General Safety Instructions:

READ SAFETY INSTRUCTIONS

Servicing:

These products are not customer serviceable. TDK-Lambda and their authorised agents only are permitted to carry out repairs.

Critical Components:

These products are not authorised for use as critical components in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the Managing Director of TDK-Lambda EMEA.

Product Usage:

These products are designed for use within a host equipment which restricts access to authorised competent personnel.

This product is a component power supply and is only to be installed by qualified persons within other equipment and must not be operated as a stand-alone product.

This product is for sale to business to business customers and can be obtained via distribution channels. It is not intended for sale to end users.

This product is a component power supply and complies with the EMC directive. The EMC performance of a component power supply will be affected by the final installation, compliance to the stated EMC standards and conformance to the EMC Directive must be confirmed after installation by the final equipment manufacturer.

For guidance with respect to test conditions please visit our website at https://emea.tdk-lambda.com/EMC_guidance or contact your local TDK-Lambda sales office.

Environmental:

These products are IPX0, and therefore chemicals/solvents, cleaning agents and other liquids must not be used.

Environment:

This power supply is a switch mode power supply for use in applications within a Pollution Degree 2, overvoltage category II environment. Material Group IIIb PCB's are used within it.

Output Loading:

The output power taken from the power supply must not exceed the rating stated on the power supply label, except as stated in the product limitations in this handbook.

Input Parameters:

This product must be operated within the input parameters stated in the product limitations in this handbook.

End of Life Disposal:

The unit contains components that require special disposal. Make sure that the unit is properly disposed of at the end of its service life and in accordance with local regulations.

RISK OF ELECTRIC SHOCK

High Voltage Warning:

Dangerous voltages are present within the power supply. The professional installer must protect service personnel from inadvertent contact with these dangerous voltages in the end equipment.

WARNING: When installed in a Class I end equipment, this product must be reliably earthed and professionally installed.

The (+) or (-) output(s) can be earthed or left floating. The unit cover(s)/chassis must not be made user accessible. The mains input connector is not acceptable for use as field wiring terminals. Do not use mounting screws, which penetrate the unit more than 3mm (FPS/RFE1000), 6mm (HFE/RFE1600/2500 & racks). Special earthing screws are used on these products which connect the cover to the chassis. They must not be removed. If they are removed by mistake, they must be replaced with new ones and the product tested for earth bonding.

This unit must be securely mounted and its earth terminal/baseplate properly boned to the main protective earth before any connection to the MAINS supply is made. An internal fuse protects the unit and must not be replaced by the user. In case of internal defect, the unit must be returned to TDK-Lambda or one of their authorised agents. A suitable mechanical, electrical and fire enclosure must be provided by the end use equipment for mechanical, electric shock and fire hazard protection.

Energy Hazards:

Certain modules are capable of providing hazardous energy (240VA) according to output voltage setting. Final equipment manufacturers must provide protection to service personnel against inadvertent contact with these module output terminals. If set such, that hazardous energy can occur, then the module terminals or connections must not be user accessible.

Disconnect device: An appropriate disconnect device shall be incorporated in the building installation wiring. Refer to the user manual of the specific model for more details.

Rack mounting safety instructions:

A) Elevated Operating Ambient - If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient. Therefore, consideration should be given to installing the equipment in an environment compatible with the maximum ambient temperature (Tma)specified by the manufacturer.

B) Reduced Air Flow - Installation of the equipment in a rack should be such that the amount of air flow required for safe operation of the equipment is not compromised.

C) Mechanical Loading - Mounting of the equipment in the rack should be such that a hazardous condition is not achieved due to uneven mechanical loading.

D) Circuit Overloading - Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.

E) Reliable Earthing - Reliable earthing of rack-mounted equipment should be maintained. Particular attention should be given to supply connections other than direct connections to the branch circuit (e.g. use of power strips).

