current settings. Please note, the current setting is the crossover current value. The crossover current is the current at which the power supply becomes a constant current source.

Connect the load and turn on the power supply by pressing the Output On/Off key. The output voltage should be close to the voltage set point. If a load change causes the current limit to be exceeded, the power supply will automatically crossover to constant current output at the preset current limit and the output voltage will drop proportionately. In setting the current limit, allowance must be made for high peak currents which can cause unwanted crossover (see Section 3.10).

3.2.3 Constant Current

To select constant current output, proceed as follows:

With the supply output off, use the keypad/encoder to program the desired voltage and current settings. Please note, the current setting is the crossover current value. The crossover voltage is the voltage at which the power supply becomes a constant voltage source.

Connect the load and turn on the power supply. The output current should be close to the current set point. If a load change causes the voltage limit to be exceeded, the power supply will automatically crossover to constant voltage output at the preset voltage limit and the output current will drop proportionately.

3.3 Remote Sensing

Remote sensing is used to improve the degradation of regulation which will occur at the load when the voltage drop in the connecting wires is appreciable. This is done by configuring the power supply for remote sensing using the following menu sequence (LOCAL/UTILITY->REMOTE SENSE ->ON). Using a pair of #20 AWG wires, connect terminal 2 of JS2 to the positive terminal of the load and connect terminal 1 of JS2 to the negative terminal of the load. Figure 3.25 illustrates standard output sensing and remote output sensing.

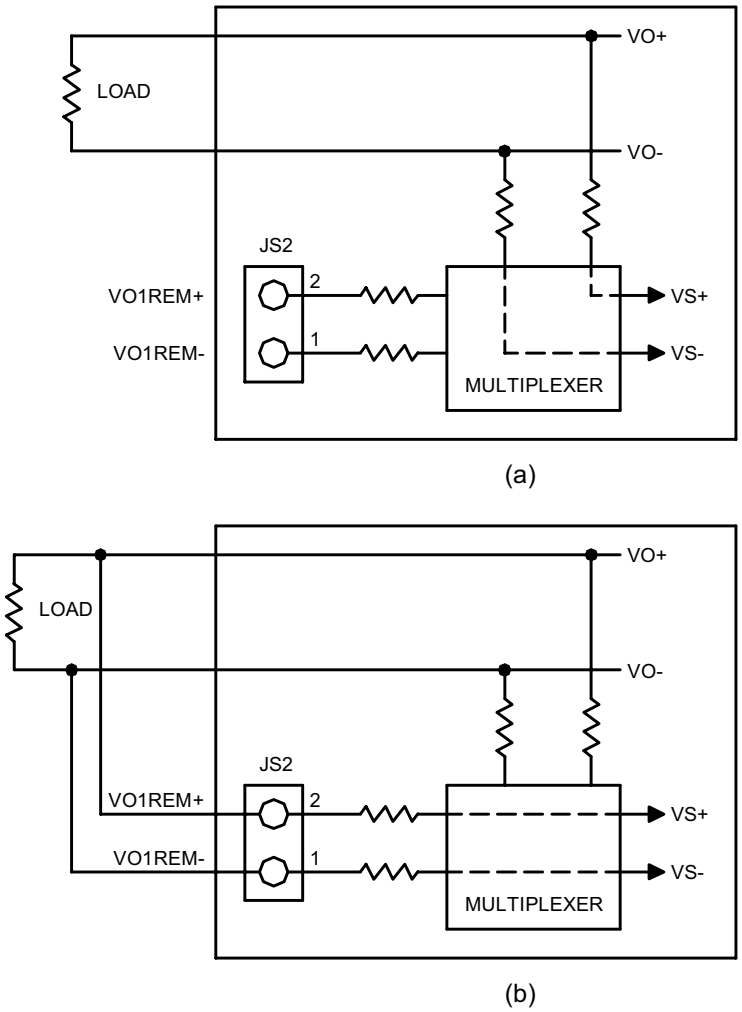


Figure 3.25 (a) Local and (b) remote sensing

Enabling remote sense activates the remote sense lead detector. The remote sense lead detector checks that the remote sense leads have been connected to the load. With the power supply configured for remote sensing and upon enabling power output, the sense location is initially set to local. The sense location is switched to remote upon reaching 5% of full scale output voltage. If the voltage detected is greater than 2% of full scale output voltage, the sense location remains remote; if the output voltage detected is less than 2%, then the sense location will automatically revert back to local.

Important Notes:

1) In the case the voltage sense returns back to local sense, first check the sense leads, then, disable and re-enable the power supply output. The remote sense lead will select between Local or Remote during the power supply output on sequence.
2) In the case the voltage sense leads are disconnected during test, the power supply will be protected by the Over-voltage protection. As good practice, always program the OV and OC settings to reflect the protection required for the DUT.

3.4 External Programming

SPS series supplies allow voltage, current, voltage trip, and current trip to be programmed from a remote location. Programming can be accomplished either by resistive, voltage, or current programming circuits.

Figure 3.26 illustrates the three alternatives for programming the voltage set point. The method applies equally to programming set point current, over voltage trip, and over current trip.

3.4.1 Resistive Programming

Resistive programming requires connection of an external potentiometer or resistors between terminals 21, 3, and 1 of EXT PRG Connector. Terminal 21 is a 2.0 V precision reference, terminal 1 is the reference ground, and terminal 3 is the voltage set point input. Like front panel rotary control, the 2.0 V precision reference produces a voltage across the potentiometer or resistors which is then used to produce the voltage set point. Metal film resistors or a wire wound potentiometer will result in the lowest temperature coefficient.

The current set point, over voltage trip, and over current trip can be programmed in the same manner. Referring to the Table 3.1 for terminal identification, use terminal 22 to program the current set point, terminal 4 to program over voltage trip, and terminal 23 to program over current trip. The power supply has been calibrated to produce full scale output voltage, output current, over voltage trip, and over current trip with a 2.0 V input at the external reference input terminals.

Over voltage trip and over current trip may be set to a value greater than full scale voltage and current by using terminal 26 as the reference voltage. The reference output at this terminal is 5.0. If the applied voltage at any input is greater than 2.50 V, the SPS supply will disable its output, the PGL (program line) indicator will appear on the VFD screen, and the power supply will latch in protection mode. If the BUZZER is on, the SPS supply will beep continuously.

3.4.2 Voltage Programming

Voltage programming is very similar to resistive programming. In this case, the voltage reference, terminal 21 of EXT PRG Connector, is not used and an external voltage reference is applied to the programming inputs directly. A 2.0 V voltage source placed between terminals 3 and 1 of EXT PRG Connector will produce full scale output voltage.

Table 3.1 EXTERNAL PROGRAMMING PARAMETERS

TERM	PARM	DESCRIPTION	RANGE (V)
3	VREF EXT	Voltage Set	0-2.0
22	IREF EXT	Current Set	0-2.0
4	TVREF EXT	Over Voltage Trip Set	0-2.2
23	TIREF EXT	Over Current Trip Set	0-2.2

The current set point, over voltage trip, and over current trip can be programmed in the same manner. Referring to the Table 3.1 for terminal identification, use terminal 22 to program the current value, terminal 4 to program over voltage trip, and terminal 23 to program over current trip. The power supply has been calibrated to produce full scale output voltage, output current, over voltage trip & over current trip with a 2.0 V input at the external reference input terminals.

If the applied voltage at any input is greater than 2.50 V, the SPS supply will disable its output, the PGL (program line) indicator will appear on the VFD screen, and the power supply will latch in protection mode. If the BUZZER is on, the SPS supply will continuously beep.

3.4.3 Current Programming

Current programming, like voltage programming, does not require the voltage reference at terminal 21 of EXT PRG Connector. To produce the voltage reference, a current source is applied to a shunt resistor. Using a 2 mA current source, place a 1.0 K precision metal film resistor between terminals 3 and 1 of EXT PRG Connector. This will produce 2.0 V at the external voltage reference input which will produce full scale output voltage. The magnitude of the current source and shunt resistor may be inversely scaled to produce the same results.

The current set point, over voltage trip, and over current trip can be programmed in the same manner. Referring to the Table 3.1 for terminal identification, use terminal 22 to program the current set point, terminal 4 to program over voltage trip, and terminal 23 to program over current trip. The power supply has been calibrated to produce full scale output voltage, output current, over voltage trip, and over current trip with a 2.0 V input at the external reference input terminals.

If the applied voltage at any input is greater than 2.50 V, the SPS supply will disable its output, the PGL (program line) indicator will appear on the VFD screen, and the power supply will latch in protection mode. If the BUZZER is on, the SPS supply will continuously beep.

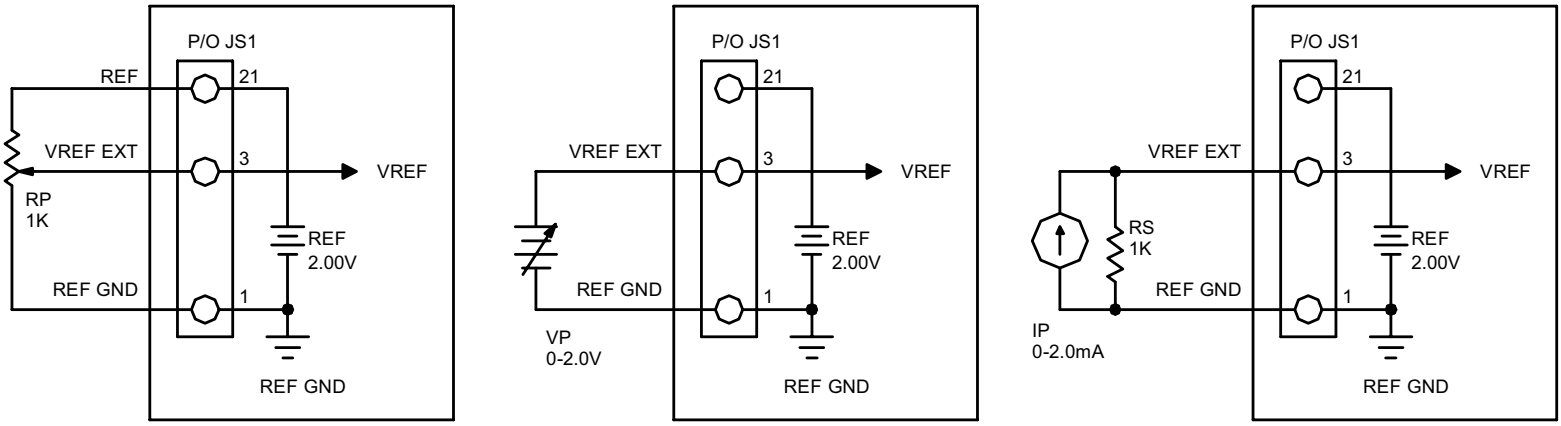


Figure 3.26 External (a) resistive, (b) voltage, and (c) current programming

3.5 Voltage and Current Monitoring

Two outputs are provided for monitoring output voltage and current and for use in master/slave series and parallel operation. As illustrated in figure 3.27, output monitoring voltage, VO2, can be obtained by monitoring the voltage between terminals terminal 5 of EXT PRG Connector and terminal 1,2 or 20 of EXT PRG Connector. Output monitoring current, IO2, can be obtained by monitoring the voltage between

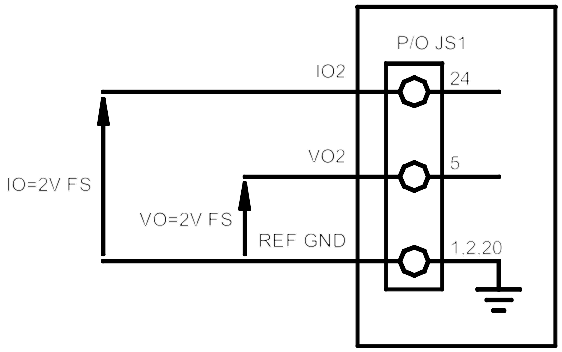


Figure 3.27 Monitoring output (a) voltage and (b) current

terminals terminal 24 of EXT PRG Connector and terminal 1,2 or 20 of EXT PRG Connector. Like the programming inputs, max output voltage & current will produce 2.0 V. The output impedance at these terminals is 100 Ω.

