

GENERAL SAFETY INSTRUCTIONS.....	2
1. Timing Sequence.....	4
2. Output Voltage Adjustment Range.....	4
3. Ripple and Noise.....	5
4. Maximum Line Regulation.....	6
5. Maximum Load Regulation.....	6
6. Over Current Protection (OCP).....	6
7. Over Voltage Protection (OVP).....	7
8. Over Temperature Protection (OTP).....	7
9. Remote Sensing (+S, -S terminals).....	7
10. ON/OFF Control.....	8
11. Parallel Operation (PS terminal).....	9
11a. Parallel for Non-Redundant Operation.....	10
11b. Parallel for Redundant Operation:.....	11
12. Series Operation.....	12
13. Power ON Signal (ENA terminal).....	13
14. AC Good Signal (AC_OK terminal).....	13
15. Power OK Signal (PWR_OK terminal).....	13
16. Voltage Share Signal (VSH terminal).....	13
17. Over temperature Warning Signal (OTW terminal).....	13
18. Auxiliary Power Supply.....	14
19. Operating Temperature Range.....	15
20. Withstand Voltage.....	21
21. Insulation Resistance.....	23
22. Connection Details.....	24
23. Safety Approvals.....	25
24. EMC & Immunity.....	25
25. Fault Finding.....	25
26. Connector Locations.....	25
28. Mechanical Drawing.....	32
29. Baseplate Temperature Measurement Point.....	34
30. Heat Sink Selection.....	34

GENERAL SAFETY INSTRUCTIONS

High Voltage Warning

Dangerous voltages are present within the power supply.

Critical Components

This product is not authorized for use as a critical component in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the Engineering Director of TDK-Lambda Americas.

Servicing

This product is not customer serviceable.

Unit repairs shall only be carried out by TDK- Lambda Americas or their Authorized agents.

Contact: TDK-Lambda Americas
401 Mile of Cars Way, Suite 125
National City, CA 91950
Tel 619-575-4400
Fax 619-575-7185

Safety Class of Protection

The unit is designed for the following parameters: Material Group IIIb, Pollution Degree 2, Overvoltage Category II, Class I (earthed), Indoor use. The unit is considered as fixed and rated IPX0. The CPFE1000FI-12 and CPFE1000FI-28 are classed as having SELV outputs. The CPFE1000FI-48 is classed as having a NON SELV output. All outputs are capable of providing hazardous energy (>240VA). The final equipment should provide protection to service personnel against inadvertent contact with the PSU output terminals.

Installation

This product is designed for use within other equipment which restricts access to Authorized competent personnel only. The unit covers/chassis must not be made user accessible.

The appliance may be mounted in any orientation. The customer has to ensure the baseplate temperature remains below certain limits.

CPFE1000FI-12, CPFE1000FI-28 & CPFE1000FI-48: Input 90V-265V baseplate temperature limited to 85°C

The mains input connector is not acceptable for use as field wiring terminals.

The appliance must be securely mounted and the baseplate properly bonded to the main protective earth contact before any connection to AC mains supply is made.

The ventilation openings must not be impeded – ensure a space at least 5cm between any obstruction and the ventilation openings.

BEFORE USING THE POWER SUPPLY UNIT

Be sure to read this instruction manual thoroughly before using this product. Pay attention to all cautions and warnings before using this product. Incorrect usage could lead to an electrical shock, damage to the unit or a fire hazard.

DANGER

- Never use this product in locations where flammable gas or ignitable substances are present.

WARNING

- Do not make unauthorized changes to power supply unit, otherwise you might have electric shock and void your warranty.
- Do not touch this unit and the internal components in operation or shortly after shut down. They might have high voltage or high temperature and as the unit dissipates its heat so the surface of the unit is hot. You might receive electric shock or burn.
- When the unit is operating, keep your hands and face away from it; you might be injured by an accident.
- Do not use unit under unusual conditions such as emission of smoke or abnormal smell and sound etc. It might cause fire and electric shock. In such case, please contact us; do not repair by yourself, as it is dangerous for the user.
- Do not drop or insert anything into unit. It might cause failure and fire.
- Do not operate these units under condensation condition. It might cause fire and electric shock.

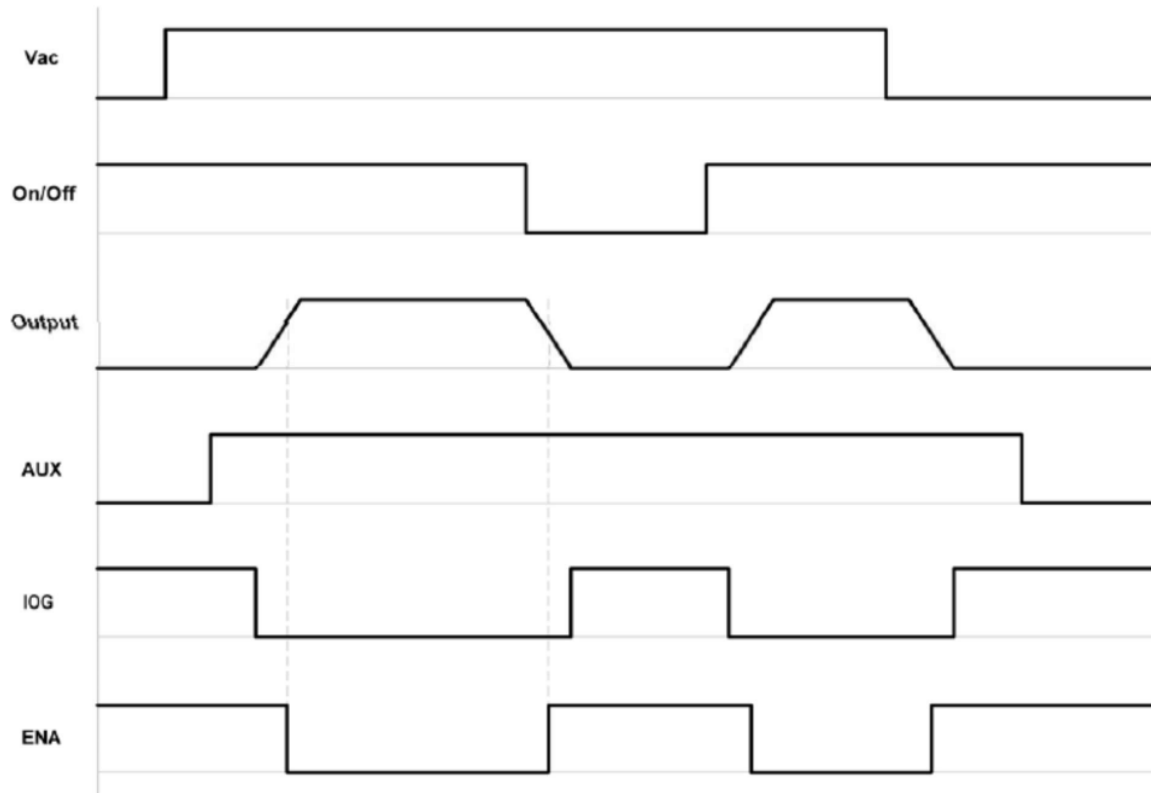
⚠ CAUTION

- As a component part, compliance with the standard will be based upon installation in the final application. This product must be installed in a restricted access location, accessible to authorized competent personnel only. These AC to DC converters have reinforced insulation between the input and the output. The outputs of these products are energy hazards. All models with an output greater than 28V model are considered to be non-SELV. As such, the instructions for use must refer to these energy hazardous outputs and Non-SELV outputs in that the outputs must not be accessible to the operator. The installer must also provide protection against inadvertent contact by a service engineer.
- The equipment has been evaluated for use in a Pollution Degree 2 environment.
- This power supply is primarily designed and manufactured to be used and enclosed in other equipment.
- Confirm connections to input/output terminals and signal terminals are correct as indicated in the instruction manual.
- Input voltage, Output current, Output power, ambient temperature and ambient humidity should be used within specifications, otherwise the unit will be damaged.
- For application equipment, which requires very high reliability (Nuclear related equipment, traffic control equipment, medical equipment, etc.), please provide fail safety function in the equipment.
- Do not use the product in environment with strong electromagnetic field, corrosive gas and conductive substance.
- Do not operate and store this unit at an environment where condensation occurs. In such case, waterproof treatment is necessary
- Never operate the unit under over current or shorted conditions for 30 seconds or more and out of Input Voltage Range as specification. Insulation failure, smoking, burning or other damage might occur to the unit.
- The output voltage of this power supply unit is considered to be a hazardous energy level (The voltage is 2V or more and the electric power is 240VA or more). Prevention from direct contact with output terminal is highly necessary. While installing or servicing this power supply unit, avoid dropping tools by mistake or direct contact with output terminal. This might cause an electrical shock. While repairing this power supply unit, the AC input power must be switched off and the input and output voltage should be level.
- To maintain the SELV output for outputs less than 28VDC, under fault conditions, the output must be connected to earth in the final application.
- The application circuits and their parameter are for reference only. Be sure to verify effectiveness of application circuits and their parameters before finalizing circuit design.
- Do not inject abnormal voltage to output terminal and signal terminal from the outside. The injection of reverse voltage or over voltage exceeding nominal output voltage to output terminals might cause damage to internal components.
- This information in this document is subject to change without prior notice. For actual design-in, please refer to the latest publications of data sheet, etc., for the most up-to date specifications of the unit.

CE Marking, when applied to a product or packing material for a product covered by this handbook, indicates compliance with the Low Voltage Directive and RoHS Directive.

UKCA Marking, when applied to a product or packing material for a product covered by this handbook, indicates compliance with the Electrical Equipment (Safety) Regulations and Restriction of the Use of Certain Hazardous Substances in Electrical & Electronic Equipment Regulations.

1. Timing Sequence



Note: IOG is an internal factory measurement test point that is not accessible to the user.

When recovering from any fault or reapplication of AC input, the output recovery may be delayed for up to 20 seconds.

2. Output Voltage Adjustment Range

Output Voltage Adjustment Range:

+/-20% of the typical voltage rating

When increasing or decreasing the output voltage, care must be taken such as not to exceed the maximum output power. If remote sensing is used, this must also be considered as not to exceed the maximum output power.

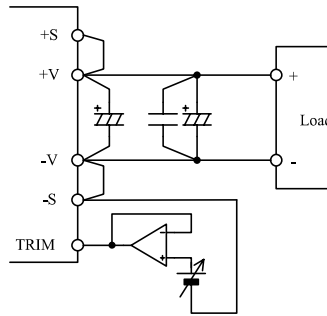
2.1 Output Voltage Adjustment by voltage adjustment potentiometer.

