

# OPERATOR'S MANUAL

## FPD 5-10-24W POWER SUPPLY

**Flat Pack Single Output Wide Range Input DC to DC Converter  
50 Watts Output  
24 Vdc Nominal Input**

KEPCO INC.  
An ISO 9001 Company.

## MODEL FPD 15-6.6-24 POWER SUPPLY

### IMPORTANT NOTES:

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

MODEL	SERIAL NO.	REV. NO.
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- 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 Operator's 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.
- 3) The contents of this manual are protected by copyright. Reproduction of any part can be made only with the specific written permission of Kepco, Inc.

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P/N 243-0780



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**FLAT PACK  
Wide Range Input  
Single Output  
DC to DC Converter**

**I INTRODUCTION:**

**SCOPE OF MANUAL:** This instruction brief contains information for the installation and operation of the Kepco FPD 5-10-24W DC to DC Converter, a switching power supply. For further operating and service information for the FPD 5-10-24W DC to DC Converter contact your Kepco Representative directly, or write to Kepco, Inc., 131-38 Sanford Avenue, Flushing, New York 11352 U.S.A.

**DESCRIPTION:** The Kepco FPD 5-10-24W DC to DC Converter is a switching power supply, having a nominal 24 Vdc input, a wide range input of 18-36 Volts and a 5 Volt DC output voltage, rated as listed in Section II. The Power Supply is a low-dissipative stabilizer, using pulse-width modulation to control the output. The unit features input/output isolation and remote ON/OFF. Remote ON/OFF is accomplished by an isolated TTL level signal that may use either mechanical or solid state closure for turn-ON. The Power Supply is guaranteed for one year when operated within the specifications given herein.

**II MODEL:**

The following specifications apply to the power supply model listed below:

MODEL	INPUT	OUTPUT
FPD 5-10-24W	24 VDC	5 VDC 10A

**NOTE:** Normal conditions are nominal input, nominal output, and 25 degrees C.

**III SPECIFICATIONS:**

Nominal Input Voltage:	24 Vdc
Input Voltage Range:	18-36 Vdc
Input Current:	2.9A Typical, 3.7A Maximum at 24 Vdc Input
Brownout Voltage:	16 Vdc
Efficiency:	80 percent Typical
Switching Frequency:	450 kHz Typical
Circuit Type:	Forward Converter
Soft Start Circuit:	None
Input Fuse:	Recommended: 6.3 to 10 Amps.

#### IV OUTPUT SPECIFICATIONS:

MODEL	FPD 5-10-24W
Output Voltage Nominal	5V
Output Current Nominal	10A
Output Power Maximum	50W
Voltage Adjustment Range	4.5~5.5V
Ripple, Maximum - 0-70 Degrees C; 10-100 % Load	150mV p-p
Noise, DC to 50 MHz, Maximum; 0-70 Degrees C 10-100% Load	250mV p-p
Overcurrent Setting - Square Wave Characteristic <sup>(1)</sup>	10.3~ 13.5A
Overvoltage Setting - Shut Down Characteristic <sup>(2)</sup>	5.5~ 6.9V

Source Effect	1% Typical — 2% Maximum (18-36 Input)
Load Effect	1% Typical — 2% Maximum (10-100% Load)
Temperature Effect	1% Typical — 2% Maximum (0-70 Degrees C)
Combined Effect	3% Typical — 6% Maximum (Source, Load, Temperature)
Time Effect	0.1% Typical — 2% Maximum (0.5~8 Hours at 25 Degrees C)
Recovery Characteristics 50 to 100% Load Change	Less Than ± 4 Percent Excursion . Recovery to within 1 percent in less than 1ms (tr, tf of load change ≥ 50 μs at 24V Input (See Figure 1)

- (1) Square type, recovery when problem is rectified  
 (2) Shut down type, recovery by input reclosing

#### V GENERAL SPECIFICATIONS

SPECIFICATIONS		CONDITIONS
Temperature	Operating 0~70 Degrees C Storage - 40 ~ 105 Degrees C	See Figures 2A, 2B, 2C and 2D
Humidity	Operating and Storage: 5 ~ 95 percent RH	Wet bulb temperature < 35 Degrees C - Non- Condensing
Vibration	5 ~ 10Hz — 10mm Amplitude 10 ~ 55Hz — 5G Acceleration	Non-Operating 1 Hour on each of 3 axes
Shock	50 G 11± 5 ms Pulse Duration	Non-Operating, 1/2 Sine Pulse - 3 Shocks each axis
Withstand Voltage	Input-Output: 500 Vdc 1 minute Input-Ground: 500 Vdc 1 minute	
Isolation Resistance	Output-Ground: > 100M ohm, 500 Vdc	at 25 Degrees C 65 percent RH
Dimensions	4.53 (115) x 2.28 (58.0) x 0.52 (13.2)	See Mechanical Outline and Terminal Location Drawings, Figure 3A & 3B
Weight	5.29 oz. (150 grams) Maximum	
Cover Material	Plastic (UL94V-0) With Aluminum Base	

## VI REMOTE ON/OFF:

The following input signals applied to the RC terminal, control the output voltage.

REMOTE CONTROL INPUT SIGNAL	POWER SUPPLY OUTPUT
TTL H Level 2.4 ~ 5.0V or Open between RC and COM	ON
TTL L Level 0 ~ 0.4V or short between RC and COM (source current 1 ma max.)	OFF

For Remote ON/OFF control, an optical-coupler circuit (see Figure 4) is suggested. This precaution is necessary since the ON/OFF circuit is connected to the primary side of the DC to DC Converter. The RC terminals should be open when not in use, as the voltage across the terminals is maintained at 5 Volts by the Power Supply. The rise time and fall time of the RC terminal input waveform is 2 msec. maximum.

Other Remote ON/OFF circuit configurations that do not have photocoupler or relay isolation are not recommended since they may short out parts of the FPD Power Supply EMI input filter. In some of these circuits large currents may return along the (-) input terminal via the common terminal (COM) of the external RC control circuit (when the Power Supply input terminal is open), thereby causing damage to the FPD PC Board.

## VII REMOTE SENSE:

Two terminals are provided for remote error sensing (see Figure 5). Remote error sensing can compensate for load wire voltage drops of up to 0.25V per wire for the Power Supply. The unit will **NOT** operate if there are no connections between the sense and output terminals. Connections must be made at the load or at the Power Supply terminals. To reduce the influence of noise, shielded or twisted wire is suggested for remote sensing applications.

