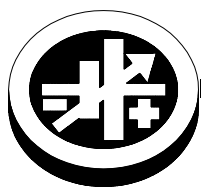


INSTRUCTION MANUAL



KEPCO An ISO 9001 Company.



KEPCO SINGLE OUTPUT 50 WATT HOT SWAP PLUG-IN POWER SUPPLIES

I — INTRODUCTION

The Kepco HSF-PFC 50 Watt series hot swappable, high frequency switching, plug-in power supplies with built in power factor correction employ forward conversion and are designed to operate in a fault tolerant power system with either a-c or d-c input. A thermistor soft-start circuit limits start-up surge. A built-in forced current share circuit and OR-ing diodes allow configuration for hot-swap and parallel-redundant N+1 operation.

These power supplies are designed to be installed in Kepco's RA 19-(X)B Rack Adapters (Figure 2). RA 19-6B accepts up to six 150W units, RA 19-7B accepts up to three 150W units, and up to four 50W or 100W units and RA 19-8B accepts up to eight 50W or 100W units. The applicable RA 19-(X)B Operator Manual can be downloaded from the Kepco web site at:

www.kepcopower.com/support/opmanls.htm#ra19-xb

All input/output connections are through a 24 pin connector that plugs into the rack adapter. All external connections are made through the rack adapter.

Six models may be selected for outputs of 3.3, 5, 12, 15, 24, or 48V (see Table 1).

When the input is cut off, the output is maintained for 15 milliseconds minimum. If the power supply shuts down due to an output overvoltage condition, it is then necessary to wait 30 seconds minimum before turning the unit on again. EMI filtering is designed to meet FCC Class B rating and VDE 0871 Class B rating. Table 1 lists specifications for each model of the HSF-PFC 50 Watt Series. See "SPECIFICATIONS" on page 4 for common specifications.

OPTIONS. Options are identified by suffix: T (-PFCT) offers improved efficiency, less weight, and the addition of a 28V, 50W model; C (-PFCC) offers current monitoring via an integral current sensing resistor (includes option T), X (-PFCX) offers remote on/off (includes option T); and Y (-PFCY) includes options C, X and T.

TABLE 1. OUTPUT RATINGS AND SPECIFICATIONS, HSF-PFC 50W SERIES

MODEL	HSF 3.3-10PFC	HSF 5-10PFC	HSF 12-4.3PFC	HSF 15-3.5PFC	HSF 24-2.2PFC	HSF 28-1.8PFC ⁽⁴⁾	HSF 48-1.1PFC
OUTPUT VOLTS, d-c (NOMINAL)	3.3V	5V	12V	15V	24V	28V	48V
ADJUSTMENT RANGE	2.8 - 3.4V	4.3 - 5.3V	11.4 - 12.6V	13.5 - 16.2V	22.5 - 25.5V	22.4 - 30.2V	44.0 - 52.0V
OUTPUT CURRENT (NOMINAL) ⁽¹⁾	10A	10A	4.3A	3.5A	2.2A (3.2A Peak) ⁽⁶⁾	1.8A	1.1A
CURRENT LIMIT ⁽²⁾	13.1A min	10.5A min	4.5A min	3.6A min	3.3A min (2.3A min) ⁽⁷⁾	1.9A min	1.15A min
OUTPUT POWER (MAX.) ⁽³⁾	33W	50W	51.6W	52.5W	52.8W	50.4W	52.8W
SHORT CIRCUIT CURRENT ⁽²⁾	16A	12.6A	5.6A	5.4A	6.2A	1.7A	2.4A
RIPPLE AND NOISE (mV p-p) 0-40°C, 10-100% LOAD	switching (typ)	80	80	100	100	150	130
	spike noise (d-c—50MHz)	120	120	150	150	200	200
OVERVOLTAGE SETTING (25°C, NOM. INPUT)	3.9 - 5.1V	5.7 - 6.4V	13.5 - 15.5V	16.8 - 18.8V	26.8 - 30.3V	32.0 - 35.0V	54.8 - 59.9V
SENSE RESISTOR (RS) value ⁽⁵⁾	0.01 Ohm	0.01 Ohm	0.02 Ohm	0.03 Ohm	0.05 Ohm	0.05 Ohm	0.1 Ohm

(1) Derates same as Output Power.

(2) Current Limit is rectangular. After the overload is removed, output is automatically restored.

(3) See power derating curve, Figure 3.