3.6 Digital Input and Output Lines

All digital input and output control lines are connected to connector EXT PRG Connector located on the rear panel. As illustrated in figure 3.28, the digital input lines are start, stop, clear, arm, and interlock set. Functionally, the first four digital input control lines emulate the functions on the front panel when external control is enabled. Enabling external control and external interlock is achieved via the UTILITY/LOCAL Menu Options.

Interlock set requires a either a physical short between terminals 26 and 37 of connector EXT PRG Connector or connection of a 5.0 V source with the positive connection at terminal 37 of EXT PRG Connector and the negative connection at terminal 7 of EXT PRG Connector. One of these two connections must be made to enable operation of the power supply. If the interlock connection is broken then the SPS supply will disable its output, the LOC (interlock) indicator will appear on the VFD screen, and the power supply will latch in protection mode. If the BUZZER is on, the SPS supply will continuously beep. As illustrated, digital control lines may be paralleled with other supplies to allow simultaneous control.

Digital output control lines provide the means to monitor diagnostic functions as well as mode of operation (voltage or current). All digital output control lines, as illustrated in Figure 3.29, are connected to connector EXT PRG Connector. Refer to this figure for terminal identification. Each output monitoring line can drive a 5.0V, 5.0mA load. An alarm condition will produce a 5.0 V output at the respective terminal.

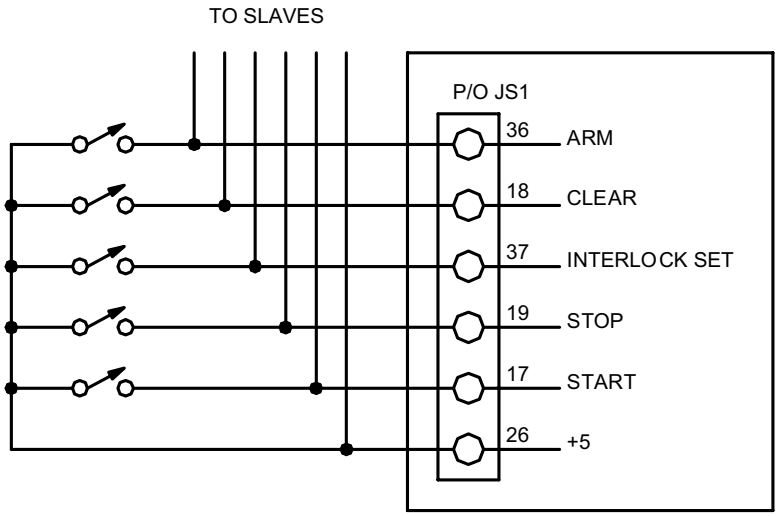


Figure 3.28 Digital input control lines

3.7 Diagnostic Functions

Diagnostic functions include thermal overload (OTT), interlock (LOC), phase loss (PHL), program line (PGL), fuse (FSE), over voltage (OVT), and over current (OCT). All diagnostic indicators have memory retention (the fault conditions are stored in a "QUES:EXT" register) which saves the fault condition until the power supply is reset. To clear a fault condition, the user must press the clear key on the front panel with internal control or by applying 5.0 V to terminal 18 of EXT PRG Connector with external control. Alternatively, the supply can be cleared by turning the power supply off and on.

Diagnostic functions and mode of control are embedded in the supply's closed loop control. The power supply will operate using voltage control or current control depending on which setting is lowest. Voltage control and current control also contain a soft start function which causes voltage and/or current to ramp to the desired set point after power is initiated. The soft start circuitry is reset upon power-on or operation of any diagnostic function.

Thermal overload or OTT (Over-temperature Trip) indicates that the input power processing devices or output rectifiers have reached a critical temperature. A resetting thermal breaker will reset upon cooling.

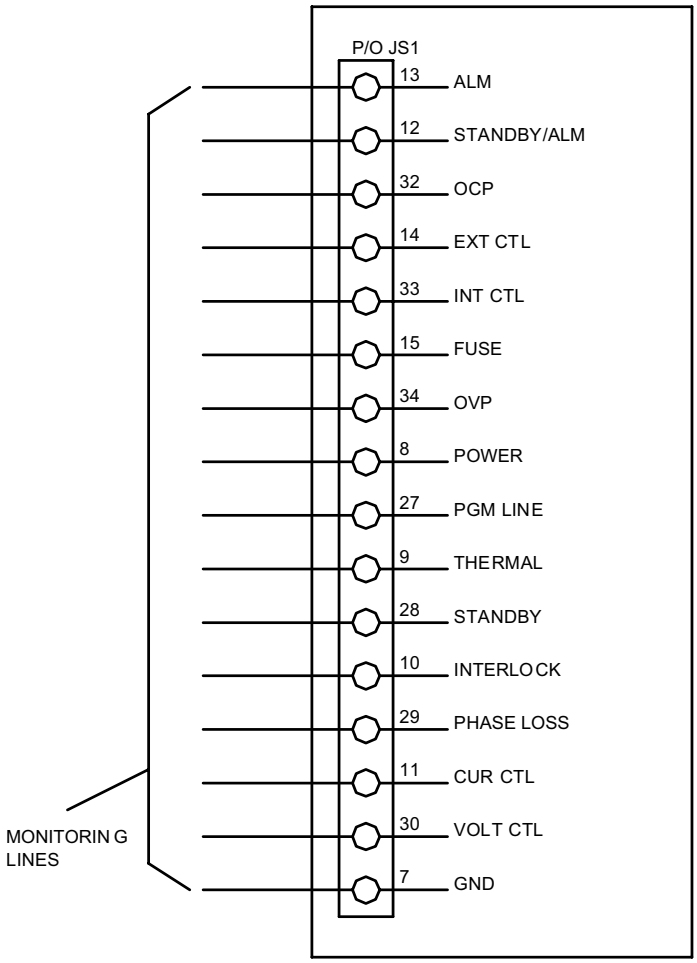


Figure 3.29 Digital output control lines

Phase loss indicates a problem with the power mains voltage.

Program line means the voltage set point, current set point, over voltage trip, or over current trip external input is set beyond the range of control. These lines are constantly monitored and if any of these references are set above the normal bounds, program line diagnostics will disable the supply.

Fuse indicates that one of the three main fuses has cleared. Power must be removed from the supply and the fuse must be replaced to correct this condition. A cleared fuse usually indicates a failed power supply requiring factory attention.

Over voltage trip indicates that the supply has exceeded the over voltage trip reference. This condition causes the supply to shutdown. To clear this condition, the user must press the clear key on the front panel with internal control or by applying 5.0 V to terminal 18 of EXT PRG Connector with external control. To restart the supply, simply press the start switch.

Over current trip indicates that the supply has exceeded the over current trip reference. To clear this condition, the user must press the clear key on the front panel with internal control or by applying 5.0 V to terminal 18 of EXT PRG Connector with external control. To restart the supply, press CLEAR to clear the protection latch and press Output On/Off to reenable output.

A secondary over current trip diagnostic provides protection of internal circuitry due to abnormal line and load conditions or due to failed internal circuitry. This over current trip conditions requires the control power to be recycled by toggling the power switch off and on.

If external interlock is enabled, interlock set requires a either a physical short between terminals 26 and 37 of connector EXT PRG Connector or connection of a 5.0 V source with the positive connection at terminal 37 of EXT PRG Connector and the negative connection at terminal 7 of EXT PRG Connector. If the interlock connection is broken then the SPS supply will disable its output, the LOC (interlock) indicator will appear on the VFD screen, and the power supply will latch in protection mode. If the BUZZER is on, the SPS supply will continuously beep.

Standby/alm is used with master/slave operation of two or more power supplies. When interconnected as illustrated in figures 3.30 or 3.31, a standby or alarm condition produced by the master power supply will turn off the slave power supplies.

Any diagnostic condition causes an alarm condition. This feature can be used as an external standalone signal to indicate there is a problem.

3.8 Parallel Operation

Two or more SPS Series power supplies can be connected in parallel to obtain a total output current greater than that available from one power supply. The total output current is the sum of the output currents of the individual power supplies. Each power supply can be turned on or off separately.

3.8.1 Parallel Operation - Direct

The simplest parallel connection involves attaching the positive terminals of all supplies to be paralleled to the positive point of the load and attaching the negative terminals to the negative point of the load. The output current controls of each power supply can be separately set. The output voltage control of one power supply (master) should be set to the desired output voltage; the other power supply (slave) should be set for a slightly higher output voltage. The master will act as a constant voltage source; the slave will act as a constant current source, dropping its output voltage to equal that of the master.

3.8.2 Parallel Operation - Master/Slave

Master/slave parallel operation permits equal current sharing under all load conditions and allows complete control of output current from one master power supply.

Figure 3.30 illustrates the terminal connection for master/slave parallel operation and salient control circuitry. The control cable, along with resistors R1 through R4 integrated into the assembly, can be fabricated by the user or purchased as an option, UID45, from the factory. These connections perform the following functions:

1. The current monitoring voltage, IO2, on the master power supply connects to the external current set point input on the slave power supply. This makes the slave power supply operate at the same current output as the master power supply
2. The power output digital control line of the master power supply connects to the start digital control line of the slave power supply. This connection causes the

slave unit to turn on when the master unit is turned on.

3. The standby/alm digital control line of the master power supply connects to the stop digital control line of the slave power supply. This connection causes the slave unit to turn off when the master unit is turned off or when a diagnostic condition appears.

4. Resistor R3 and R4 connections set the voltage set point of the slave unit to approximately 2% above the voltage set point of the master unit. This ensures that the slave unit will operate as a current source with an output voltage not to exceed 2% that of the master unit under any steady state or transient condition.

5. Resistor R1 and R2 connections set over voltage trip and over current trip to set points just beyond full scale values. This forces the slave power supply to operate simply as a current source whose current set point is established by the master unit.

The slave power supply must be configured for external program input.

To add a second slave unit, connect the output terminals of the second slave in parallel with the other two power supplies. Furthermore, connect a second control cable between the second slave unit and the master unit.

3.9 Series Operation

Two or more power supplies can be connected in series to obtain a total output voltage greater than that available from one power supply. The total output voltage is the sum of the output voltage of the individual power supplies. Each power supply can be turned on or off separately.

Caution: No plus or minus voltage should exceed 1000 Vdc with respect to ground.

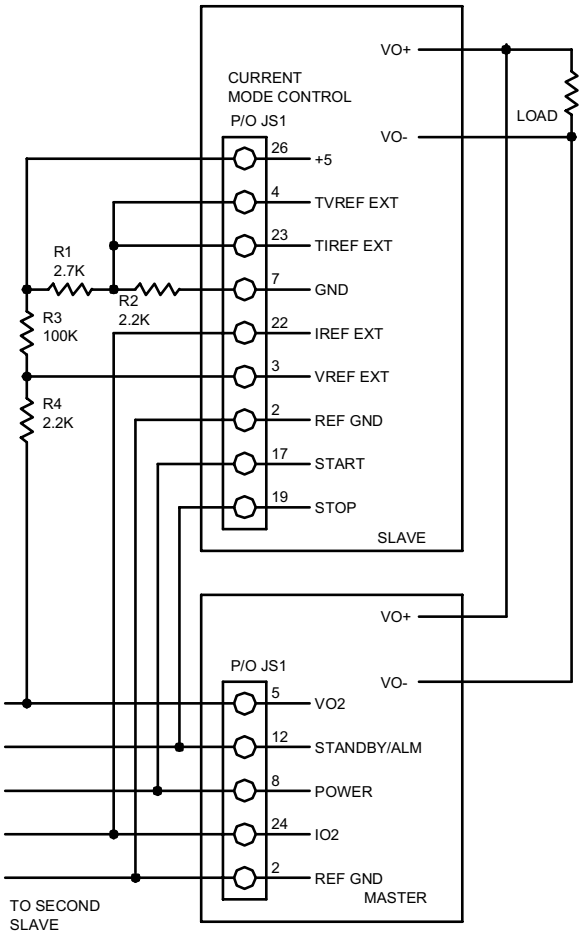


Figure 3.30 Master/slave parallel connection

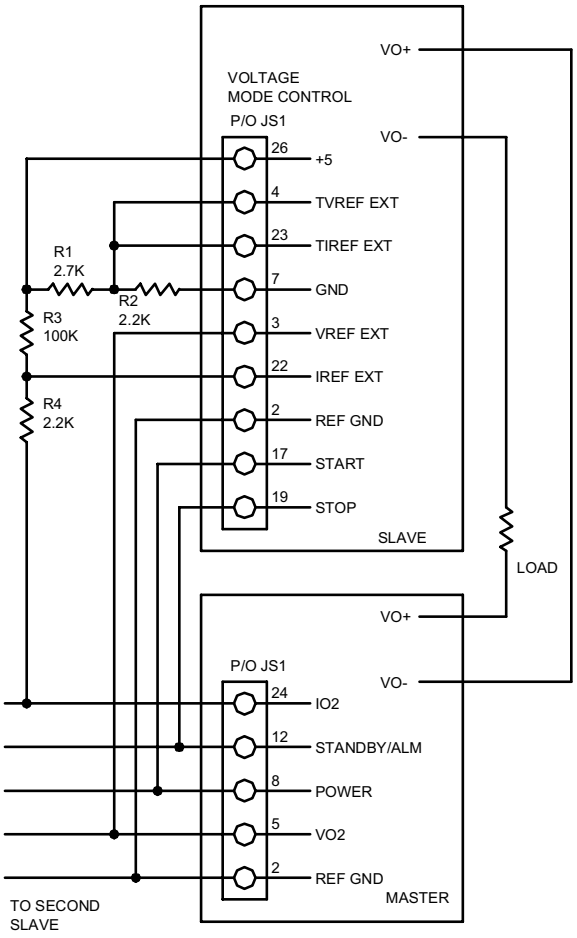


Figure 3.31 Master/slave series connection

3.9.1 Series Operation - Direct

The simplest series connection involves attaching the positive terminal of the first supply to the negative terminal of the second supply. The load is connected between the negative terminal of the first supply and the positive terminal of the second supply. The output current controls of each power supply are operative and the current limit is equal to the lowest control setting. If any one output current control is set too low with respect to the total output current, the series power supplies will automatically crossover to constant current operation and the output voltage will drop.