**NOTE:** If long sense wires are used it is recommended to place a 0.1 $\mu$ F (or more) electrolytic capacitor between the (+) and (+S) terminals and between the (-) and (-S) terminals to reduce possible oscillations of the output voltage. This step will also prevent the false triggering of the over-voltage or over-current protection circuits. If using electrolytic capacitors, observe the polarity markings. When not in use, keep the Remote Sensing terminals shorted to their respective output terminals, (+S) to (+) and (-S) to (-) terminals.

If there is no short circuit connection between these terminals (when not in use) the output voltage may rise and cause the over-voltage protection circuit to be activated.

## VIII OUTPUT VOLTAGE CONTROL

Terminals (RV1) and (RV2) are provided for the addition of fixed and trimmer resistors to permit control of the output voltage within the published specifications. Output

OUTPUT VOLTAGE	5V
TRIMMER RESISTOR	10K
FIXED RESISTOR	1K

voltage adjustment can be achieved up to 10% of rated output voltage. Maximum current is the rated current and maximum power is the rated power (see Figure 6).

**NOTE:** For a fixed output voltage do not connect any resistors to the (RV1) and (RV2) terminals.

## **IX CONNECTIONS FOR LINE INDUCTANCE**

When the DC to DC Converter is turned ON, extra oscillations may be observed at the output because of the presence of line inductance on the input lines. This same effect can also occur when the input line is controlled (ON/OFF) by a relay, and the input voltage exceeds the maximum specified level. For these situations, it is recommended to place a 120 $\mu$ F capacitor across the input lines and as close as possible to the input terminals of the FPD unit. The capacitor must be selected according to the maximum ripple current specifications, in view of the possibility that (depending on the input line conditions of the DC to DC Converter) relatively large ripple currents may be flowing through the capacitor. However, if it turns out that the ripple current level is beyond the specification, it is suggested to place a film capacitor in parallel with the electrolytic capacitor; or to place an input inductor between the electrolytic capacitor and the input terminals to the Power Supply (see Figures 7 and 8).

## **X FOR SINGLE POWER SUPPLY OPERATION**

For single power supply operation connect the Overcurrent Sense terminal (OC1) to the Common terminal (COM) (see Figure 9) – In this configuration, the maximum output current and power is delivered to the load: Keep this jumper as short as possible.

## **XI PARALLEL OPERATION**

Parallel operation is available to increase the output current. For parallel operation open the connection between the Common terminal (COM) and the Overcurrent Sense terminal (OC1) (see Figure 10). The output power of each power supply will then be 80 percent of the maximum rated power. To get a balanced output current from each power supply (in parallel operation) the user must check to ensure that the difference in output voltages are limited to 1.0 percent of maximum for each power supply, (this can be achieved via a terminating resistor).

The user should be aware of the possibility of mutual interference between FPD units, and of it contributing to the improper operation of each Power Supply. Keep the winding impedance as low as possible between each Power Supply and load.

## **XII SERIES OPERATION**

Series operation is available to increase the output voltage. In series operation the output current is limited to the power supply with the lowest rated current (See Figure 11).

To prevent damage resulting from a reverse biased voltage being applied to the FPD output terminals, place a diode across the output terminals of each DC to DC Converter. The rated current of the diode should be double the rated current, and the rated voltage of the diode should be double the rated voltage; present at the FPD output terminals (the forward voltage of the diode should be as low as possible).

## **XIII POLARITY OF INPUT POWER**

The power supply has no built-in protection circuit against reverse connection of the (+) and (-) input terminals. The following circuit is recommended (with a diode and fuse on

the input terminals) for protection against a reverse polarity connection (see Figure 12). The rated current of the diode should be two or three times that of the fuse due to the blow specification of the fuse.

#### **XIV CONNECTION OF OTHER TERMINALS**

The (OC2) terminal and the GATE terminal must remain open. Do not connect any signals to these terminals. If signals are connected to these terminals the power supply will not work correctly and may be subject to electrical damage.

