OPERATOR'S MANUAL

HSP-A SERIES

1000 AND 1500 WATT SWITCHING POWER SUPPLY

VOLTAGE/CURRENT STABILIZED DC SOURCE

KEPCO INC.
An ISO 9001 Company.

MODEL
HSP-A SERIES
POWER SUPPLY

ORDER NO.	REV. NO

IMPORTANT NOTES:

1) This manual is valid for the following Model and associated serial numbers:

MODEL	SERIAL NO.	REV. NO.

2) A Change Page may be included at the end of the manual. All applicable changes and revision number changes are documented with reference to the equipment serial numbers. Before using this Instruction Manual, check your equipment serial number to identify your model. If in doubt, contact your nearest Kepco Representative, or the Kepco Documentation Office in New York, (718) 461-7000, requesting the correct revision for your particular model and serial number.

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P/N 243-1414

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THE POWER SUPPLIER™

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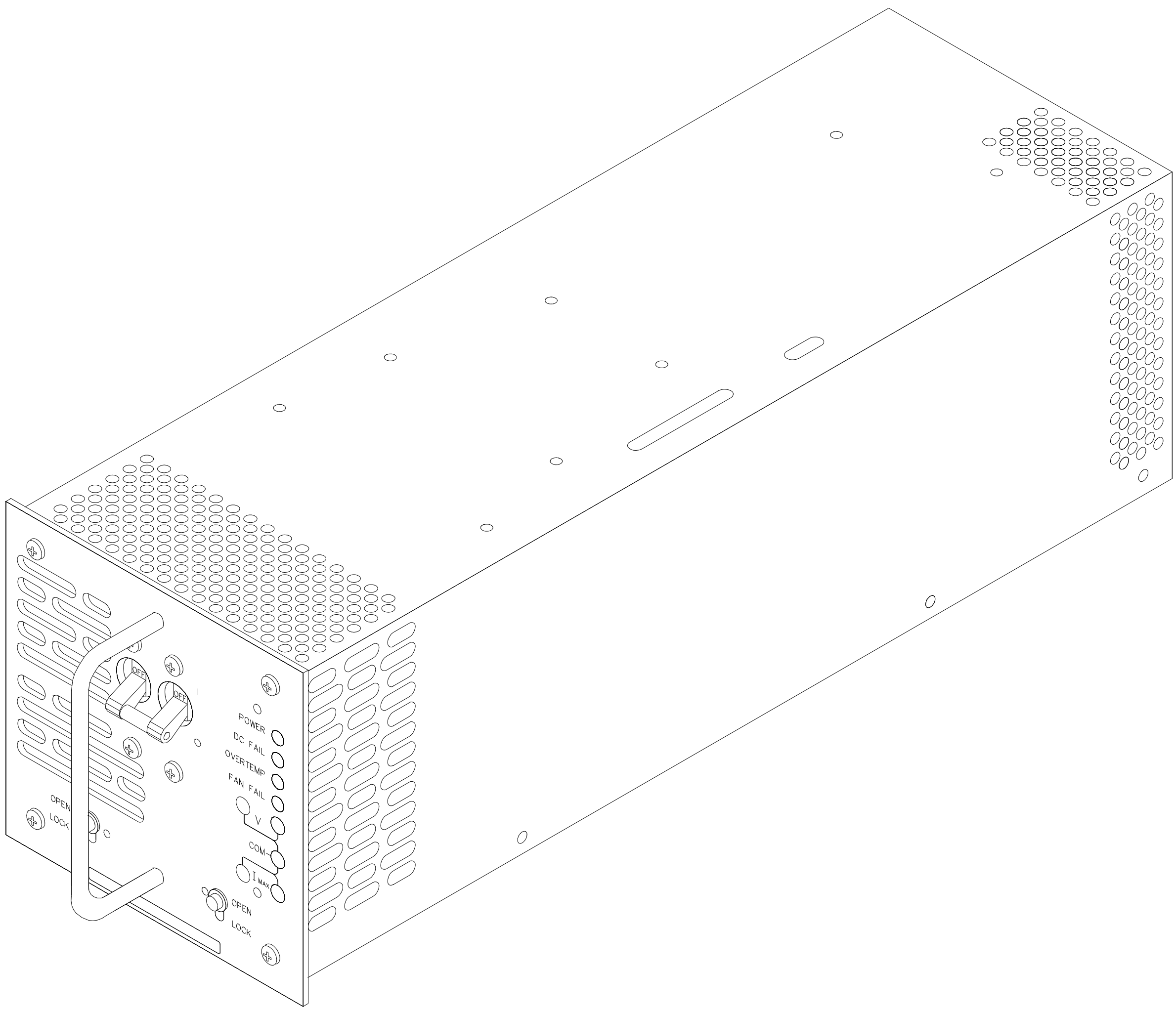

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FIGURE 1-1. HSP-A SERIES POWER SUPPLY

SECTION 1 - INTRODUCTION

1.1 SCOPE OF MANUAL

This manual contains instructions for the installation and operation of the 1000W and 1500W HSP (with suffix A) Series of voltage and current stabilized d-c power supplies manufactured by Kepco, Inc., Flushing, New York, U.S.A. These models are referred to throughout this manual as HSP-A.

1.2 DOCUMENTATION

The HSP-A power supply is designed to operate when installed in a Series RA 90 rack adapter (RA 90, RA 92, RA 93). All external connections to the HSP-A are made through the rack adapter. In addition to this manual, the following manuals are needed for a complete understanding of HSP-A installation and operation, and can be downloaded free from the Kepco web site at:

www.kepcopower.com/support/opmanls.htm

- HSP-A Quick Start Guide P/N 228-1935
- RA 90 Series Quick Start Guide P/N 229-1937
- RA 90 Series Operator Manual P/N 243-1413

1.3 GENERAL DESCRIPTION

The HSP-A power supply (Figure 1-1) is basically a voltage and current stabilized d-c source with a sharp crossover between voltage and current mode operation. This permits HSP-A power supplies to be used both as conventional regulated voltage sources and in applications such as battery chargers, where automatic crossover between constant voltage and constant current operation is required.

HSP-A power supplies are available in a single mechanical size and are nominally rated at either 1000 or 1500 watts of output power. HSP-A 1000 watt power supplies are designed to operate over the universal a-c power mains voltage range of 90-277V (47-63Hz), with operation from 125-420V d-c also available. HSP-A 1500 watt products provide full power over the a-c mains range of range of 180-277V a-c, and 1000W output power from 90-132V a-c; contact Kepco for information on operation over other source voltage ranges. Active power factor correction circuitry limits source current harmonics to negligible levels, significantly improving source power utilization. Cooling is provided via an internal d-c fan. Additional options (see PAR. 1.6) include a variable speed fan controlled by internal temperature, an output 0-10V d-c signal proportional to internal temperature, the ability to read internal temperature on the front panel meter, and built-in free-wheeling (flyback) diodes needed for series configurations.

The HSP-A permits adjustment of both output voltage (V_O) and current limit (I_{MAX}), either by internal (front panel pot) or external (resistance or voltage) methods; programming method is selected via DIP switches accessed through the top of the unit. A digital meter on the front panel displays either voltage or current (switch selectable). Independent circuitry provides protection against overvoltage, overcurrent and overtemperature failures; fault detection circuitry monitors performance of the output and critical internal functions, providing both visual and electrical indicators. A switch-selectable “current walk-in” circuit and optional float/equalize functions enhance the performance of HSP-A power supplies for such applications as battery chargers.

The HSP-A power supply is specifically designed for use in Kepco RA 90 or similar plug-in rack adapters as a hot replaceable module in a redundant power system. Forced current sharing and internal output blocking diodes enhance power system reliability. Optional built-in free-wheeling (fly-back) diodes are available for series configurations. Mechanical keying eliminates the risk of incorrect module insertion. Tool-operated latches on the front panel provide positive security against casual removal of an operating module.

1.4 SPECIFICATIONS

Table 1-1 below indicates specifications for parameters that vary for different HSP-A models; Table 1-2 lists general specifications that apply to all HSP-A models.

TABLE 1-1. MODEL PARAMETERS

MODEL (2)		OUTPUT VOLTAGE (Volts)		OVP SETTING (Volts)	OUTPUT CURRENT (Amps)			RIPPLE (mV p-p)		NOISE (mV p-p)	EFFICIENCY(1) (Percent)
		Nominal (Factory Set)	Adjustment Range	Factory Setpoint	50°C	60°C	71°C	Source max	Switching max	(Spike) 20MHz	100% Load 115V a-c
1000 Watts	HSP 3.3-230A	3.3	0.7-3.6	4.29	230	173	105	20	30	100	69
1000 Watts	HSP 5-200A	5	1.0-5.5	6.5	200	150	95	20	30	100	70
1000 Watts	HSP 12-84A	12	2.4-13.2	15.6	84	63	40	20	40	120	71
1000 Watts	HSP 15-66A	15	3.0-16.5	19.5	66	49.5	31.4	20	40	150	73
1000 Watts	HSP 24-42A	24	4.8-26.4	31.2	42	31.5	20	20	60	240	75
1000 Watts	HSP 28-36A	28	5.6-30.8	36.4	36	27	17	20	60	280	76
1000 Watts	HSP 48-21A	48	9.6-59.2	62.4	21	16	10	20	60	480	78
1000 Watts	HSP 125-8A	125	25 - 140	162	8	6	3.8	20	60	850	79
1500 Watts	HSP 24-60A	24	4.8-26.4	31.2	60	45	28.6	20	60	120	75
1500 Watts	HSP 28-53A	28	5.6-30.8	36.4	53	39.8	25.2	20	60	140	76
1500 Watts	HSP 48-30A	48	9.6-59.2	62.4	30	22.5	14.3	20	60	240	78
1500 Watts	HSP 125-12A	125	25 - 140	162	12	9	5.6	20	60	850	79

(1) At nominal input voltage and output power.
(2) Designed to meet UL specifications.

TABLE 1-2. GENERAL SPECIFICATIONS

SPECIFICATION		RATING/DESCRIPTION	CONDITION/COMMENT
SOURCE/INPUT			
Source Voltage	AC Single Phase:	1000W / 1500W Nominal: 100-250V rms / 200-250V rms Range: 90-277V rms / 180-277V rms	
	DC:	125-420V d-c	Polarity insensitive. (See Note 1.)
Brown-out Voltage	1000W	75V a-c typ.	
	1500W	150V a-c typ.	
Source Current	120V a-c	11A rms max	
	240V a-c	1000W: 5.5A rms max 1500W: 8.0A rms max	
Power Factor	typical	0.99	For all source conditions and loads from 25% to 100% of rated load..
	minimum	0.96	
Inrush Current		75A Peak max	
Efficiency		See Table 1-1.	

NOTES:
1. Safety Agency approval not applicable for noted conditions.

TABLE 1-2. GENERAL SPECIFICATIONS (CONTINUED)

SPECIFICATION		RATING/DESCRIPTION	CONDITION/COMMENT
SOURCE/INPUT (Continued)			
Withstand Voltage	Input to Output	3000V rms	25°C, 65% RH
	Input to Case	1500V rms	
	Output to Case	500V rms	
Leakage Current		<0.50mA @ 115V a-c, 47-63Hz <1.0mA @ 230V a-c, 47-63Hz	
Safety Agency Approvals		Designed to meet (SELV) UL 62368	
		Designed to meet CSA (SELV) CSA 22.2 No. 62368-1; 19	
Immunity (See Note 2)	Radiated RF (Ampl. Mod.)	(ENV50140) 10V/m, 80-1000MHz	
	Radiated RF (Pulse Mod.)	(ENV50204) (Pulse) 10V/m, 900MHz	
	Magnetic Field	(EN 61000-4-8) 30A/m, 50Hz	
	Electrostatic Discharge	(EN 61000-4-2) Contact: 4KV, Air: 8KV	
	Conducted RF	(ENV50141) 10Vrms, 0.15-80MHz	
	Electrical Fast Transient	(EN 61000-4-4) 2KV, Tr/Th = 8/20µs	
	Input Surge	(EN 61000-4-5) Comm. Mode: 2KV; Diff. Mode: 1KV	
Emissions	Conducted RF	(CISPR 22) Class A Limits, 0.15-30MHz	
	Current Harmonics	(EN 61000-3-2) 0-2KHz, any source/load condition)	
OUTPUT/LOAD			
Nominal Voltage		See Table 1-1.	
Rated Current		See Table 1-1.	See Note 3.
Minimum Output Current		2% of rated load	See Note 4.
Output Voltage Range		See Table 1-1.	

NOTES:
2. Per EN 50082-2, Acceptance Criteria A.
3. When in parallel/current share operation, only one unit will deliver current if total output load is <5% of rated HSP-A power (50W for HSP-A 1000W, 75W for HSP-A 1500W).
4. Lower output conditions may result in increased output ripple and increased transient response recovery time.

TABLE 1-2. GENERAL SPECIFICATIONS (CONTINUED)

SPECIFICATION		RATING/DESCRIPTION	CONDITION/COMMENT
OUTPUT/LOAD (Continued)			
Regulation Error	Source Effect	0.1% over full source voltage range	
	Load Effect	0.1% from 5% to 100% of rated load	
	Temperature Effect	0.02%/°C, 0°C<TA<50°C	
	Time Effect (Drift)	0.1%/24 hr period after 30 min. warm-up	
	Conducted RF	(ENV50141) 10Vrms, 0.15-80MHz	
	Combined Effect	0.3%	
Ripple and Noise		See Table 1-1.	
Start-up Time		1 sec maximum at rated output current	
Output Hold-up Time		21.5 msec transparent power loss (no indication) 5 msec following power loss indication >27 msec total time prior to loss of output regulation	
Turn-on/Turn-off Overshoot		Within load transient response envelope	
Load Transient Response	Maximum excursion	3% of nominal output voltage	25% load transient, 2A/µsec rise/fall time
	Recovery time	100µsec return to within 1% of set voltage	
Output Polarity		All outputs are floating and can be referenced as required by the user at up to ±500V d-c.	
PROTECTION			
Input Fusing		Front Panel circuit breaker (2-line)	
Low A-C Protection		HSP-A Power supplies will self-protect, no fixed limit.	
Overvoltage Protection		Latched shutdown if output voltage exceeds user-selected limit (see Operating Instructions, PAR. 3.9)	
Overcurrent Protection		Constant current limiting (optional undervoltage-activated latched shutdown	See Note 5 and see Operating Instructions, PAR. 3.11.
Overtemperature Protection		Thermostat shutdown with hysteretic recovery and automatic restart.	