A multi-turn potentiometer is located between the (+) and (-) output studs. Turning the adjustment screw on the potentiometer clockwise increases the output voltage; likewise, turning the screw counter clockwise decreases the output voltage. Note: Care must be taken as not to adjust the output voltage higher than the highest voltage specified within the specified voltage range; doing so may cause the over voltage protection (OVP) circuit to activate thus immediately reducing the output voltage to zero.

2.2 Output Voltage Adjustment by applying external voltage

By applying an external voltage at the TRIM terminal, the output voltage can be adjusted within the same output voltage adjustment range of +/- 20% of the nominal output voltage. Exceeding the maximum specified output voltage will cause activation of the Over Voltage Protection (OVP) circuit.

Likewise, exceeding the minimum output voltage will cause activation of the Low Voltage Protection (LVP) circuit. The nominal output voltage is present without using the external output voltage adjustment circuit.



**Fig. 2-1 Output Voltage Adjustment
by applying external voltage**

Model	Adjustment Range	Typical External Voltage Range
CPFE1000FI-12	9.6 – 14.4V	0.65 – 1.0V
CPFE1000FI-28	22.4 – 33.6V	0.65 – 1.0V
CPFE1000FI-48	38.4 – 57.6V	0.67 – 1.0V

Note: The Trim terminal voltage must be limited to 1.00V maximum; otherwise, the over-voltage protection circuit will activate and shut down the output voltage.

3. Ripple and Noise

Ripple and Noise is measured according to the description below in accordance with JEITA RC-9131C (Sections 7.16, 7.17 and 7.18).

The measurement connection is shown in Fig. 3-1.

C1 (0.1 μ F Ceramic Capacitor), C2 (47 μ F Aluminum Electrolytic Capacitor) must be connected in parallel at 30cm from the output terminals, along the load cable. Attach a maximum 1.5m 50 Ω coaxial cable from the ceramic capacitor electrodes to a filter attachment installed on the oscilloscope. The filter attachment consists of C3 (4700pF film capacitor) in series with R (50 Ω resistor). Use 100MHz bandwidth oscilloscope or equivalent.

In general, output ripple voltage and output spike noise voltage can be reduced by increasing external capacitance.

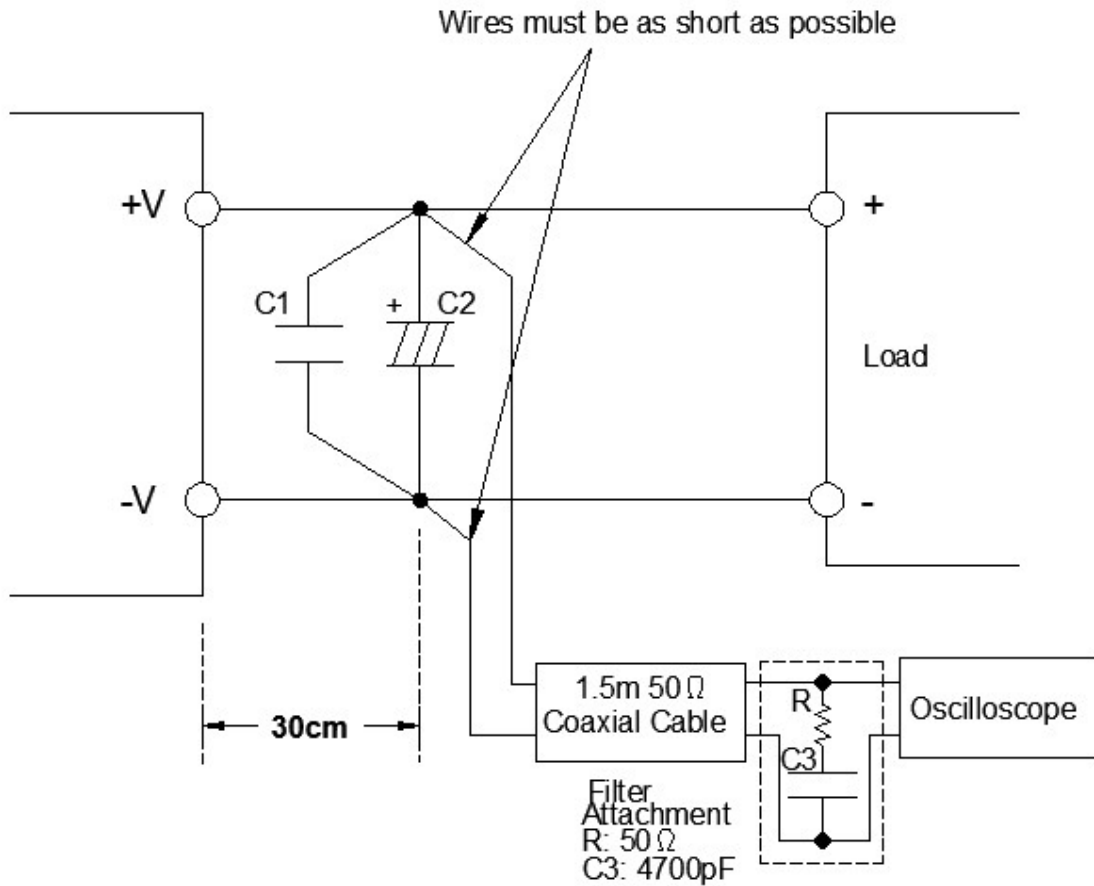


Fig. 3-1
Output Ripple Voltage (including Spike Noise)
Measurement Method

4. Maximum Line Regulation

Maximum line regulation is defined as the maximum output voltage change when the input voltage is gradually changed within the specification range.

5. Maximum Load Regulation

Maximum load regulation is defined as the maximum output voltage change when output load current is gradually changed within specification range.

6. Over Current Protection (OCP)

The CPFE1000FIxx is equipped with an OCP feature; constant current limiting. The output will enter hiccup mode when the output current is between 105 to 140% of its output current rating. OCP value is fixed and cannot be adjusted externally. The power supply is also protected from a short circuit on the output. The output voltage will recover within 20 seconds after the short is removed.

If OCP occurs while the OTW signal is HIGH, the unit will not try to recover until after the OTW signal goes LOW.

7. Over Voltage Protection (OVP)

The CPFE1000FIxx is equipped with OVP feature. The unit will shut down if the voltage on the output is between 125% and 145% of nominal output voltage.

The output voltage will recover within 20 seconds after the OVP condition is removed.

If OVP occurs while the OTW signal is HIGH, the unit will not try to recover until after the OTW signal goes LOW.

8. Over Temperature Protection (OTP)

The CPFE1000FIxx is equipped with an OTP feature. Upon detection of an over temperature condition (OTP trip point = 95°C, typical), the OTP circuit will shut down the output. The output voltage will recover after the baseplate has been allowed to cool and the OTW signal goes LOW.

The output voltage will recover within 20 seconds after the OTW signal goes LOW.

9. Remote Sensing (+S, -S terminals)

This unit has remote sensing terminals to compensate for voltage line drop from the output terminals to the output load. When remote sensing is not required, leave the sense terminals disconnected.

Note that line drop (voltage drop due to wiring) compensation voltage range must be such that the output voltage is within the output voltage adjustment range and that the voltage between -V and -S must be within 0.5V.

Consider power loss due to line drop and use this unit within the maximum allowable output power. Reduce the effect of noise induced into the remote sensing lines by using shielded lines, a twist pair, or a parallel pattern, etc.

When remote sensing lines are long, add the electrolytic capacitor as shown in Fig 9-1. (if needed)

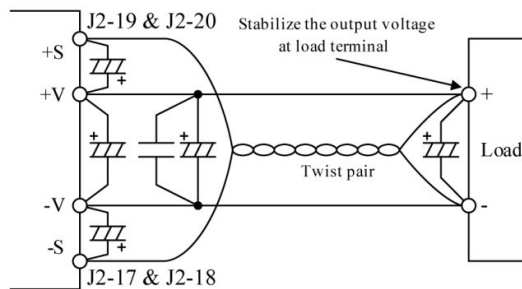


Fig. 9-1 Remote Sensing is used

10. ON/OFF Control

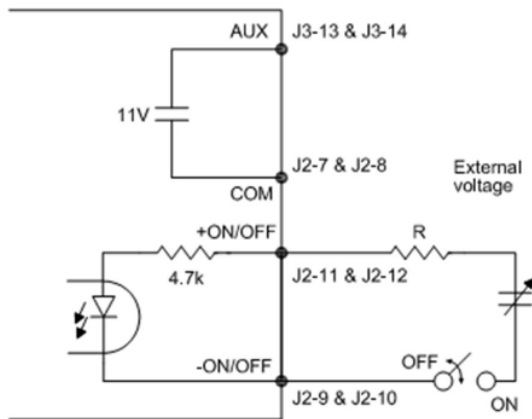
(+ON/OFF, -ON/OFF terminal)

The CPFE1000FIxx is equipped with a ON/OFF control function. Without turning the input supply on and off, the output can be enabled and disabled using this function.

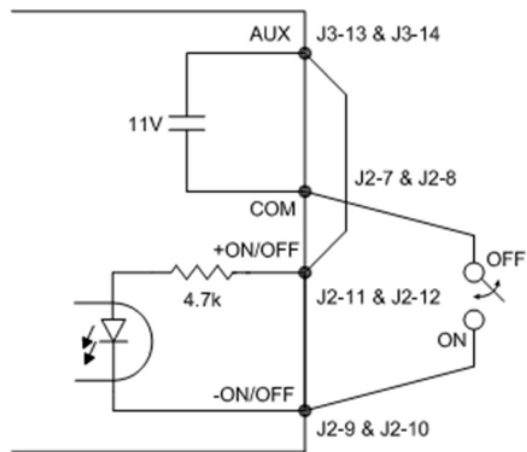
The ON/OFF control circuit is isolated from input circuit of the power supply by a photo-coupler.

The unit comes factory set for local ON/OFF control, via jumpers on the J4 connector. For external control, the J4 jumpers need to be removed.

Fig. 10-1 and Fig. 10-2 are examples of how to connect to the ON/OFF control. When the external ON/OFF control is not used, re-install jumpers onto J4 connector (J4-1 & J4-2 shorted, J4-3 & J4-4 shorted).