#### **XV AVOID EXTRA OSCILLATIONS**

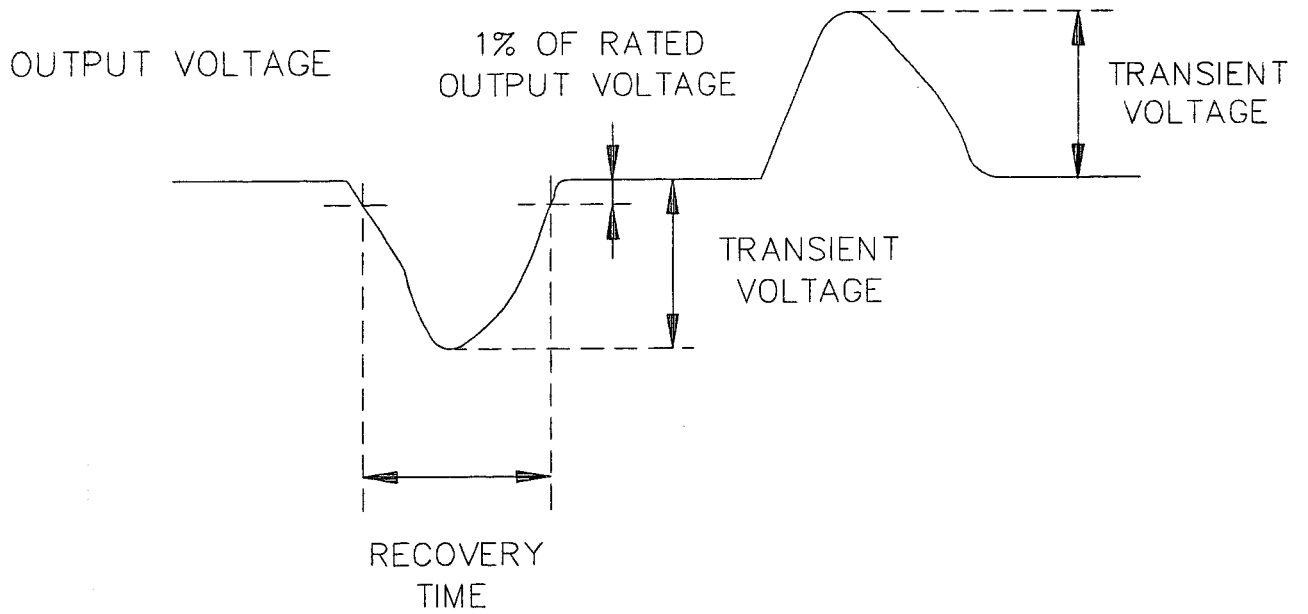
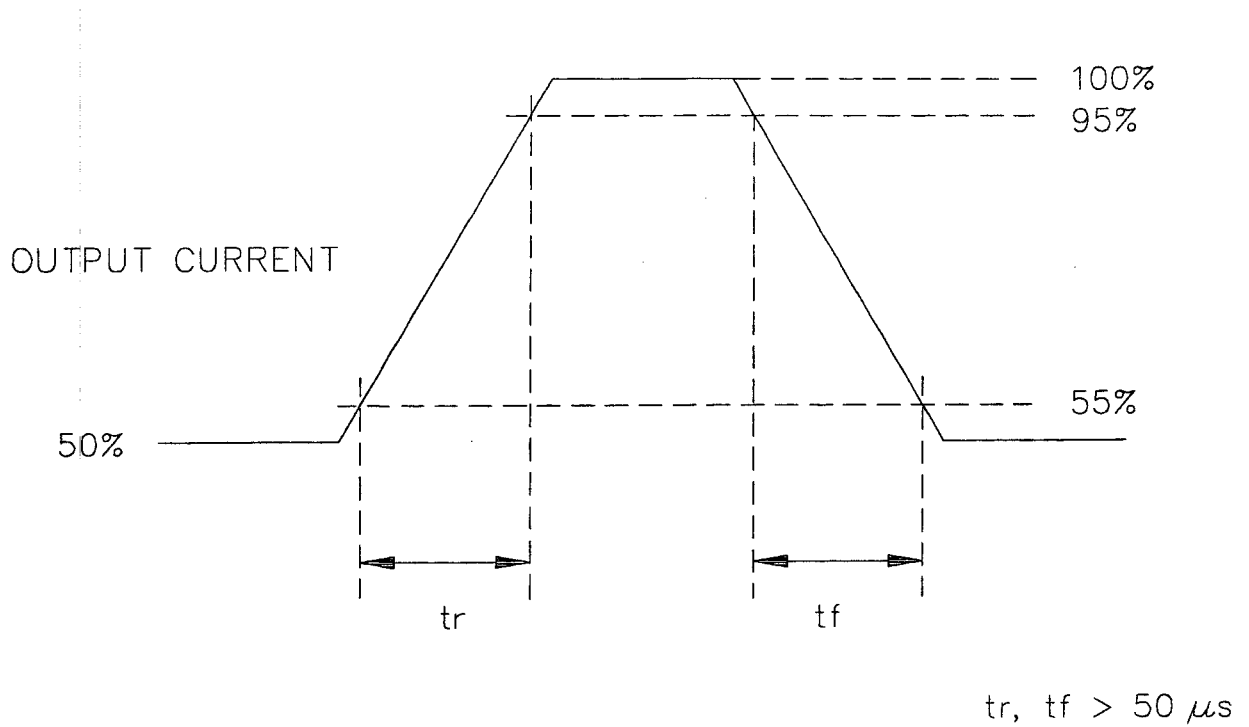
If the input or output cables to the power supply are too long, the output voltage waveforms may show extra oscillations attributable to line inductance or noise.

In that case, placing a 100 $\mu$ F (to 470  $\mu$ F) capacitor between the input terminals or between the output terminals (or at both sets of terminals) will reduce the oscillations.

#### **XVI HEAT SINKS**

Kepeco recommends the use of a Heat Sink Model FIN 50 with the FPD 5-10-24W Power Supply. The performance of the Power Supply is improved with a heat sink (see Figures 2A and 2B, and 2c).