HOT SURFACE

External Hot Surfaces:

In accordance with local regulations for Health and Safety at work, manufacturers have an obligation to protect service engineers as well as users. In order to comply with this, a label must be fitted to these products which is clearly visible to service personnel accessing the overall equipment, and which legibly warns that surfaces of these products may be hot and must not be touched when the products are in operation.

The unit may be mounted in any orientation except inverted (mounted on its top) or vertical with the airflow downwards. The ventilation openings on these products must not be impeded. Ensure that there is at least 50mm spacing between any obstruction and the ventilation openings.

The unit cover/chassis is designed to protect skilled personnel from hazards. They must not be used as part of the external covers of any equipment where they may be accessible to operators, since under full load conditions, part or parts of the unit chassis may reach temperatures in excess of those considered safe for operator access.

FPS1000 INSTRUCTION MANUAL

	FPS1000 SERIES SPECIFICATIONS		FPS1000-12	FPS1000-24	FPS1000-32	FPS1000-48
1	Rated output voltage	V	12	24	32	48
2	Output voltage set point	V	12+/-1%	24+/-1%	32+/-1%	48+/-1%
3	Output voltage range	V	10.5~13.2	21.5~29	28.8~38.4	43~58
4	Maximum Output Current (Refer to Fig.1)	A	72	40	31	21
5	Maximum output power	W	864	960	992	1008
6	Input voltage / frequency range (*1)	---	85~265Vac continuous, 47~63Hz, Single phase			
7	Maximum input current (at 100/200Vac)	A	12.0/6.0			
8	Power Factor (Typ)	---	>0.98 at 115/230V and maximum output power			
9	Efficiency (Typ) (*2)	%	81/83%	84/86%	84/86%	85/88%
10	Inrush current (*3)	A	Less than 40A			
11	Hold-up time	mS	20mS typical at 100Vac input, rated output voltage and less than 80% of rated load.			
12	Maximum line regulation (*5)	---	0.40%			
13	Max load regulation (*6)	---	0.80%			
14	Output Ripple and noise pk-pk (*4)	mV	150	200	250	300
15	Temperature stability	---	0.05% of rated Vout for 8hrs after 30min warm-up. Constant line, load and temperature.			
16	Temperature coefficient	PPM/°C	200			
17	Remote sensing (*7)	V	Possible. Refer to Instruction Manual.			
18	Parallel operation (*9)	---	Possible. Refer to Instruction Manual.			
19	Series operation	---	Possible. Refer to Instruction Manual.			
20	Over current protection	---	104%~125% of maximum output current.			
21	Over voltage protection (*8)	V	14.3~15.7	31~34	41.5~45.5	62~66
22	Over temperature protection	---	Inverter shut down method, automatic reset.			
23	Remote On/Off control	---	By electrical signal or dry contact. ON: 0~0.6V or short. OFF: 2~15V or open.			
24	DC OK signal	---	Open collector signal. On when Vout ≥ 80+/-5% rated output. Max.sink current: 10mA			
25	Over-Temp. warning	---	Open collector signal. Refer to Instruction Manual			
26	AC fail signal	---	Open collector signal. Refer to Instruction Manual			
27	Auxiliary power supply	---	11.2~12.5VDC. 0.25A Maximum output current.			
28	Vout voltage trimming	---	Possible, via Vout Trim pin in the I/O connector. Refer to Instruction Manual.			
29	Front panel indicators	---	AC OK, DC OK, DC FAIL			
30	I²C Interface	---	Optional. Refer to Instruction Manual.			
31	Operating temperature-models without IEC inlet	---	0~50°C: 100% load. Derate 2%/°C, 50°C to 60°C, Derate 2.5%/°C, 60°C to 70°C.			
	models with IEC inlet	---	0~50°C: 100% load. Derate 2%/°C, 50°C to 60°C.			
32	Storage temperature	---	-30~85°C			
33	Operating humidity	---	10~90% RH, no condensation.			
34	Storage humidity	---	10~95% RH, no condensation.			
35	Cooling	---	By internal Fans. Variable speed control.			
36	Vibration	---	Built to meet ETS 300 019			
37	Shock	---	Built to meet ETS 300 019			
38	Conducted emission (*10)	---	Built to meet EN55032B, FCC part 15J-B, VCCI-B			
39	Radiated emission	---	Built to meet EN55032B, FCC part 15J-B, VCCI-B			
40	Applicable safety standards	---	IEC 62368-1 UL62368-1 CSA22.2 No.62368-1 EN62368-1.			
41	Withstand voltage	---	Input-Output: 3000Vrms, 1min. Input-Ground: 2000Vrms, 1min. Output-Ground: 500Vrms,1min.			
42	Isolation resistance	---	More than 100Mohm at 25°C and 70% RH. Output-Ground: 500Vdc			
43	Leakage current	mA	Less Than 1.1mA at 230Vac			
44	Weight (Typ)	Kg	2.0			
45	Size (W*H*D)	---	127x41x290mm. Refer to Outline Drawing.			