**Fig. 10-1 ON/OFF Control
Connection Example 1
(ON/OFF Control by External Voltage)**



**Fig. 10-2 ON/OFF Control
Connection Example 2
(ON/OFF Control by Built-in AUX)**

Select the external voltage and external resistance per the ON/OFF terminal current shown in the table below.

ON/OFF terminal current	Output Voltage
2.5mA (+/-0.5mA)	ON
Less than 0.15mA	OFF

Recommended ON/OFF Terminal Current

11. Parallel Operation (PS terminal)

By connecting the PS terminal of each CPFE1000FIxx, output current can be equally drawn from each unit. A maximum of 6 units of the same model can be connected.

Maximum output current is derated by parallel operation units as shown in Table 11-1.

Note that usage of power module at out-of-rated condition might result in power module temperature abnormal rise or damage.

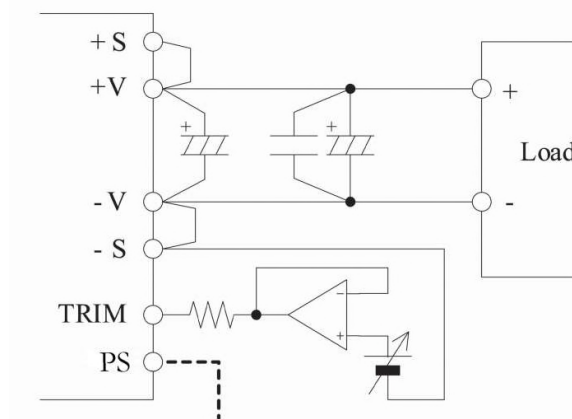
Parallel units	Maximum output current
~3 units	90% of nominal output current
4~6 units	85% of nominal output current

Table 11-1 Condition for Parallel Operation

Set the accuracy of the output voltage within +/-1% when adjust the output voltage for parallel operation.

When adjusting the output voltage by applying external voltage at the TRIM terminal, insert approximately a 10k ohm resistor between TRIM terminal and external source.

Moreover, external circuits are necessary for TRIM terminal at each individual module.



**Fig. 11-1 Output Voltage Adjustment by applying external voltage
(For parallel operation)**

Limitations of power supplies in parallel operation:

- If the power supplies are not connected for redundant operation (no oring diodes), the green LED indicator on all power supplies can be lit whenever the output common bus voltage is present and the output voltage read by the I²C bus is the voltage of the output common bus; not of the individual power supply.
- The output current reading by the I²C bus is the average value of all currents from the power supplies connected in parallel.
- Remote sense cannot compensate for the voltage drop across the oring diodes. To maximize the compensation during redundant operation, attach the oring diodes as close as possible to the point of load and attach +S to the anode of the associated oring diode (See Fig. 11-3).
- When recovering from a fault condition, the output recovery may be delayed for up to 20 seconds to allow for proper start-up.

11a. Parallel for Non-Redundant Operation

The VSH terminal of each CPFE1000FIXX should be connected together during parallel operation.

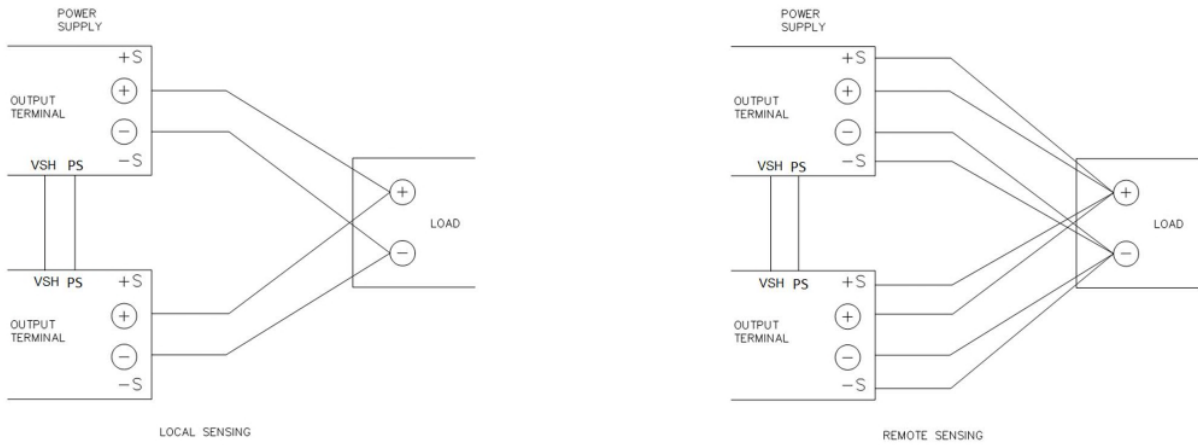


Fig. 11-2 Parallel Operation

11b. Parallel for Redundant Operation:

In cases where an end product or system cannot tolerate any downtime, a redundant power supply or system configuration should be considered. There are a number of ways to construct redundant or fault-tolerant power system. The most common method is to have at least one supply with sufficient output power to fully satisfy the system's power requirements. Then a second power supply of the exact same rating is provided as a back-up in the event one of the two supplies fails. This forms a basic N+1 redundant and fault tolerant power system. "N" equals the number of supplies required to fully power the system and "+1" equals one back-up or redundant supply that will take over for a failed supply. Parallel for redundant operation can be achieved by isolating the outputs using oring diodes. With this method the output load must not exceed the maximum load current of "N" supplies and remote sensing around these diodes is not allowed.

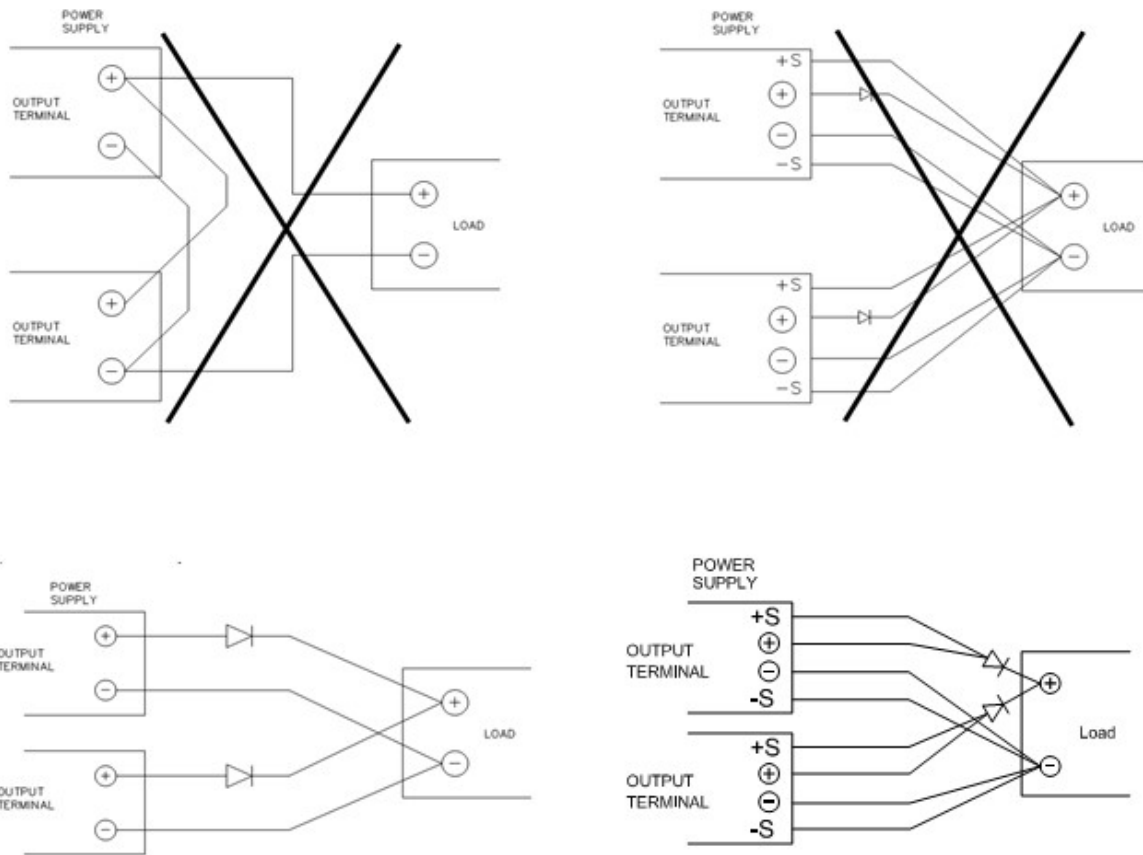


Fig. 11-3 Parallel for Redundant Operation

Limitations of power supplies in parallel operation for Redundant Operation:

- Where it is imperative that a single unit fault does not cause any downtime, it is advised that the parallel sense (PS) and Vshare (VSH) be left disconnected between units. To ensure proper startup in this mode, it is advised to power on the units before applying the load.

12. Series Operation

The output of several units can be connected in series for increased output voltage. It is recommended that diodes be connected in parallel with each unit output to prevent reverse voltage during start-up sequence or in case one of the units shuts down. Each diode should be rated to at least the power supply rated output voltage and output current. Refer to Fig. 12-1 and 12-2 for series operation with local and remote sensing.