3.9.2 Series Operation - Master/Slave

Master/slave series operation permits equal voltage sharing under all load conditions and allows complete control of output voltage from one master power supply.

Figure 3.31 illustrates the terminal connection for master/slave series operation and salient control circuitry. The control cable, along with resistors R1 through R4 integrated into the assembly, can be fabricated by the user or purchased as an option, UID45, from the factory. These connections perform the following functions:

1. The voltage monitoring voltage, VO2, on the master power supply connects to the external voltage set point input on the slave power supply. This makes the slave

power supply operate at the same voltage output as the master power supply

2. The power output digital control line of the master power supply connects to the start digital control line of the slave power supply. This connection causes the slave unit to turn on when the master unit is turned on.

3. The standby/alm digital control line of the master power supply connects to the stop digital control line of the slave power supply. This connection causes the slave unit to turn off when the master unit is turned off or when a diagnostic condition appears.

4. Resistor R3 and R4 connections set the current set point of the slave unit to approximately 2% above the current set point of the master unit. This ensures that the slave unit will operate as a voltage source with an output current not to exceed 2% that of the master under any steady state or transient condition.

5. Resistor R1 and R2 connections set over voltage trip and over current trip to set points just beyond full scale values. This forces the slave power supply to operate simply as a voltage source whose voltage set point is established by the master unit.

The slave power supply must be configured for external program input.

To add a second slave unit, connect the output terminals of the second slave in series with the other two power supplies. Furthermore, connect a second control cable between the second slave unit and the master unit.

3.10 Pulse Loading

The power supply will automatically crossover from constant voltage to constant current operation, or the reverse, in response to an increase (over the preset limit) in the output current or voltage, respectively. With the preset limit set to the average output current or voltage, high peak currents or voltages, as occur in pulse loading, may exceed the preset limit conditions and cause crossover to occur. To avoid this unwanted crossover, the preset limit must be set for the peak requirement and not the average.

There are internal capacitors across the output terminals of the power supply. These capacitors help to supply high-current pulses of short duration during constant voltage operation. Any capacitance added externally will improve the pulse current capability, but will decrease the safety provided by the constant current circuit. A high-current pulse may damage load components before the average output current is large enough to cause the constant current circuit to operate.

3.11 Nomenclature

The following defines user connections on the terminal strips and input/output power connections.

AC INPUT:

A: Phase A input.

B: Phase B input.

C: Phase C input.

DC OUTPUT:

VO+: Positive output.

VO- : Negative output.

PROGRAMMING INPUTS AND OUTPUTS:

REF GND: Reference ground.

REF: Reference for external analog control

VO1REM+: Remote positive voltage sense.

VO1REM-: Remote negative voltage sense.

VO2: Output monitoring voltage.

IO2: Output monitor current.

VREF: Voltage set point reference.

IREF: Current set point reference.

TVREF: Over voltage trip reference.

TIREF: Over current trip reference.

DIGITAL INPUT CONTROL LINES:

STOP: Remote stop.

START: Remote start.

CLEAR: Clear.

9ARM: Arm.

INTERLOCK SET: Interlock set.

DIGITAL OUTPUT CONTROL LINES:

STANDBY: Standby.

POWER: Control circuit power.

INT CTL: Internal control.

EXT CTL: External control.

PGL: Program line shutdown.

OVT: Over voltage trip shutdown.

OCT: Over current trip shutdown.

PHL: Phase loss shutdown.

OTT: Thermal overload shutdown.

FSE: Fuse cleared.

VOLT CTL: Voltage control.

CURRENT CTL: Current control.

LOC: Interlock open.

STANDBY/ALM: Standby or alarm.

ALM: Alarm condition.

4.0 PROGRAMMING WITH SCPI COMMANDS

4.1 Command Features

The SPS Series power supplies provide RS232 and IEEE-488 as standard interfaces or Ethernet communications as an optional feature. A second UART port, a factory installed option, is enabled after power on by recognizing which port is receiving communications. Once a particular port has been activated, the other UART port cannot be recognized unless there has been a period of inactivity for 5 minutes. After this period, a new UART port can be recognized by sending communications.

In addition to RS232, and IEEE-488, the Ethernet interface is available as an option. Please review Section 4.4.

The RS232 port, a DB9 connector, located on the rear panel, allows all of the front panel functions plus some additional commands to be implemented using SCPI commands. To establish RS232 communications, use the keypad to navigate the Utility Menu Tree to set the RS232 Baud Rate and EOS type. Then connect a straight through DB9 RS-232 cable between the computer interface and the RS-232 Port.

RS232 communications to the SPS Series power supply can be made using a Terminal program or with the Remote Interface Software supplied with the power supply. The Remote Interface Software, covered in Section 5.0, contains command output frames to display the SCPI command being written to obtain the desired result. This feature provides feedback to the user to help program with SCPI commands.

4.2 Electrical Testing Using RS-232 Communications

The SPS Series power supplies can be tested using any Terminal program; one is included with Microsoft Windows (tm) called HyperTerminal. The following outlines the procedure.

1. Connect a straight through DB9 RS-232 cable between the computer interface and RS-232 port on the rear of the SPS power supply.
3. Verify the availability of the RS-232 port selected.
4. Turn on the power switch of the SPS Series power supply and turn on the IBM PC or compatible computer.
5. Start the HyperTerminal test software and set the COM port to the one connected to the SPS Series power supply. Configure the terminal for 19200, N, 8, 1. Set the terminal to echo typed characters locally and “append line feeds to incoming line ends.” (The echo feature is not functional with Windows 98.)

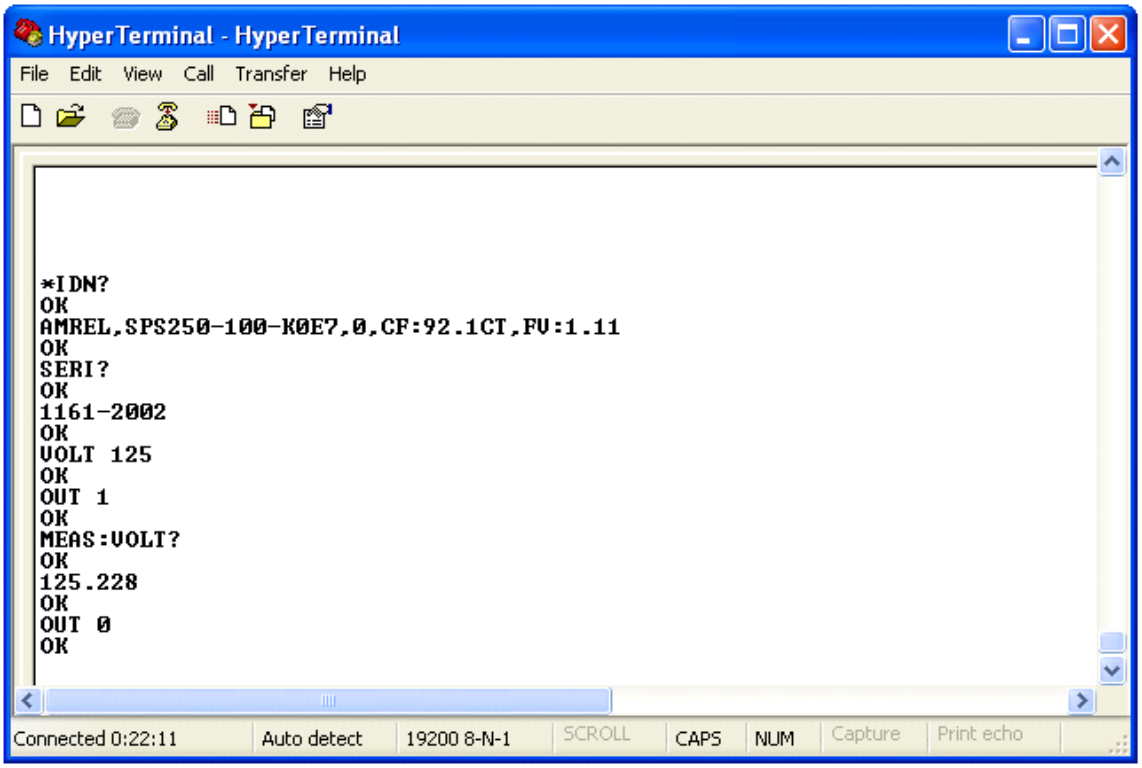


Figure 4.1 RS-232 Communications using Microsoft Windows(tm) HyperTerminal

6. Type the query command *"*IDN?"* in the output data window and press enter. The text should be entered inside the quotation marks.
7. As illustrated in figure 4.1, the returned data will display the following: "Amrel,SPS250-100-K0E7,0,CF:92.1CT,FV:1.11" where the model number may be different depending on the unit being tested.
8. Type the query command *"SERI?"* in the output data window and press enter. The text should be entered inside the quotation marks.
9. Verify that the model number in the *"*IDN?"* response corresponds to the power supply under test and the serial number on the rear of the unit matches the *"SERI?"* response..
10. With the output terminals of the power supply open, enter the command *"VOLT xx"*, where xx is 50% of rated voltage and press enter. Verify the voltage setting on the VFD display.
11. Enter the command *"OUT 1"* and press enter. The power supply's contactor should close with an audible click and the front panel indicators and VFD display should indicate power flow via the voltage reading. Verify that the power supply's output voltage is equal to the VOLT setting set in the previous command.
11. Enter the command *"MEAS:VOLT?"* and press enter. Verify the output voltage corresponds to the voltage read back on the VFD display of the power supply.
12. Enter the command *"OUT 0"* and press enter. The power supply's contactor should open with an audible click and the front panel indicators and meters should indicate operation in a standby state.

4.3 GPIB CAPABILITIES OF THE POWER SUPPLY

All Power Supply functions except for setting the GPIB address are programmable over the GPIB Interface.

GPIB Address

The power supply operates from a GPIB address that is set from the rear panel switch. To set the GPIB address, utilize the LOCAL/UTILITY MENU and program the GPIB Address accordingly.

4.4 ETHERNET CAPABILITIES OF THE POWER SUPPLY (Optional)

The power supply provides an Ethernet programming interface as optional. All SCPI commands are also available through Ethernet programming. When the Ethernet interface is selected, the GPIB interface and RS-232 interface should not be operated.

Obtain Network Information

To connect the power supply to the network, you only need a cross-over network cable with RJ-45 connector. No transceiver is necessary. However, you need to obtain the following information from the power supply unit and your network administrator:

1. Power supply Ethernet MAC Address:

It's a twelve digits string that unequally identifies the power supply unit. It can be obtained from the control board.