NOTES:
5. Latched shutdown requires that source power be cycled for restart (optional restart by cycling REMOTE ON/OFF control signal); see Operating Instructions, PAR. 3.14.

TABLE 1-2. GENERAL SPECIFICATIONS (CONTINUED)

SPECIFICATION		RATING/DESCRIPTION	CONDITION/COMMENT
SIGNAL AND CONTROL			
Remote Error Sensing	3.3V & 5V Models	0.25V per wire	
	All other Models	0.8V per wire	
Remote On/Off Control		Isolated TTL-compatible signal; either logic high or logic low will disable output.	
Load Sharing		Within 5% of load when connected via load sharing wire.	See PAR. 2.7.1.
Load Monitor		0-5V analog signal proportional to output load current; 5V at 100% of rated load.	
Status Flags (Form C dry relay contacts) (see PAR. 3.16) (See Notes 6 and 7.)	POWER	Indicates low source voltage; signal asserted a minimum of 5 msec prior to loss of output voltage.	
	OUTPUT	Indicates HSP-A Power Supply in normal operating mode.	
	OVERTEMP	Indicates HSP-A Power Supply in overtemperature shutdown.	
	FAN FAIL	Indicates failure of internal cooling fan.	
Status Indicators (front Panel LEDs) (See Note 6.)	POWER	Green; lit when source voltage is above minimum limit to support output voltage.	
	DCFAIL	Red; lit when output is outside normal voltage regulation limits	
	OVERTEMP	Yellow; lit when overtemperature protection is activated.	
	FAN FAIL	Red; lit when fan failure latch is activated.	
Front Panel Test Points		Monitors output voltage and current limit set points; allows each HSP-A Power Supply to be set while operating in any configuration, including redundant mode.	
Front Panel Meter Accuracy	Voltmeter:	±1%	
	Ammeter:	25 to 100% of rated output current: ±3% of reading. 0 to 25% of rated output current: ±3% of reading ± 3 digit counts	
Auxiliary Voltage (Isolated)		4.75-5.25V d-c output, 0 - 100mA, parallelable, output isolated (500 V d-c), Input isolated (SELV)	See PAR. 3.13.

NOTES:
6: Status indicators and status flags are isolated and operate independently, although driven by the same detector circuit.
7. Form C contacts: rated from 30V d-c/1A to 60V d-c/0.3A.

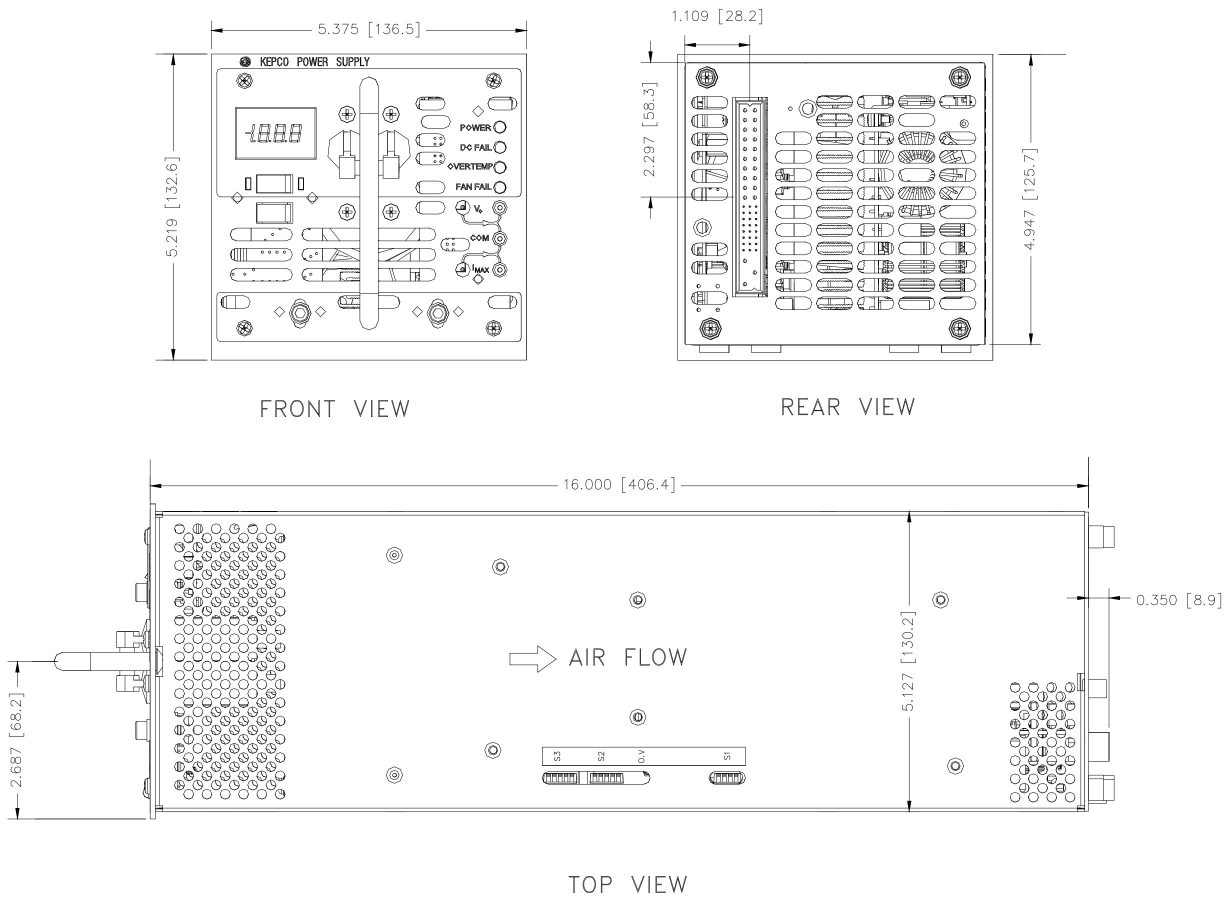
TABLE 1-2. GENERAL SPECIFICATIONS (CONTINUED)

SPECIFICATION		RATING/DESCRIPTION	CONDITION/COMMENT
SIGNAL AND CONTROL (Continued)			
Voltage Set Programming Mode selected by internal switches	Internal	Multiturn pot	See Note 8. and PAR. 3.3.
	External 1	Resistance: 0-50kΩ	
	External 2	0-10V, 500mA max	
Current Limit Programming	Internal	Multiturn pot	
	External	0-10V, 500mA max	
ENVIRONMENT			
Temperature Range	Operating	0 to 50° C: rated load (50° C to 71° C: derate by 2.5%/° C.	Nominal mains; see Figure 1-3A.
		1500W at lower mains voltage: see Figure 1-3B.	See Note 1.
	Storage	–40 to +85° C	
Cooling		Internal d-c fan	inlet, exhaust per Figure 1-2.
Humidity		0-95% RH	Non-condensing, operating and storage.
Shock		Non-operating, 20g, 11msec 50%, half sine, 3 axes, 3 shocks each axis	
Vibration	5-10Hz	10mm, double amplitude	
	10-55Hz	2g	
Altitude		Sea level to 10,000 feet	
PHYSICAL			
Dimensions		See Figure 1-4.	
Weight		16 lbs. (7.3Kg)	
Source Connections		Pins 45, 46, 47 of 47-pin PCI standard connector (see Figure 2-3).	See Note 9.
Load Connection		Pins 1 through 20 of 47-pin PCI standard connector (see Figure 2-3).	See Note 9.
Signal Connection		Pins 21 though 44 of 47-pin PCI standard connector (see Figure 2-3).	See Note 9.

NOTES:

8: The POWER/DCFAIL fault detector window tracks programmed output voltage, however, the overvoltage protection trip point remains unaffected.

9. All user connections are made at rack adapter (see RA 90 Series Operator Manual for details.)



NOTES:
1. MATERIAL:
   A) CHASSIS & BACKPLATE 0.064" THK. ALUM. 5052–H32
   B) COVER 0.050" THK. ALUM 3003–H14
   C) FRONT PANEL 0.090 THK. ALUM. 6061–T6
2. FINISH:
   A) CHASSIS, COVER & BACKPLATE – IRIDITE GOLD
   B) FRONT PANEL –KEPCO GRAY
3. DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS
4. TOLERANCES:
   A) BETWEEN MOUNTING HOLES ± 1/64 (±0.4)
   B) ALL OTHER DIMENSIONS ±1/32 (±0.8)
   UNLESS OTHERWISE SPECIFIED

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FIGURE 1-2. HSP-A OUTLINE DRAWING. (SHEET 1 OF 2)

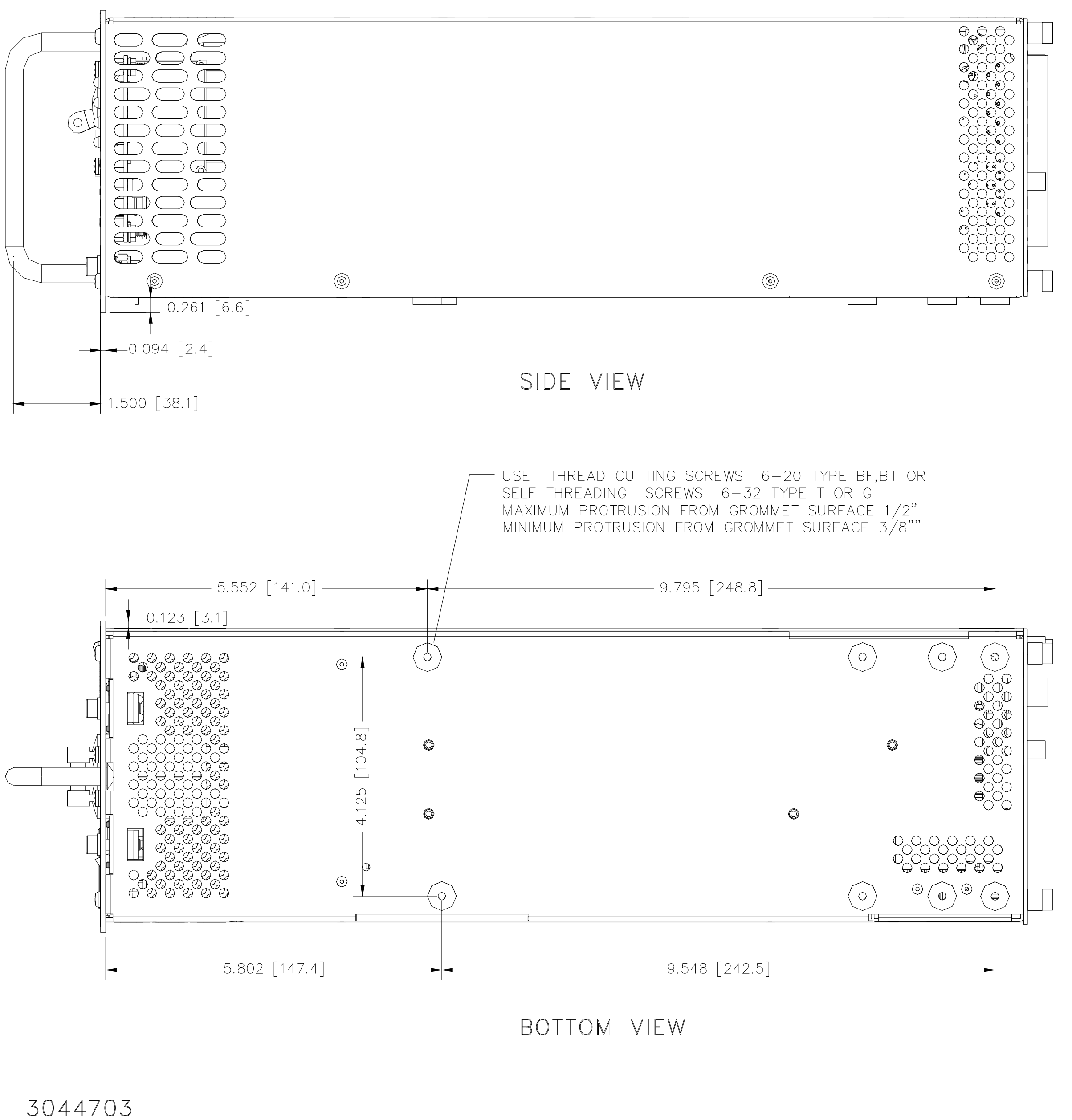


FIGURE 1-2. HSP-A OUTLINE DRAWING (SHEET 2 OF 2)