Notes:

*1: For cases where conformance to various safety standards (UL, EN etc.) is required, to be described as 100-240Vac (50/60Hz).

*2: At 100/200Vac, rated load and 25° C ambient temperature.

*3: Not applicable for the noise filter inrush current less than 0.2mS.

*4: Measured with JEITA RC-9131A 1:1 probe, 20MHz B.W.

*5: From 85~132Vac or 170~265Vac, constant load.

*6: From No-load to Rated load, constant input voltage. Measured at the sensing point in Remote sense.

*7: Remote sensing can compensate up to 1V drop on each load wire.

*8: Inverter shut down method. Reset by AC voltage recycle or by On/Off control.

*9: Derate Maximum output power by 10% for input voltage less than $100V_{RMS}$

*10 For FPS 1000-12/P(S), when used not with FPS-S1U or FPS-T1U racks, an EMI suppressor clamp should be attached to the AC cable, as close as possible to the AC inlet, to meet class B.

Model / V/I	FPS1000 -12	FPS1000 -24	FPS1000 -32	FPS1000 -48
V1 (V)	12	24	32	48
V2 (V)	13.2	29	38.4	58
I1 (A)	66	33	26	17.25
I2 (A)	72	40	31	21

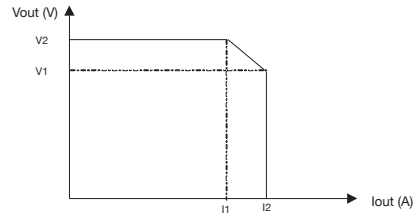


Fig. 1: Rated output current vs output voltage

REAR IN/OUT CONNECTOR PINS FUNCTION DESCRIPTION

Pin No	Function	Description
1,2,4	+V	Positive output voltage
3,5,6	-V	Negative output voltage
7	On/Off control	Turns the output to On and Off by electrical signal or dry contact between pin 7 and pin 10 (Signal Return). 0~0.6V or Short: On, 2~15V or Open: Off. The maximum sink current is 2.6 mA
8	+Sense	Positive sensing. The +Sense signal should be connected to the positive terminal of the load. The +Sense and -Sense leads should be twisted pair to minimize noise pick-up effect. The maximum load wires drop compensation is 1V/wire
9	DC_OK	Open collector signal, referenced to pin 10 (Signal Return). On when Vout ≥80% +/-5% The maximum sink current is 10mA and the maximum external voltage is 15V.
10	Signal_Return	Return for the following control and supervisory signals: On/Off, DC_OK, Over_temperature Alarm, AC_Fail, Auxiliary 12V supply. The Signal return is isolated from the output terminals.
11	AC_Fail	Open collector signal, referenced to pin 10 (Signal Return). On when the input voltage is ≥85Vrms. The maximum sink current is 10mA and the maximum external voltage is 15Vdc.
12	Over Temperature Alarm	Open collector signal, referenced to pin 10 (Signal Return). On when the internal temperature is within safe limit, Off approx. 10°C below Thermal shut down. The maximum sink current is 10mA and the maximum external voltage is 15V.
13	-Sense	Negative sensing. The -S signal should be connected to the negative terminal of the load. The -S and +S leads should be twisted pair to minimize noise pick-up effect. The maximum load wires drop compensation is 1V/wire.
14	V_Trim	Connection for output voltage trimming. The voltage can be trimmed within its range specifications.
15	CS	Current sharing signal. When units are connected in parallel, the CS pins of the units should be connected to allow current balance between units.
16	+12V Auxiliary	Auxiliary voltage output, 11.2~12.5V, referenced to pin 10 (Signal Return). The maximum load current is 0.25A. This output has built in Oring diode and is not controlled by the On/Off control.
17	SDA	Serial Data used in the I²C interface option. Refer to the I²C interface description.
18	SCL	Serial Clock used in the I²C interface option. Refer to the I²C interface description.
19,20,21	A0, A1, A2	I²C interface address lines. Refer to the I²C interface description.
22	AC Ground	AC Ground connection, refer to the safety instructions for safety standards requirements. For "/P" models the AC Ground is connected via the front panel IEC inlet.
23	AC Line	AC Line connection, refer to the safety instructions for safety standards requirements. For "/P" models the AC Line is connected via the front panel IEC inlet.
24	AC Neutral	AC Neutral connection, refer to the safety instructions for safety standards requirements. For "/P" models the AC Neutral is connected via the front panel IEC inlet.