2. Network information:

    1) DHCP server enabled? Yes or no.
    2) Power supply IP address: _____._____._____._____
    3) Gateway IP address: _____._____._____._____
    4) Subnet mask: _____._____._____._____

Setting the Power Supply Ethernet Parameters

You need to set the power supply Ethernet IP address first. The power supply IP address uniquely identifies the power supply to other devices on the network, and is required for the power supply to communicate over the network.

A. Ethernet Network settings: DHCP supported. The purpose of a DHCP (Dynamic Host Configuration Protocol) server is to issue an IP address to a network device that requests an address. The IP address enables the device to communicate with the network. This is similar to personal computer Plug & Play concept.

The following procedure presumes that your power supply has the Ethernet option and you have connected the power supply to your network.

If your network supports DHCP server, do the following:

1) Power on the power supply.
2) Set IP address as: “0.0.0.0” using command: “SYST:NET:ADDR 0.0.0.0”.
3) Set Net mask to “0.0.0.0” using command: “SYST:NET:SUBN 0.0.0.0”.
4) Set network gateway as “0.0.0.0” using command: “SYST:NET:GAT 0.0.0.0”.

Note: If the DHCP server assign a dynamic IP address, then the value of the power supply IP address maybe different each time you power on the power supply. However, if you intend to remotely control the power supply, a static IP address is more convenient, as the power supply IP address does not change, making it easier for remote devices to access power supply.

B. Ethernet Network settings: DHCP not supported. If your network does not support DHCP server, you must enter the Ethernet settings manually which you obtained from your network administrator.

The following procedure presumes that your power supply has the Ethernet option and you have connected the power supply to your network.

If your network does not support DHCP server, do the following:

1) Power on the power supply.
2) Set IP address as: “value” using command: “SYST:NET:ADDR <value>” where the value is assigned by your network administrator.
3) Set IP net mask as: “value” using command: “SYST:NET:SUBN <value>” where the value is provided by your network administrator.
4) Set IP network gateway as: “value” using command: “SYST:NET:GAT <value>” where the value is provided by your network administrator.

C. The Ethernet Port Number is 3000.
D. Please contact AMREL Technical Support @ 800.654.9838 for additional Ethernet Set-up Questions.

E. PROGRAMMING COMMAND SET FOR SPS SERIES POWER SUPPLY

This section gives the syntax and parameter for all the programming commands used by AMREL SPS series power supply, including the terms, symbols, and syntactical structures used here and give an introduction to programming. You should also be familiar with front panel operation in order to understand how the power supply functions.

The programming examples are simple applications of SCPI commands. Because the SCPI syntax remains the same for all programming languages, the examples given for each command are generic.

Syntax Forms "keywords") — Syntax definitions use the long form, but only short form headers (or appear in the examples. Use the long form to help make your program self-documenting.

Parameters — Most commands require a parameter and all queries will return a parameter. The range for a parameter may vary according to the model of power supply. When this is the case, refer to the Specifications table.

Models — If a command only applies to specific models, those models are listed in the <Model> Only entry. If there is no <Model> Only entry, the command applies to all models.

Related Commands — Where appropriate, related commands or queries are included. These are listed because they are either directly related by function, or because reading about them will clarify or enhance your understanding of the original command or query.

Order of Presentation — The manual is organized according to the following categories: common commands, subsystem commands, Non-SCPI commands, and IEEE 488.1 commands. Each category commands that follow are arranged in alphabetical order. Section 1, command list includes all the commands.

COMMON COMMANDS LIST

*CLS	Clears status
*ESE <n>	Enables standard event status
*ESE?	Returns standard event status
*ESR?	Returns event status register
*IDN?	Returns instrument identification
*OPC	Enables “operation complete” bit in ESR
*OPC?	Returns a “1” when operation completes
*RCL	Recalls profile settings
*RST [<channel>]	Resets
*SAV [<channel>] [n]	Saves instrument state and profile
*SAV? <channel>	Returns saving status
*SRE <n>	Sets service request enable register
*SRE?	Returns service request enable register
*STB?	Returns status byte
*TRG	Trigger
*TST?	Performs self-test and returns test result

4.5.1 Subsystem Commands Syntax

ABORt	Resets the trigger system to idle state
CURRent	
[:LEVel]	
[IMMediate] <channel> <value>	Sets / Queries the output current level
:PROTection	
:CLEar <channel>	Resets latched current protection
:STATe <channel> <bool>	Sets / Queries current protection state
LIST	
:COUNt <channel> <count>	Sets / Queries the number of times for a list
:CURRent <channel> <point> <value>	Sets / Queries current value for a list point
:STATe <channel> <bool>	Sets / Queries current list state
:TIMe <channel> <point> <value>	Sets / Queries current dwell time for a list point
:VOLTage <channel> <point> <value>	Sets / Queries voltage value for a list point
:STATe <channel> <bool>	Sets / Queries voltage list state
:TIMe <channel> <point> <value>	Set / Queries voltage dwell time for a list point
MEASure	
:CURRent? <channel>	Returns current measured value
:DELay <n>	Sets / Queries delay time for measuring
:VCOUT? <channel>	Returns both voltage and current measured value
:VOLTage? <channel>	Returns voltage measured value
OUTPut	
[:STATe] <channel> <bool>	Sets / Queries output status
:PROTection	
:CLEar <channel>	Resets latched protection
STATus	
:OPERation	
[:EVENt]? <channel>	Returns the value of operation event register
:QUEStionable	
[:EVENt]? <channel>	Returns the value of questionable event register
:ENABle <channel>	Enables / Queries the specific bit in the questionable enable register
:EXT <channel>	Enables / Queries the specific bit in the questionable external register
SYSTem	
:BUZZer <bool>	Sets / Queries system buzzer mode
:CONSol	
:BAUD <baudrate>	Sets / Queries RS-232 baud rate value
:EOS <n>	Sets / Queries RS-232 EOS mode
:DEFault:OUTPut <n>	Sets / Queries default power on output status
:EOS <n>	Sets / Queries current interface EOS mode
:ERRor?	Returns error number and string
:EXT:CONT <n>	Sets / Queries External Control State
:GPIB:EOS	Sets / Queries GPIB EOS mode
:INT:CONT <n>	Sets / Queries the State of the Interlock Function
:NET	
:ADDRess	Sets / Queries Ethernet IP address
:DHCP?	Queries if the DHCP is enabled
:EOS	Sets / Queries Ethernet EOS mode
:GATE	Sets / Queries Ethernet gateway IP address
:STATe?	Queries Ethernet configuration state
SUBNet	Sets / Queries Ethernet subnet value
:PROT	Returns value of Protect Event Status register
:REM:SENSE <n>	Sets / Queries Local/Remote Voltage Sense

VOLTage
[:LEVel]
[:IMMediate] <channel> <value> Sets / Queries the output voltage level
:PROTection
:CLEar <channel> Resets latched voltage protection
:COUNt <channel> <value> Sets / Queries over-voltage protection counts
[:LEVel] <channel> <value> Sets / Queries over voltage protection level
:STATe <channel> <bool> Sets / Queries over voltage protection state

DESCRIPTION OF COMMON COMMANDS

Common commands begin with an * and consist of three letters (command) or three letters and a "?" (query). They are defined by the IEEE 488.2 standard to perform common interface functions. The SPS series power supply responds to the following commands:

***CLS**
Meaning and Type
Clear Status Device Status

Description
This command causes the following actions (see "Status Reporting" for descriptions of all registers):

- Clears the following registers:
  - Standard Event Status ("*ESR?" returned value)
  - Status Byte ("*STB?" returned value)
- Clears the Error Queue ("SYST:ERR?" returned value)
- Also clears over-voltage protection status (to comply with AMREL old 488.1 unit).

Command Syntax	*CLS
Parameters	(None)
Query Syntax	*(None)*
Related Commands	*ESR? *STB? SYST:ERR?

***ESE**
Meaning and Type
Event Status Enable Device Status

Description
This command programs the Standard Event Status Enable register bits. The programming value determines which events of the Standard Event Status Event register (see ***ESR?**) are allowed to set the Event Summary Bit of the Status Byte register. A "1" in the bit position enables the corresponding event. All of the enabled events of the Standard Event Status Event register are logically ORed to cause the Event Summary Bit of the Status Byte register to be set.

Bit Configuration of Standard Event Status Enable Register Table:

Bit Position	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Bit Name	**PON**	**0**	**CME**	**NU**	**NU**	**QYE**	**0**	**OPC**
Bit Weight	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
CME = Command error; OPC = Operation complete; PON = Power-on; QYE = Query error; NU = Not used.								

Command Syntax	*ESE <NR1>
Parameters	*0 to 255*
Power On Value	128
Suffix	(None)
Example	*ESE 32
Query Syntax	*ESE?
Returned Parameters	<NR1> (Register decimal value)
Related Commands	*ESR? *STB? *OPC*

<Note> *: The OPC bit at the register cannot be set through ****ESE*** command. It must use ****OPC*** command. But the OPC bit can only be cleared by executing ****ESE*** command.

***ESR?**
Meaning and Type
Event Status Register Device Status

Description
This query reads the Standard Event Status Event register. Reads the register and clears it. The bit configuration of this register is the same as the Standard Event Status Enable register (***ESE**).

Query Syntax	*ESR?
Parameters	(None)
Returned Parameters	<NR1> (Register decimal value)
Related Commands	*CLS *ESE *ESE? *OPC

***IDN?**
Identification Query
Meaning and Type
Identification System Interface

Description
This query requests the power supply to identify itself. It returns a string composed of five fields separated by commas.

Query Syntax	*IDN?	
Returned Parameters	<CRD>	
	Field	Information
	AMREL,	Manufacturer
	xxxxx-xx,	Model number
	0,	
	CF:92.CT,	
	FV:x.xx	Revision levels of firmware
Example	AMREL,SPS-MC1,0,CF:92.1CT,FV2.47	
Related Commands	(None)	

***OPC**
Meaning and Type
Operation Complete Device Status

Description
This command causes the interface to set the OPC bit (bit 0) of the Standard Event Status register when the power supply has completed all pending operations. (see ***ESE** for the bit configuration of the Standard Event Status register.) Pending operations are complete when:

- All commands sent before ***OPC** have been executed. This includes overlapped commands. Most commands are sequential and are completed before the next command is executed. Overlapped commands are executed in parallel with other commands. Commands that affect output voltage, current or state, relays, and trigger actions are overlapped with subsequent commands sent to the power supply. The ***OPC** command provides notification that all overlapped commands have been completed.
- Any change in the output level caused by previous commands has been completed (completion of settling time, relay bounce, etc.)
- All triggered actions are completed.

***OPC** does not prevent processing of subsequent commands but Bit 0 will not be set until all pending operations are completed.

Command Syntax	*OPC
Parameters	(None)
Related Commands	*OPC? *ESE?

***OPC?**
Meaning and Type
Operation Complete Device Status

Description
This query causes the interface to place an ASCII "1" in the Output Queue when all pending operations are completed. *Pending operations* are as defined for the ***OPC** command. Unlike ***OPC, *OPC?** prevents processing of all subsequent commands. ***OPC?** is intended to be used at the end of a command line so that the application program can then monitor the bus for data until it receives the "1" from the power supply Output Queue.

CAUTION: Do not follow ***OPC?** with ***TRG** or GPIB bus triggers. Such triggers sent after ***OPC?** will be prevented from executing and will prevent the power supply from accepting further commands.

***RCL**
Meaning and Type
Recall Device State

Description
This command recalls the power supply profile settings, which is saved by *SAV command.

Command Syntax	*RCL [<channel>] [n]
Parameters	<channel>: 1 – 31, channel number n: 0 – 3, profile number.
Query Syntax	(None)
Related Commands	*SAV

***RST**
Meaning and Type
Reset Device State

Description
This command resets the power supply to a factory-defined state as defined below. ***RST** also forces an **ABORt** command.

COMMAND	STATE	COMMAND	STATE	COMMAND	STATE
SYST:REM:SENS	OFF	LIST:VOLT:STAT	OFF	SYST:INT:CONT	OFF
CURR[:LEV][:IMM]	1.0	SYST:EXT:CONT	OFF	UNDER:PROT:STAT	OFF
CURR:PROT:STAT	OFF	VOLT[:LEV][:IMM]	5.0	CURR:PROT:LEV	MAX
LIST:COUN	0	VOLT:PROT:LEV	MAX		
LIST:CURR:STAT	OFF	VOLT:PROT:STAT	OFF		

Command Syntax	*RST [<channel>] *
Parameters	None or 1 – 31
Query Syntax	(None)
Related Commands	*SAV

<Note> *: If this command is sent without a channel number, it resets all channels connected to the master controller.