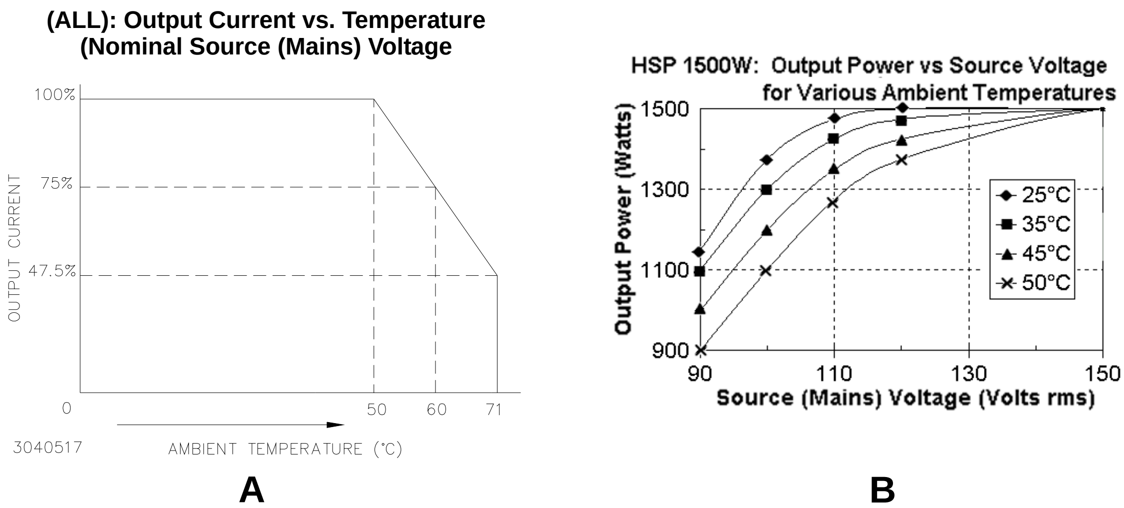


FIGURE 1-3. HSP-A MAINS VOLTAGE/TEMPERATURE DERATING

1.5 MISCELLANEOUS FEATURES

1.5.1 CONTROL/PROGRAMMING

a) **VOLTAGE CHANNEL:** Output voltage is controlled continuously throughout the specified adjustment range via a 10-turn potentiometer mounted behind the front panel. External control can be exercised either by resistance or by control voltage (see PAR's. 3.3 and 3.4).

b) **CURRENT CHANNEL:** Output current is controlled continuously throughout the specified adjustment range via a 10-turn potentiometer mounted behind the front panel. External control can be exercised by control voltage (see PAR's. 3.5 and 3.6).

c) **OVERVOLTAGE LEVEL:** The output voltage level at which the overvoltage protection latch is activated may be adjusted locally via a 10-turn potentiometer accessed through the top cover (see PAR. 3.9).

d) **REMOTE INHIBIT:** Operation of the output regulator can be inhibited remotely via either one of two TTL-level control lines, RC1 and RC2. Both of these signals are isolated from both the input and output, allowing single-point control of several power supplies operating at different potentials. Both positive and negative logic are supported (see PAR. 3.14).

1.5.2 STATUS INDICATORS/FLAGS

a) **STATUS INDICATORS:** Four LED indicators at the front panel provide the following operational information (see PAR. 3.16):

- **POWER:** Green; lit when source voltage is above minimum required to support rated load.
- **DCFAIL:** Red; lit when output voltage is beyond regulation limits or when load current is below minimum load sharing requirement.
- **OVERTEMP:** Amber; lit when internal overtemperature protection is activated.
- **FANFAIL:** Red; lit when internal cooling fan failure is detected.

b) **STATUS FLAGS:** Four sets of Form C dry relay contacts (3 wires each) are provided at the I/O connector which duplicate the front panel status indicator functions (see PAR. 3.16). If Option T is installed, the Internal Temperature Readout signal 0 - 10V (referenced to fan return/aux return) proportional to 0 - 100°C internal unit temperature is provided at the I/O connector.

1.5.3 SETPOINT MONITORS: Analog voltage signals which display programmed output voltage and current limit values. These signals are available both at the front panel test points (V_O and I_{MAX}) and at the I/O connector (VSET and ISET). Signals are referenced to negative error sense (see PAR. 3.8).

1.5.4 REMOTE ERROR SENSING: Separate voltage sensing connections permit 4-wire connection to load. Will compensate for static load effects due to power lead d-c resistance (DCR) up to specified maximum voltage drop per load lead at maximum specified output voltage (see PAR. 2.7).

1.5.5 LOAD SHARING: Bidirectional control port provides forced load sharing between two or more HSP-A series power supplies wired in parallel (see PAR. 2.7.1).

1.5.6 LOAD MONITOR: Analog voltage signal which indicates actual load current delivered by the HSP-A power supply (see PAR. 3.15).

1.5.7 AUXILIARY SUPPLY: Logic-level secondary output provides up to 0.5 watts of power at 5V d-c. This output is isolated from the output and is unaffected by the status of the main output. Provides power for external Remote Inhibit controls (see PAR. 3.13).

1.5.8 OVERCURRENT/UNDERVOLTAGE PROTECTION: Switch-selectable option provides the user load protection against long-term output overloads or undervoltage conditions (see PAR. 3.11).

1.5.9 CURRENT WALK-IN: Switch-selectable option provides control of output current rise rate based on Bellcore TR-TSY-000947 requirements for battery chargers (see PAR. 3.12).

1.5.10 REMOTE RESET: Switch-selectable option provides capability to reset the latch used by the overvoltage protection circuitry to disable the output regulator, using the Remote Inhibit control lines (see PAR. 3.14).

1.5.11 METER: HSP-A power supplies are supplied with a front panel meter which displays output voltage and output current (switch selectable). Refer to PAR. 3.17 for operation.

1.5.12 INTERNAL BLOCKING DIODE (R SUFFIX): HSP-A power supplies include a blocking diode in series with the output, required for “hot swap” applications.

1.6 OPTIONS

HSP-A options are described below; more than one option may be incorporated into any HSP-A Power Supply.

1.6.1 BATTERY CHARGERS (B SUFFIX): The battery charger option adds switch selectable “float” and “equalize” functions which provide two separate voltage regulation settings, as well as an expanded window for the output voltage fault detector compatible with normal battery operating voltages (Refer to PAR. 3.18 for operation).

1.6.2 FREE-WHEELING (FLYBACK) DIODE (L SUFFIX): This option includes built-in diodes used to clamp negative voltage spikes when used with inductive loads. Can serve as a polarity protection feature or can be “built-in” for series connection applications.

1.6.3 INTERNAL TEMPERATURE READOUT (T SUFFIX): An Internal Temperature Readout signal 0 - 10V (referenced to fan return/aux return) that is proportional to 0 - 100°C of internal unit temperature is provided at the I/O connector.

1.6.4 METER DISPLAY OF INTERNAL TEMPERATURE READOUT (MT SUFFIX): In addition to an Internal Temperature Readout signal 0 - 10V (referenced to fan return/aux return) that is proportional to 0 - 100°C of internal unit temperature available at the I/O, this option includes a front panel switch that allows the front panel meter to display unit internal temperature.

1.6.5 VARIABLE SPEED FAN CONTROLLED BY INTERNAL TEMPERATURE (S SUFFIX): To improve reliability and reduce acoustic noise the option S fan speed is variable. Fan speed varies linearly from 30% (when internal temperature is 25°C or less) to 100% (when internal temperature is greater than or equal to 75°C.

1.7 ACCESSORIES

Accessories for HSP-A Power Supplies are listed in Table 1-3.

TABLE 1-3. ACCESSORIES

ACCESSORY	PART NUMBER	USE
RACK ADAPTER OPTIONS	RA 90	Plug-in rack adapter provides for three HSP-A Power Supplies in a 19-inch rack. Designed specifically for hot-swap applications when used with R-suffix HSP-A models; the power outputs of all three positions of this rack adapter are permanently bussed together in parallel. Separate source power and I/O signal connections for each position.
	RA 91	Same as RA 90 except accommodates up to four HSP-A Power Supplies in a 24-inch rack for plug-in and hot swappable applications.
	RA 92	Same as RA 90 except that two positions are bussed together in parallel while the remaining position is left isolated for independent operation.
	RA 93	Same as RA 90 except that all three positions are isolated for independent operation.
	-23E	Incorporates wider mounting ears to accommodate a 23-inch rack; available for all 19-inch rack adapters above.
	-24E	Incorporates wider mounting ears to accommodate a 24-inch rack; available for all 19-inch rack adapters above.
SERIES CLAMPING DIODES	124-0600	Used with HSP-A 24V, 28V and 48V models when wired for series operation. User must provide wiring and heat sink. One diode required for each power supply. See RA 90 Series Operator Manual, Series Connections. (This diode is built in if L option installed.)
	124-0601	Used with HSP-A 3.3V, 5V, 12V and 15V models when wired for series operation. User must provide wiring and heat sink. One diode required for each power supply. See RA 90 Series Operator Manual, Series Connections. (This diode is built in if L option installed.)
CABLE ASSEMBLY	118-1453	Mates with I/O connector to provide access to a-c input and d-c output pins for unit calibration outside of rack adapter.

SECTION 2 - INSTALLATION

2.1 UNPACKING AND INSPECTION

This instrument has been thoroughly inspected and tested prior to packing and is ready for operation. After careful unpacking, inspect for shipping damage before attempting to operate. Perform the preliminary operational check as outlined in PAR. 2.5. If any indication of damage is found, file an immediate claim with the responsible transport service.

2.2 TERMINATIONS AND CONTROLS

a) Front Panel: Refer to Figure 2-1.

b) Configuration Controls: Refer to Figure 2-2 and Table 2-1.

c) Rear Panel: Refer to Figure 2-3 and Table 2-2.

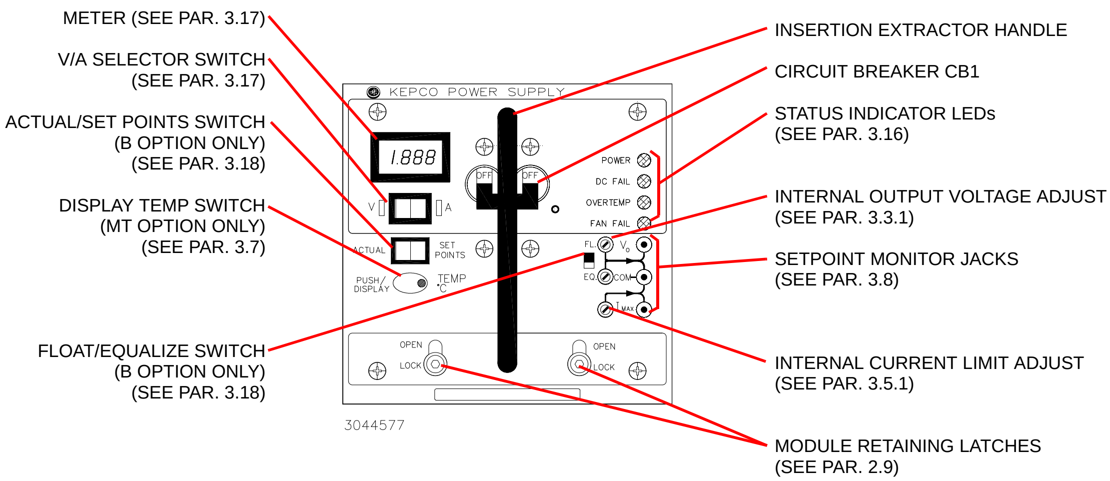
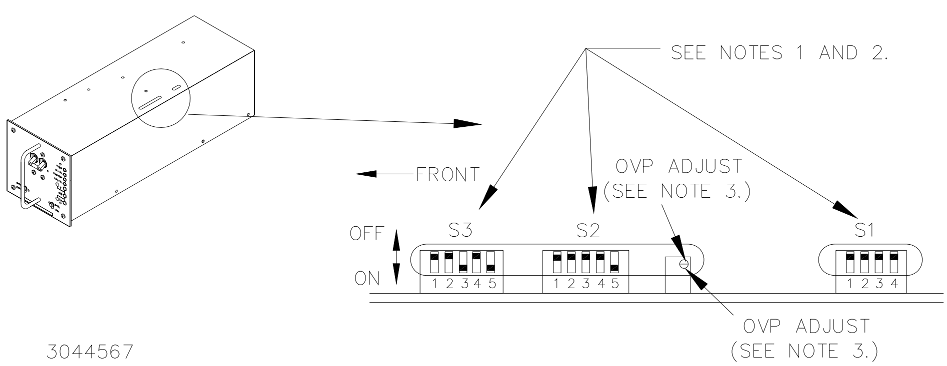


FIGURE 2-1. HSP-A SERIES FRONT PANEL CONTROLS AND INDICATORS



NOTES
1: Do not change configuration without first referring to paragraph referenced in Table 2-1.
2. Switches shown in default position.
3. See PAR. 3.9 for OVP Adjust Procedure.