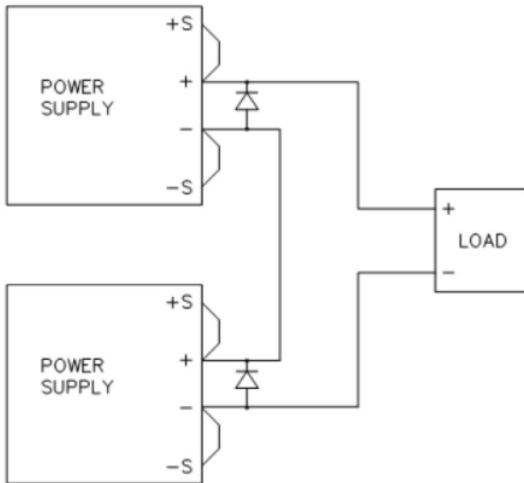


Fig. 12-1: SERIES CONNECTION, LOCAL SENSING

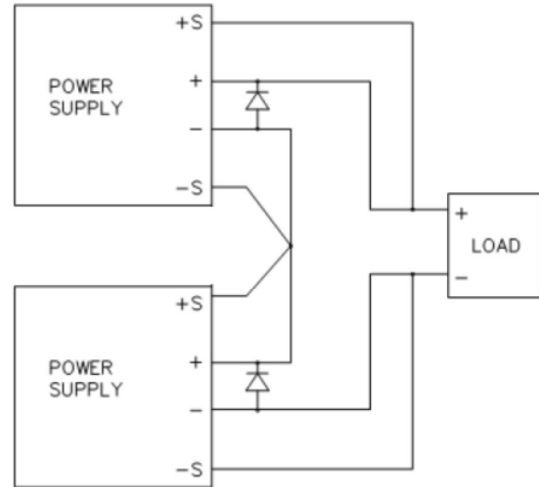


Fig. 12-2: SERIES CONNECTION, REMOTE SENSING

Limitations of power supplies in series operation:

- If the total voltage of outputs connected in series exceeds the 60Vdc SELV limit then all outputs must be considered Non-SELV.
- Non-SELV outputs are hazardous and must not be made user accessible. They must be guarded to avoid a service engineer making inadvertent contact with the output studs or dropping a metal tool onto them.
- Without galvanic isolation, the I²C can't be used with series operation because the GND pin of the I²C signal is internally connected to -V of the unit. Consult factory for operation in this mode.
- Without galvanic isolation, the signals (AUX, TRIM, OTW, PWR_OK, AC_OK & ENA) cannot be used with series operation because the COM pin is internally connected to -V of the unit. Consult factory for operation in this mode.

13. Power ON Signal (ENA terminal)

This signal is located at the secondary side (output side) and is internally connected to a 5V source via a 4.99kΩ pullup resistor. (Maximum sink current is 100mA and maximum applied voltage is 50V.)

Return line for ENA terminal is the COM terminal. When output voltage goes over a specified voltage level at start up, Power ON signal is LOW.

Output voltage threshold level above which the Power ON signal is LOW:

CPFE1000FI-12 : 8V (TYP)

CPFE1000FI-28 : 19V (TYP)

CPFE1000FI-48 : 33V (TYP)

Output voltage threshold level below which the Power ON signal is HIGH :

CPFE1000FI-12 : 6V (TYP)

CPFE1000FI-28 : 15V (TYP)

CPFE1000FI-48 : 28V (TYP)

14. AC Good Signal (AC_OK terminal)

This signal is located at the secondary side (output side) and is internally connected to a 5V source via a 4.99kΩ pullup resistor. (Maximum sink current is 100mA and maximum applied voltage is 50V.)

Return line for AC_OK terminal is the COM terminal. When sufficient AC voltage is present on the input to enable the unit to function the AC_OK signal is LOW.

15. Power OK Signal (PWR_OK terminal)

This signal is located at the secondary side (output side) and is internally connected to a 5V source via a 4.99kΩ pullup resistor.. (Maximum sink current is 100mA and maximum applied voltage is 50V.)

Return line for PWR_OK terminal is the COM terminal.

The PWR_OK signal is the logical conjunction of the ENA signal AND the AC_OK signal. The PWR_OK signal is LOW when both the ENA signal and the AC_OK signal are LOW. The PWR_OK signal is HIGH if either the ENA Signal or the AC_OK signal are HIGH.

16. Voltage Share Signal (VSH terminal)

The VSH terminal is used during parallel operation to prevent any single unit from going into current limit during start-up while under load. For proper operation, the VSH terminals from each unit should be connected together.

Entering any fault condition or removing the AC input voltage will result in the VSH signal changing.

When recovering from any condition that triggers a change in the VSH signal, the output recovery may be delayed for up to 20 seconds to allow for proper restart.

17. Over temperature Warning Signal (OTW terminal)

This signal is located at the secondary side (output side) and is internally connected to a 5V source via a 4.99kΩ pullup resistor. (Maximum sink current is 100mA and maximum applied voltage is 50V.)

Return line for OTW terminal is the COM terminal.

When the temperature of the unit increases to within approximately 20°C of the OTP limit, the OTW signal goes HIGH.

When the temperature of the unit is less than approximately 20°C below the OTP limit, the OTW signal goes LOW.

The OTW signal must go LOW before the unit will attempt to recover from an OTP condition.

If any output fault (OVP, OCP, OTP or Short Circuit) occurs while the OTW signal is HIGH, the unit will not try to recover until after the OTW signal goes LOW.

18. Auxiliary Power Supply

For external circuits (AUX terminal)

The auxiliary output voltage is within the range of 10~14VDC and has a maximum output current of 20mA. The Ground for the auxiliary output is the COM terminal. Avoid shorting the AUX terminal with any other terminal as this will damage the unit.

19. Operating Temperature Range

The CPFE1000FIxx can be mounted in any direction; however, careful consideration should be given to avoid heat accumulation around the module. Verify baseplate temperature at worst case operating condition at the measurement point as shown on page 34. The baseplate temperature must be maintained at or below 85°C on all models.

Due to the temperature limit of other components in the power supply that are not directly installed on the base plate, the ambient temperature must also be maintained at or below the maximum limits. Figure 19- 1 shows the orientation of the power supply that corresponds to the orientation listed in the derating tables. The tables below show the de-rated output power at different ambient temperatures and orientations.

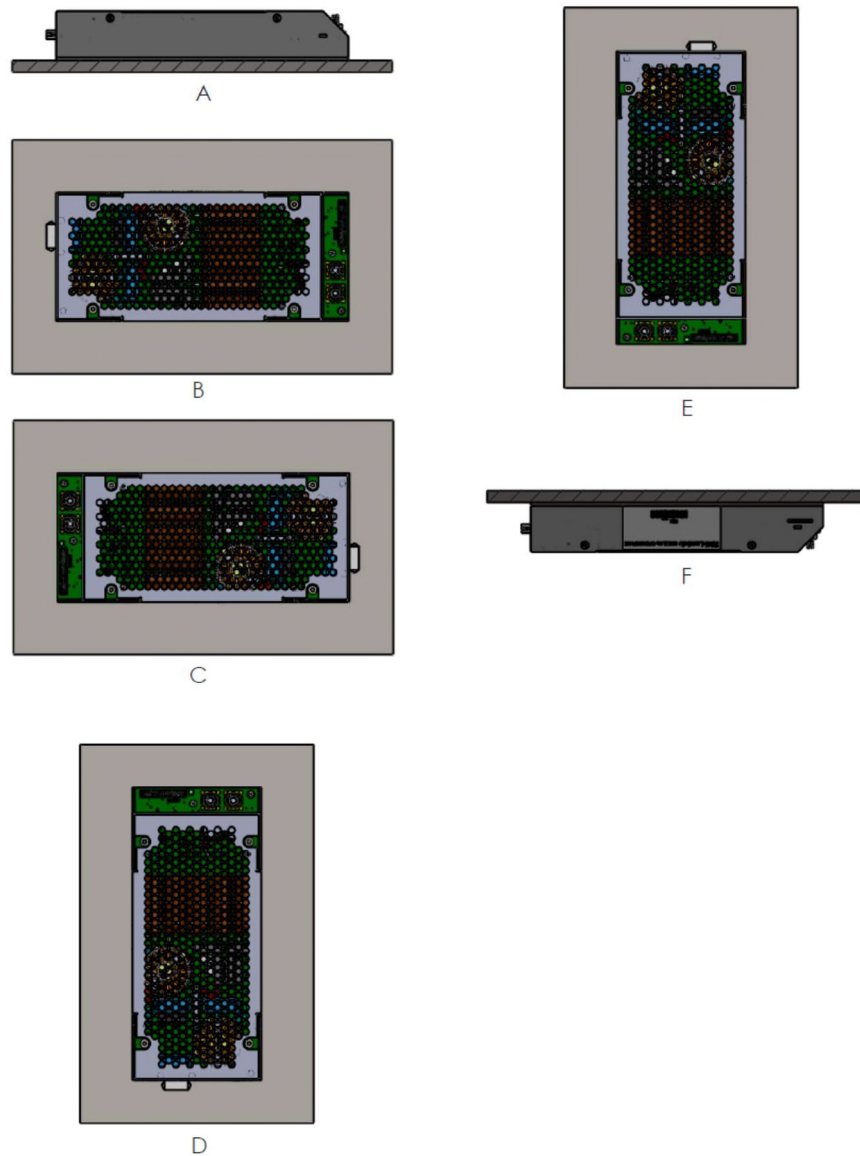


Figure 19- 1: Test Orientations of Power Supply

OUTPUT RATINGS TABLES

For Model CPFE1000FI-48 (also represents CPFE1000FI-48/P, CPFE1000FI-48/PH and CPFE1000FI-48/H)

Orientation	Output Rating (DC)				
	Voltage (V)	Current (A) @ 90-135 V ac	Power Max (W)	Current (A) @ 170-265 V ac	Power Max (W)
A	48 (38.4– 57.6)	21 @ 50°C 20 @ 60°C 18 @ 70°C	1008 @ 50°C 960 @ 60°C 864 @ 70°C	21 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
B		21 @ 45°C 20 @ 50°C 18 @ 60°C 16 @ 70°C	1008 @ 45°C 960 @ 50°C 864 @ 60°C 768 @ 70°C	21 @ 45°C, 50°C, 60°C & 70°C	1008 @ 45°C, 50°C, 60°C & 70°C
C		21 @ 50°C 20 @ 60°C 18 @ 70°C	1008 @ 50°C 960 @ 60°C 864 @ 70°C	21 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
D		21 @ 50°C 20 @ 60°C 18 @ 70°C	1008 @ 50°C 960 @ 60°C 864 @ 70°C	21 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
E		21 @ 50°C 20 @ 60°C 18 @ 70°C	1008 @ 50°C 960 @ 60°C 864 @ 70°C	21 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
F		21 @ 45°C 20 @ 50°C 19 @ 60°C 17.5 @ 70°C	1008 @ 45°C 960 @ 50°C 912 @ 60°C 840 @ 70°C	21 @ 45°C, 50°C, 60°C & 70°C	1008 @ 45°C, 50°C, 60°C & 70°C

Test orientations are as follows:

- A – Horizontal – components pointed toward the top
- B – Sideways – input connector on the left and output connector on the right
- C – Sideways – input connector on the right and output connector on the left
- D – Vertical – input connector pointed towards the bottom and output connector pointed towards the top
- E – Vertical – input connector pointed towards the top and output connector pointed towards the bottom
- F – Horizontal – components pointed toward the bottom

Note: Baseplate temperature not to exceed 85°C on all orientation.