Table 1: Rear In/Out connector pins function description

Refer to Table 1 for description of the control and supervisory signals provided at the rear In/Out connector.
Refer to Fig. 1.1~5.1 for typical connections for operation.

FPS1000 SAFETY INSTRUCTIONS

SAFETY APPROVALS

UL 62368-1 and CSA C22.2 No. 62368-1 | UL Recognized (UR Mark)
IEC 62368-1 | CB Test Report and Certificate
EN 62368-1 | TUV Mark and CE/UKCA Mark
Marking by the CE Symbol indicates compliance to the EMC Directive, the Low Voltage Directive and RoHS Directive of the European Union.
UKCA Marking, when applies to a product covered by this handbook, indicates compliance with the Electrical Equipment (safety) Regulations 2016, Electromagnetic Compatibility Regulations 2016 and Restriction of the Use of Certain Hazardous Substances in Electrical & Electronic Equipment regulation 2012.
A CE "Declaration of Conformity" in accordance with the preceding directives and standards has been made and available on file at our EU representative TDK LAMBDA GERMANY GmbH, located at Karl-Bold-Str. 40, D-77855 Achern.
A UKCA "Declaration of Conformity" in accordance with the preceding directive and standards has made and is on file at our UK representative TDK-Lambda UK Limited, Kingsley Avenue, Ilfracombe, Devon EX34 8ES.
Both "Declaration of Conformity" may be accessed via company website https://www.emea.lambda.tdk.com/safety_cert

CAUTION: The following safety precaution must be observed during all phases of operation, service and repair of this equipment. Failure to comply with the safety precautions or warnings in this document violates safety standards of design, manufacture and intended use of this equipment and may impair the built-in protections within. TDK Lambda shall not be liable for user's failure to comply with these requirements.

CAUTION: FPS1000 units are not authorized for use as critical component in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the managing director of TDK-Lambda.

INSTALLATION (OVERVOLTAGE) CATEGORY& ENVIRONMENTAL CONDITIONS

The FPS1000 units have been evaluated to Overvoltage category II.
The FPS1000 units intended for use in the following operation conditions:
* Indoor use * Pollution degree 2 * Max. operational altitude: 3000m above sea level
*Ambient temperature: -10°C-50°C at 100% load, up to 70°C with output de-rating applied (See Specification)

GROUNDING

FPS1000 units are Class I product. To minimize electrical shock hazard, the FPS1000 units must be connected to an electrical ground. The instruments must be connected to the AC power supply mains through a three conductor power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the supply mains, the protective earth terminal must be connected to the safety electrical ground before any other connection is made. Any interruption of the protective ground conductor or disconnection of the protective earth terminal will cause a potential shock hazard that might cause personal injury.