FIGURE 2-2. CONFIGURATION SWITCHES AND OVP ADJUST POTENTIOMETER

TABLE 2-1. CONFIGURATION CONTROLS

SWITCH POSITION	FUNCTION	REFER TO PAR.
S1-1	Remote Lockout Reset	3.14
S1-2	Current Walk-in	3.12
S1-3	Undervoltage Lockout	3.11
S1-4	Ovp Retrigger/retrigger Lockout	3.10
S2-1	Range Select (Voltage Loop)	3.4
S2-2	Range Select (Fault Detector)	3.4
S2-3	Ext. Volt. Prog. (Voltage Loop)	3.3
S2-4	Ext. Res. Prog. (Voltage Loop)	3.3
S2-5	Int. Prog. (Voltage Loop)	3.3
S3-1	Range Select (Current Loop)	3.6
S3-2	Ext. Volt. Prog. (Current Loop)	3.5
S3-3	Int. Prog. (Current Loop)	3.5
S3-4	Int. Temp Monitor	3.7
S3-5	Ext Voltage Prog	3.3

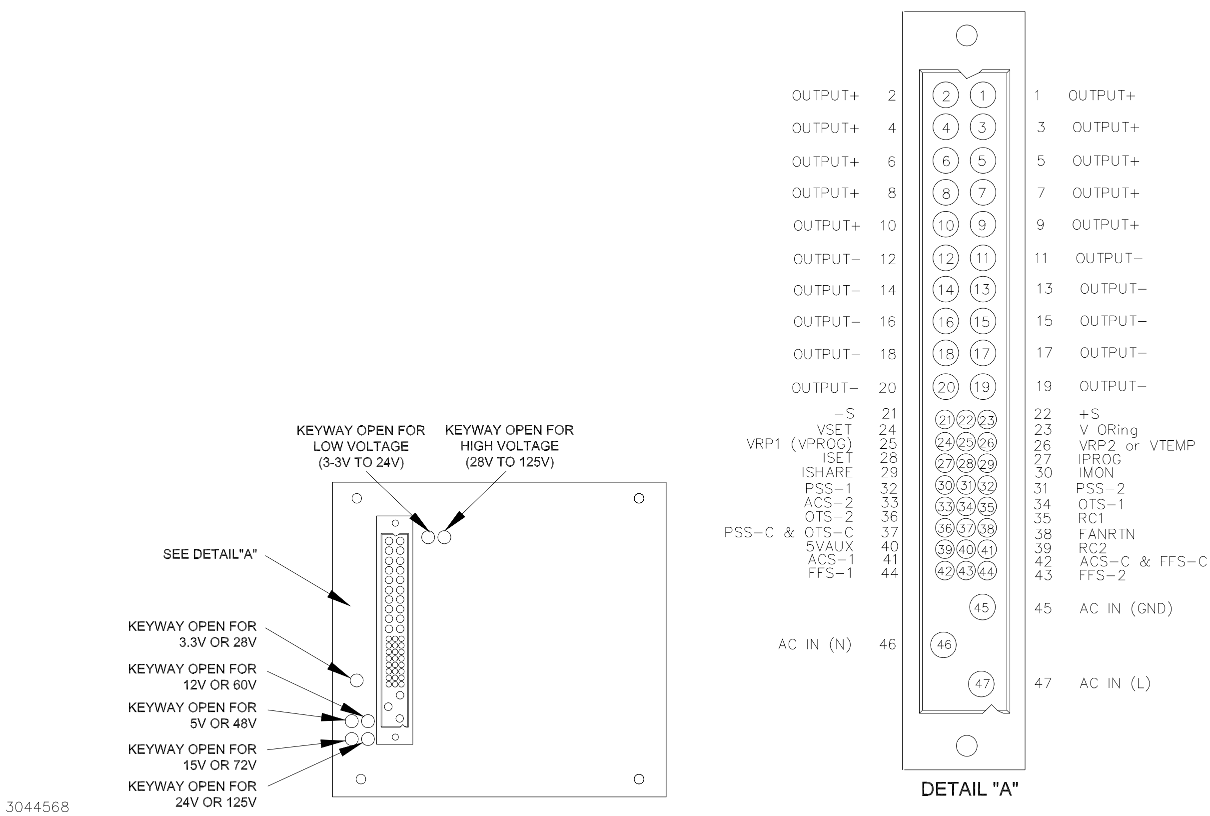


FIGURE 2-3. HSP-A SERIES REAR PANEL CONNECTIONS

TABLE 2-2. RACK ADAPTER/POWER SUPPLY MAIN INTERFACE CONNECTOR PIN ASSIGNMENTS

PIN NO.	NAME	DESCRIPTION OF FUNCTION	PAR. REF.
1 - 10	(+)	Positive output	2.7.1
11 - 20	(-)	Negative output	2.7.1
21	-S	Negative error sense input	2.7.1
22	+S	Positive error sense input	2.7.1
23	V ORing	Output voltage prior to OR-ing diode; used to detect failed power supply in parallel configuration.	2.7.1
24	VSET	Output voltage setpoint monitor (0 -10V) (2)	3.8
25	VRP1 (VPROG)	Analog programming input - voltage (0 - 10V) (2)	3.3
26	VRP2 or VTEMP	VRP2: Resistive programming (0 - 50k) input voltage reference. VTEMP: Output voltage, 0 -10V, proportional to HSP-A internal temperature (0.1V/°C) (3)	3.3
27	IPROG	Analog programming input - current (0 - 10V) (2)	3.5
28	ISET	Current limit setpoint monitor (0 - 10V) (2)	3.8
29	ISHARE	Load share signal bus (0 - 5.5V)(2)	2.7.1
30	IMON	Analog output current monitor (0 - 5.5V) (2)	3.15
31	PSS-2	Output status - normally closed contact	3.16
32	PSS-1	Output status - normally open contact	3.16
33	ACS-2	Source power status - normally closed contact	3.16
34	OTS-1	Overtemp status - normally closed contact	3.16
35	RC1	Remote inhibit - normally high input(1)	3.14
36	OTS-2	Overtemp status - normally open contact	3.16
37	PSS-C & OTS-C	Common contact for output status and Overtemp status	3.16
38	FANRTN	Return for fan (auxiliary) supply	3.16
39	RC2	Remote inhibit - normally low input (1)	3.14
40	5VAUX	Auxiliary (fan) supply output	3.16
41	ACS-1	Source power status - normally open contact	3.16
42	ACS-C & FFS-C	Common contact for source power status and fan status	3.16
43	FFS-2	Fan status - normally open contact	3.16
44	FFS-1	Fan status - normally closed contact	3.16
45	GND	A-c input voltage - Ground	2.7.1
46	N	A-c input voltage - Neutral	2.7.1
47	L	A-c input voltage - Line	2.7.1

(1) These signals are referenced to fanrtn (pin 38).
(2) These signals are referenced to -S (pin 21).
(3) Normally VRP2 except VTEMP for HSP-A, Option T or MT units.

2.3 SOURCE POWER REQUIREMENTS

This power supply will operate with the installed circuit breaker from single phase a-c mains power over the specified voltage and frequency ranges without adjustment or modification. Operation from d-c power is also available; please contact factory for limitations imposed when using d-c source power. Connection to source power is through the rack adapter; refer to RA 90 Series Rack Adapter Operator Manual for details.

2.4 COOLING

The power devices used within the HSP-A power supply are maintained within their operating temperature range by means of internal heat sink assemblies cooled by an internal cooling fan. The cooling method utilizes pressurization rather than evacuation, resulting in greater cooling efficiency and reduced contaminant collection within the enclosure. **ALL INLET AND EXHAUST OPENINGS AROUND THE POWER SUPPLY CASE MUST BE KEPT CLEAR OF OBSTRUCTION TO ENSURE PROPER AIR ENTRY AND EXHAUST**. Periodic cleaning of the power supply interior is recommended. If the power supply is rack mounted, or installed within a confined space, care must be taken that the ambient temperature, which is the temperature of the air immediately surrounding the power supply, does not rise above the specified limits for the operating load conditions (see PAR. 1.4 and Figure 1-3).

2.5 PRELIMINARY CHECK

A simple visual check after unpacking and before equipment installation is advisable to ascertain whether the power supply has suffered damage resulting from shipping. Refer to Figures 2-1, 2-2 and 2-3 for location of operating controls and electrical connections.

2.6 INSTALLATION (REFER TO FIGURE 1-2, OUTLINE DRAWING)

The HSP-A power supply is operated as a plug-in modular instrument.

NOTE: HSP-A and HSP (legacy) models are not interchangeable, however replacement of HSP modules with HSP-A is easily done by replacing the RA 60 Series rack adapter with the corresponding RA 90 Series rack adapter: RA 60 with RA 90, RA 62 with RA 92 and RA 63 with RA 93. RA 90 series rack adapters are drop-in compatible, using the same rack connections and lugs.

For all installations, provide adequate clearance around air inlet and exhaust locations and ensure that the temperature immediately surrounding the unit and especially near the air inlets does not exceed the maximum specified ambient temperature for the operating conditions.

2.6.1 REMOVAL/INSERTION

The following paragraphs outline the proper way to remove the HSP-A from the rack adapter and insert a replacement. Refer to Figures 2-1 and 2-3 for HSP-A component locations.

2.6.1.1 PREPARATION OF REPLACEMENT HSP-A

1. Preset HSP-A parameters (Voltage, overvoltage and current limit settings, etc.) by referring to PAR. 3.3 through 3.15 as needed.

   WARNING: Do not attempt to set HSP-A parameters in a live/hot swap system.

2. Move HSP-A to the insertion location. When handling the unit, be sure the 40 pin main connector at rear of HSP-A is not damaged or distorted and observe ESD procedures. Do not rest unit on bus bars.

3. Verify that both HSP-A latches (see PAR. 2.9) are in the up (OPEN) unlatched position.

4. Do not alter HSP-A keying plugs. Verify that rack adapter's keying pins match the voltage of the HSP-A to be inserted (see PAR. 2.8).

5. Verify HSP-A DIP switch settings are correct (see Table 2-1 and Figure 2-2).

6. Verify that there is adequate clearance around air inlet and exhaust locations.

2.6.1.2 REMOVAL OF HSP-A FROM RACK ADAPTER

1. Set Power ON/OFF circuit breaker to OFF.

2. Release the two cap head screw retaining latches (see Figure 2-1) by loosening the cap-head screw approximately 1/2 turn CCW (use 5/32” hex key) and slide to OPEN (up) position.

3. Grasp the insertion/removal handle and pull the HSP-A straight out from the rack adapter.

2.6.1.3 INSERTION OF HSP-A IN RACK ADAPTER

1. Verify that HSP-A Power ON/OFF circuit breaker is set to OFF and replacement HSP-A is properly prepared (see PAR. 2.6.1.1).

2. Verify that the retaining latches are locked in the OPEN (up) position. Figure 2-1 shows the latches in the OPEN position.

3. Grasp the insertion/removal handle and slide the HSP-A firmly into the rack adapter. Verify the HSP-A is fully inserted into the rack adapter and is flush with other HSP-A units. **CAUTION: If it is not flush with, or within 1/16-inch of other units and rack adapter ear brackets, do not force the unit into the rack adapter. Remove it and troubleshoot as follows:**

   a. If there is a gap between the HSP-A front panel and the rack adapter of approximately 1/4 inch, this is indicates that the main 40 pin HSP-A connector has mated properly with the corresponding rack adapter connector, or that keying is not properly matched. Remove the HSP-A and examine the main connector for damage. Also verify that the mating connector on the rack adapter is not damaged. Another possibility in case of a gap larger than 1/8” is that the keying guide pins on the rack adapter are loose. Verify that they are torqued in place. Also verify that the HSP-A backplate guide bushings are free of obstructions and deformations.

   b. If there is a gap between the HSP-A front panel and the rack adapter of approximately 3/8 inch, this is common when the latches are not fully in the OPEN (up) position. Pull out the HSP-A, loosen the cap screws, hold each latch in the OPEN (fully up) position and tighten the cap screw to secure the latch in place.

   c. If there is a gap between the HSP-A front panel and the rack adapter of approximately 1/2 inch, this is common when the rack adapter keying does not match the module being inserted.

4. Loosen the cap head screws on the retaining latches and move the latches into the LOCK (down) position and lock in place by tightening the screws. **CAUTION: Do not proceed if latches are not fully lowered.**

5. Set HSP-A Power ON/OFF circuit breaker to ON. Verify front panel indications are normal.

6. The following is an additional check to verify proper seating of the main connector and prevent HSP-A overvoltage:

   - Using an Ohmmeter, verify continuity (less than 2 Ohms resistance) between the COM test point at the HSP-A front panel and the corresponding (-) output stud on the rack adapter rear panel (or the closest accessible negative load circuit).

   - For two units in parallel use an Ohmmeter to verify continuity (less than 2 Ohms resistance) between the two front panel COM test points. If there is no continuity then either the unit is not fully inserted, there is a problem with mating of HSP-A/RA 90 connectors, or there is a discontinuity in the paralleling of the negative sense line (depending on the configuration used, either the DIP switches are not configured properly, or there is a wiring discontinuity from the RA 90 I/O terminal blocks or the I/O connector pins).

2.7 WIRING INSTRUCTIONS

Interconnections between an a-c power source and a stabilized power supply, and between the power supply and its load are as critical as the interface between other types of electronic equipment. If optimum performance is expected, certain rules for the interconnection of source, power supply and load must be observed by the user.

Since all wiring of the HSP-A power is accomplished at the rack adapter, detailed wiring instructions can be found in the RA 90 Series Rack Adapter Operator Manual under the following paragraph headings:

- Safety Grounding
- Source Power Connections
- D-C Output Grounding
- Power Supply/Load Interface
- Load Connection - General (includes Local Sense, Remote Sense, Parallel and Series connections)
- Parallel/Redundant and Hot Swap Operation
- Independent/Series Operation
- Load Sharing

2.7.1 SIGNAL CONNECTIONS

The I/O Signal portion of the connector, located on the rear panel of the HSP-A power supply (see Figure 2-3), provides access for all programming inputs and status signal outputs. These signals are routed through the rack adapter and are accessible at the corresponding rack adapter rear panel I/O connector. Refer to the RA 90 Series Rack Adapter manual for instructions regarding the use of these signals.

These signals provide the user access to portions of the regulation control circuitry of the HSP-A and, as such, must be protected from radiated and conducted noise as well as from physical contact with non-valid driving sources. The following subsections address specific programming signal applications; in general, however, when accessing this connector from distant locations or high-noise environments, it is recommended that a shielded cable be used, with the shield terminated to the system's single point ground.

a. Remote Error Sense

b. External Voltage Programming (Voltage or Current)

c. External Resistance Programming (Voltage)

d. Remote Inhibit Controls (RC1, RC2)

2.8 MECHANICAL KEYING

When used with Kepco plug-in rack adapters (RA 60 and similar), HSP-A power supplies can be configured for extraction from and insertion to an active system, or “hot-swap”. Hot-swapping requires the use of series blocking diodes for each output (see RA 90 Series Operator Manual). The HSP-A incorporates a mechanical keying system to be used in conjunction with the plug-in rack adapters to prevent installation of any but the correct model HSP-A in a given position. The keying mechanism is comprised of (7) holes, each corresponding to an HSP-A model; all holes are plugged except for the “keyway,” thus providing the keying function in conjunction with a pin installed in each rack adapter position. All HSP-A power supplies are keyed by voltage at the factory. ***It is essential that the user: 1) not remove or alter the keyway plugs, and 2) replace any plugs which are inadvertently removed in accordance with the view shown in Figure 2-3.*** To change module keying, see instructions accompanying the RA 90 series plug-in rack adapters.