***SAV**
Meaning and Type
Save Device State

Description
This command stores the present state of the power supply to a specified location in memory, and the profile settings. If a particular state is desired at power on, it should be stored in a profile number 0. It then will be recalled at power on if the power supply configuration switch is set for this mode of operation.

The following power supply states are stored by ***SAV:**

CURR[:LEV][:IMM] VOLT[:LEV][IMM] VOLT:PROT[:LEV], LIST:COUN, LIST:CURR, LIST:CURR:TIM, LIST:VOLT, LIST:VOLT:TIM

Command Syntax	*SAV <channel> [n]
Parameters	channel: 1 to 31 n: 0 to 3, profile number
Query Syntax	*SAV? <channel>
Returned Parameter	<NR1> 0 | 1 0 Indicates saving successfully 1 Indicates saving in processing
Related Commands	*RST, *RCL

NOTE: If saved without the profile number (***SAV <channel>**), it may require 2-3 minutes processing time or at least wait until query returns to 0.

***SRE**
Meaning and Type
Service Request Enable Device Interface

Description
This command sets the condition of the Service Request Enable register. This register determines which bits from the Status Byte register (see ***STB** for its bit configuration) are allowed to generate an SRQ. A *1* in any Service Request Enable register bit position enables the corresponding Status Byte register bit and all such enabled bits then are logically ORed to cause Bit 6 of the Status Byte register to be set.

When ***SRE** is cleared (by programming it with 0), the power supply cannot generate an SRQ to the controller.

Command Syntax	*SRE <NR1>
Parameters	0 to 255
Default Value	0
Example	*SRE 32
Query Syntax	*SRE?
Returned Parameters	<NR1> Register decimal value
Related Commands	*ESE *ESR

***STB?**
Meaning and Type
Status Byte Device Status

Description
This query reads the Status Byte register, which contains the status summary bits. Reading the Status Byte register does not clear it. It is cleared at power on or by ***CLS**.

Bit Configuration of Status Byte Register Table:

Bit Position	7	6	5	4	3	2	1	0
Bit Name	NU	SRQ	SE	MSA	QD	NU	NU	NU
Bit Weight	128	64	32	16	8	4	2	1
MSA = Message available; NU = Not used; QD = Questionable date enable register; SE = Standard event enable register; SRQ = Service request.								

Query Syntax *STB?
Returned Parameters <NR1> Register decimal value
Related Commands (None)

***TRG**
Meaning and Type
Trigger Device Trigger

Description
This command generates a trigger to power supply.

Command Syntax *TRG
Parameters (None)
Query Syntax (None)
Related Commands ABOR; CURR:TRIG
TRIG[:IMM]; VOLT:TRIG

***TST?**
Meaning and Type
Test Device Test

Description
This query causes the power supply to do a self-test and report any errors.

Query Syntax *TST?
Returned Parameters <CRD> A string representing a 4-byte Hexadecimal value with a "&H" header. Each bit represents self-test result for the corresponding channel:
0 Indicates power supply passed self-test.
1 Nonzero, indicates an error.
Related Commands *VRF

Bit configuration of *TST? query returned value corresponding to channel number table:

Bit Position	7	6	5	4	3	2	1	0
Channel	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Bit Position	15	14	13	12	11	10	9	8
Channel	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**
Bit Position	23	22	21	20	19	18	17	16
Channel	**24**	**23**	**22**	**21**	**20**	**19**	**18**	**17**
Bit Position	31	30	29	28	27	26	25	24
Channel	**NU**	**31**	**30**	**29**	**28**	**27**	**26**	**25**

<Note> 1) Example: If the returned string is "&H7FFFFFFE", it means only channel 1 was connected and passed the self-test by converting the Hexadecimal value "7FFFFFFE" to binary value which is "0111 1111 1111 1111 1111 1111 1111 1110" and comparing the bit configuration with the above table to get the channel number.

<Note> 2) Example: If the returned value is a series of numbers, such as “26 48 37 46 46 46 46 46 46 45”, it represents ASCII code in Hexadecimal format, same as “&H7FFFFFFE “. It means only channel 1 was connected and passed the self-test.

DESCRIPTION OF SUBSYSTEM COMMANDS

ABOR

This command cancels any trigger actions presently in process. Pending trigger levels are reset equal to their corresponding immediate values. **ABOR** also cancels any programmed lists that may be in process.
ABOR also resets the WTG bit in the Operation Condition Status register. **ABOR** is executed at power turn on and upon execution of ***RST**.

Command Syntax	ABORt
Parameters	(None)
Examples	ABOR
Query Syntax	(None)
Related Commands	*RST *TRG TRIG

CURRENT SUBSYSTEM

This subsystem programs the output current of the power supply.

CURR
This command directly programs the immediate current level of the power supply. The immediate level is the current applied at the output terminals.

Command Syntax	CURRent[:LEVel][:IMMediate] <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: minimum to maximum current value of the channel
Default Suffix	*A*
*RST Value	1.0
Examples	CURR 1 0.500; CURR:LEV 1 30.0
Query Syntax	CURRent[:LEVel] [:IMMediate]? <channel> CURRent[:LEVel] [:IMMediate]? <channel> MAX CURRent[:LEVel] [:IMMediate]? <channel> MIN
Returned Parameters	<NRf>: CURR? returns the present programmed current level. CURR? MAX and CURR? MIN return the maximum and minimum programmable current levels.
Related Commands	*SAV *RST

CURR:PROT:CLE
This command clears the over-current protection status, and it dose not clear the over-current protection setting (**CURR:PROT:STAT**). After this command, output remains in OFF state.

Command Syntax	CURRent:PROTection:CLEar <channel>
Parameter	<channel>: 1-31, channel number
Example	CURR:PROT:CLE 1
Query Syntax	(None)
Related Commands	CURR:PROT:STAT

CURR:PROT:STAT
This command enables or disables the power supply over-current (OC) protection function. If the over-current protection function is enabled and the power supply goes into constant current (CC) mode, then the output is disabled and the Questionable Condition status register OC bit is set (**STAT:QUES?**). An over-current status can be cleared with the **OUTP:PROT:CLE** command.

Command Syntax	CURRent:PROTection:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | 1 | OFF | ON
*RST Value	OFF
Examples	CURR:PROT:STAT 1 0; CURR:PROT:STAT 1 ON
Query Syntax	CURRent:PROTection:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	OUTP:PROT:CLE; *RST

LIST SUBSYSTEM

This subsystem controls the generation of parameter lists that sequence the power supply output through values of voltage and current. Two subsystem commands specify lists of output voltages (**LIST:VOLT**), and currents (**LIST:CURR**), the time interval or dwell time that each value (point) of a list is to remain in effect (**LIST:VOLT:TIME and LIST:CURR:TIME**) A count command (**LIST:COUN**) determines how many times the power supply sequences through a list before that list is completed (Fixed at either once or Continuous). Each list can have from 1 to 20 points.

LIST:COUN
This command sets the number of times that the list is executed before it is completed. The command accepts parameters in the range 1 through 60000, but any number greater than 65534.

Command Syntax	LIST:COUNt <channel> <NR1>
Parameters	<Channel>: 1 – 31, channel number <NR1>: 0 or 1| 0 – Once & 1 - Continuous
*RST Value	1
Examples	LIST:COUN 1 1
Query Syntax	LIST:COUNt? <channel>
Returned Parameters	<NR1> number of times
Related Commands	LIST:CURR; LIST:VOLT

LIST:CURR
This command specifies the output current points in a list. The current points are given in the command parameters, which are separated by commas. Up to 20 points may be entered and the output current values specified by the points will be generated in the same order as they were entered.

Command Syntax	LIST:CURRent <channel> <point> <NRf>
Parameters	<channel>: 1 – 31, channel number <point>: 1 – 20, point number <NRf>: minimum to maximum current value of the channel
Default Suffix	*A*
Examples	LIST:CURR 1 1 2.5
Query Syntax	LIST:CURRent? <channel> <NR1>
Returned Parameters	<NRf>: current level at the point specified by the point number
Related Commands	LIST:CURR:STAT

LIST:CURR:STAT
This command enables or disables the output current list operation state.

Command Syntax	LIST:CURRent:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | 1 | OFF | ON
Examples	LIST:CURR:STAT 1 ON; LIST:CURR:STATE 2 OFF
Query Syntax	LIST:CURR:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	LIST:CURR:STEP

LIST:CURR:TIM
This command sets the dwell time for the output current list of the specified point. Each point specifies the time, in seconds, that the output of the power supply is to remain at the level specified by the corresponding point in the current list if the "LIST:COUN" is set to Continuous. At the end of the dwell time for each point, the power supply output will continue to the next LIST point, and run each point continuously. If "LIST:COUN 0" is set, the LIST cycle will run only once.

Command Syntax	LIST:CURRent:TIMe <channel> <point> <NR1>
Parameters	<channel>: 1 – 31, channel number <point>: list point number <NR1>: 0.01 – 9997, dwell time
Default Suffix	*S (seconds)*
Examples	LIST:CURR:TIM 1 10 1000
Query Syntax	LIST:CURRent:TIMe? <channel> <point>
Returned Parameters	<NR1> dwell time
Related Commands	LIST:CURR:STAT

LIST:VOLT
This command specifies the output voltage points in a list. The voltage points are given in the command parameters, which are separated by commas. Up to 20 points may be entered and the output voltage values specified by the points will be generated in the same order as they were entered.

Command Syntax	LIST:VOLTage <channel> <point> <NRf>
Parameters	<channel>: 1 – 31, channel number <point>: 1 – 20, point number <NRf>: minimum to maximum voltage value of the channel
Default Suffix	*V*
Examples	LIST:VOLT 1 1 2.5
Query Syntax	LIST:VOLTage? <channel> <NR1>
Returned Parameters	<NRf>: voltage level at the point specified by the point number
Related Commands	LIST:VOLT:STA

LIST:VOLT:STAT
This command enables or disables the output voltage list operation state.

Command Syntax	LIST:VOLTage:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | 1 | OFF | ON
Examples	LIST:VOLT:STAT 1 ON; LIST:VOLT:STATE 2 OFF
Query Syntax	LIST:VOLTage:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	LIST:VOLT:STEP

LIST:VOLT:TIM
This command sets the dwell time for the output current list of the specified point. Each point specifies the time, in seconds, that the output of the power supply is to remain at the level specified by the corresponding point in the current list if the “LIST:COUN” is set to Continuous. At the end of the dwell time for each point, the power supply output will continue to the next LIST point, and run each point continuously. If “LIST:COUN 0” is set, the LIST cycle will run only once.

Command Syntax	LIST:VOLTage:TIMe <channel> <point> <NR1>
Parameters	<channel>: 1 – 31, channel number <point>: list point numner <NR1>: 0.01 – 9997, dwell time
Default Suffix	*s*
Examples	LIST:VOLT:TIM 1 10 1000
Query Syntax	LIST:VOLTage:TIMe? <channel> <point>
Returned Parameters	<NR1> dwell time
Related Commands	LIST:VOLTage:STAT

4.5.6 Measurement Subsystem

The commands / queries in this subsystem wither return the current measured at the power supply output terminals or the voltage measured at the sense terminals, or set or query the measurement delay time.

MEAS:CURR?
This query returns the current measured at the power supply output terminals.

Query Syntax	MEASure:CURRent? <channel>
Parameters	<channel>: 1 – 31, channel number
Default Suffix	*A*
Examples	MEAS:CURR? 1
Returned Parameters	<NRf> measured current value
Related Commands	CURR

MEAS:DEL
This command sets the delay time to obtain read back value for “MEAS:VOLT?” and “MEAS:CURR?” queries.

Command Syntax	MEASure:DELay <NR1>
Parameters	<NR1>: 1 – 5000, delay time
Default Suffix	*ms*
Default value	0 ms
Examples	MEAD:DEL 800
Query Syntax	MEASure:DELay?
Returned Parameters	<NR1> delay time
Related Commands	MEAR:VOLT? MEAS:CURR?

MEAS:VCOUT?
This query returns the voltage and current measured at the power supply sense terminals.