# OUTPUT CHARACTERISTIC

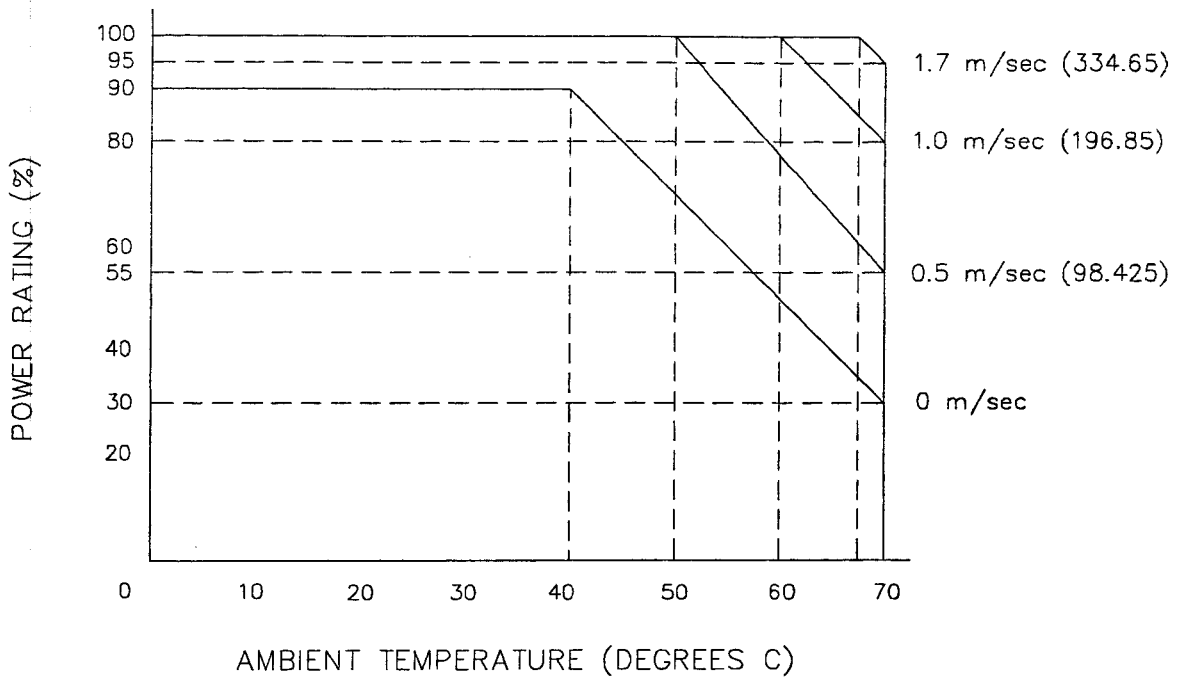


**FIGURE 1 THE RECOVERY CHARACTERISTICS OF THE FPD 50W-24W POWER SUPPLY**

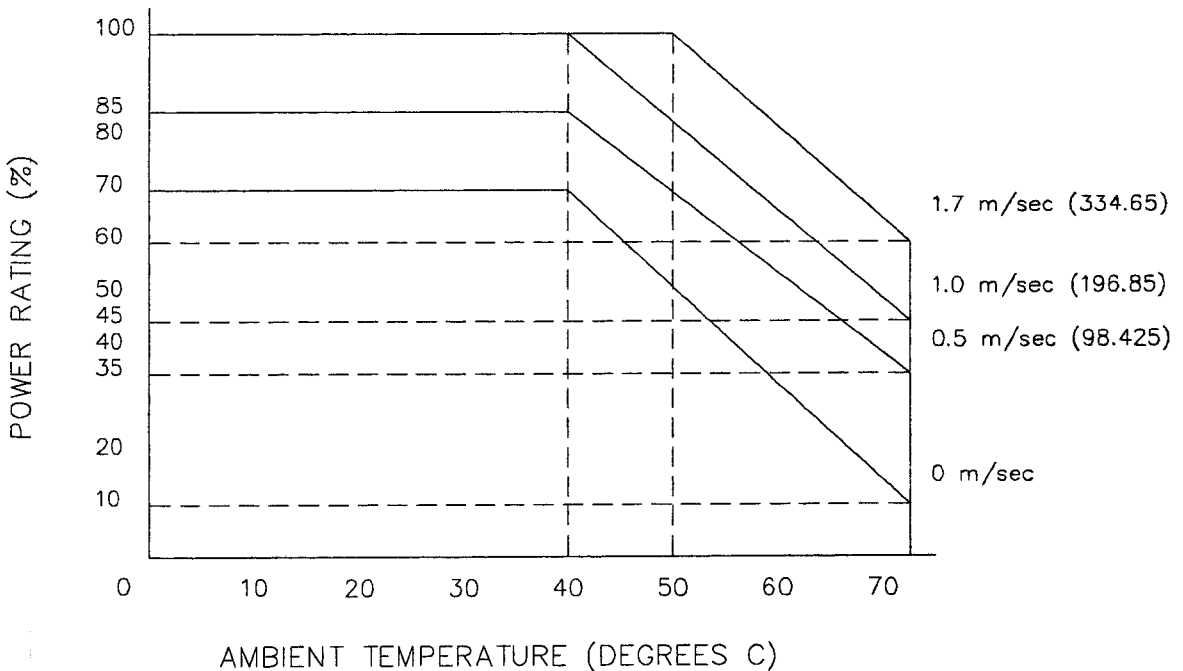
**NOTE:** To further reduce the transient voltage place a capacitor between the (+) and (-) output terminals of the power supply, preferably close to the load.



WITH KEPKO RECOMMENDED HEAT SINK P/N 536-0069



WITHOUT HEAT SINK



**FIGURE 2A (TOP) PERCENT OUTPUT POWER RATING VERSUS AMBIENT TEMPERATURE DEGREES C FOR THE FPD 50W-24W DC TO DC CONVERTER WITH HEAT SINK**

**NOTE:** The maximum temperature on the power supply base plate (aluminum plate) is 85°C. Dimensions in parentheses are in linear ft/min.

**FIGURE 2B (BOTTOM) PERCENT OUTPUT POWER RATING VERSUS AMBIENT TEMPERATURE DEGREES C FOR FPD 50W-24W DC TO DC CONVERTER WITHOUT HEAT SINK**