(4) 28V Model available with T, C, X and Y Options only.

(5) Sense resistor Included with C and Y models only.

(6) Peak current and thermal protection applicable to some 24V models: standard (no options) and C option only. See Figure 1 for peak power requirements.

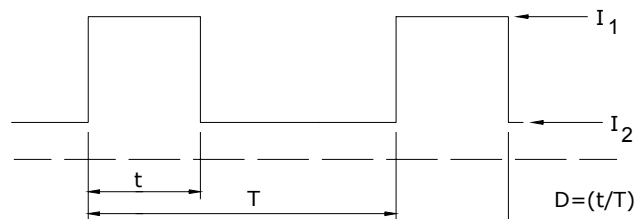
(7) For 24V Model, s T, X and Y options only.

II — FEATURES

FRONT PANEL ACCESS. The front panel provides a power ON/OFF switch controlling input power and a “VDC ON” light which indicates when the unit is operating.

NOTE: The ON/OFF switch must be set to OFF before removing unit from rack adapter. The front panel “MASTER ON” LED lights when 1) the unit operates independently, or 2) the unit is used in parallel redundant configurations while a) the output is less than 10% of nominal or b) the output is within 10% to 100% of nominal and the unit is functioning as a master. In parallel redundant configurations, the module with the highest voltage functions as the master. The other units are slaves, and track the output voltage of the master. Refer to **Current Share Bus (CSB)** on page 3 for details. (The MASTER ON LED is not used on 3.3V model; it is always off.) The front panel Vadj trimmer provides adjustment of the output voltage within the limits specified in Table 1; test points connected to the +S and –S lines are available at the front panel for measuring the output.

FORCED CURRENT SHARE CIRCUIT. (Not available on 3.3V model.) When units are configured for N+1 parallel redundant operation, it is desirable for current to be divided equally among the paralleled supplies. When the CSB (Current Share Bus) lines of paralleled HSF-PFC units are connected together, the load current is forced to divide equally between all paralleled units. If one unit fails, the remaining units will continue to supply the load, and the load current will be divided equally among the remaining operating units. The failed unit is automatically isolated from the circuit by a built-in isolation diode. Refer to **Current Share Bus (CSB)** on page 3 for details.



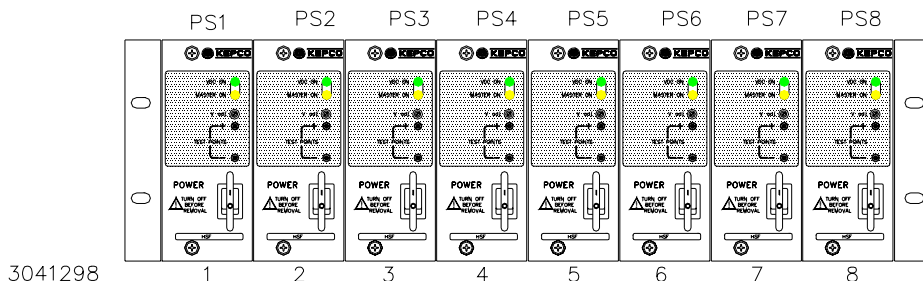
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Some 24V Models (standard (no options) and Option C) can supply Peak current listed in Table 1 if the four conditions listed below are met. These models include thermal protection, voltage shutdown type. Restart by removing a-c input; after sufficient cooling, reapply a-c input (wait at least 30 seconds).

1. Time: $t \leq 10$ Seconds
2. $I_1 \leq$ Peak Current (Amperes)
3. Effective Current:

$$\sqrt{DI_1^2 + (I - D) \times I_2^2} \leq \text{Rated current (Amperes)}$$
4. Effective Power $P \leq$ Maximum Power (Watts)
 (output RMS current x output voltage)

FIGURE 1. 24V MODEL PEAK CURRENT REQUIREMENTS



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FIGURE 2. HSF-PFC 50 WATT POWER SUPPLIES (8) INSTALLED IN RA 19-8B RACK ADAPTER

REMOTE ON-OFF. Remote on-off (X and Y models only) is via $\pm RC$ assigned to pins of the RA 19-(X)B I/O connector: off = no voltage, short circuit, or 0 to 0.8V, on = 4.5 to 12.5V (or 12.5 to 24.5V via 1.5K Ohms). To reverse on-off polarity contact Kepco. There is no isolation between $\pm RC$, d-c output and alarm circuit. Refer to the applicable RA 19-(X)B Manual for details.