Query Syntax	MEASure:VCOUT? <channel>
Parameters	<channel>: 1 – 31, channel number
Default Suffix	*None*
Examples	MEAS:VCOUT? 1
Returned Parameters	<NRf> measured voltage and current value
Related Commands	VOLT, CURR

MEAS:VOLT?
This query returns the voltage measured at the power supply sense terminals.

Query Syntax	MEASure:VOLTage? <channel>
Parameters	<channel>: 1 – 31, channel number
Default Suffix	*V*
Examples	MEAS:VOLT? 1
Returned Parameters	<NRf> measured voltage value
Related Commands	VOLT

OUTPUT SUBSYSTEM

This subsystem controls the power supply voltage/current outputs and the optional output relay.

OUTP
This command enables or disables the power supply output. The state of a disabled output is a condition of zero output voltage.

Command Syntax	OUTPut[:STATe] <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | OFF | 1 | ON
*RST Value	0
Examples	OUTP 1 ON OUTP:STAT 1 OFF
Query Syntax	OUTPut[:STATe]? <channel>
Returned Parameters	0 | 1
Related Commands	*RST

OUTP:PROT:CLE
This command clears any over-voltage (OV), over-current (OC), or under-voltage (UV) protection latch. The corresponding status bits in “STAT:QUES?” Register are also cleared.

Command Syntax	OUTPut:PROTection:CLEar <channel>
Parameters	<Channel>: 1 – 31, channel number
Examples	OUTP:PROT:CLE 1
Query Syntax	(None)
Related Commands	OUTP:STAT? STAT:QUES?

STATUS SUBSYSTEM

This subsystem programs the power supply status registers. The power supply has three groups of status registers: **Operation, Questionable**, and **Standard Event**. The Standard Event group is programmed with Common commands.

STAT:OPER?
This query returns the value of the Status Operation Event register. The Event register is a read-only register, which holds (latches) all operation events that are set by users. Reading the Operation Event register does not clear it.

Query Syntax	STATus:OPERation[:EVENt]? <channel>
Parameters	<channel>: 1 – 31, channel number
Returned Parameters	<NR1> Register Decimal Value
Examples	STAT:OPER? 1
Related Commands	*RST

Status Operation Registers

The bit configuration of Status Operation register is shown in the following table:

Bit Configuration of Operation Register Table:

Bit Position	7	6	5	4	3	2	1	0
Bit Name	**AUTO**	**ONCE**	**WTG**	**REL**	**POL**	**OV**	**OC**	**CAL**
Bit Weight	128	64	32	16	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Bit Name	**NU**	**NU**	**NU**	**PARA**	**LSV**	**LSC**	**TTL**	**OUT**
Bit Weight	32768	16384	8192	4096	2048	1024	512	256

CAL = Interface is computing new calibration constants. OC = The over-current protection operation is ON. OV = The over-voltage protection operation is ON. POL = The relay is in negative position (set to REVerse). REL = The relay operation is connect (set to CLOSE). WTG = Interface waiting for a trigger. ONCE = Stepping on dependant upon the ONCE trigger function. AUTO = Stepping on is depend upon AUTO trigger function. OUT = Output is configured to ON. TTL = TTL shut down. LSC = The current stepping operation is ON. LSV = The voltage stepping operation is ON. PARA = Power supply is in parallel operation mode. NU = Not used.

STAT:QUES?
This command returns the value of the Questionable Event register. The Event register is a read-only register, which holds (latches) all events that occurred. Reading the Questionable Event register does not clear it.

Query Syntax	STATus:QUEStionable[:EVENt]? <channel>
Parameters	<channel>: 1 – 31, channel number
Returned Parameters	<NR1> Register Decimal Value
Examples	STAT:QUES:EVEN? 1
Related Commands	*RST

Status Questionable Registers

The bit configuration of all Status Questionable registers is as follows:

Bit Configuration of Questionable Registers Table:

Bit Position	7	6	5	4	3	2	1	0
Bit Name	**LSC**	**LSV**	**OUT**	**OT**	**CC**	**CV**	**OC**	**OV**
Bit Weight	128	64	32	16	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Bit Name	**EXT_ALM**	**NU**	**TRAC**	**UV**	**ORO**	**UNR**	**TTL**	**POL**
Bit Weight	32768	16384	8192	4096	2048	1024	512	256

OV = Over-voltage protection circuit has tripped. OC = Over-current protection circuit has tripped. CV = The power supply is in constant voltage mode. CC = The power supply is in constant current mode. OT = Over-temperature status condition exists. OUT = Power supply output states. LSV = The voltage list operation. LSC = The current list operation. POL = The relay operation is on negative operation**.** TTL = TTL shut down is occurred. UNR = Power supply output is unregulated. ORO: Output Relay Open = 1, Output Relay Close = 0. UV: Under Voltage Protection: protection was triggered. TRAC: Tracking operation enabled=1. EXT_ALM = An alarm bit has enabled in the STAT:QUES:EXT Alarm Register

STAT:QUES:ENAB

This command sets or reads the value of the Questionable Enable register. This register is a mask for enabling specific bits from the Questionable Event register to set the questionable summary bit of the Status Byte register. This bit (bit 3) is the logical OR of all the Questionable Event Register bits that are enabled by the Questionable Status Enable Register.

Command Syntax	STATus:QUEStionable:ENABle <NRf>
Parameters	0 to 32727
Suffix	(None)
Default Value	0
Example	STAT:QUES:ENAB 18
Query Syntax	STATus:QUEStionable:ENABle?
Returned Parameters	<NR1> Register Decimal Value
Related Commands	STAT:QUES?

STAT:QUES:EXT?

This command returns the value of the Questionable External Event register. The External Event register is a read-only register, which holds (latches) all events that occurred. When an event occurs, bit 15 of the “STAT:QUES?” register will latch high and querying the “STAT:QUES:EXT?” will provide the detailed failure. Reading the Questionable Event register does not clear it.

Query Syntax	STAT:QUES:EXT? <channel>
Parameters	<channel>: 1 – 31, channel number
Returned Parameters	<NR1> Register Decimal Value
Examples	STAT:QUES:EXT? 1
Related Commands	*RST

Status Questionable Registers

The bit configuration of all Status Questionable registers is as follows:

Bit Configuration of Questionable Registers Table:

Bit Position	7	6	5	4	3	2	1	0
Bit Name	**ALM**	**NU**	**FUSE**	**OT**	**PGM**	**PB**	**OC**	**OV**
Bit Weight	128	64	32	16	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Bit Name	**NU**	**NU**	**NU**	**NU**	**NU**	**NU**	**REM**	**ILOC**
Bit Weight	32768	16384	8192	4096	2048	1024	512	256

OV = Over-voltage protection circuit has tripped. OC = Over-current protection circuit has tripped. PB = Phase Balance Protection Tripped. PGM = Program Line Protection Tripped. OT = Over-temperature Protection Tripped. Fuse = Fuse Protection Tripped. NU = Not Used. ALM = Alarm Protection Tripped. ILOC = Interlock. REM = Remote. NU = Not Used.

SYSTEM SUBSYSTEM

The commands / queries in this subsystem include some millenniums system information, such as setting or querying the maximum number of channels for a controller, EOS mode, error code, and system version.

SYST:BUZZ
This command sets and queries the power supply buzzer mode.

Command Syntax	SYSTem:BUZZer <bool>
Parameter	<bool>: 0 | OFF – Buzzer sound OFF 1 | ON – Buzzer sound ON
Default Value	1
Example	SYST:BUZZER 0
Query Syntax	SYSTem:BUZZer?
Returned Parameter	<NR1> represents Buzzer mode.
Related Commands	None

SYST:DEF:OUTP
This command sets and queries the power on output status.

Command Syntax	SYSTem:DEFault:OUTPut <NR1>
Parameters	<NR1>: 0 | 1 0 -- Power ON output status always OFF 1 -- Power ON output status same as the Power OFF status
Example	
Query syntax	SYST:DEF:OUTP 1 SYST:DEF:OUTP 0
Returned Parameters	SYSTem:DEFault:OUTPut?
Related Commands	<NR1>: Represented the default power on output status None

SYST:EOS
This command sets and queries the end of string (EOS) mode for read back of current interface.

Command Syntax	SYSTem:EOS <NR1>
Parameter	<NR1>: 0 – 3, end of string (EOS) mode 0 NONE * 1 CR 2 LF 3 CR + LF (For RS-232 interface only)
Default Value	3
Example	SYST:EOS 1
Query Syntax	SYSTem:EOS?
Returned Parameter	<NR1> represented EOS mode
Related Commands	NONE

<Note> *: If the end of string mode is set to 0 using this command, the returned value is in binary format if users communicate the power supply using National Instrument's Measurement and Automation software.

SYST:ERR?
This query returns the next error message response string from the remote programming error queue. The queue is a FIFO (first-in, first-out) buffer that stores maximum 9 errors as they occur. As it is read, each error is removed from the queue. When all errors have been read, the query returns **255-255-0**.

The error response string format CH-CMD-ERR, containing three fields, where CH indicates the channel number where the error occurs (if error is not related to channel, or no error occurs, this field is 255), CMD indicates the command index (if error is not related to a command or no error occurs, this field is 255. Please refer to Appendix A for command index table), and the ERR indicates the actual error code (if no error occurs, this field is 0. Please refer to Appendix A for error code).

Query Syntax	SYSTem:ERRor?
Parameters	(None)
Returned Parameters	<CRD> CH-CMD-ERR
Example	SYST:ERR?

SYST:EXT:CONT
This command sets or queries the external control function of the SPS Power Supply

Command Syntax	SYST:EXT:CONT <NR1>
Parameters	<NR1>: 0 – OFF (Local Control) 1 – ON (External Control)
Example	SYST:EXT:CONT 1
Default value	0
Query syntax	SYST:EXT:CONT?
Returned Parameters	<NR1>: External Control On/Off
Related Commands	None

SYST:GPIB:EOS
This command sets and queries the GPIB interface EOS mode.

Command Syntax	SYSTem:GPIB:EOS <NR1>
Parameters	<NR1>: 0 – None 1 – CR 2 – LF 3 – CR + LF
Example	SYST:GPIB:EOS 1
Query syntax	SYSTem:GPIB:EOS?
Returned Parameters	<NR1>: Represents EOS mode
Related Commands	SYST:EOS

SYST:NET:ADDR
This command sets and queries the Ethernet IP address.

Command Syntax	SYSTem:NET:ADDRess [<CRD1>] <CRD2>
Parameters	<CRD>: <CRD1>: serial number <CRD2>: IP address in decimal dot notation
Example	SYST:NET:ADDR 192.168.1.3
Query syntax	SYSTem:NET:ADDRess? [<Serial Number>]
Returned Parameters	<CRD>: Represents IP address
Related Commands	SYST:NET:GATE, SYST:NET:SUBNET

SYST:NET:DHCP
This query reads if the power supply Ethernet configuration is from DHCP server.

Query syntax	SYST:NET:DHCP?
Returned Parameters	<NR1>: 0 – Ethernet configuration is from set up 1 – Ethernet configuration is from DHCP server
Related Commands	SYST:NET:ADDR

SYST:NET:EOS
This command sets and queries the Ethernet interface EOS mode.

Command Syntax	SYSTem:NET:EOS <NR1>
Parameters	<NR1>: 0 – None 1 – CR 2 – LF 3 – CR + LF
Example	SYST:NET:EOS 1
Query syntax	SYSTem:NET:EOS?
Returned Parameters	<NR1>: Represents EOS mode
Related Commands	SYST:EOS

SYST:NET:GAT
This command sets and queries the Ethernet default gateway IP address.

Command Syntax	SYSTem:NET:GAT <CRD>
Parameters	<CRD>: Gateway IP address in decimal dot notation
Example	SYST:NET:GAT 192.168.1.0
Query syntax	SYSTem:NET:GAT?
Returned Parameters	<CRD>: Represents gateway IP address
Related Commands	SYST:NET:ADDR, SYST:NET:SUBN

SYST:NET:STAT
This query reads Ethernet configuration state.

Query syntax	SYST:NET:STATe?
Returned Parameters	<CRD>: Represents the net configuration state containing the following fields: <serial number>: power supply serial number <DHCP flag>: if net setting is from DHCP or not <ip address>: power supply unit IP address <idn string>: same as "*IDN?" query string
Related Commands	CHAN:SER, SYST:NET:DHCP, SYST:NET:IP, *IDN?