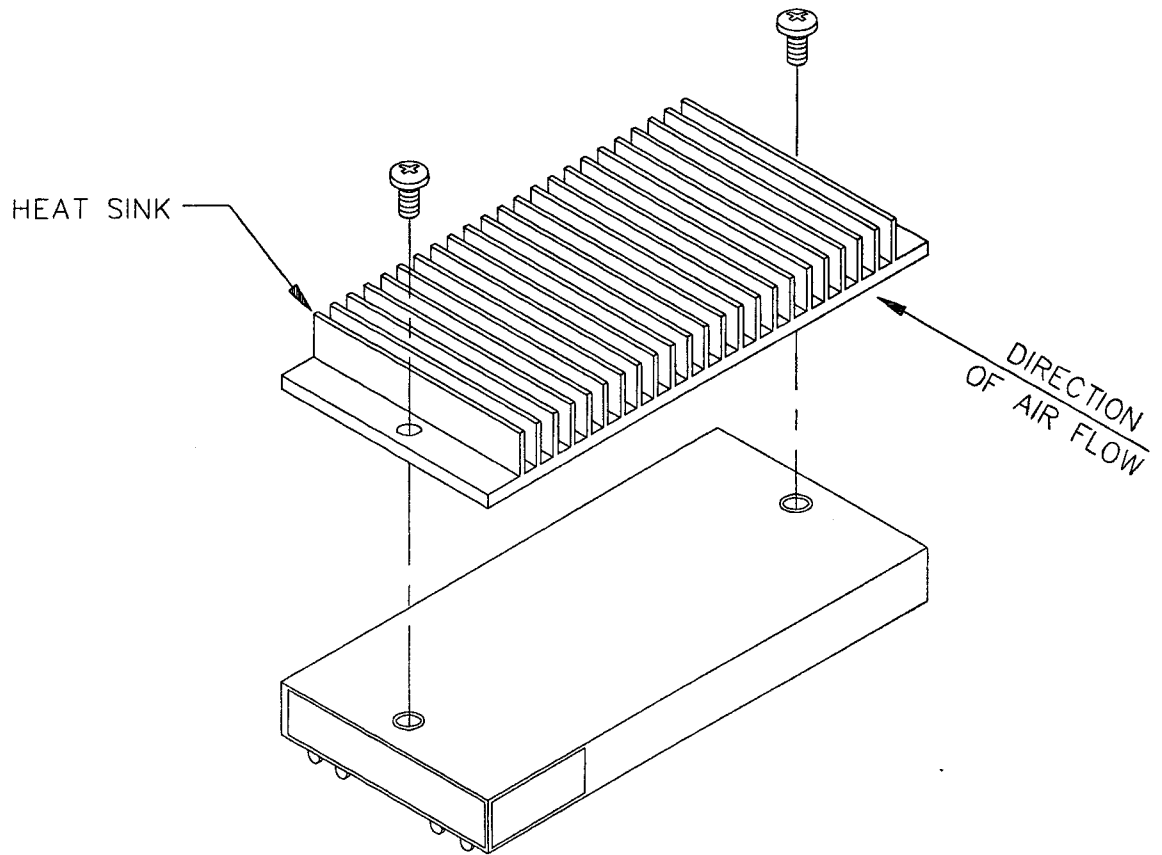


FIGURE 2C HEAT SINK FOR MOUNTING OF THE FPD 50W-24W DC TO DC CONVERTER

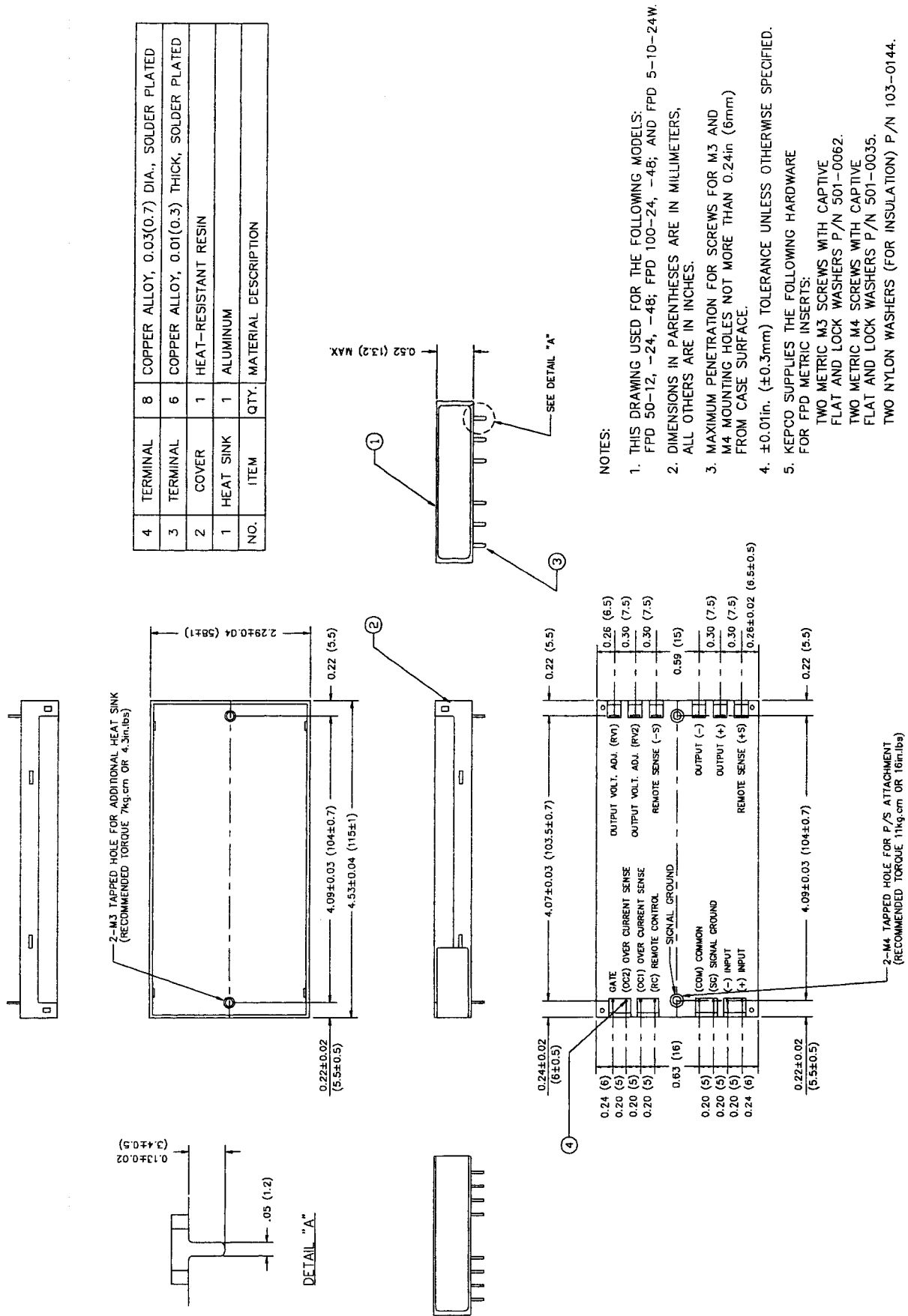
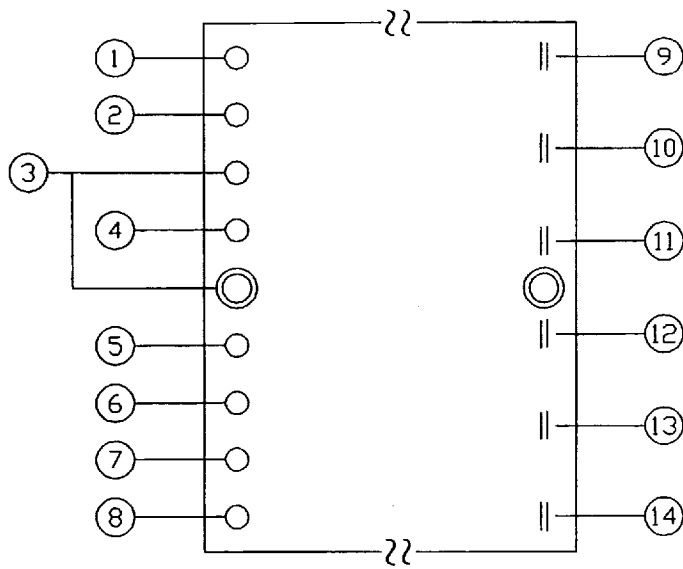
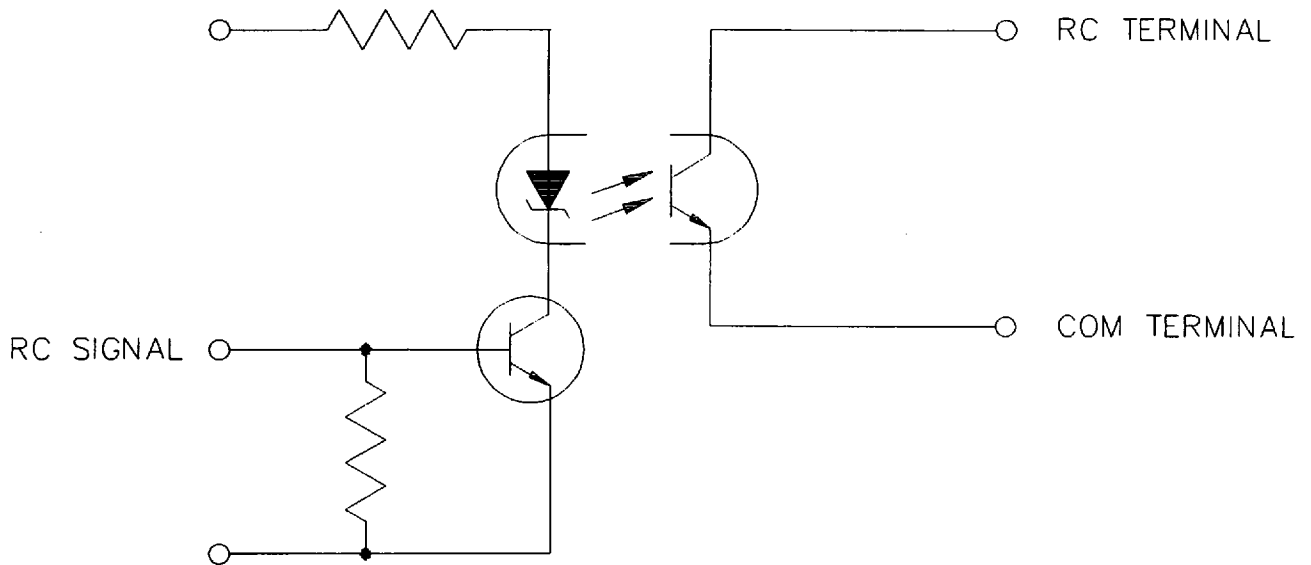