CURRENT MONITOR. Current monitor (C and Y models only) is via $\pm IMON$ assigned to pins of the RA 19-(X)B I/O connector: Monitored Output Current (Amps) = Voltage drop across R_s (Volts) / R_s (Ohms) (see Table 1), where voltage drop across R_s is measured across $\pm IMON$ pins (requires millivoltmeter, range 0 to 200mV). Accuracy is $\pm 10\%$; contact Kepco if greater accuracy is required. There is no isolation between $\pm IMON$, alarm circuit and d-c output. Refer to the applicable RA 19-(X)B Manual for details.

ALARM CIRCUIT. The HSF-PFC includes an isolated internal relay offering normally closed and normally open contacts referenced to an isolated common. These contacts are rated for 1A at 30V d-c and 0.5A at 125V a-c. These contacts may be used to configure “close on failure” or “open on failure” alarm circuits. (Refer to the Series RA 19-(X)B Manual for alarm configurations for multiple HSF-PFC power supplies.) Any condition which causes the unit to be out of specified voltage/current ranges (including overvoltage, overcurrent, overtemperature, open sense line, ac input line failure, etc.) results in an alarm.

KEYING. Keying of the HSF-PFC is established at the factory. The output voltage determines which keyway is open. When the corresponding rack adapter key (pin) is installed by the user, only a power supply of the correct voltage can be inserted in the rack adapter slot.

CONNECTIONS: The 24-pin I/O connector is designed to mate with the corresponding connector in the Series RA 19-(X)B Rack Adapter.

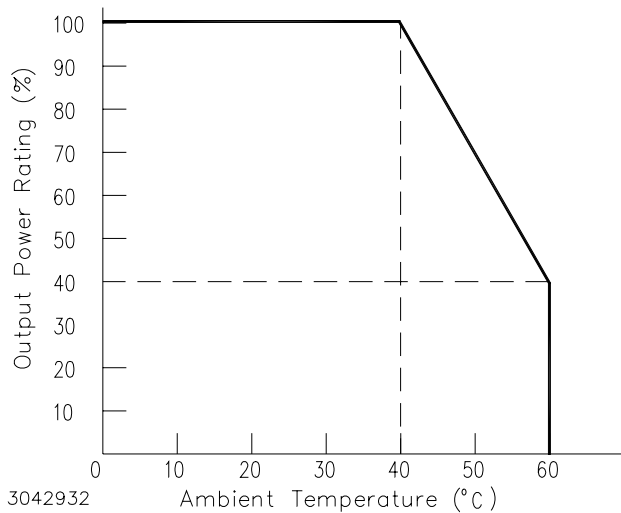


FIGURE 3. % OUTPUT POWER RATING VS. AMBIENT TEMPERATURE

(+) SENSE, (-) SENSE: These lines are provided to compensate for voltage drops in the load connecting wires. The Sense lines must be connected to their respective (+) and (-) output terminals, either at the load or at the rack adapter (see Rack Adapter Manual). The connection ensures the most accurate error tracking. Error compensation in the connecting wires is up to 0.25 Volts per lead for all models.

NOTE:

The Sense lines must be connected for the HSF-PFC Power supply to work properly!

OUTPUT (+), OUTPUT (-): HSF-PFC power supply d-c output.

CURRENT SHARE BUS (CSB): (Not available on 3.3V model.) Connecting the CSB lines of HSF-PFC power supplies operating in a parallel configuration causes output current to be shared equally. (See Rack Adapter Manual for additional information on parallel configurations.) For current sharing to work properly the outputs of all paralleled units must be within 250 mV (max) of each other and each unit must be operating at between 10% to 100% of rated output. If current to the load goes below 10% for each unit in current share mode, all MASTER ON lights may go on (see load effect specifications); this indicates that forced current share is no longer working, units are simply in current share mode. (If forced current sharing at less than 10% nominal current per supply is needed, contact Kepco application engineering.) Remote sensing is recommended. For master/slave operation to work properly each unit should be adjusted to 40 mV (optimum) less than the next paralleled unit (unit 1 is adjusted to V_{OUT} , unit 2 to $V_{OUT} - 40mV$, and unit 3 to $V_{OUT} - 80mV$, etc. If the master fails, the unit 2 will become the new master). The 40 mV difference can be reduced to a minimum of 25 mV as needed to parallel many units and still keep all units within 250 mV of each other. Adjust the outputs using Vadj trimmer on front panel.