SYST:NET:SUBN
This command sets and queries the Ethernet subnet value.

Command Syntax	SYSTem:NET:SUBNet <CRD>
Parameters	<CRD>: Subnet value in decimal dot notation
Example	SYST:NET:SUBNET 255.255.255.0
Query syntax	SYSTem:NET:SUBNet?
Returned Parameters	<CRD>: Represents subnet value
Related Commands	SYST:NET:ADDR, SYST:NET:GATE

SYST:PROT?
This query can only be used after SRQ is properly set. It reads the Protect Event Status register, which contains channel number where protection has occurred. A 1 in any Protect Event Status register bit position indicates that the protected channel number is the bit position plus 1.

Query Syntax	SYST:PROT? PROT:CHAN?
Parameters	(None)
Returned Parameters	Hexadecimal string (with &H) representing protect register value
Examples	"&H00000020" indicates protection occurred at channel 6
Related Commands	(None)

Bit configuration of Protect Register is shown in the following table:

Bit Position	7	6	5	4	3	2	1	0
Channel	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Bit Weight(hex)	80	40	20	10	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Channel	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**
Bit Weight(hex)	8000	4000	2000	1000	800	400	200	100
Bit Position	23	22	21	20	19	18	17	16
Channel	**24**	**23**	**22**	**21**	**20**	**19**	**18**	**17**
Bit Weight(hex)	800000	400000	200000	100000	80000	40000	20000	10000
Bit Position	31	30	29	28	27	26	25	24
Channel	**32**	**31**	**30**	**29**	**28**	**27**	**26**	**25**
Bit Weight(hex)	80000000	40000000	20000000	10000000	8000000	4000000	2000000	1000000

SYST:REM:SENSE
This command sets or queries the state of the Voltage Sense (Local or Remote).

Command Syntax	SYST:REM:SENSE <NR1>
Parameters	<NR1>: 0 – Local Voltage Sense 1 – Remote Voltage Sense
Example	SYST:REM:SENSE 1
Default value	0
Query syntax	SYST:REM:SENSE?
Returned Parameters	<NR1>: LOCAL or REMOTE SENSE
Related Commands	None

SYST:VERS?
This query returns the power supply's controller firmware version. The returned value is of the form "FV:x.xx" where x.xx is the firmware revision number.

Query Syntax	SYSTem:VERSion?
Parameters	(none)
Returned Parameters	<CRD>
Example	SYST:VERS?
Related Commands	*IDN?

VOLT SUBSYSTEM

This subsystem programs the output voltage of the power supply.

VOLT

This command directly programs the immediate voltage level of the power supply. The immediate level is the voltage applied at the output terminals.

Command Syntax	VOLTage[:LEVel] <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: minimum to maximum voltage value of the channel
Default Suffix	*V*
*RST Value	5.0
Examples	VOLT 1 0.500; VOLT:LEV 1 30.0
Query Syntax	VOLTage[:LEVel]? <NR1> VOLTage[:LEVel]? <NR1> MAX VOLTage[:LEVel]? <NR1> MIN
Returned Parameters	<NRf>: VOLT? returns the present programmed volatge level. VOLT? MAX and VOLT? MIN return the maximum and minimum programmable voltage levels.
Related Commands	*SAV *RST

VOLT:PROT

This command sets the over-voltage protection (OVP) level of the power supply. If the output voltage exceeds the OVP level, and the **VOLT:PROT:STAT** is set to ON, then the power supply output is disabled and the Questionable status register (**STAT:QUES?**) OV bit is set . An over-voltage condition can be cleared with the **OUTP:PROT:CLE or VOLT:PROT:CLE or *RST** command after the condition that caused the OVP trip is removed.

Command Syntax	VOLTage:PROTection[:LEVel] <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: 5.0% to 110% of maximum voltage level
Default Suffix	*V*
*RST Value	110% of maximum voltage level
Examples	VOLT:PROT 1 25.0; VOLT:PROT:LEV 1 33.0
Query Syntax	VOLTage:PROTection[:LEVel]? <channel>
Returned Parameters	<NRf> represents presently programmed OVP level
Related Commands	OUTP:PROT:CLE; VOLT:PROT:CLE; *RST; *SAV

VOLT:PROT:CLE

This command clears the over-voltage protection status, and it dose not clear the over-voltage protection setting (**VOLT:PROT:STAT**). After this command, output remains in OFF state.

Command Syntax	VOLTage:PROTection:CLEar <channel>
Parameter	<channel>: 1-31, channel number
Example	VOLT:PROT:CLE 1
Query Syntax	(None)
Related Commands	VOLT:PROT:STAT

VOLT:PROT:COUN
This command sets or queries the power supply over-voltage (OV) protection counts value. It is used for OVP calibration. Please refer to the sample program, OVP calibration for details.

Command Syntax	VOLTage:PROTection:COUNt <channel> <value>
Parameters	<channel>: 1 – 31, channel number <value>: count value, depending on models.
Examples	VOLT:PROT:COUN 1 270
Query Syntax	VOLTage:PROTection:COUNt? <channel> VOLTage:PROTection:COUNt? <channel> MAX
Returned Parameters	0 to maximum count value.
Related Commands	VOLT:PROT:STAT

VOLT:PROT:STAT
This command enables or disables the power supply over-voltage (OV) protection function. If the over-voltage protection is enabled and the output voltage exceeds the OVP level, then the output is disabled and the Questionable Condition status register (**STAT:QUES?**) OV bit is set. An over-voltage status can be cleared with the **OUTP:PROT:CLE, VOLT:PROT:CLE or *RST** command.

Command Syntax	VOLTage:PROTection:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | 1 | OFF | ON
*RST Value	OFF
Examples	VOLT:PROT:STAT 1 0; VOLT:PROT:STAT 1 ON
Query Syntax	VOLTage:PROTection:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	OUTP:PROT:CLE; VOLT:PROT:CLE; *RST

SYST:CHAN
This command sets the current active channel.

Command Syntax	SYST:CHAN <channel>
Parameters	Channel number: 1 – 31
Example	SYST:CHAN 2 (sets channel 2 as current active channel)
Query Syntax	SYST:CHAN?
Returned Parameters	<NR1>: Representing current active channel.

SYST:STATUS?
This query reads the value from status register.

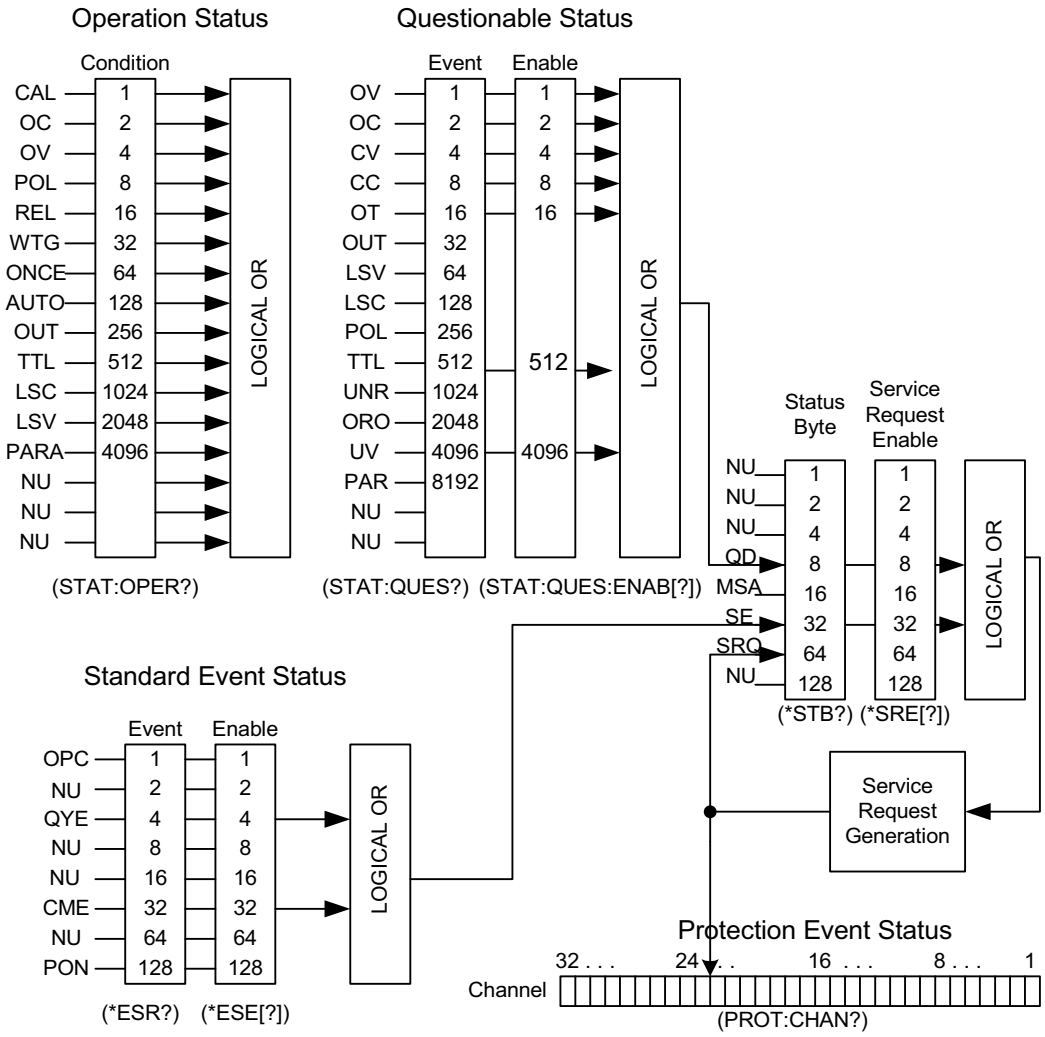
Query Syntax	SYST:STATUS? <channel>
Parameters	Channel numbers: 1 – 31
Returned parameters	Decimal value representing status register

Bit configurations for status register table:

Bit Position	7	6	5	4	3	2	1	0
Bit Weight	128	64	32	16	8	4	2	1
Definition	CC/CV	NU	NU	OC Set	OV Set	OUT	OV	OC
OC: Over-current protection circuit has tripped; OV = Over-voltage protection circuit has tripped; OUT: Output is set to ON; OV Set: OVP is set to ON; OC Set: OCP is set to ON; NU: not used; CC/CV: 0 means SPS unit is in CC mode, 1 means SPS unit is in CV mode.								

SCPI GPIB COMMAND STATUS REPORTING

The following figure shows the SCPI GPIB command status model of the power supply.



The above figure shows the status register structure of the power supply. The Standard Event, Status Byte, and Service Request Enable registers perform standard GPIB functions. The Operation Status, Questionable Status, and Protection Event Status registers implement status functions specific to the power supplies. Bit configuration for each register is also shown in the above figure.

OPERATION STATUS REGISTER

The Operation Status Condition register latches any operation condition that is passed to the power supply by users. It is a read-only register. Use “STAT:OPER?” query to read the register, but not clear it.

Questionable Status group

The Questionable Status group consists of two registers. The Questionable Status Event register holds real-time status of the power supply. It is a read-only register. Use “STAT:QUES?” query to read it, but not clear it. The Questionable Status Enable register is a mask for enabling specific bits from the Questionable Event register to set the Questionable Data (QD) bit of the Status Byte register. This bit (bit 3) is the logical OR of all the Questionable Event register bits that are enabled by the Questionable Status Enable register. Use “STAT:QUES:ENAB” command to set or read this register.

Standard Event Status group

Standard Event Status group consists of an Event register and an Enable register that are programmed by COMMON commands. The Standard Event register latches events relating to interface communication status. It is a read-only register. The Standard Event Enable register functions similarly to the enable registers of the Questionable Status Enable register. The common “***ESE”** command programs specific bits in the Standard Event Status Enable register. “***ESR?”** reads the Standard Event Status Event register. Reading the register clears it.

Status byte and Service Request Enable registers

Status Byte register summarizes the information from all other status groups. The register can be read by “***STB?”.** Whenever the power supply requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller services the interrupt, RQS is cleared inside the register and returned in bit position 6 of the response. The remaining bits of the Status Byte register are not disturbed. No bits of the Status Byte register are cleared by reading it.

Service Request Enable register determines which bits from the Status Byte register are allowed to generate SRQ using “***SRE**” common command.