For Model CPFE1000FI-48/C (also represents CPFE1000FI-48/CH)

Orientation	Output Rating (DC)						
	Voltage (V)	Current (A) @ 90-135 V ac	Power Max (W)	Current (A) @ 170-265 V ac	Power Max (W)		
A	48 (38.4– 57.6)	21 @ 30°C 20 @ 40°C 19 @ 50°C 18 @ 60°C 17 @ 70°C	1008 @ 30°C 960 @ 40°C 912 @ 50°C 864 @ 60°C 816 @ 70°C	21 @ 30°C, 40°C, 50°C, 60°C & 70°C	1008 @ 30°C, 40°C, 50°C, 60°C & 70°C		
B		21 @ 30°C 20 @ 40°C 19 @ 50°C 18 @ 60°C 17 @ 70°C	1008 @ 30°C 960 @ 40°C 912 @ 50°C 864 @ 60°C 816 @ 70°C				
C		21 @ 40°C 20 @ 50°C 19 @ 60°C 18 @ 70°C	1008 @ 40°C 960 @ 50°C 912 @ 60°C 864 @ 70°C			21 @ 40°C, 50°C, 60°C & 70°C	1008 @ 40°C, 50°C, 60°C & 70°C
D		21 @ 40°C 20 @ 50°C 19 @ 60°C 18 @ 70°C	1008 @ 40°C 960 @ 50°C 912 @ 60°C 864 @ 70°C			21 @ 40°C, 50°C, 60°C & 70°C	1008 @ 40°C, 50°C, 60°C & 70°C
E		21 @ 40°C 20 @ 50°C 19 @ 60°C 18 @ 70°C	1008 @ 40°C 960 @ 50°C 912 @ 60°C 864 @ 70°C			21 @ 40°C, 50°C, 60°C & 70°C	1008 @ 40°C, 50°C, 60°C & 70°C
F		19 @ 25°C 18 @ 40°C 17 @ 50°C 16 @ 60°C 15 @ 70°C	912 @ 25°C 864 @ 40°C 816 @ 50°C 768 @ 60°C 720 @ 70°C			21 @ 25°C, 40°C, 50°C, 60°C & 70°C	1008 @ 25°C, 40°C, 50°C, 60°C & 70°C

Test orientations are as follows:

- A – Horizontal – components pointed toward the top
- B – Sideways – input connector on the left and output connector on the right
- C – Sideways – input connector on the right and output connector on the left
- D – Vertical – input connector pointed towards the bottom and output connector pointed towards the top
- E – Vertical – input connector pointed towards the top and output connector pointed towards the bottom
- F – Horizontal – components pointed toward the bottom

Note: Baseplate temperature not to exceed **85°C** on all orientation.

For Model CPFE1000FI-28 (also represents CPFE1000FI-28/P, CPFE1000FI-28/PH and CPFE1000FI-28/H):

Orientation	Output Rating (DC)				
	Voltage (V)	Current (A) @ 90-135 V ac	Power Max (W)	Current (A) @ 170-265 V ac	Power Max (W)
A	28 (22.4– 33.6)	36 @ 50°C 34 @ 60°C 32 @ 70°C	1008 @ 50°C 952 @ 60°C 896 @ 70°C	36 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
B		36 @ 50°C 34 @ 60°C 32 @ 70°C	1008 @ 50°C 952 @ 60°C 896 @ 70°C	36 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
C		36 @ 50°C 34 @ 60°C 32 @ 70°C	1008 @ 50°C 952 @ 60°C 896 @ 70°C	36 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
D		36 @ 50°C & 60°C 34 @ 70°C	1008 @ 50°C & 60°C 952 @ 70°C	36 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
E		36 @ 50°C 34 @ 60°C 31 @ 70°C	1008 @ 50°C 952 @ 60°C 868 @ 70°C	36 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
F		36 @ 40°C 34 @ 50°C 32 @ 60°C 30 @ 70°C	1008 @ 40°C 952 @ 50°C 896 @ 60°C 840 @ 70°C	36 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C

Test orientations are as follows:

- A – Horizontal – components pointed toward the top
- B – Sideways – input connector on the left and output connector on the right
- C – Sideways – input connector on the right and output connector on the left
- D – Vertical – input connector pointed towards the bottom and output connector pointed towards the top
- E – Vertical – input connector pointed towards the top and output connector pointed towards the bottom
- F – Horizontal – components pointed toward the bottom

Note: Baseplate temperature not to exceed **85°C** on all orientation.

For Model CPFE1000FI-28/C (also represents CPFE1000FI-28/CH):

Orientation	Output Rating (DC)						
	Voltage (V)	Current (A) @ 90-135 V ac	Power Max (W)	Current (A) @ 170-265 V ac	Power Max (W)		
A	28 (22.4– 33.6)	36 @ 30°C 34 @ 40°C 32 @ 50°C 30 @ 60°C 28 @ 70°C	1008 @ 30°C 952 @ 40°C 896 @ 50°C 840 @ 60°C 784 @ 70°C	36 @ 30°C, 40°C, 50°C, 60°C & 70°C	1008 @ 30°C, 40°C, 50°C, 60°C & 70°C		
B		36 @ 40°C 34 @ 50°C 32 @ 60°C 30 @ 70°C	1008 @ 40°C 952 @ 50°C 896 @ 60°C 840 @ 70°C			36 @ 40°C, 50°C, 60°C & 70°C	1008 @ 40°C, 50°C, 60°C & 70°C
C		36 @ 45°C 35 @ 50°C 33 @ 60°C 31 @ 70°C	1008 @ 45°C 980 @ 50°C 924 @ 60°C 868 @ 70°C			36 @ 45°C, 50°C, 60°C & 70°C	1008 @ 45°C, 50°C, 60°C & 70°C
D		36 @ 50°C 34 @ 60°C 32 @ 70°C	1008 @ 50°C 952 @ 60°C 896 @ 70°C			36 @ 50°C, 60°C & 70°C	1008 @ 50°C, 60°C & 70°C
E		36 @ 45°C 35 @ 50°C 33 @ 60°C 30 @ 70°C	1008 @ 50°C 980 @ 60°C 924 @ 60°C 840 @ 70°C			36 @ 45°C, 50°C, 60°C & 70°C	1008 @ 45°C, 50°C, 60°C & 70°C
F		33 @ 25°C 31 @ 40°C 30 @ 50°C 28 @ 60°C 26 @ 70°C	924 @ 25°C 868 @ 40°C 840 @ 50°C 784 @ 60°C 728 @ 70°C			36 @ 25°C, 40°C, 50°C, 60°C & 70°C	1008 @ 25°C, 40°C, 50°C, 60°C & 70°C

Test orientations are as follows:

- A – Horizontal – components pointed toward the top
- B – Sideways – input connector on the left and output connector on the right
- C – Sideways – input connector on the right and output connector on the left
- D – Vertical – input connector pointed towards the bottom and output connector pointed towards the top
- E – Vertical – input connector pointed towards the top and output connector pointed towards the bottom
- F – Horizontal – components pointed toward the bottom

Note: Baseplate temperature not to exceed **85°C** on all orientation.

For Model CPFE1000FI-12 (also represents CPFE1000FI-12/P, CPFE1000FI-12/PH, CPFE1000FI-12/H, CPFE1000FI-12C and CPFE1000FI-12/CH):

Orientation	Output Rating (DC)				
	Voltage (V)	Current (A) @ 90-135 V ac	Power Max (W)	Current (A) @ 170-265 V ac	Power Max (W)
A	12 (9.6–14.4)	60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C	60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C
B		60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C	60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C
C		60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C	60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C
D		60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C	60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C
E		60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C	60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C
F		60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C	60 @ 50°C, 60°C & 70°C	720 @ 50°C, 60°C & 70°C

Test orientations are as follows:

- A – Horizontal – components pointed toward the top
- B – Sideways – input connector on the left and output connector on the right
- C – Sideways – input connector on the right and output connector on the left
- D – Vertical – input connector pointed towards the bottom and output connector pointed towards the top
- E – Vertical – input connector pointed towards the top and output connector pointed towards the bottom
- F – Horizontal – components pointed toward the bottom

20. Withstand Voltage

This unit is safety certified to meet a withstand voltage of 4242VDC between input to output, 2500VDC between input and baseplate, and 500VDC from output to baseplate. During production the unit is tested, in accordance with safety requirements, to verify withstand voltage performance.

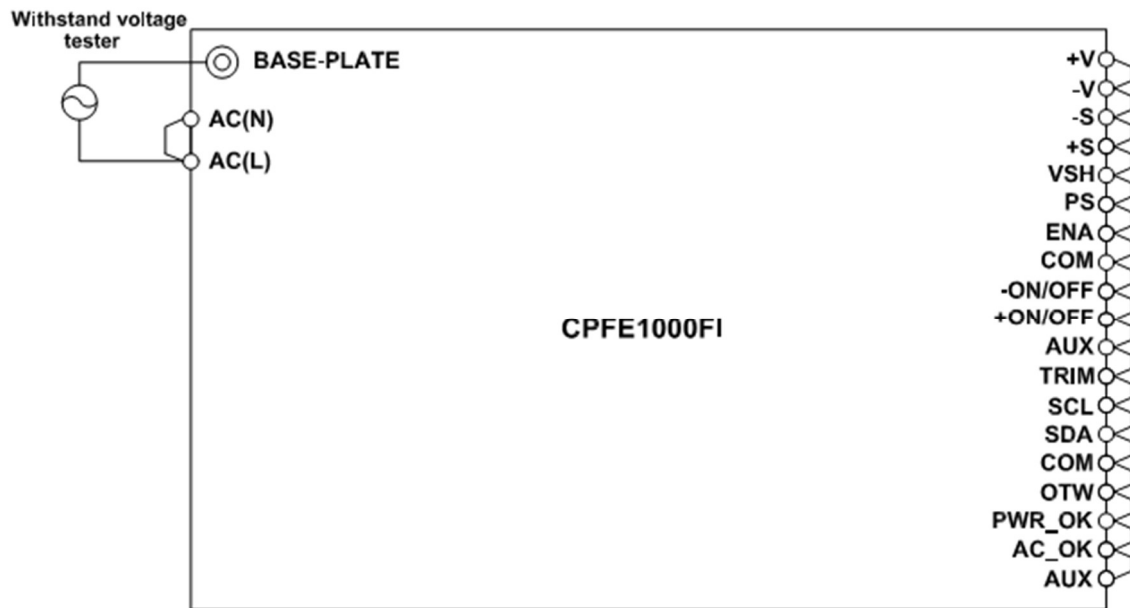
If additional withstand voltage testing in end equipment is required, limit the applied withstand voltage to 2500VDC between input to output (short output to baseplate) and 2500VDC between input and baseplate for a maximum dwell of 1 minute. Failure to reduce the voltage to these levels could result in components being damaged.