- Optimum difference among output voltages of paralleled units: 40mV
- Maximum difference among output voltages of paralleled units: 250 mV
- Minimum difference among output voltages of paralleled units: 25 mV

ALARM: The Alarm NC (normally closed) - Open on Failure and Alarm NO (normally open) - Close on Failure lines are relay contacts referenced to Alarm Common. If the unit fails, the path between Alarm NC - Open on Failure and Alarm Common opens, the path between Alarm NO - Close on Fail and Alarm Common is a short circuit. Figure 4 illustrates typical Close on Fail and Open on Fail circuits to give a failure indication if any one of a number of power supplies fail.

INPUT POWER: Line (either a-c or d-c source power), Neutral and Ground (chassis)

III — SPECIFICATIONS

The following specifications apply to all HSF-PFC 50 Watt Series models (also refer to Table 1). Other models are also available; consult your Kepco representative for their specifications.

INPUT:

Voltage: 120V a-c/240V a-c nominal; Range 95-265V a-c; 125-370V d-c. (polarity insensitive)

Frequency: Nominal 50-60 Hz; Range 47-440Hz (at 440Hz leakage current exceeds UL/VDE safety spec.limit).

Current (nominal output at rated load):
0.8A rms max. (100-120 Va-c input, 100% load)

0.4A rms max. (200-240 Va-c input, 100% load)

3.3V Model:

0.7A rms max @100 - 120V a-c:

0.35A rms max. @200 - 240V a-c:

Initial Turn-on Surge: cold start 25 °C (First surge only, not including the current flow into the EMI filter)

14A typ. (100 V a-c, 100% load);

28A typ. (200 Va-c, 100% load).

Brownout Voltage: 85V a-c, 110V d-c.

Switching Frequency: 140KHz typical, nominal load.

STABILIZATION:

Source Effect: Range 95-132V a-c or
190-265V a-c, 0.2% typ.; 0.3% max.

Load Effect: Range 10%-100% load
0.5% typ.; 1.5% max.

Temperature Effect: Range 0° to 40°C
0.5% typ.; 1.0% max.

Combined Effect: 0.9% typ.; 1.8% max. (includes source, load, and temperature effects).

Time Effect (1/2 hr-8 hr at 25°C):
0.2% typ.; 0.5% max.

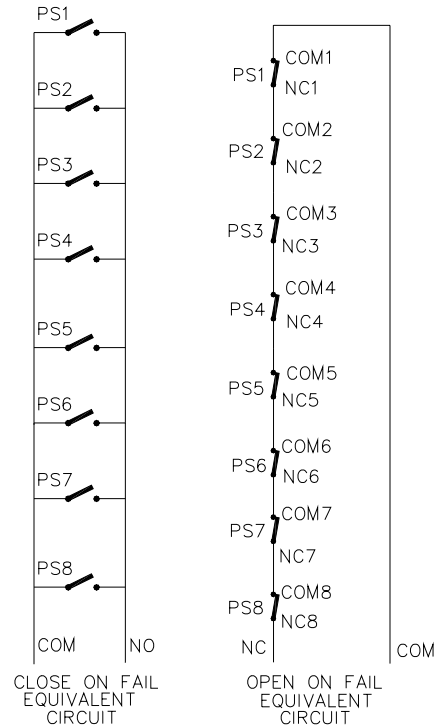
RECOVERY CHARACTERISTICS: A step load change from 50% to 100% produces less than ±4% output excursion. Recovery occurs to within ±1% of the original setting in <1 ms (load change t_r or t_f equal to or greater than 50µsec).

START-UP TIME: 500 ms. maximum.

HOLDUP TIME:

40 ms. typ., 20 ms. min. (100V a-c);

50 ms. typ., 25 ms. min. (240V a-c).



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FIGURE 4. TYPICAL ALARM CIRCUIT DIAGRAMS

DIELECTRIC STRENGTH:

Between input and output:
2KV a-c for one minute.

Between input and output with Y-capacitor removed:
3KV a-c for one minute.

Between input and case (ground):
2KV a-c for one minute.

INSULATION RESISTANCE: Between input and ground, output and ground, input and output:
100 Megohms min. (500V d-c).

LEAKAGE CURRENT

(UL method, 120V a-c): 0.24 mA maximum.