Users can determine the reason for an SRQ by the following actions:

- Use the “***STB?”** query to determine which summary bits are active.
- Read the corresponding Event register for each summary bit to determine which events caused the summary bit to be set. If it is caused by Questionable Data (QD) bit of the Status Byte register, users must read the Protection Event Status register to determine the actual channel number where the SRQ is generated.
- The interrupt will recur until the specific condition that caused the event is removed.

Protection Event Status Register

Protection Event Status register stores the channel number where a service request is occurred if it is caused by the Questionable Data (QD) bit of the Status Byte register. Use **“SYST:PROT?”** query to read it but not clear it. It is cleared only after the specific condition that caused the event is removed.

5.0 PRINCIPLE OF OPERATION

5.1 General

Figure 5.1 illustrates the block diaram of the SPS Series power supply. As illustrated, SPS Series power supplies are comprised of either master or master/slave modules. All master modules have a power rating of 15 kW whereas slave modules have power ratings of 5 kW, 10 kW, or 15 kW. One module is required for 15 kW systems, two modules for 20 kW to 30 kW systems, and three models for systems greater than 30 kW.

SPS Series power supplies have a number of feedback loops to insure balance between modules. The details of the modules are described below.

5.2 Master Module

Power is fed through ac fuses and is distributed to the driver board, inrush limiter, and main 3ϕ contactor. The driver board contains a switching power supply and supplies power to the other printed circuit boards in the system. The inrush limiter is a step start device which is used to initially charge capacitors on the input dc bus and limit the inrush of current. The inrush limiter is initiated when the power supply is switched from a standby to a power state. After the charge cycle, the main 3ϕ contactor is energized and power is allowed to flow to the load. The optional EMI filter filters common mode and differential mode noise emanating from the supply.

Output power is controlled through a polyphase chopper. For the 15 kW master module, three choppers, phased 120˚ apart, provide a current source to a current fed inverter. The choppers are controlled with current mode, pulse width modulation (PWM). This modulation scheme provides a quick response for transients and filtering harmonics on the dc bus. As illustrated, chopper output current is monitored for balancing and for sensing overload current conditions. The polyphase chopper has been engineered to eliminate harmonic components minimizing currents circulating in the power supply.

The polyphase chopper produces a controlled dc bus which is connected to dc link inductors and current fed, IGBT medium frequency link inverter. The inverter, which operates at 400 Hz to 600 Hz, excites the main transformer at higher than normal line frequencies. This operation produces ohmic isolation between the input and output of the power supply using a transformer of dramatically reduced size.

The inverter operates with a 50% duty cycle and its frequency of operation is transparent to the performance of the power supply.

The output of the main power transformer is converted to dc via rectifiers. Low voltage versions of the SPS Series power supply use midpoint diode configurations and higher voltage versions use bridge configurations.

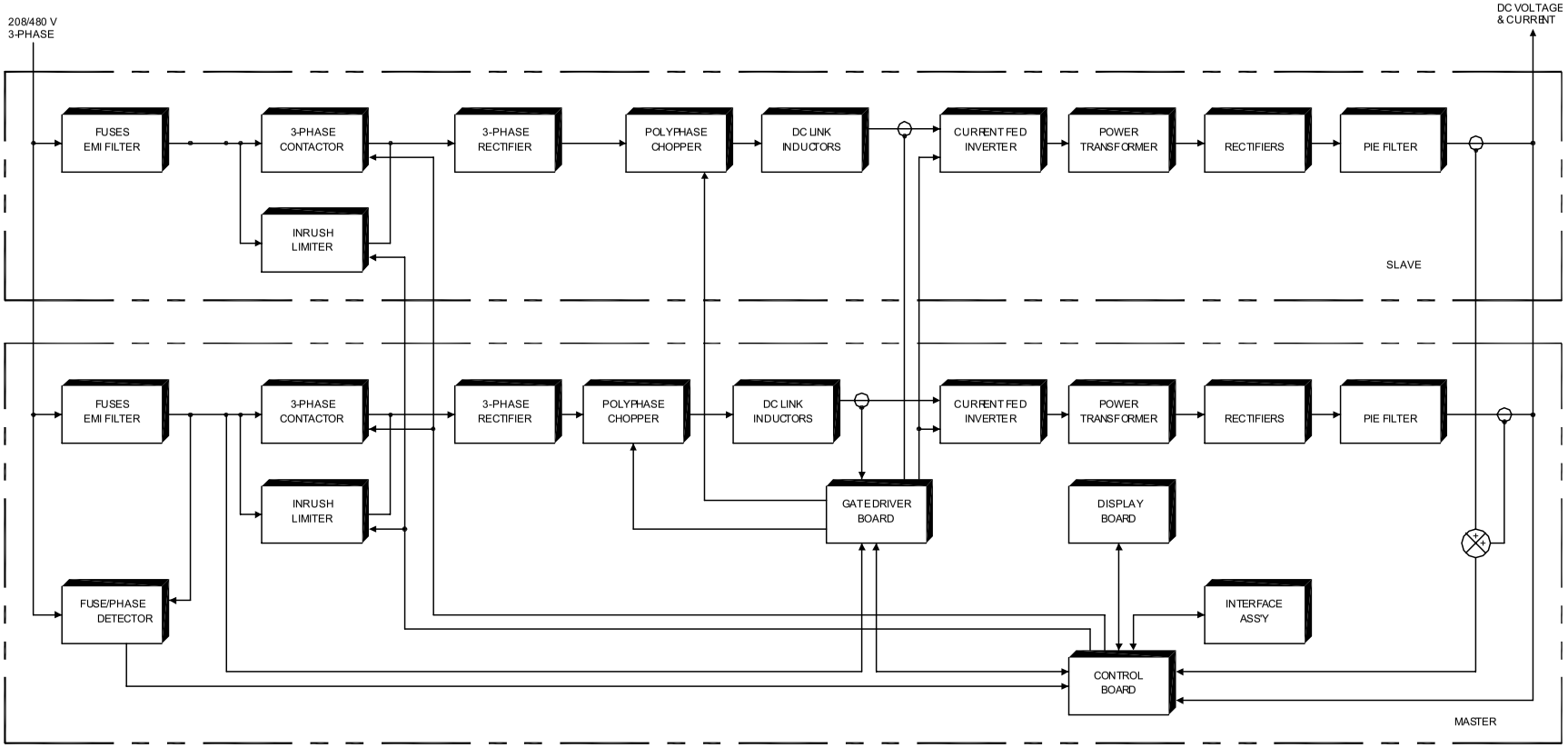


Figure 5.1 Block diagram

The dc output voltage is filtered with a pie section filter. This, in combination with the dc link
inductors, form a double stage inductive capacitive (LC) filter.

The gate driver board supports a synchronized modulation scheme which integrates power semiconductor switching of the switching power supply, polyphase chopper, and medium frequency link inverter.

The fuse/phase detector senses input line voltage on each phase and continuity of each fuse. Upon detection of a problem, the control board is signaled to shutdown the system. The control board, which is referenced to earth ground, contains optically isolated amplifiers to sense output voltage and current. This circuitry allows the output to be referenced ±1000 Vdc above earth ground.

The display board contains light-emitting diodes for displaying diagnostic conditions and provides an interface for meters and switches.

5.3 Slave Module

The slave module is very similar to the master module except that the power rating may be 5 kW, 10 kW, or 15 kW. Like the master module, output power is controlled through a polyphase chopper. For the 15 kW slave module, three choppers, phased 120˚ apart, provide a current source to the current fed inverter. The 10 kW SPS power supply uses two choppers, phased 180˚ apart, and the 5 kW supply uses only one chopper.

The choppers are controlled with current mode, pulse width modulation (PWM) from signals derived from the master module gate driver board. The second set of chopper signals are displaced 60˚ from the first set of chopper signals in the master module. Together, a 30 kW system has six chopper modules phased 60˚ apart.

The current fed inverter in the slave module uses the same driver signals as the master module.

For systems greater than 30 kW, a second gate driver module is required in the second slave to control a third set of polyphase choppers.

The slave module's diagnostic features are coordinated with the master module to provide high performance with virtually any combination of modules. Balance between chopper currents is insured by independent sampling and feedback control. Power supply, chopper, and inverter modules are synchronized to avoid instabilities at different operating points.

6.0 MAINTENANCE AND TROUBLE SHOOTING

6.1 General

The SPS Series power supplies consist of a multistage power processing system. Because of its complexity, it is highly recommended that all repairs be performed by the factory or qualified power supply technician. Before attempting maintenance or repair, the technician should be familiar with the components of the systems and the theory of operation. Some basic test equipment is also necessary: source of ac power, means of loading the power supply, dc voltmeter with accuracy and resolution better than the unit specifications, and an oscilloscope.

Caution: When servicing the power supply, dangerous voltage levels exist. All ac and dc capacitors should be discharged. Be especially careful of person and equipment when measuring primary circuitry since this is at line potential.

6.2 Trouble Shooting Guide

1. Fuse F1, F2, or F3 blows when the power supply is turned on. Power supply has a short on the primary side.
   a. Check diode bridge DB1.
   b. Check for failed power semiconductor on the Chopper Module.
   c. Check for isolation to ground on the input side of the power supply.

2. Over current trips and power supply cannot be reset. An auxiliary over current detector limits input dc link current. Exceeding safe levels will cause an over current diagnostic condition that cannot be reset.
   a. Restart the supply. Transient voltages on the input voltage could have caused the problem.
   b. Check diodes D1 through D4 on the secondary side of transformer T1.
   c. Check for a shorted winding on transformer T1.
   d. Check for failed IGBT's in the Chopper and Inverter Modules.

3. Unit goes to high output immediately after starting.
   a. Check for loose connectors internal to the power supply.

4. High ripple voltage.
   a. Check the mains voltage for balance and magnitude.

APPENDIX A IEEE-488 COMMUNICATIONS

SPS Series power supplies are available with an optional IEEE-488 (GPIB) interface. When specified at time of order, an IEEE-488 interface module is installed to make a second UART port available for communications. With two UART ports available, RS232 and IEEE-488, the one first receiving communications after power on is the port that is activated. Once activated, the other UART port cannot be recognized unless there has been a period of inactivity for 5 minutes. After this period, a new UART port can be recognized by sending communications.

A.1 IEEE-488 Communications with MAX

National Instruments offers Measurement and Automation Explorer (MAX), a Graphical User Interface, as a terminal emulation program for configuring an Interchangeable Virtual Instrument (IVI). MAX is usually installed with one of National Instrument's Application Development Environments such as LabVIEW, Measurement Studio, or with hardware product drivers such as NI-488.2 and NI-DAQ.

To operate the power supply with MAX, the instrument must first be located for communications. The following steps describe this procedure.

1. Run the MAX application program.
2. In the Configuration window, press the + sign to the left of Devices and Interfaces to view the installed devices.
3. If there is more than one IEEE-488/GPIB device listed, then select the correct GPIB device.
4. Press Scan for Instruments on the menu bar and wait several seconds.
5. At least one instrument should appear under the GPIB controller. If no instruments appear, then refer to Section A.1 to verify the correct setup.
6. Press Communicate with Instrument - a NI-488.2 Communicator dialog box should appear.
7. In the NI-488.2 Communicator dialog box, press the Configure EOS button. The Termination Method dialog box should appear.
    a. Select the option Send EOI at end of Write.
    b. Enter 0 into th EOS byte.
    c. Press OK.

APPENDIX B ETHERNET COMMUNICATIONS

SPS Series power supplies are available with an optional Ethernet interface. When specified at time of order, an Ethernet interface module is installed to make a second UART port available for communications. With two UART ports available, RS232 and Ethernet, the one first receiving communications after power on is the port that is activated. Once activated, the other UART port cannot be recognized unless there has been a period of inactivity for 5 minutes. After this period, a new UART port can be recognized by sending communications.

B.1 Ethernet Communications using HyperTerminal

The following procedure outlines using Microsoft Windows (tm) HyperTerminal Program to communicate using the Ethernet communications.

1. Start the HyperTerminal application and when prompted select “TCP/IP (Winsock)” in the “Connect using” list box.
2. Insert the recorded IP address in the “Host address” text box and port number in the “Port number” text box.
3. Click the “OK” button.
4. Set the following properties for HyperTerminal’s ASCII setup:
   a. Send line ends with line feeds
   b. Echo typed characters locally
   c. Append line feeds to incoming line ends
5. Type “*IDN?” in the input window and press enter. The identification of the instrument should appear.