2.9 RETAINING LATCHES

HSP-A series power supplies are provided with (2) retention latches located at each side of the bottom edge of the front panel (see Figure 2-1). These latches work in conjunction with the HSP-A series plug-in rack adapters to prevent unauthorized or inadvertent module extraction from an operating power system. The latch is engaged by loosening the cap-head screw approximately 1/2 turn CCW (use 5/32” hex key) and sliding the latch down to the bottom of the slot, then retightening the cap-head screw CW until snug. DO NOT OVERTIGHTEN! To release, follow the same procedure, except lift the latch to the top of the slot. Be sure to move the latch completely up or down to ensure full engagement and disengagement of the latching mechanism. When the HSP-A power supply is not installed in its plug-in rack adapter, it is recommended that the latch be secured in the open (up) position to prevent damage.

NOTE: Retaining latches must ***not*** be used to secure the HSP-A power supply in the rack adapter for shipping purposes.

SECTION 3 - OPERATING INSTRUCTIONS

3.1 OPERATING CONFIGURATION

The following paragraphs review the various HSP-A features and indicate how to select and operate each function. The default settings for each function indicate the as-shipped status for standard HSP-A series power supplies. Prior to insertion in the rack adapter and applying source power, the operating configuration of the HSP-A power supply must be selected. This setup is performed via the multiposition configuration switches S1, S2 and S3 which are accessed via slots in the top cover (see Figure 2-2), while the external control signals (programming input and status output) are accessed via the I/O Connector on the rear panel of the HSP-A power supply (see Figure 3-1).

HSP-A series power supplies incorporate several advanced features which expand their applicability beyond that of simple voltage stabilizers. These functions include both internal and external programming of voltage and current regulation points, remote error sensing, active load sharing circuitry, output overvoltage and undervoltage protection, output current “walk-in,” in-circuit voltage and current setpoint monitors, and dual-mode floating inhibit controls, as well as Form-C relay contact outputs indicating source, output and fan status, and overtemperature shutdown.

Access to HSP-A control signals is only via one of the three 37-pin I/O connectors on the rear panel of the rack adapter. See Figure 3-1 and Table 3-1. Refer to the RA 90 Series Operator Manual for wiring details and parallel and series configurations.

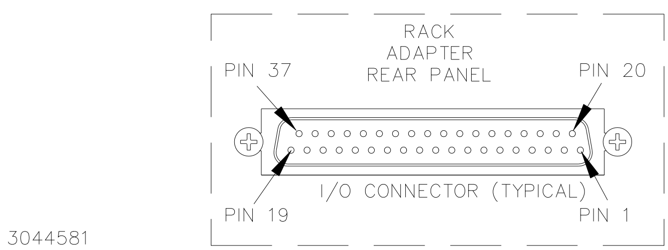


FIGURE 3-1. RACK ADAPTER I/O CONNECTOR, TYPICAL

3.2 ERROR SENSING

All HSP-A power supplies are equipped with remote error sensing to compensate for the voltage drop inherent in any power supply/load interconnection scheme. The amount of compensation varies based on output voltage: 3.3V and 5V models compensate up to 0.25V drop in each power lead (0.5V total), while 12V through 48V models provide for up to 0.8V drop in each lead (1.6V total). ***The remote error sense leads must be connected to the output power terminations, either locally at the power supply output terminals of the rack adapter or remotely at the load terminations, using the correct polarity, for the HSP-A to operate properly.*** Refer to the RA 90 Series Operator manual for details regarding local or remote error sensing configurations

TABLE 3-1. RACK ADAPTER I/O CONNECTOR PIN ASSIGNMENTS

PIN NO.	NAME	DESCRIPTION OF FUNCTION (5)
1	V ORing	Allows detection of failed unit within parallel combination
2	-	No Connection
3	FFS-1	Fan Status - Normally Closed Contact
4	ACS-C	Source Power Status - Common Contact
5	ACS-2 (N.C.)	Source Power Status - Normally Closed Contact
6	- (1)	No Connection
7	RC2 (2)	Remote Inhibit - Normally Low Input
8	RC1 (2)	Remote Inhibit - Normally High Input
9	-(1)	No Connection
10	-	No Connection
11	OTS-C	Overtemp Status - Common Contact
12	PSS-C & OTS-C	Output Status - Common Contact
13	PSS-2 (N.C.)	Output Status - Normally Closed Contact
14	ISHARE (3)	Load Share Signal Bus (0-5.5V)
15	IPROG (3)	Analog Programming Input - Current (0-10V)
16	-S	Negative Error Sense Input
17	VRP-1	Resistive Programming Input (0-50k)
18	VPROG (3)	Analog Programming Input - Voltage (0-10V)
19	-S	Negative Error Sense Input
20	-	No Connection
21	FFS-2	Fan Status - Normally Open Contact
22	FFS-C	Fan Status - Common Contact
23	ACS-1 (N.O.)	Source Power Status - Normally Open Contact
24	- (1)	No Connection(1)
25	FANRTN	Fan Supply Return
26	5VAUX	Auxiliary Supply Output
27	X-(1)	No Connection(1)
28	-	No Connection
29	OTS-2 (N.O.)	Overtemp Status - Normally Open Contact
30	OTS-1 (N.C)	Overtemp Status - Normally Closed Contact
31	PSS-1 (N.).)	Output Status - Normally Open Contact
32	IMON (3)	Analog Output Current Monitor (0-5.5V)
33	ISET (3)	Current Limit Setpoint Monitor (0-10V)
34	-S	Negative Error Sense Input
35	VRP2/VTEMP (2)(4)	Resistive Programming Input - Voltage (0-50k)
36	VSET (3)	Output Voltage Setpoint Monitor (0-10V)
37	+S	Positive Error Sense Input

(1) These pins are left blank to provide voltage isolation between output and a 5V aux supply which powers the remote inhibit control circuitry.
(2) These signals are referenced to FANRTN (pin 25) and are not galvanically isolated from each other.
(3) These signals are referenced to -S (pins 16, 19 and 34).
(4) This signal is VTEMP (output) instead of VRP2 if Option T or MT is installed (see PAR. 3.7).
(5) Refer to Series RA 90 Operator Manual for details.

3.3 OUTPUT VOLTAGE PROGRAMMING

HSP-A power supplies provide three different methods for programming the output voltage regulation point: internal (see PAR. 3.3.1), external resistance (see PAR. 3.3.2) and external voltage (see PAR. 3.3.3). When using either internal or external resistance programming, the minimum programmable voltage is 16.6-20% of nominal, while external voltage programming permits adjustment down to zero. Performance specifications are only guaranteed over the range shown in Table 1-1. The programming method is selected via S2 switch positions 3, 4 and 5 as follows:

NOTE: One programming mode ***must*** be selected, or the HSP-A output voltage programs to zero; ***never*** select more than one programming mode at a time.

3.3.1 INTERNAL PROGRAMMING

Internal programming is the factory-set (default) mode (see Figure 2-2). When enabled via S2-5 set to ON, the output voltage is adjusted using the front panel potentiometer labeled "V_O" (see Figure 2-1).

3.3.2 EXTERNAL RESISTANCE PROGRAMMING

NOTE: External resistance programming is not available if Option T or MT is installed. For these units VRP2 (pin 35) is changed to output signal VTEMP, used for internal temperature readout (see PAR. 3.7).

When external resistance programming is enabled (S2-3, S2-4, and S3-5 set to ON, S3-4 set to OFF), this mode provides for output voltage adjustment via an external resistance or potentiometer (R_{POT} = 0 - 50Kohms) connected between pins 17 and 35 (VRP1, VRP2) of the corresponding I/O connector on the rack adapter (see Figure 3-2).

To calculate output voltage using R_{POT}: use $V_{OUT} = V_{NOM} * (10K / (10K + R_{POT}))$
Where:
V_{OUT} = Output voltage
V_{NOM} = Nominal voltage of the unit
R_{POT} = Resistance of the potentiometer or external fixed resistor

The adjustment range using the above formula applies either to the nominal or high range voltage, as selected by S2 positions 1 and 2 (see PAR. 3.4). This technique is useful for applications where the voltage output of the power supply must be locked to a preset value without means of adjustment (security), or where the voltage output of the power supply must be remotely adjusted after installation (convenience).

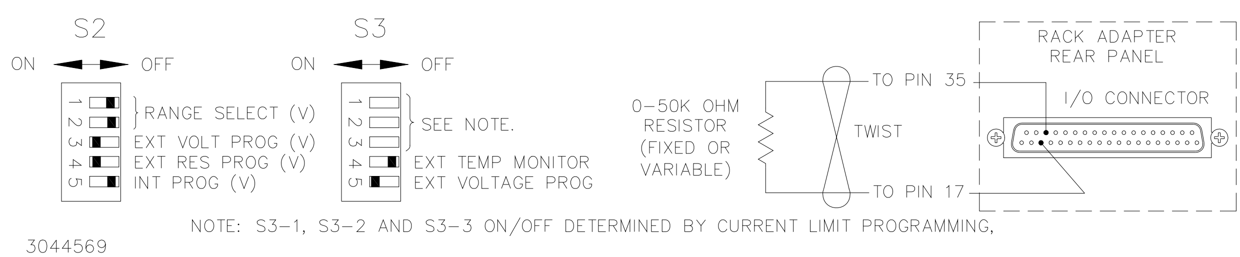


FIGURE 3-2. EXTERNAL RESISTANCE PROGRAMMING OF OUTPUT VOLTAGE

3.3.3 EXTERNAL VOLTAGE PROGRAMMING

When enabled (S2-3 set to ON), this mode provides for output voltage adjustment via an external voltage source (0-10V) connected between pins 18 and 19 (VPROG, -S) of the corresponding I/O connector on the rack adapter (see Figure 3-3). This technique is useful when implementing digital control of the power supply output voltage via a D/A converter; Kepco's SN/SNR 488 programmers are ideally suited to these requirements.

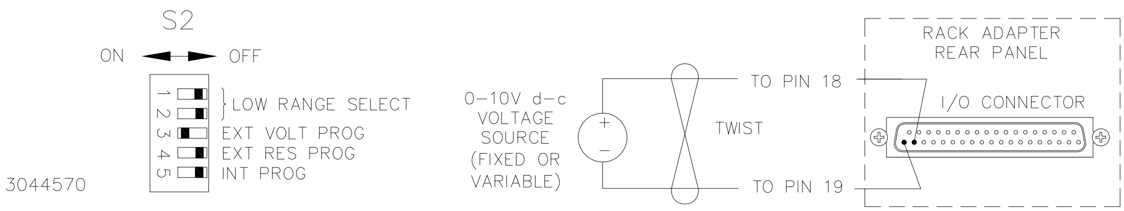


FIGURE 3-3. EXTERNAL VOLTAGE PROGRAMMING OF OUTPUT VOLTAGE

3.4 OUTPUT VOLTAGE RANGE

The user may select the maximum programmable voltage, either high range (PAR. 3.4.1) or low range (PAR. 3.4.2), via S2 switch positions 1 and 2 (see Figure 2-2). This permits the user to trade adjustment range for programming resolution. This is especially useful when used in conjunction with external voltage programming (see PAR. 3.3) for precise output adjustment (±0.2%), or for limiting the maximum programmable voltage. Operation of range selector is as follows:

NOTE**:** When setting the programming range, both S2-1 ***and*** S2-2 must be set to the same position; otherwise, the fault detector voltage window will be offset from the programming value and will not operate properly.

3.4.1 HIGH RANGE

High range is the factory-set (default) mode: S2-1 and S2-2 set to OFF). The maximum programmable output voltage is 110% of nominal V_O for 3.3V through 28V models, 125% of nominal V_O for 48V model and 112% of nominal V_O for 125V model.

3.4.2 LOW RANGE

When low range is enabled (S2-1 and S2-2 set to ON), the maximum programmable output voltage is equal to the nominal output voltage V_O for all models. Since the programming resistance and voltage ranges do not change, the resolution for a given programming input increment increases by 10% for 3.3V through 28V models, 25% for 48V model, and 12% for 125V model.

3.5 CURRENT LIMIT PROGRAMMING

HSP-A power supplies provide two different methods for programming the output current limit point: internal (see PAR. 3.5.1) and external voltage (see PAR. 3.5.2). When using internal programming, the minimum programmable current limit is 50-60% of nominal, while external voltage programming permits adjustment down to near zero. The programming method is selected via S3 switch positions 2 and 3 as follows:

NOTE: One programming mode ***must*** be selected, or the HSP-A current limit programs to zero; ***never*** select more than one programming mode at a time.

3.5.1 INTERNAL CURRENT LIMIT PROGRAMMING

Internal current limit programming is the factory-set default: S3-2 set to ON (see Figure 2-2); when enabled (S3-3 set to ON), the current limit is adjusted via the front panel potentiometer labeled I_{MAX} (see Figure 2-1).

3.5.2 CURRENT LIMIT PROGRAMMING BY EXTERNAL VOLTAGE

When enabled (S3-2 set to ON, S3-3 set to OFF), this mode provides for current limit adjustment via an external voltage source (0-10V) connected between pins 15 and 19 (IPROG, -S) of the I/O connector (see Figure 3-4). This technique is useful when implementing digital control of the power supply current limit via a D/A converter; Kepco's SN/SNR 488 programmers are ideally suited to these requirements.