When performing this test, set the current limit of test equipment to 20mA.

When applying the 500VDC withstand voltage between output and baseplate, limit the applied dwell to 1 minute. When performing this test, be sure to apply DC voltage only. Avoid applying AC voltage during this test because this will damage the module.

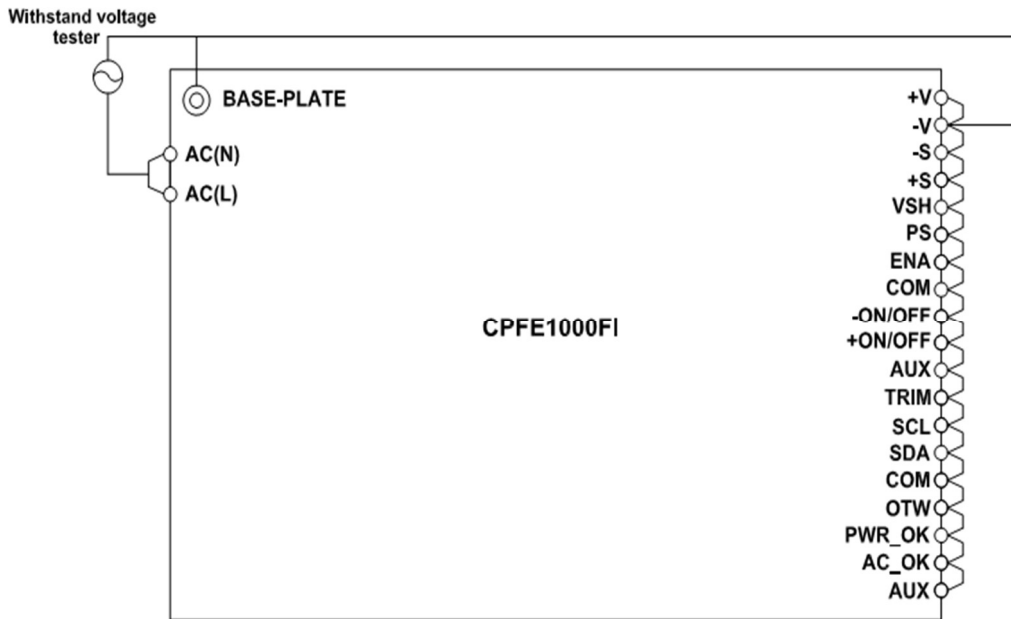
Refrain from injecting a high test voltage suddenly. Be sure to gradually increase the applied voltage during testing and gradually reduce the voltage after the test.

Caution- when using a timer switch on the test equipment, an impulse voltage which is higher than the applied set voltage, can be generated when the timer switch is cut off. This causes damage to the power module. Connect each terminal according to the circuit diagrams shown below.

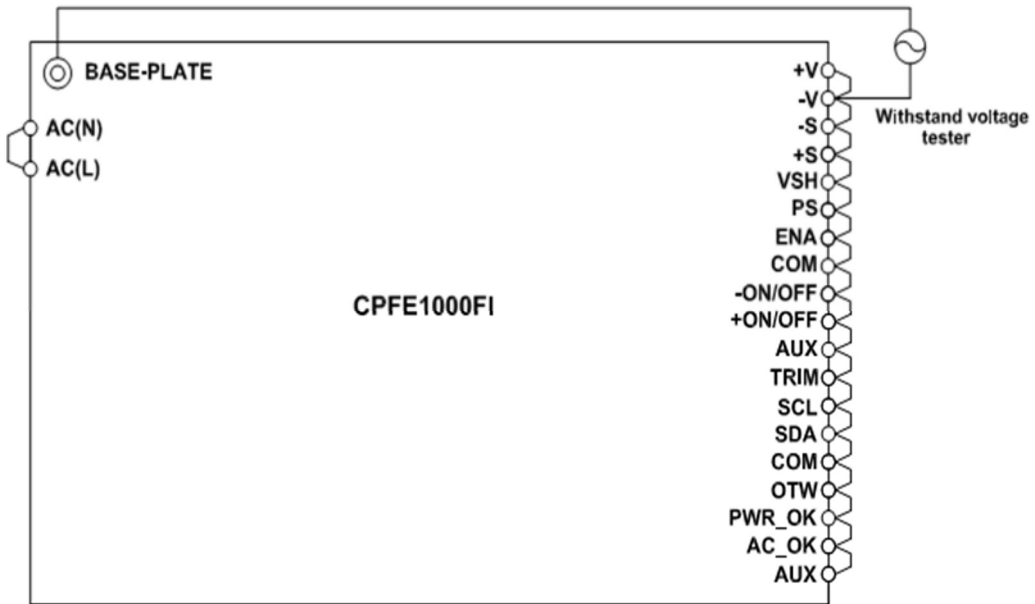


2.5kVDC 1 minute (20mA)

Fig. 20-1 Input to Baseplate Withstand Voltage Test Method



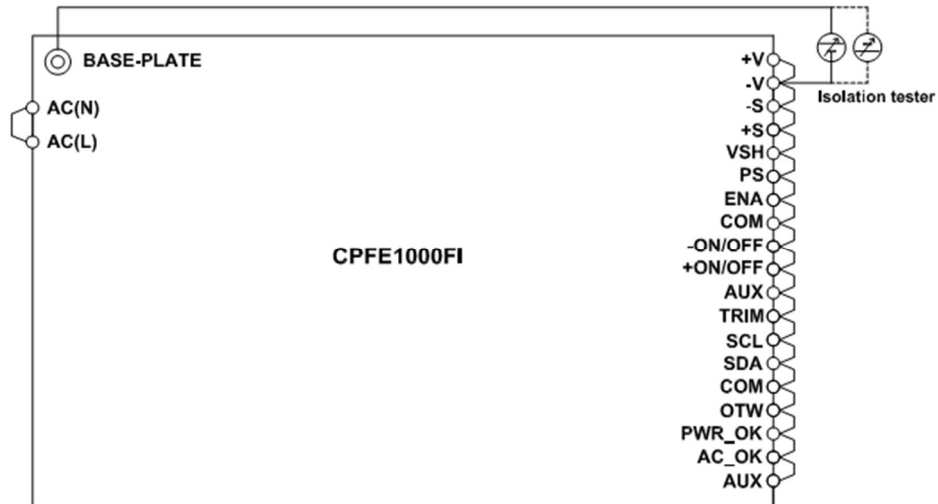
2.5kVDC 1 minute (20mA) (Short Output to Baseplate)
Fig. 20-2 Input to Output Withstand Voltage Test Method



500VDC 1 minute (20mA)
Fig.20-3 Output to Baseplate Withstand Voltage Test Method

21. Insulation Resistance

Use DC Insulation Resistance test equipment (MAX.500V) between output and baseplate.
Insulation Resistance must be 100Mohm or more at 500VDC. Take caution that some types of test equipment generate high pulse voltage when switching applied voltage. After test, discharge this module using resistor, etc.



100Mohm or more at 500VDC
Fig. 21-1 Insulation Resistance Test Method

22. Connection Details

Input Connection

Mains input connection by 3way AMP 'Mate-n-lock' connector

Mating 3-way housing: AMP 350766-1.

Mating crimp terminals: AMP 926893-1 (14~20AWG), 926895-1 (18~24AWG)

Pin 3 : Live

Pin 2 : Earth

Pin 1 : Neutral

Internal Fuse Type: 20A 250VAC Time Lag

Output Power Connection

DC output +V & -V connection by two M6x20 studs, max torque 10Nm.

Use appropriate ring terminals and wire for the load and short circuit current.

Output Signals

Signal connections available on one 20 pos. 2mm header connector (ref J2) and on one 14 pos. 2mm header connector (ref J3)

Mating 20-way housing : Molex 51110-2051.

Mating crimp terminals : Molex 50394 type

Mating 14-way housing : Molex 51110-1451.

Mating crimp terminals : Molex 50394 type

J2 Pin	Function
1	VSH
2	VSH
3	PS
4	PS
5	ENA
6	ENA
7	COM
8	COM
9	-ON/OFF
10	-ON/OFF
11	+ON/OFF
12	+ON/OFF
13	AUX
14	AUX
15	TRIM
16	TRIM
17	-S
18	-S
19	+S
20	+S

J3 Pin	Function
1	SCL
2	SCL
3	SDA
4	SDA
5	COM
6	COM
7	OTW
8	OTW
9	PWR_OK
10	PWR_OK
11	AC_OK
12	AC_OK
13	AUX
14	AUX

Table 22-1 Pin Assignments

23. Safety Approvals

UL/CSA 60950-1, IEC/EN60950-1

Intended for installation in a non-operator access environment

Intended for installation in an external electrical/mechanical/fire enclosure

24. EMC & Immunity

Conducted Emissions - EN55022/EN55032 Class B

Radiated Emissions - EN55022/EN55032 Class A

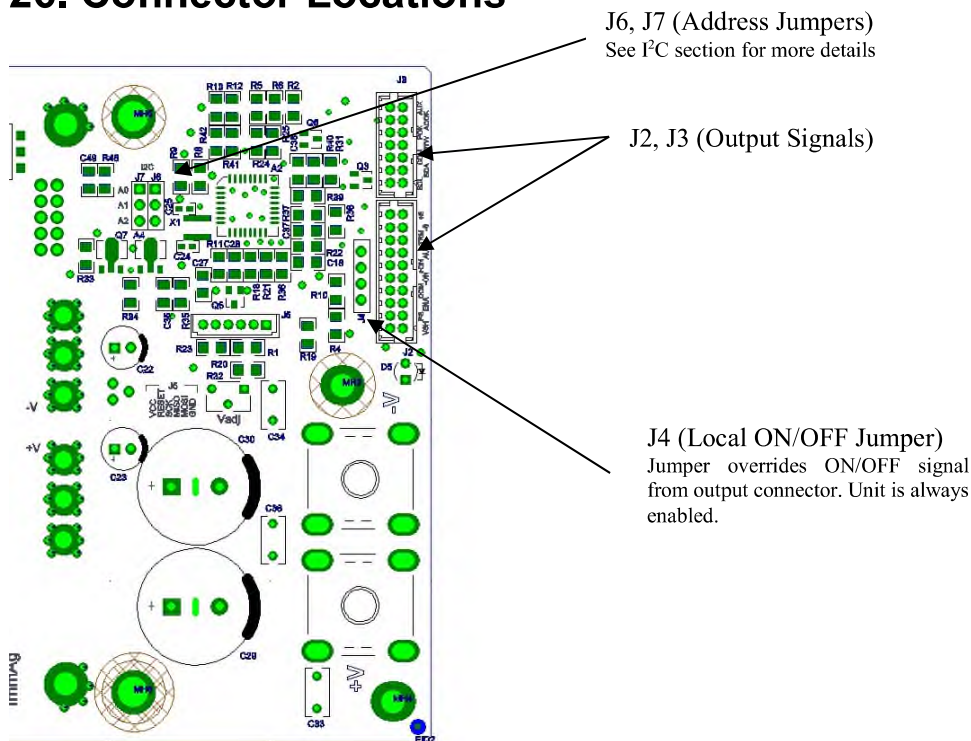
Immunity - EN61000-4-2, -3, -4, -5, -6, -8, -11, -12, -14

25. Fault Finding

If the unit shuts down, cycle the AC power to the supply. The over voltage or over temperature protection circuit may have been activated thus shutting down the output. In the event of an over temperature condition, ensure the unit has cooled down before re-applying the AC input.