FIGURE 3A MECHANICAL OUTLINE DRAWING OF THE FPD 50W-24W DC TO DC CONVERTER



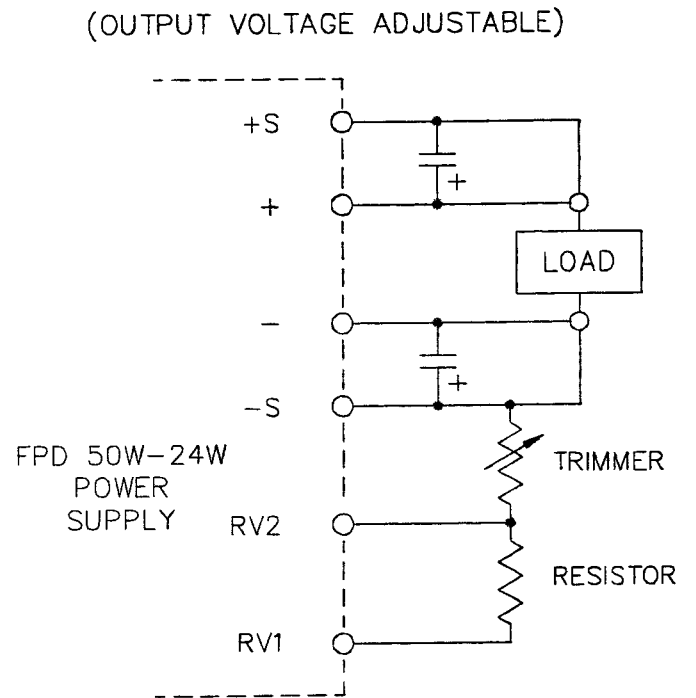
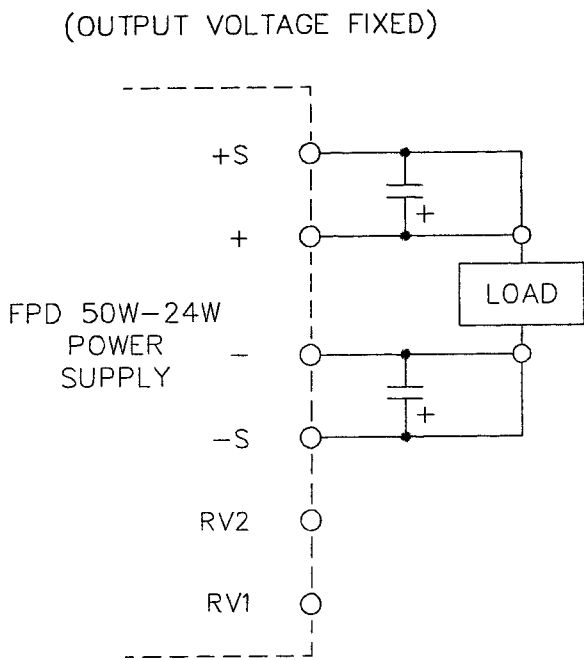
ALUMINUM PLATE SIDE (TOP VIEW)

- ① INPUT (+)
- ② INPUT (-)
- ③ SIGNAL GROUND (SG)
- ④ COMMON (COM)
- ⑤ REMOTE CONTROL (RC)
- ⑥ OVER-CURRENT SENSE (OC1)
- ⑦ OVER-CURRENT SENSE (OC2)
- ⑧ GATE
- ⑨ REMOTE SENSE (+S)
- ⑩ OUTPUT (+)
- ⑪ OUTPUT (-)
- ⑫ REMOTE SENSE (-S)
- ⑬ OUTPUT VOLTAGE ADJUST (RV2)
- ⑭ OUTPUT VOLTAGE ADJUST (RV1)



**FIGURE 3B (TOP) TERMINAL LOCATIONS OF THE FPD 50W-24 DC TO DC CONVERTER, ALUMINUM PLATE SIDE (TOPVIEW)**

**FIGURE 4 (BOTTOM) RECOMMENDED REMOTE ON/OFF INPUT CIRCUIT TO THE RC TERMINAL OF THE FPD 50W-24W POWER SUPPLY**



**FIGURE 5 (LEFT) THE FPD 50W-24W DC TO DC CONVERTER WITH REMOTE SENSING AND FIXED OUTPUT VOLTAGE**

**FIGURE 6 (RIGHT) THE FPD 50W-24W DC TO DC CONVERTER WITH ADJUSTABLE OUTPUT VOLTAGE**

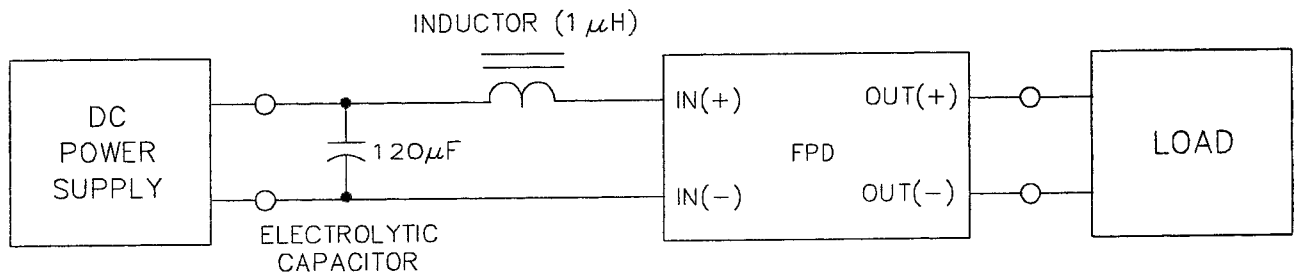
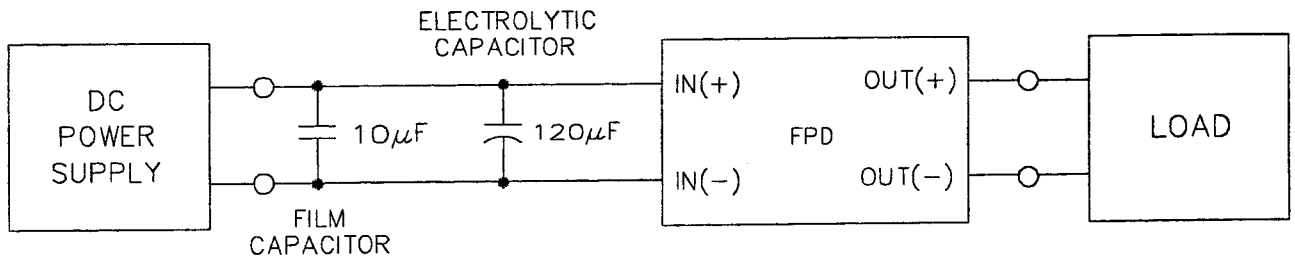