(VDE method, 240V a-c): 0.48 mA maximum.

POWER FACTOR:

0.99 typ. at 100V a-c,

0.95 typ. at 200V a-c

SAFETY: Units are designed to meet UL60950 3rd Edition, CSA 22.2 No. 60950 and EN 60950 and are CE marked per the Low Voltage Directive (LVD), 73/23/EEC and 93/68/EEC. [The standards do not apply with DC input operation]

EMI: Designed to meet FCC Class B (100-120V a-c) and VDE 0871 Class B (220-240V a-c).

VIBRATION: (non-operating, one hour on each one of the three axes):

- 5-10 Hz, 10 mm amplitude.
- 10-55 Hz, 2g acceleration.

SHOCK: (non-operating, one-half sinusoidal pulse, three shocks to each axis):

- Acceleration: 20g
- Duration: 11ms ±5ms

OPERATING TEMPERATURE: See Figure 3.

STORAGE TEMPERATURE: -40°C to +75°C.

RELATIVE HUMIDITY: Operating and storage: up to 95% (wet bulb temp. <35°C non-condensing).

FUSE: Slow Blow, 2A, 250V; (5 x 20 mm), Littelfuse, P/N 215002PG; Kepco P/N 541-0137.

DIMENSIONS: See Figure 6.

WARRANTY: 5 years.

IV — INSTALLATION

MOUNTING THE POWER SUPPLY. Refer to Figure 2 and insert HSF-PFC power supply into selected slot of RA 19-(X)B Rack adapter until power supply front panel is flush with rack adapter chassis and secure with front panel Phillips head mounting screw.

CONNECTIONS. All connections are made at the rear panel of the RA 19-(X)B Rack Adapter (see applicable RA 19-(X)B Operator Manual). Connect the load to the applicable ± DC OUTPUT terminals. AC input power to each slot

is applied via two INPUT POWER terminal blocks as indicated on the rack adapter rear panel. Make sure to connect the AC input Neutral, Line and Ground wires to the respective terminals of the terminal blocks.

REMOVAL. To remove a power supply, first use the POWER switch to turn off the unit. Then loosen the mounting screw and extract the unit from the RA 19-(X)B Rack Adapter.

V — OPERATION

Turn the unit on using the front panel POWER switch (see Figure 5). **CAUTION: DO NOT repeatedly toggle the POWER on/off switch as this may cause unit to fault.**

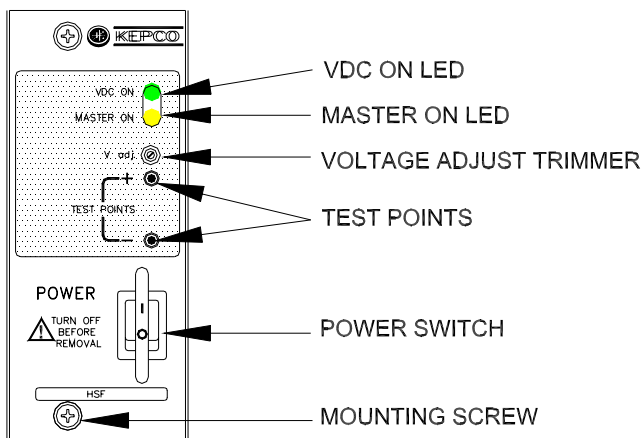
Master/slave parallel configurations of one or more HSF-PFC power supplies are covered in the applicable RA 19-(X)B Rack Adapter manual.

The MASTER ON LED (amber) goes on under any of the following three conditions:

- Independent operation.
- Operation in a parallel master/slave configuration to indicate which unit is the master
- Operation in a parallel master/slave configuration to indicate that a slave unit is no longer within the proper specifications for paralleled units. Slave 1 should be optimally adjusted to 40mV less than master, slave 2 adjusted to 40mV less than slave 1, etc. The maximum allowable difference between paralleled units is 250mV. The minimum allowable difference between paralleled units is 25mV. If a slave exceeds these limits, the MASTER ON light goes on.

NOTE: MASTER ON LED not used on 3.3V model: always OFF.

Additional information for various parallel and alarm configurations can be found in the applicable RA 19 Rack Adapter manual referenced on page 1.



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FIGURE 5. COMPONENT LOCATIONS

When output voltage is available, the green VDC ON LED is on. While monitoring output voltage at the front panel test points, the Output Voltage Adjust trimmer allows adjustment of the output voltage.