When recovering from a fault, the output recovery may be delayed for up to 20 seconds to allow for proper start-up. If the unit still fails to power up, return to TDK-Lambda Americas for evaluation and repair.

26. Connector Locations



27. I2C Bus Interface

1.- Introduction

The I²C interface option includes facilities to monitor operating parameters of the Power Supply (PS). The parameters are then transferred to the host PC if demanded, over a standard I²C bus.

The following data can be monitored for the individual units connected to the I²C bus:

- 1.- Status of the unit
- 2.- Actual Output voltage, output current and internal temperature of the unit.
- 3.- Manufacturing related data (model, serial number, manufacturing date, etc.....)

At startup there is an approximate 2 second lockout before the I²C function is available.

During operation, activity on the bus can cause delays, so it is not recommended to trigger protection mechanisms from the data being monitored on the I²C bus. For triggering protection mechanisms, it is recommended to use the analog signals at connectors J2 and J3 (See Section 22 for pin-out details)

2. - Addressing (A0, A1, A2)

Three address lines allow up to 8 units to be addressed on a single I2C bus. The address lines are internally pulled-up to +5V by resistors. Addressing of a unit is achieved by hard wiring an address line to the –sense to set to “0” or leaving the address line open to set it to “1”.

A0, A1, A2 are in the PS (J6,J7) for Customer configuration of the I²C address. Addresses are on Hex format 0x00

A2	A1	A0	Address
0	0	0	A0
0	0	1	A2
0	1	0	A4
0	1	1	A6
1	0	0	A8
1	0	1	AA
1	1	0	AC
1	1	1	AE

Jumper = “0”

Open = “1”

3.- Serial Clock

This line is clocked by the processor which controls the I²C bus. It is internally connected to +5V via a pull-up resistor. The I2C interface is designed to run with a serial clock speed of 100KHz

4.- Serial Data

This line is a bidirectional data line. It is internally connected to +5V via a pull-up resistor.

5.- Operation and Functions

5.1 Digital status

Digital status functions are provided by a status byte register. This is an 8-bit word when read by the I²C controller.

Status Byte:

Address: 07

Bytes: 1

Example for CPFE1000Fi12 model:

Get the Hexadecimal number: 27

Convert the Hexadecimal number to Binary number: 00100111

Binary number is read from right to left, so for our example:

Function	Bit	Description
On_Off status	1	Unit is OFF
Enable	1	Vout < 6 volts
IOG	1	Main Inverter stops working
OTW	0	Base plate temperature <90C
OTG	0	Base plate temperature <100C, not OTP
VoutOK	1	Vout is not present
IOK	0	Unit is not in OCP condition
AC_OK	0	AC Input Voltage Present

Bit	Function	Description	
0	On_Off status	0 = Unit On , 1 = Unit Off	ON/OFF status on the I2C command.
1	Enable	0 = Good , 1 = Bad	See Section 13 for Output voltage threshold level above which the Power ON signal is LOW (Good) and level below which the signal is HIGH (Bad).
2	IOG	0 = Good , 1 = Bad	Good if main Inverter is working OK, Bad is main inverter stops working or it's working abnormally
3	OTW	0 = Good , 1 = Warning	Good if base plate temperature is < ~80C, Warning if base plate temperature is > ~80C, unit is ON
4	OTG	0 = Good , 1 = Bad	Good if base plate temperature is < ~100C, Bad if base plate temperature is > ~100C, unit in OTP status
5	VoutOK	0 = Good , 1 = Bad	Good if Vout is present, Bad if not Vout is present
6	IOK	0 = Good , 1 = Bad	Good if Iout is below or nom current, Bad if Iout is in over current condition
7	AC_OK	0 = Good , 1 = Bad	Good if AC is present, Bad if AC is Lost

5.2 EEPROM Data

A 512 bytes EEPROM is included on the I2C option. The EEPROM is programmed at the factory with the data shown on the following table:

Serial Number: Address: 01
Bytes: 20

Example:

43	4C	57	2D	33	31	35	53	31	30	2D	30	31	36	30	2D	53	35	32	31
C	L	W	-	3	1	5	S	1	0	-	0	1	6	0	-	S	5	2	1

Each number represents an ASCII character in hexadecimal numbering system.

Firmware Revision: Address: 02
Bytes: 4

Example:

56	31	2E	30
V	1	.	0

Product Revision: Address: 03
Bytes: 4

Example:

58	31	2E	30
X	1	.	0

Unit Part Number: Address: 08
Bytes: 12

Example:

43	50	46	45	31	30	30	30	46	49	31	32
C	P	F	E	1	0	0	0	F	I	1	2

Each number represents an ASCII character in hexadecimal numbering system.

Unit Manufacturing Date: Address: 09
Bytes: 8

Each number represents an ASCII character in hexadecimal numbering system.

Unit Manufacturing Location: Address: 10
Bytes: 3

Each number represents an ASCII character in hexadecimal numbering system.

5.3 Analog Functions

Analog functions are provided by a 8-channel 10-bit resolution Analog-Digital Converter (ADC). When this device is read by the I2C bus controller it provides a 2 bytes word information.

Address	Bytes	Data
04	2	Output Voltage Readback
05	2	Output Current Readback
06	2	Baseplate Temperature Readback

The ADC has to be scaled to obtain a correct value for the voltage, current and temperature readings. The following scaling factor (SF) should be employed:

CPFE1000FI12	Range	SF	Accuracy
Voltage	0 – 15V	0.01668	+/-2%
Current	0-60A	0.0815	+/-5%
Temperature	0-100°C	Note 1	+/-3%

CPFE1000FI28	Range	SF	Accuracy
Voltage	0 – 34V	0.03973	+/-2%
Current	0-36A	0.0488	+/-5%
Temperature	0-100°C	Note 1	+/-3%

CPFE1000FI48	Range	SF	Accuracy
Voltage	0 - 58V	0.06772	+/-2%
Current	0-21A	0.0282	+/-5%
Temperature	0-100°C	Note 1	+/-3%

Note 1: At ambient temperatures below -20C, a period of warm-up may be required before the current readback meets these accuracy levels. The current readback accuracy may also be affected during fault (OTP, OVP, OCP) condition.

Note 2: Use the following formula for calculating temperature.

$$T_{base} (C) = (DEC \text{ number} - 610) / 2.048 + 25$$

Where DEC Number is the decimal conversion of the HEX number read on address 6 (temp reading)

Example:

For 12 volts output @ 30C baseplate temperature

02	6D
----	----

Get the HEX number: 26D

Convert the HEX to DEC number: 621

Apply formula: Temp = (DEC number – 610)/2.048 + 25

$$(621 - 610) / 2.048 + 25 = 30.4C$$

Temp ≈ 30.4C

Output Voltage:

Address: 04

Bytes: 2

Example:

For 12

02	C4
----	----

 volts output

Get the HEX number: 2C4

Convert the HEX to DEC number: 708

Multiply the DEC number by Scaling Factor (SF): 0.01668

$V_{out} = 708 * 0.016687 = 11.814$ Volts

Same method is used for current readings.

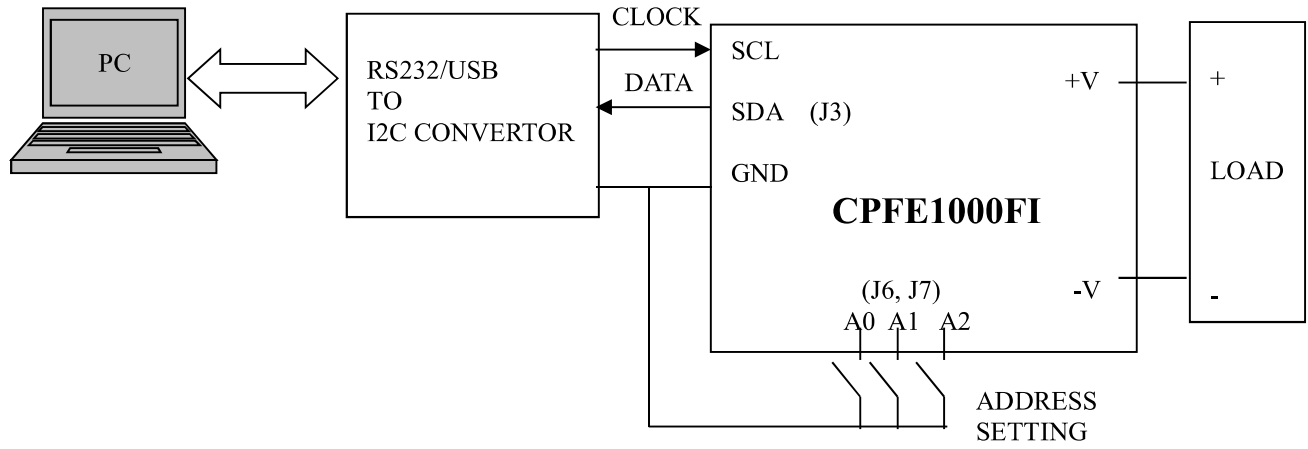
5.4 Remote ON/OFF thru I²C.