FIGURE 7 (TOP) ELECTROLYTIC AND/OR FILM CAPACITOR CONNECTION TO REDUCE RIPPLE FROM THE FPD 50W-24W POWER SUPPLY

FIGURE 8 (BOTTOM) INDUCTOR CONNECTION TO REDUCE RIPPLE FROM THE FPD 50W-24W

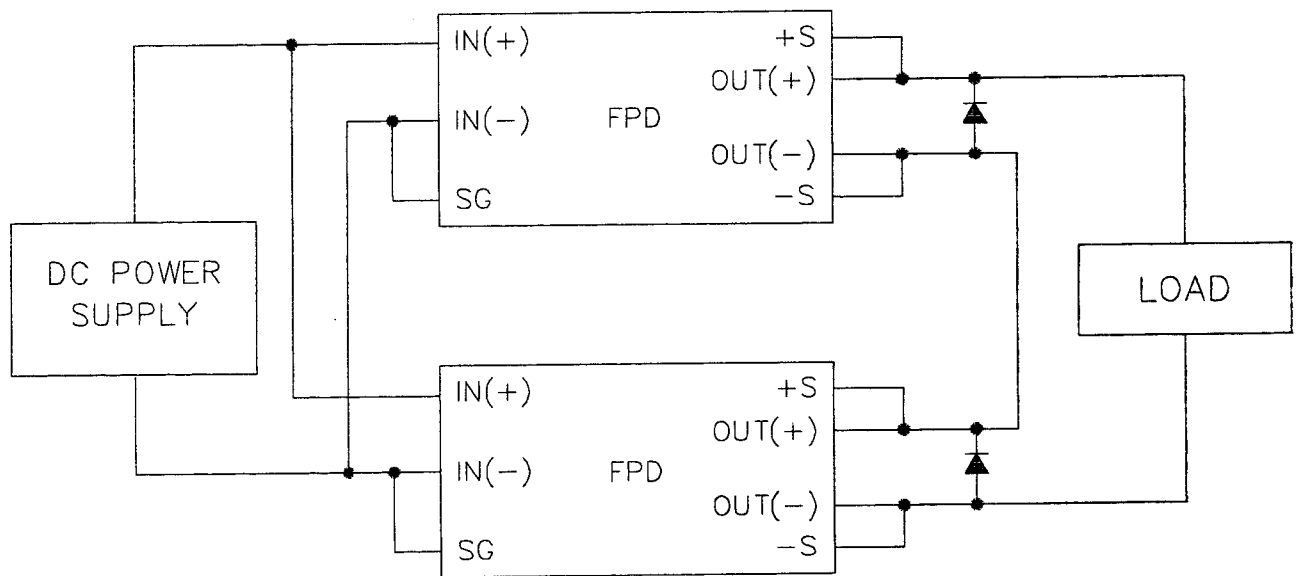
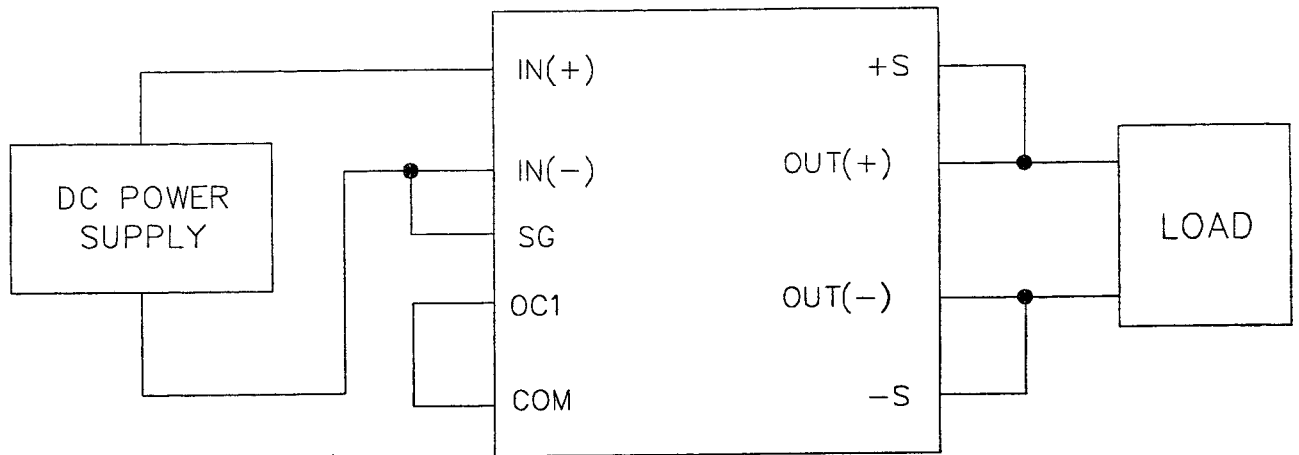