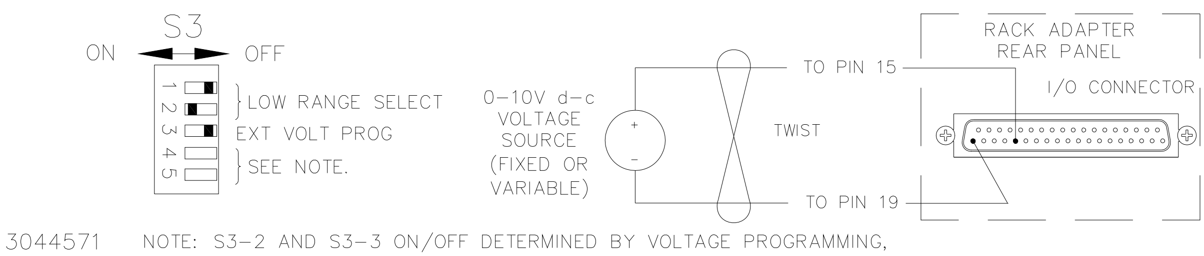


FIGURE 3-4. EXTERNAL VOLTAGE PROGRAMMING OF CURRENT LIMIT

3.6 CURRENT LIMIT PROGRAMMING RANGE

The user may select the maximum programmable current limit, either high or low range, via S3 switch position 1 (see Figure 2-2). This permits the user to trade adjustment range for programming resolution. This is especially useful when used in conjunction with external voltage programming of current limit (see PAR. 3.5.2) for precise limit adjustment, or for limiting the maximum programmable current limit. Operation of the range selector is as follows:

3.6.1 HIGH RANGE

High Range is the factory-set default mode: (S3-1 set to OFF); the maximum programmable current limit is 110% of rated I_O for all models.

3.6.2 LOW RANGE

When enabled (S3-1 set to ON), the maximum programmable current limit is equal to the rated output current I_O for all models. Since the programming voltage range does not change, the resolution for a given programming input increment increases by 10%.

3.7 INTERNAL TEMPERATURE MONITORING (OPTION T OR MT)

Both Option T and MT allow monitoring of internal unit temperature via a status signal that is proportional to internal temperature: When option T or MT is installed, an internal thermal sensor provides an output voltage proportional to internal temperature between 0V (0°C) and 10V (100°C ±2°C) at the ratio of 0.1V/°C. This voltage is available at pin 35 (VTEMP) referenced to pin 25 (FANRTN) of the corresponding of I/O connector at the rack adapter rear panel. Since the unit will shut down due to overtemperature at 85¯C, VTEMP will be in the range of 2V (20°C) to 8.5V (85°C).

If option T or MT is installed, internal unit temperature monitoring is enabled by setting S2-4 to OFF, S3-4 to ON and S3-5 to OFF (see Figure 3-5).

NOTE: When T or MT Option is installed, the external resistance programming feature (see PAR. 3.3.2) is not available since pin 35 is used for VTEMP instead of VRP2.

Option MT is similar to Option T, however it also allows direct reading of internal temperature on the front panel meter (see PAR. 3.17.3).

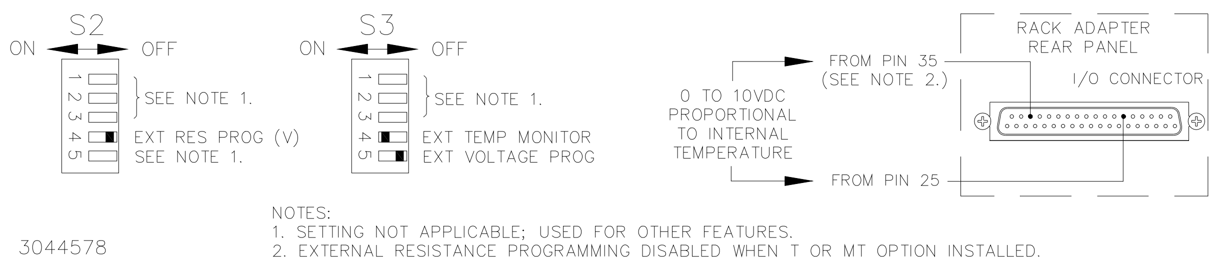


FIGURE 3-5. INTERNAL TEMPERATURE MONITORING (OPTION T OR MT)

3.8 SETPOINT MONITORS

HSP-A power supplies provide measurement ports which permit the user to verify the programmed output voltage and current limit points while the power supply is in an active circuit, and even when operated in a parallel/redundant configuration. These setpoint monitors access the voltage and current loop reference sources to determine the programmed values, and convert these reference levels to proportional voltages readable by the user. As the quantities measured are control circuit setpoints and not actual output measurements, the external operating conditions do not influence these measurements and they remain valid even when the power supply output is disabled; only valid source power is required.

The setpoints are available at two locations on the power supply. The first is via test probe jacks on the front panel of the HSP-A, directly adjacent to their corresponding internal adjustment controls (see Figure 2-1); the jacks are labeled V_O and I_{MAX}, with a third test point labeled COM providing access to the circuit return. The second location is at the corresponding I/O connector at the rear panel of the rack adapter. The test points are pin 36 (VSET) and pin 33 (ISET), with circuit return accessed at pin 19 (-S) (see Figure 3-6).

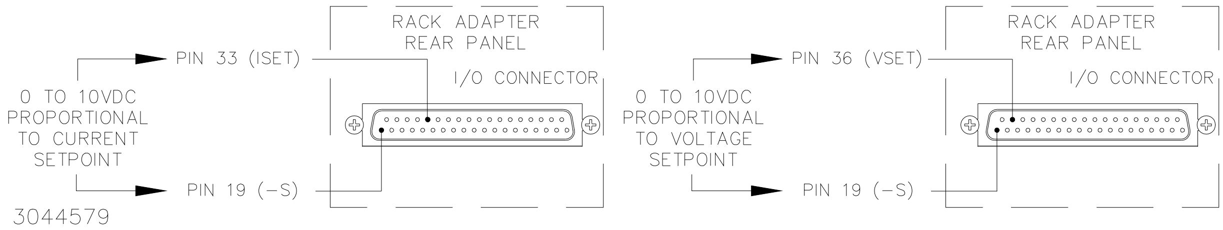


FIGURE 3-6. VOLTAGE AND CURRENT SETPOINT MONITORS

Measurement quantities are defined as follows:

V_O, VSET: This voltage represents 1/10 (1/100 for 125V models) of the programmed output voltage. As an example, VSET (or V_O) = 4.63V corresponds to a programmed output voltage of 46.3V ±1%. This relationship is constant, regardless of the programming range selected (see PAR. 3.4).

I_{MAX}, ISET: This voltage represents the percentage of available power supply current as a percentage of rated current, with 10V corresponding to 100%; available current is defined as the maximum current limit available based on the programming range (see PAR. 3.6). Unlike VSET, ISET is always based on a 0-10V scale, regardless of the range selected. For example, ISET (or I_{MAX}) = 6.2V corresponds to 62% of the maximum programmable current; for the low programming range, this corresponds to 62% of the rated module current, but for the high programming range the number is 62% of 110%, or 68.2% of rated module current. If the module is HSP-A 5-200, for example, the programmed current limit is either 124A or 136.4A, depending on the range selection. Current setpoint monitor accuracy is ±5%.

3.9 OVERVOLTAGE PROTECTION ADJUSTMENT

HSP-A power supplies incorporate output overvoltage protection (OVP) circuitry which latches the output regulator off in the event that the output voltage rises above a predetermined level. Reset requires that the user remove source power for a minimum of 30 seconds (optional remote reset is described in PAR. 3.14). To avoid false detection of OVP for temporary voltage spikes the HSP-A includes an OVP Retrigger feature (see PAR. 3.10

The trip level is preset at the factory for 130% of the nominal output voltage (see Table 1-1), however, this level can be adjusted from 100% to 140% of the nominal output (except Model HSP-A 48-21, which can be adjusted from 100% to 160% of the nominal output) via the OVP ADJUST control accessed through the top cover (see Figure 2-2). To set the trip level to a new value, perform the following steps:

NOTE: For 48V Models only, do not set OVP trip level above 63V.

1. Disconnect any external load circuitry which may be damaged by excessive voltage.

2. Connect a static load, R, across output terminals; a minimum load of 5W is recommended. The load value is determined by the nominal output voltage of the HSP power supply and must be capable of handling 2% of the power supply output rating (minimum power capability of 20 watts). R is calculated as approximately equal to output voltage2/20 (R = E2/P). For example, for the HSP 48-21, R = 482/20 = 115.2; use load of 120 ohms, 20 watts.

3. With source power removed, connect load as shown in Figure 3-7 for local sensing and connect a 20k ohm potentiometer between pin 37 and the output bus bar; adjust the pot for minimum resistance.

4. Rotate OVP ADJUST control on HSP-A fully clockwise.

5. Apply source power; while monitoring voltage at output terminals (bus bars), increase external pot resistance until the output voltage is set for the desired overvoltage protection value.

6. ***Slowly*** rotate the OVP ADJUST pot counterclockwise until the output is latched off (voltage drops rapidly toward zero); the overvoltage trip level is now adjusted to the desired overvoltage protection value (step 4, above).

7. Remove source power for at least 30 seconds, or until the front panel indicator LEDs begin to blink; reduce the external pot resistance slightly, and reapply source power.

8. While monitoring the output voltage, ***slowly*** increase the pot resistance until the output shuts down, and verify trip set point; if necessary, repeat steps 3 through 6 above.

NOTES:
1. ALL CONNECTIONS AND SWITCHES SHOWN ARE AT CORRESPONDING SLOT OF RACK ADAPTER REAR PANEL.
2. POSITION 1 AND 2 OF DIP 1, 2, OR 3 MUST BE OFF WHEN USING EXTERNAL SENSE WIRES.
3. POSITION 3 AND 4 OF DIP 1, 2, OR 3 MUST BE OFF WHEN THE SLOT IS CONFIGURED AS INDEPENDENT.

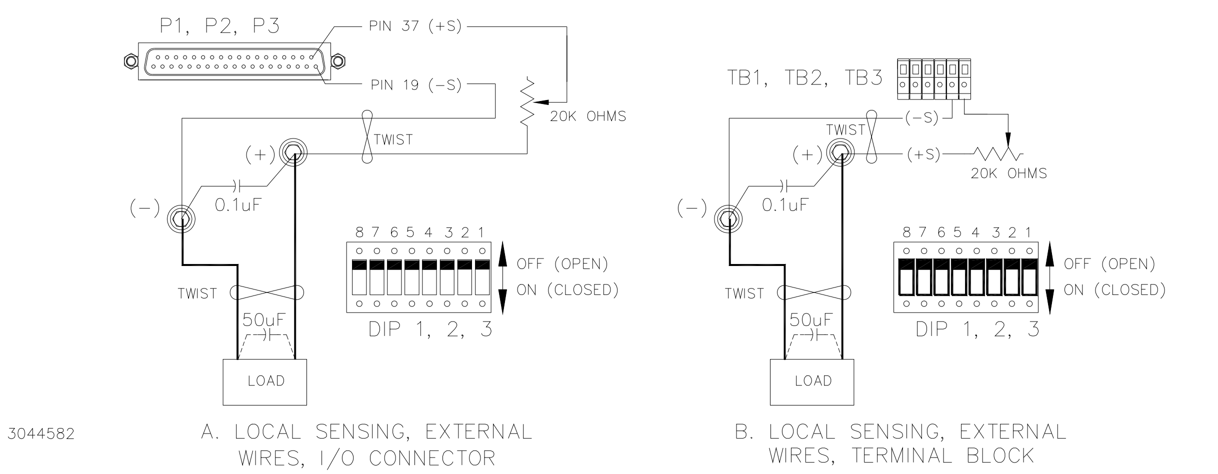


FIGURE 3-7. OVP ADJUSTMENT SETUP

The signal generated by the OVP detector is gated with a signal from the fault detector circuit to produce a selective overvoltage shutdown function which prevents shutdown of operational power supplies in a parallel-redundant power system configuration. The OVP latches of any working power supplies are disabled, allowing only the faulty modules to be latched off; system operation can then return to normal, assuming sufficient load capacity in the remaining modules to support the load. This function is critical in fault-tolerant power systems, otherwise a single overvoltage failure could ripple through all of the operating supplies and result in a complete power system loss.

NOTE**:** The overvoltage protection circuit senses the voltage ***directly at the output terminals*** of the power supply, not at the error sensing point. When selecting an overvoltage set point, the user must take into account the expected power lead voltage drop and, if applicable, the transient response overshoot in order to avoid false shutdowns. The HSP-A design is such that the power supply cannot generate an output voltage high enough to cause internal damage, regardless of OVP setting.

3.10 OVP RETRIGGER/RETRIGGER LOCKOUT

HSP-A includes an OVP retrigger feature that can avoid false detections of OVP due to a temporary voltage surge or spike. This feature is enabled by setting configuration switch S1-4 to ON (see Figure 2-2).

Once OVP is detected, if this feature is enabled the HSP-A makes two attempts within 15ms to retrigger the internal SCR and reset OVP. If OVP was detected due to a temporary spike, the SCR will be retriggered and the unit will not shut down, avoiding a hard reset (cycling of power) or redundant system failure of multiple units. If the OVP condition lasts more than 15ms, the unit will shut down (or it may end up in a hiccup mode of operation), protecting the load from the overvoltage condition).

If necessary for the HSP-A to function the same as a legacy HSP model, the retrigger feature can be locked out (disabled) by setting S1-4 to OFF.

3.11 CURRENT LIMIT CHARACTERISTIC

HSP-A power supplies provide two different current limiting modes for different applications; selection of the desired mode is accomplished via switch S1-3, accessed through the top cover of the HSP-A (see Figure 2-2). The following describes the operational differences and selection method of each:

3.11.1 CONTINUOUS LIMITING

Continuous limiting is the factory-set (default) mode of current limit operation. When the output current of the power supply reaches the programmed current limit, the output regulator switches to current mode operation and maintains the output current by modulating the output voltage. Current mode is maintained indefinitely, and recovery to voltage regulation mode is automatic upon reduction of the output current below the current limit point. This mode is ideal for high-power battery chargers and applications where operation in current regulation mode is normal, or where immediate recovery from an overload condition of any duration is critical.

NOTE**:** HSP-A power supplies are designed to maintain continuous delivery of 110% of rated current indefinitely. When operating parallel/redundant power supply configurations in continuous limiting mode, the user must size the power supply/load interconnection conductors to withstand the total maximum load current available from all of the paralleled power supply modules.