Unit can be remotely turned OFF by the OFF command on address 0A. Once address 0A is called out, the unit will stay OFF until the ON command is called out thru address 1A or the Input Line is removed for about 30 seconds.

Address	Function
1A	Turn output On
0A	Turn output Off

For the remote ON/OFF to function, the unit must be enabled via the ON/OFF Control (See Section 10) or the local ON/OFF jumper (J4 connector).

6.- Typical application diagram



28. Mechanical Drawing

The CPFE1000Fi series of units are available in the following three chassis configurations: 1) The standard configuration is installed in a U-channel chassis, without a top cover, 2) The /C option is installed in the U-channel chassis with a ventilated top cover (shown in Fig 28-1), and 3) The /P option which has neither the top cover nor the U-channel chassis (shown in Fig 28-2). Overall dimensions for the standard model and the /C option are shown in Fig 28-1. Overall dimensions for the /P option is shown in Fig 28-2.

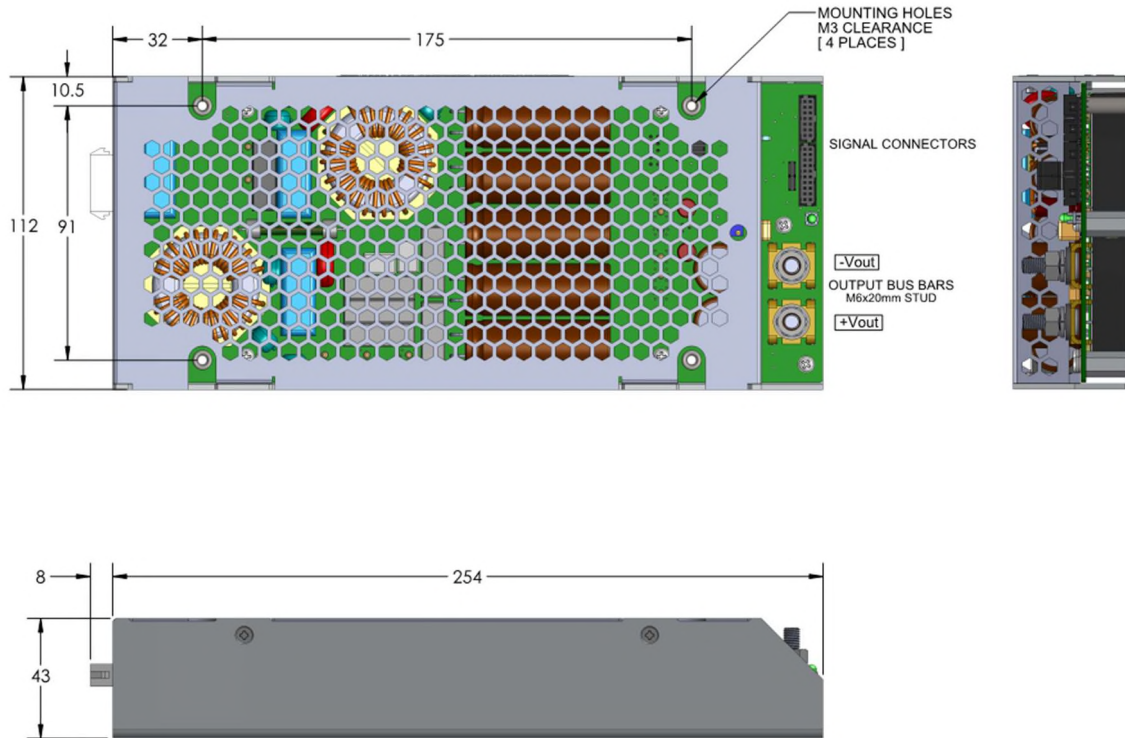


Fig 28-1: Dimensions for Standard and /C chassis configurations

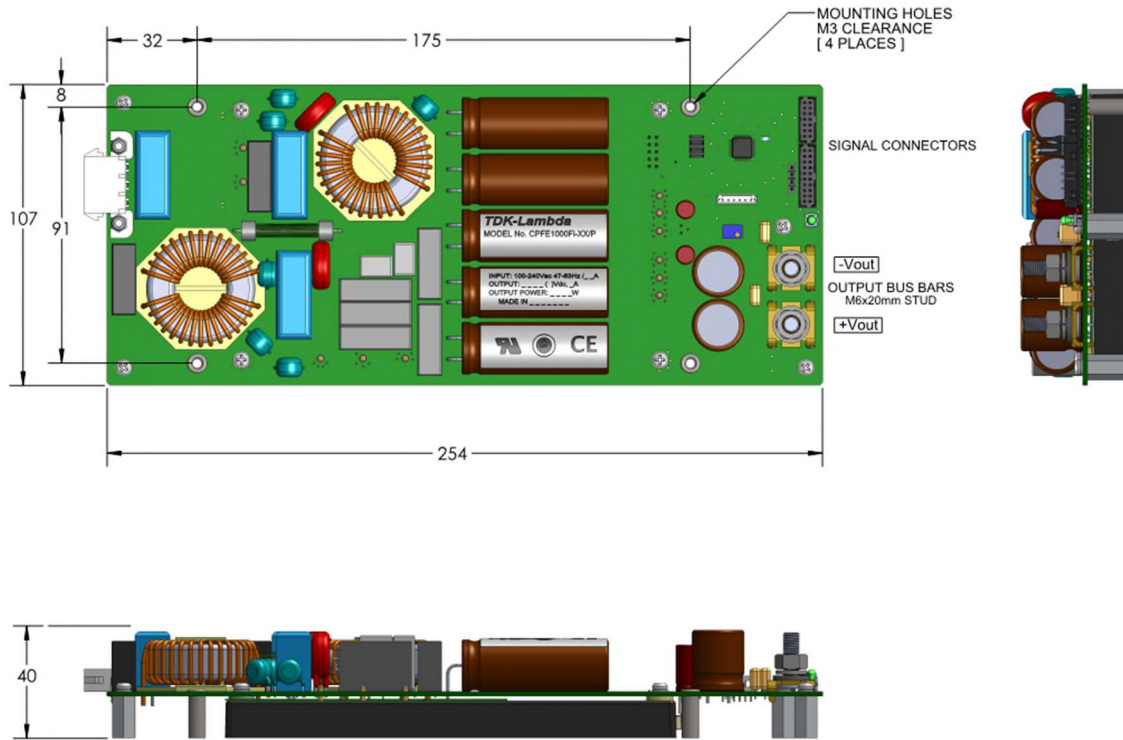
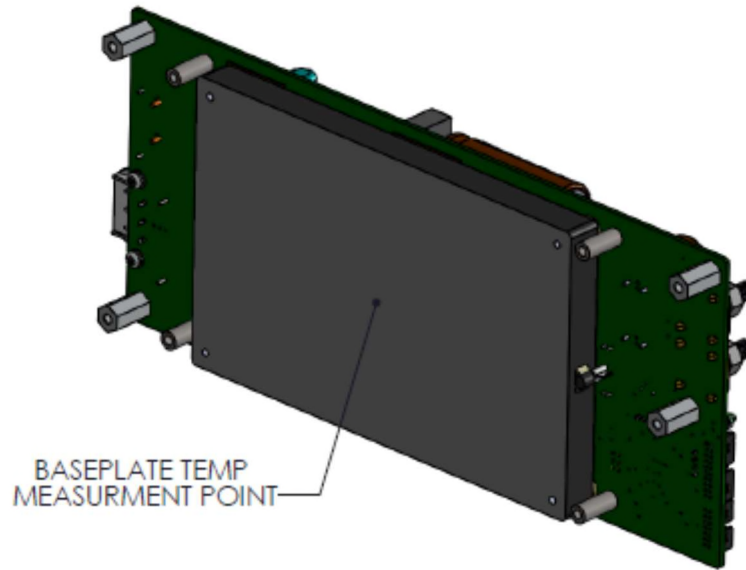
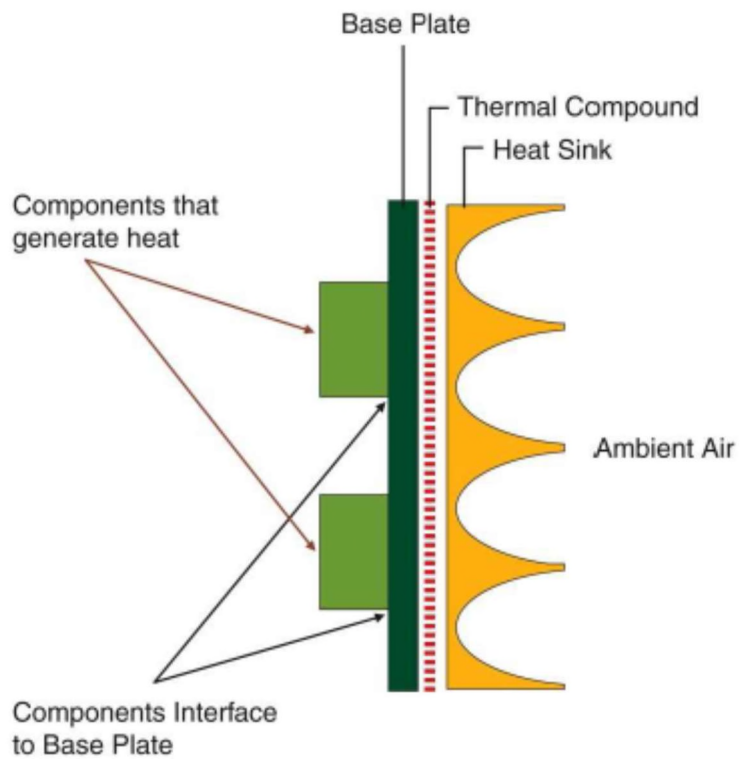


Fig 28-2: Dimensions for /P chassis configuration.

29. Baseplate Temperature Measurement Point



30. Heat Sink Selection



PD = Power Dissipation

$$\frac{P_{out}}{eff} - P_{out} = \frac{1000}{.85} - 1000 = 176 \text{ Watts}$$

θ = Thermal Resistance, degrees C per Watt, °C/W

Tb = Temperature of Base Plate

Ta = Temperature of Ambient Air

θ_{sa} = Thermal resistance between Heat Sink and Ambient Air

θ_{ba} = Thermal resistance between Base Plate and Heat Sink

Example: Ambient 25°C
 Base Plate 100°C

$$\theta = \frac{Tb - Ta}{PD} = \frac{75^\circ C}{176} = .43^\circ C/W$$