FIGURE 9 (TOP) CONNECTION FOR SINGLE FPD 50W-24W POWER SUPPLY OPERATION

FIGURE 10 (BOTTOM) CONNECTION FOR PARALLEL OPERATION OF THE FPD 50W-24W POWER SUPPLY

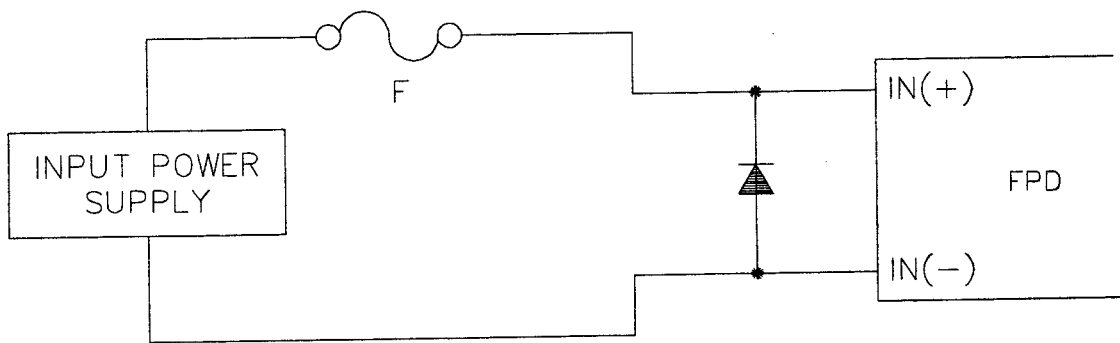
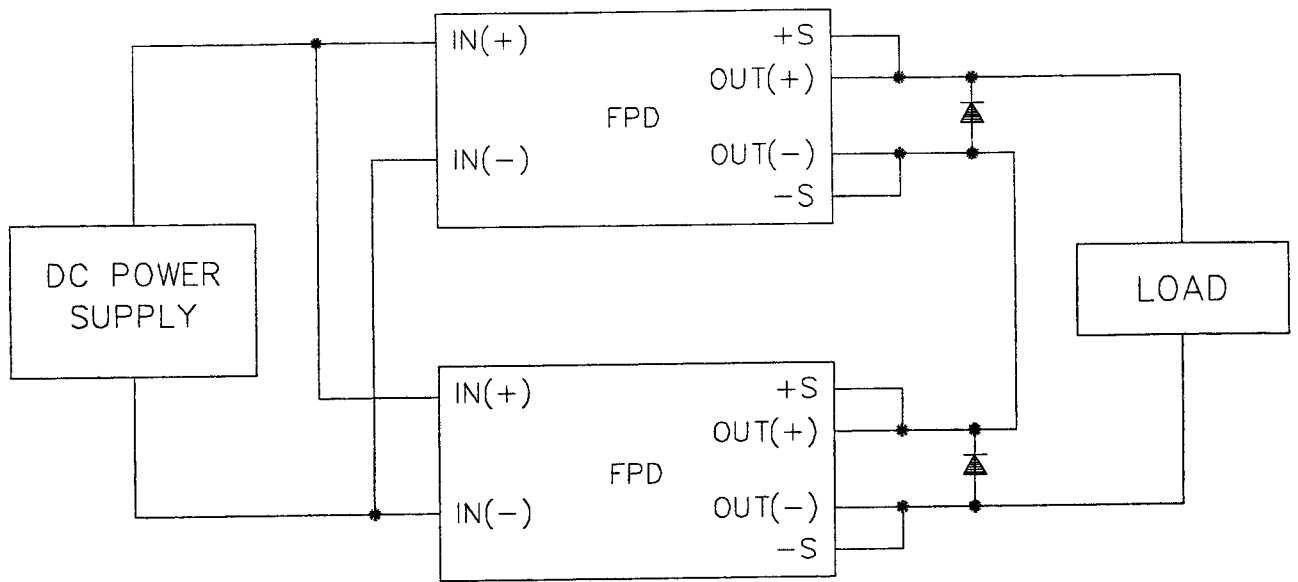


FIGURE 11 (TOP) CONNECTION FOR SERIES OPERATION OF THE FPD 50W-24W POWER SUPPLY

FIGURE 12 (BOTTOM) PROTECTION CIRCUIT FOR A REVERSE POLARITY CONNECTION TO THE FPD 50W-24W POWER SUPPLY







You must register your product to comply with the terms of the warranty. Either fill out the form below and mail or fax to Kepco, or for rapid on-line registration go to:

<http://www.kepcopower.com/warranty.htm>

**PRODUCT PURCHASED:**

Model Number) \_\_\_\_\_  
Serial Number \_\_\_\_\_

**PURCHASE INFORMATION:**

Date Purchased: \_\_\_\_\_  
Date Received: \_\_\_\_\_

**REQUEST ADDITIONAL INFORMATION**

- Send complete Catalog
- Have Sales Engineer Call
- Contact via:  E-Mail  Telephone  Fax  S-mail

**REGISTER TO:**

Registered by: \_\_\_\_\_  
Company Name: \_\_\_\_\_  
Street: \_\_\_\_\_  
City: \_\_\_\_\_  
State: \_\_\_\_\_  
Country: \_\_\_\_\_  
Zip: \_\_\_\_\_  
E-mail: \_\_\_\_\_  
FAX: \_\_\_\_\_  
Phone: \_\_\_\_\_

**WHAT INFLUENCED YOUR CHOICE OF THIS POWER SUPPLY?**

- Previous Experience (which Kepco Models do you have?)  
\_\_\_\_\_  
\_\_\_\_\_
- Magazines (which ones?) \_\_\_\_\_  
\_\_\_\_\_
- Trade Shows (which ones?) \_\_\_\_\_
- Directory? \_\_\_\_\_

- Kepco Catalog or Brochure? \_\_\_\_\_
- Sales Representative?
- Web Site
- Other (please explain): \_\_\_\_\_

What products would you like to see Kepco make?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

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## *Kepco 1 Year Warranty*

This is to certify that we, KEPSCO, INC., (hereinafter called "Company"), Flushing, NY 11355 USA, warrants for a period of ONE YEAR, this instrument known as:

MODEL: \_\_\_\_\_

SERIAL NO. \_\_\_\_\_

The Company's products are warranted for a period of one year from date of delivery to be free from defects in materials and workmanship and to conform to the specifications furnished or approved by the Company. Liability under this warranty shall be limited to the repair or replacement of any defective product at Company's option.

If any defect within this warranty appears within the warranty period, the Purchaser shall promptly notify the Company in writing. No material will be accepted for repair or replacement without written authorization of the Company.

Upon such authorization, and in accordance with instructions of the Company, parts or materials for which replacement is requested shall be returned to the Company for examination, with shipping charges prepaid by the Purchaser. Final determination as to whether a product is actually defective rests with the Company.

This warranty does not extend to any product which has been subjected to misuse, neglect, accident, improper installation, or use in violation of instructions furnished by the Company. The warranty does not extend to, or apply to, any unit which has been repaired or altered outside of the Company's factory by persons not expressly approved by the Company.

THE WARRANTY HEREIN CONTAINED IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, INCLUDING WITHOUT LIMITATION THE WARRANTY OF MERCHANTABILITY.

**THIS KEPSCO PRODUCT IS WARRANTED FOR ONE YEAR!**

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