3.11.2 UNDERVOLTAGE LOCKOUT

Undervoltage lockout mode is enabled when S1-3 is set to ON (Figure 2-2). The crossover from voltage- to current-mode operation is the same as for Continuous Limiting. However, after approximately 15 seconds, the output load regulation circuit is locked off via the overvoltage protection latch, requiring the user to recycle source power to restart the power supply (see PAR. 3.9). This mode permits automatic recovery from short-term overloads, but eliminates the danger of overheating and damage to the load and load wiring due to continuous exposure to high current. This is especially useful in redundant power systems, where the continuous overload current of all of the paralleled power supply modules can be in excess of twice the normal load current. As the circuit is triggered by the occurrence of an output undervoltage condition, this circuit can also protect circuits which may be unduly stressed in the presence of an extended undervoltage condition. An example of this are batteries, which can be damaged by discharge voltages below a specified minimum.

NOTE**:** When undervoltage lockout mode is enabled, it is necessary to also enable the Remote Reset function (see PAR. 3.14) in order for the Remote Inhibit function to operate properly.

3.12 CURRENT WALK-IN CIRCUIT

HSP-A power supplies incorporate a specialized output regulator start-up circuit for applications involving use of the HSP-A as a battery charger. This circuit, enabled via switch S1-2, overrides the normal duty-cycle-based soft-start circuit, which could still result in very fast output current rise rates into a discharged battery, and substitutes a controlled-current rise circuit with a time constant in accordance with Bellcore TR-TSY-000947 requirements for telecommunications battery rectifiers (see Figure 3-8). The circuit is reset each time that the output regulator is shut down. This circuit is targeted for battery charger applications, but is ideal for any application which draws very large currents at power-up, such as high-capacitance loads, where this large current spike could result in circuit disruptions due to inductive coupling.

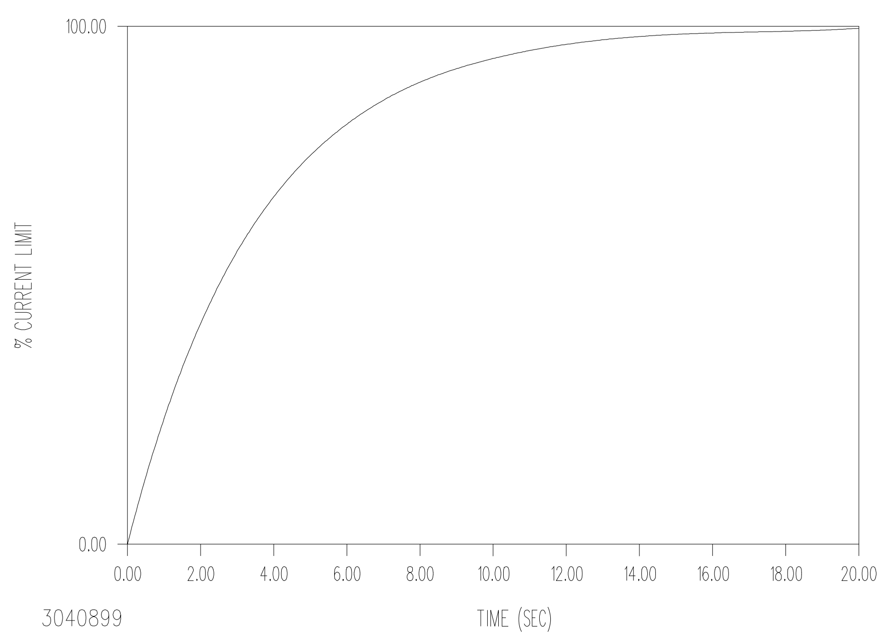


FIGURE 3-8. CURRENT WALK-IN CHARACTERISTIC

3.13 5VAUX FLOATING SUPPLY

HSP-A power supplies are equipped with an internal auxiliary supply which provides 5V at loads up to 100mA. It is derived from the internal cooling fan supply and is, therefore, present whenever the source power is within specification and the internal bias supply is operating, regardless of the status of the output regulator. This supply is SELV and is isolated from the output power lines as well, permitting the user to employ this supply to power circuits which do not share the same ground return as the output; in fact, this supply provides interface power for the remote inhibit control signals (see PAR. 3.14). Typical applications include single-circuit control of several HSP-A power supplies operating at various potentials and polarities with respect to the controller. The output is protected against overload, and is diode-isolated to permit paralleling with the auxiliary outputs of other HSP-A units (regardless of model) for additional load capacity or redundancy. This output is available at the corresponding I/O connector at the rack adapter rear panel: pin 26 (5VAUX) and 25 (FANRTN).

3.14 REMOTE INHIBIT/REMOTE RESET CONTROLS

HSP-A power supplies incorporate two TTL-level inputs, RC1 and RC2, accessed via the corresponding I/O connector at the rack adapter rear panel, which can be used to disable the output regulator via external stimulus. These two controls operate from an internal 5V supply (5VAUX) which is isolated from both input and output (see PAR. 3.13), creating a “floating” inhibit control circuit which allows the user to control several HSP-A power supplies operating at different return potentials from a single source. The two control lines differ in that RC1 (pin 8) is normally high, initiating an output inhibit with application of a low signal level, while RC2 (pin 7) is normally low and requires application of a high level signal to inhibit the output. Both of these signals are applied with respect to FANRTN (see Figure 3-9), and can be operated at potentials as much as ±100V from the HSP-A output(s).

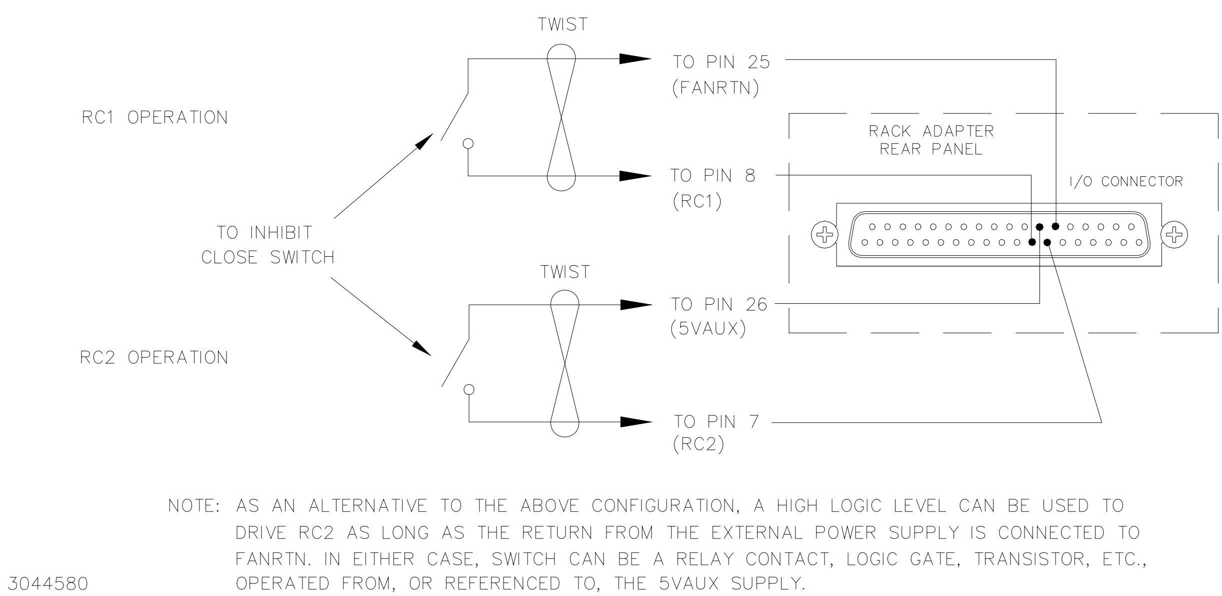


FIGURE 3-9. REMOTE INHIBIT CONTROL OPERATION

These two signal levels are TTL-compatible, both for voltage levels and source/sink capability. If not actively driven, these signals have no effect on power supply operation. Activation of either one of these control lines results in an immediate shutdown of the output PWM regulator, including reset of the soft-start, undervoltage, and current walk-in circuits. Operation is inhibited until the appropriate control line is released, whereupon the power supply output restarts as from initial cold turn-on.

An additional function which can be derived from the remote inhibit control circuitry is the ability to reset the overvoltage/undervoltage latch circuitry without cycling the source power (Remote Lockout Reset). When this function is enabled via switch S1-1, the latch can be reset by toggling one of the inhibit control signals from enable to disable and back. The main advantages of this remote reset function are the ability to reset the power supply from a remote location and an instantaneous reset time (compared to the 30-second minimum waiting period imposed when cycling the source power for reset).

3.15 MODULE CURRENT MONITOR

HSP-A power supplies provide a 0-5.5V analog signal named IMON, accessed via pin 32 of the corresponding I/O connector on the rack adapter rear panel, referenced to pin 19. IMON is proportional to output current: 0 to 5V represents 0 to 100% of rated current in Amperes, 5.5V represents 110% of rated output current. This signal duplicates the voltage level of the load sharing feedback signal (ISHARE) generated by each HSP-A. This permits the user to determine the load being provided by each module within a parallel or redundant power system configuration. The IMON signal is current-limited and isolated from the ISHARE signal, so that it cannot affect the load share function if shorted. The voltage level of this signal is generated with respect to the negative sense return (pin 19 of the rack adapter I/O connector).

3.16 STATUS INDICATORS AND STATUS FLAGS

HSP-A power supplies provide both visual and electrical indication of the status of various critical functions including source power status, output status, fan status and overtemperature condition; both visual and signal indicators are provided. Visual indication is provided via the four LED indicators located on the front panel (see Figure 2-1). Signal indication is obtained via four sets of Form C dry relay contacts accessed via the rack adapter I/O connector; all three contacts are provided to the user, permitting the selection of either normally-open (NO), normally-closed (NC) or both for any application (refer to Table 3-1). The definition of “normal” in this instance refers to the status of the contacts when the HSP-A is powered and operating normally (no fault); status flag outputs remain valid even when source power is removed. These relay contacts are SELV and are isolated from each other and from the output by 100V d-c to permit flexibility in application. A description of the function of each status signal follows. Table 3-2 indicates the condition of status flags and indicators for normal, fault, and no power conditions.

3.16.1 POWER INDICATOR/SOURCE POWER STATUS FLAGS

The POWER indicator and source power status flags monitor available source voltage to determine if sufficient energy is available to sustain rated output for normal operation. These signals indicate a fault condition until the bulk voltage is greater than 390V d-c. Once the bulk voltage reaches 390V d-c (indicating that the PFC boost converter is operating and assuring that full ride-through time is available at rated load) these signals revert to “normal” (see Table 3-2). These signals will indicate a fault a minimum of 5 milliseconds prior to loss of output regulation due to source power loss, providing a transparent source power ride-through time of 21.5 milliseconds; POWER STATUS is not reset until the bulk d-c again reaches 390V d-c; see Figure 3-10 for timing relationships.

TABLE 3-2. STATUS INDICATORS AND FLAGS

CONDITION	SIGNAL/INDICATOR	STATUS **		
		NORMAL *	FAULT DETECTED	NO POWER APPLIED
Source Power Status	Power Indicator	ON (GREEN)	OFF	OFF
	Source Power Status NC	CLOSED	OPEN	OPEN
	Source Power Status NO	OPEN	CLOSED	CLOSED
Output Status	Dc Fail Indicator	OFF	ON (RED)	OFF
	Output Status NC	CLOSED	OPEN	OPEN
	Output Status NO	OPEN	CLOSED	CLOSED
Fan Status	Fanfail Indicator	OFF	ON (RED)	OFF
	Fan Status NC	CLOSED	OPEN	CLOSED
	Fan Status NO	OPEN	CLOSED	OPEN
Overtemperature Status	Overtemp Indicator	OFF	ON (AMBER)	OFF
	Overtemp Status NC	CLOSED	OPEN	CLOSED
	Overtemp Status NO	OPEN	CLOSED	OPEN

* Normal is defined as the HSP-A powered and operating with no faults (source power within specifications, output power within rated limits, fan operating, and no overtemperature condition sensed).

** CLOSED and OPEN are referenced to the associated status common termination.

NOTE: Upon initial turn-on, fan and overtemperature status lines will be in “normal” condition unless a fault condition is sensed.

3.16.2 DCFAIL INDICATOR AND OUTPUT STATUS FLAGS

The OUTPUT status flags and DCFAIL indicator LED are both controlled by the output fault detector circuit, which monitors both output voltage and module current to assess d-c output status. An output fault condition (DCFAIL indicator “ON”) is generated if one of three fault conditions is detected: (1) Overvoltage fault, (2) Undervoltage Fault - output voltage is outside specified regulation limits, or (3) Undercurrent fault - the power supply module is supplying less than 70% of the current required by the circuit (as indicated by the load sharing signal) while the output voltage is within specification limits.

A fault condition is not generated for a combination of overvoltage and undercurrent indications, as these are mutually exclusive conditions for power supplies which are not part of a parallel-redundant configuration; this combination does, however, indicate proper operation for operational power supply modules which are part of a parallel-redundant power scheme in which one or more power supply modules are presenting overvoltage failures.