LIVE CIRCUITS

Operating personnel must not remove the FPS1000 units cover. No internal adjustment or component replacement is allowed by non-TDK Lambda qualified service personnel. Never replace components with power cable connected. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components. Restricted Access Area: FPS1000 units should only be installed in a Restricted Access Area. Access should be available to service personnel only

PARTS SUBSTITUTIONS & MODIFICATIONS

Parts substitutions and modifications are authorized TDK Lambda service personnel only. For repairs or modifications, the instrument must be returned to TDK Lambda service facility.

AC INPUT

Do not connect FPS1000 units to mains supply exceeding the input voltage and frequency rating. The input voltage and frequency rating is: 100-240V~, 50/60Hz. For safety reasons, the mains supply voltage fluctuations should not exceed +/-10% of nominal voltage.

ENERGY HAZARD

The main output of FPS1000 units is capable of providing hazardous energy. Due to hazardous energy level the output and connections therefore must not be user accessible. Manufacturer's final equipment must provide protection to service personnel against inadvertent contact with output bus bars.

FUSE

Internal fuse is sized for fault protection and if a fuse was opened it would indicate that service is required. Fuse replacement should be made by qualified technical personnel.
FPS1000 unit's fuse ratings are described below. F101: F20A H 250Vac; F102: 6.3A 400VDC.

OVERCURRENT PROTECTION:

A readily accessible branch circuit over-current protective device rated 20A max. must be incorporated in the building wiring.

SYMBOLS

CAUTION Risk of Electrical Shock.

Instruction manual symbol. The instrument will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

Indicates hazardous voltage.

Indicates ground terminal.

Protective earth; protective ground. Indicates the terminal which is intended for connection to an external conductor for protection against electric shock in case of a fault.

WARNING

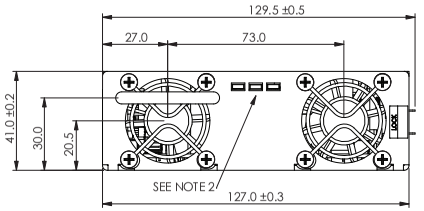
Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in personal injury. A WARNING sign should not be skipped and all indicated conditions must be fully understood and met.

CAUTION

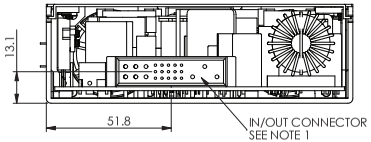
Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in damage to the equipment.

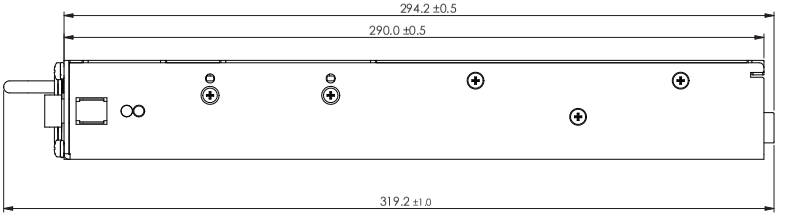
FPS 1000 SERIES OUTLINE DRAWING

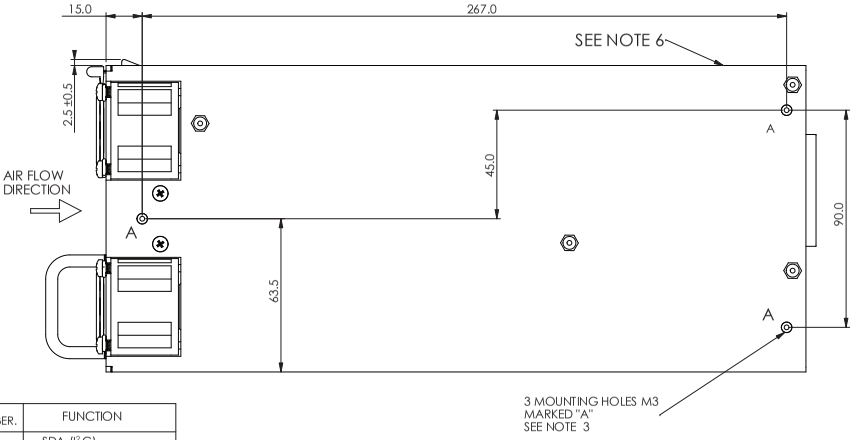
FRONT VIEW



REAR VIEW

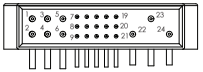






NOTES

1. CONNECTOR TYPE: PCIB24W9M400A1, POSITRONIC.
   FEMALE CONNECTOR TYPE: PCIB24W9F400A1.
2. LED INDICATORS. REFER TO INSTRUCTION MANUAL.
3. MOUNTING SCREWS MUST NOT PENETRATE MORE THAN 3mm INTO THE UNIT.
4. MODEL NAME ,INPUT AND OUTPUT RATING AND SAFETY APPROVALS SYMBOLS ARE DESCRIBED ON TOP SURFACE LABEL.
5. ALLOW MINIMUM 50 mm OF UNRESTRICTED AIR SPACE AT THE REAR OF UNIT. DO NOT OBSTRUCT AIR FLOW TO THE UNIT FRONT PANEL.
6. EU REPRESENTATIVE ADDRESS LABEL ON CHASSIS RIGHT SIDE.
7. IN OUT CONNECTOR BACK VIEW AND PINS ASSIGNMENT:



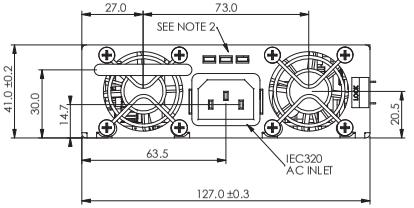
PIN NUMBER.	FUNCTION
1	+v
2	+v
3	-v
4	+v
5	-v
6	-v
7	ON/OFF
8	+S

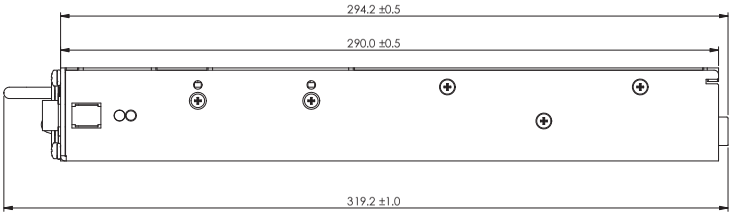
PIN NUMBER.	FUNCTION
9	DC_OK
10	SIGNAL_RTN
11	AC_FAIL
12	TEMP_ALARM
13	-S
14	V_TRIM
15	CS
16	+12V_AUX

PIN NUMBER.	FUNCTION
17	SDA (I^2C)
18	SCL (I^2C)
19	A0 (I^2C)
20	A1 (I^2C)
21	A2 (I^2C)
22	ACG
23	ACL
24	ACN

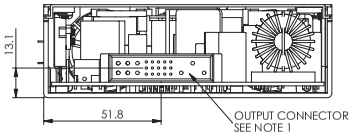
FPS 1000/P SERIES OUTLINE DRAWING

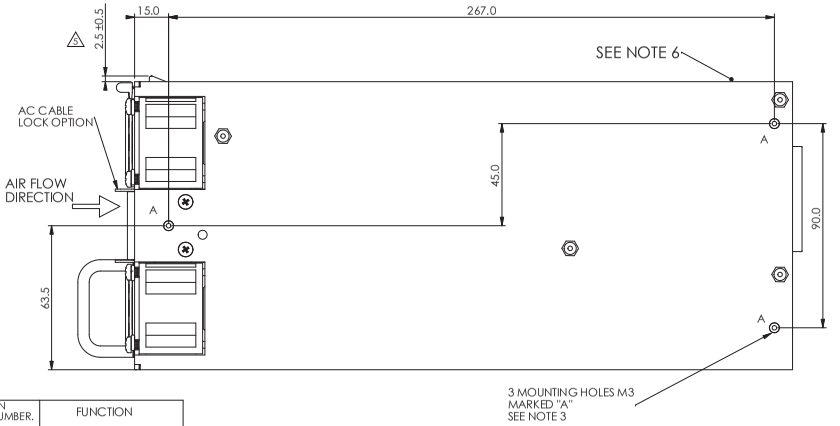
FRONT VIEW





REAR VIEW





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   FEMALE CONNECTOR TYPE: PCIB24W9F400A1.
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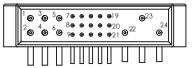