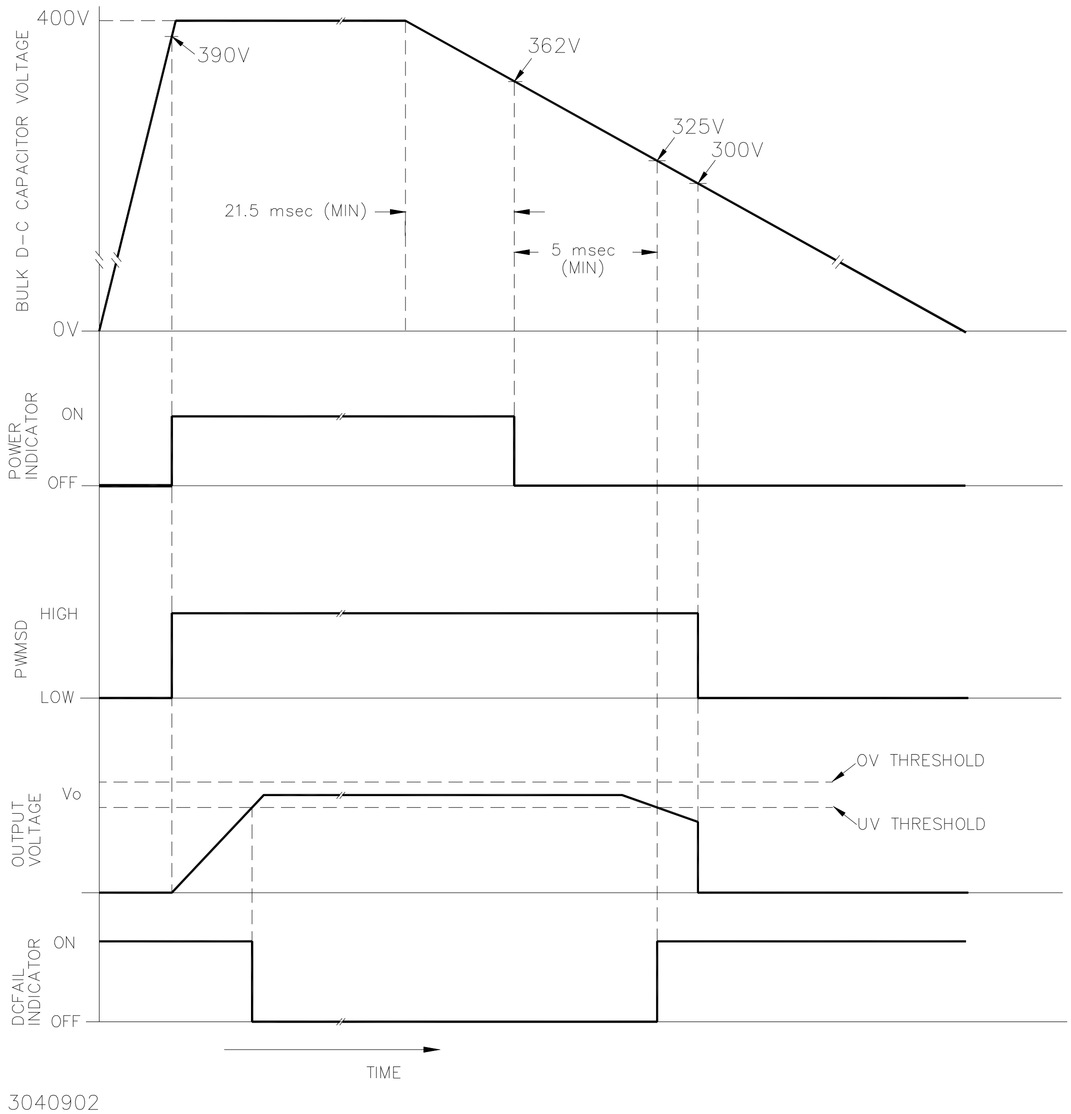


FIGURE 3-10. TIMING DIAGRAM FOR POWER AND DCFAIL STATUS

Table 3-3 provides an operating matrix of the DCFAIL status function; see Figure 3-10 for timing relationships. The output voltage fault limits are ±5% of programmed output voltage, while the undercurrent fault limit is <70% of required module current; signal reset requires output voltage recovery to within the specified ±1% regulation range and/or module current recovery to >85% of required module current, respectively.

TABLE 3-3. FAULT DETECTOR OPERATION

UNDERVOLTAGE	UNDERCURRENT	OVERVOLTAGE	DCFAIL STATUS
N	N	N	OFF
Y	X	*	ON
N	Y	N	ON
*	N	Y	ON
*	Y	Y	OFF
Y = YES; N = NO; X = DON'T CARE; * = EXCLUDED BY ANOTHER ASSUMED CONDITION			

3.16.3 OVERTEMP INDICATOR AND STATUS FLAGS

This fault is generated in the event that either the input or output module heatsink temperature rises above a safe operating level; output regulator shutdown occurs simultaneously. Recovery occurs automatically upon reduction of internal temperatures to normal levels.

3.16.4 FANFAIL INDICATOR AND STATUS FLAGS

This fault is generated in the event of a failure of the internal cooling fan; a delay of approximately 5 seconds is incorporated to prevent nuisance indications at turn-on. Reset occurs when fan operation resumes.

3.17 FRONT PANEL METER OPERATION

HSP-A series power supplies incorporate a 3½ digit LED meter display on the front panel. The meter provides both voltmeter and ammeter functions. The V-A rocker switch directly below the meter (Figure 2-1) selects either output voltage (V) or module current (A) as the normally-displayed parameter. The associated LED, either V or A, lights to show the selected switch position. When depressed, the ACTUAL/SETPOINTS momentary-contact switch located below the V-A selector switch causes the meter to display the programmed value of output voltage or current limit, as selected by the V-A switch. The following paragraphs describe the meter functions in detail.

NOTE: If option MT is installed, the front panel meter can also display internal unit temperature (see PAR. 3.17.3),

3.17.1 VOLTMETER OPERATION

With the V-A selector switch set to ‘V' position (green V indicator illuminated), the meter normally displays the actual output voltage present at the error sense terminals (within ±2%). If the ACTUAL/SETPOINTS switch is depressed with the V-A selector switch set to V, the display shows the *programmed* output voltage (±1%) of that module, regardless of the actual output status at the time (refer to VSET, PAR. 3.8); unlike VSET, however, both actual and setpoint voltages are displayed in volts. If desired, the programmed setpoint can be adjusted using the previously selected output voltage programming method (PAR. 3.3). Releasing the ACTUAL/SETPOINTS switch causes the meter to resume displaying actual output voltage.

3.17.2 AMMETER OPERATION

With the V-A selector switch set to ‘A' position (amber A indicator illuminated), the meter normally displays the actual output current (within ±3%) presently being supplied by the module. If the ACTUAL/SETPOINTS switch is depressed with the V-A selector switch set to I, the display shows the programmed current limit (±1%) of that module, regardless of the actual current being supplied at the time (ref. ISET, PAR. 3.8); unlike ISET and ISHARE, however, both actual current and setpoint current limit are displayed in amperes. If desired, the programmed setpoint for current limit can be adjusted using the previously selected current limit programming method (PAR. 3.5). Releasing the ACTUAL/SETPOINTS switch causes the meter to resume displaying actual module output current.

NOTE: Ammeter accuracy of ±3% applies for load currents between 25 and 100% of rated output current (e.g., between 50 and 200 Amperes for HSP-A 5-200). For load currents less than 25%, ammeter accuracy will be ±3% ±3 digit counts. Under “no load “ or “zero-Ampere” conditions the meter may show ±0.3, ±0.2, ±0.1 or 0.0.

3.17.3 OPTION MT METER OPERATION

If option MT is installed and properly configured (see PAR. 3.7), the front panel meter can also display the internal unit temperature by pressing the PUSH/DISPLAY TEMP °C switch on the front panel (see Figure 2-1). When the switch is pressed, the meter displays internal temperature of the unit, from 0.0 to 100.0 (°C) instead of Volts/Amps. An integral LED (blue) lights while temperature is displayed. To return to VOLTAGE or CURRENT display function press the PUSH/DISPLAY TEMP °C switch: meter displays voltage or current per the V-A selector switch setting and the blue LED is not lit,

3.17.4 PARALLEL/REDUNDANT METER OPERATION

The meter display function is fully operational when HSP-A is used either singly, as a standalone power supply, or in multiples, as part of a parallel/redundant or series load arrangement. When used as part of a parallel/redundant power system, however, the following points should be noted.

When the meters are functioning as voltmeters:

- The actual voltage displayed by each power supply module represents the *output bus voltage*, and *not* the individual voltage supplied by each module.

- The setpoint function, however, *does* display the individual setting for the specific power supply module being measured, thus allowing on-line calibration of all of the power supply modules in the system.

When the meters are functioning as ammeters,

- The actual current displayed by each power supply module represents actual module output current regardless of output configuration.

- The setpoint function for current limit displays the individual setting for the specific power supply module being measured,

3.18 BATTERY (B OPTION) OPERATION

The Battery Charger Option (B suffix) adds a second switch-selectable voltage network to the front panel. This permits the user to preset two different voltage regulation values corresponding to “float” and “equalize” functions for battery charging applications. This option is available for 1000W HSP-A models covering 12V, 24V and 48V, and 1500W models covering 24V and 48V nominal battery voltages.

When the Float-Equalize switch is set to FL (see Figure 2-1), the Float potentiometer adjusts the output voltage; when set to EQ, the Equalize potentiometer adjusts the output voltage. The FL-EQ position also determines which voltage is available at test point Vo.

CAUTION: Adjusting the non-selected potentiometer (e.g., FL potentiometer with switch set to EQ) can have adverse effects, because an unknown output voltage will be applied to the load when the switch position is changed.

The fault detector window is altered to accommodate the normal range of battery voltage from fully discharged to peak equalize charge as shown in Table 3-4.:

TABLE 3-4. B OPTION FAULT DETECTION WINDOW

Nominal Battery Voltage	Kepco Model	Min. Volts	Max. Volts
12V	HSP 15-66AB	10.6	14.6
24V	HSP 28-36AB, HSP 28-53AB	21.1	29.2
48V	HSP 48-21AB, HSP 48-30AB	42.2	58.4

The programmed current limit (I_{MAX}) applies to both float and Equalize operation. The meters operate as described above (see PAR. 3.17) except that the displayed setpoint value is determined by the FL-EQ switch.

3.19 CONFIGURING PARALLEL COMBINATIONS FOR PROPER LOAD SHARING

To ensure that load sharing works properly, first review and adhere to ALL the requirements described in the RA 90 Operator Manual for Load Sharing, summarized as follows:

- Use remote sensing if possible. If local sensing is used ensure load wire voltage drops are minimized.
- Install local noise decoupling capacitors across all sense wire termination points.
- Locate units as close to each other as possible.
- Voltage setpoints as close to each other as possible (within 2% max).
- Minimize the load share signal wire interconnection lengths.
- Use twisted wires or shielded cable (shielded cable is preferred for long runs or between racks) for ISHARE connections; connect shield to OUT (–).terminal.

3.19.1 VERIFY POWER SUPPLY OUTPUT VOLTAGES SET CORRECTLY.

Set the front panel meter V/A switch to V position and press the momentary SETPOINTS switch. The meter displays the voltage set point of the unit. Repeat for each unit in the parallel combination. While pressing the momentary SETPOINTS switch, adjust the corresponding Vo trimpot of each unit so that all setpoints are the same.

To accomplish the above without using the meter, measure VSET at either the Vo and COM jacks on the front panel or at pin 36 of the corresponding I/O connector on the rack adapter, referenced to pin 19 (see PAR. 3.8). VSET is 0 to 10V, representing 10% of the voltage set point. E.g., if VSET = 4.36V, the voltage setpoint is 43.6V ±1%. Adjust Vo of each unit while monitoring VSET to set all units to the same programmed output voltage.

Once output voltage of each power supply is set, turn on only one power supply at a time connected to the full load and measure the output voltage of each power supply. Verify that the output voltage readings of each individual power supply are within ±2% of each other. If not, check load wiring for unbalanced resistance.

3.19.2 VERIFY CURRENT SHARE WORKING PROPERLY.

Forced current share (current balancing) starts working only when

shared load (Amperes) > n x 6% I_{NOM}

where: n = number of units in parallel with current balancing implemented
I_{NOM} = Nominal output current of unit in Amperes

If load current is less than n x 6% I_{NOM}, the master unit will deliver most of the load current. For example, for three HSP 28-36A units in parallel redundant with current balancing implemented, and load current less than n x 6% I_{NOM} the master will deliver 3 x 6% x 36 = 6.48A. If the load current increases beyond 6.48A, then all units start sharing current. The optimum current share ratio of 55/45 is achieved for load current ≥ n x 10% I_{NOM} (for this example 3 x 10% x 36 = 10.8A).

When load current is between n x 6% I_{NOM} and n x 10% I_{NOM}, the share ratio may be between 95/5 and 55/45. The actual ratio depends on a number of factors, e.g., how close the voltage settings of each unit are to each other, load wire gage, and whether local or remote sensing is in place,

To verify that load sharing is working properly it is necessary to determine how much load current is being supplied by the master, and how much by the slaves.

Set the front panel meter V/A switch to A and observe the current delivered by that unit on the meter. Record the value and repeat for all units. The sum of the individual currents recorded is the current supplied to the load.

To accomplish the above without using the meter, the current delivered by each unit can be calculated by measuring the IMON signal at pin 32 of the I/O connector referenced to pin 19 (S–). IMON is a 0 to 5V signal representing 0 to 100% of the rated output current of the unit. E.g., for the HSP 12-84A, IMON of 3V represents 60% or 84A, or 50.4A.

The current share ratio is calculated as follows;

Current share ratio = % of current of one unit/% of current of other unit

E.g., for a parallel combination of two HSP 12-84A units,
if one unit delivers 46.2A, (46.2/84 = 55%), and other delivers 37.8A (37.8/84 = 45%) the ratio is 55/45.

For units using remote sensing as outlined in PAR. 2.7.1, ratios up to 55/45 are optimum. If the ratio is 57/43 or higher (e.g., 58/42), the DC FAIL light will go on indicating load sharing is not working. Higher ratios can occur for load s that draw more than 10% of I_{Onom}.

For units using local sensing, where the load draws less than 10% of I_{Onom}, ratios outside the range or 55/45 may be experienced without the DC FAIL indication. For this case, it is advisable to revisit ALL the requirements of PAR. 2.7.1 and take any additional measures necessary to reduce voltage drops on the power leads which can cause the load sharing to be unbalanced. Pay particular attention to increasing wire size, verifying that voltage of each unit is within 2% of each other, and ensuring that the minimum system load restriction is obeyed.

If load sharing is not still not within the proper load share ratio of 55/45, it is recommended to measure the output voltage of each power supply one at a time with all the other paralleled units turned off to verify that output voltage matches the VSET (programmed) output voltage.