PIN NUMBER.	FUNCTION
1	+v
2	+v
3	-v
4	+v
5	-v
6	-v
7	ON/OFF
8	+S

PIN NUMBER.	FUNCTION
9	DC_OK
10	SIGNAL_RTN
11	AC_FAIL
12	TEMP_ALARM
13	-S
14	V_TRIM
15	CS
16	+12V_AUX

PIN NUMBER.	FUNCTION
17	SDA (I^2C)
18	SCL (I^2C)
19	A0 (I^2C)
20	A1 (I^2C)
21	A2 (I^2C)
22	NC
23	NC
24	NC

FPS 1000 CONNECTIONS FOR OPERATION

1. SINGLE UNIT OPERATION

1.1. Remote sensing*

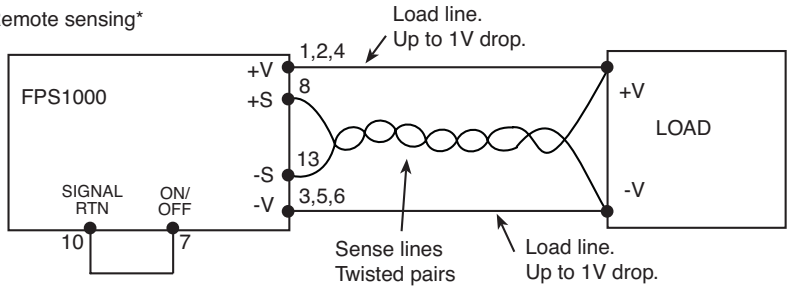


Fig 1-1

0.0324

* In Local sense applications, the +/- sense have to be connected to the +/-V terminals of the FPS1000 units prior the operating the FPS1000 units

1.2. Output voltage trimming

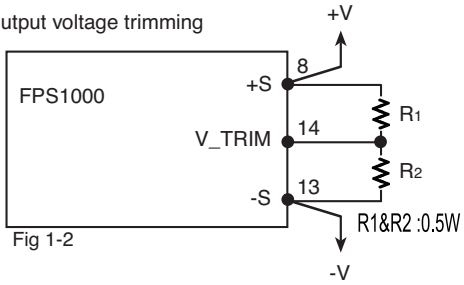


Fig 1-2

FPS1000-12

$R_2(K\Omega) = 0.0324 * V_{out}^2 - 1.1298 * V_{out} + 9.9342$

$R1(K\Omega) = 5 - R2(K\Omega)$

FPS1000-24

$R_2(K\Omega) = 0.0785 * V_{out}^2 - 5.819 * V_{out} + 105.132$

$R1(K\Omega) = 20 - R2(K\Omega)$

FPS1000-32

$R_2(K\Omega) = 0.0463 * V_{out}^2 - 4.5805 * V_{out} + 109.49$

$R1(K\Omega) = 20 - R2(K\Omega)$

FPS1000-48

$R_2(K\Omega) = 0.0497 * V_{out}^2 - 7.2795 * V_{out} + 259.04$

$R1(K\Omega) = 50 - R2(K\Omega)$

1.3. On/off control

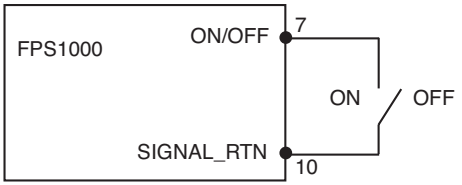


Fig 1-3

1.4. Supervisory signals

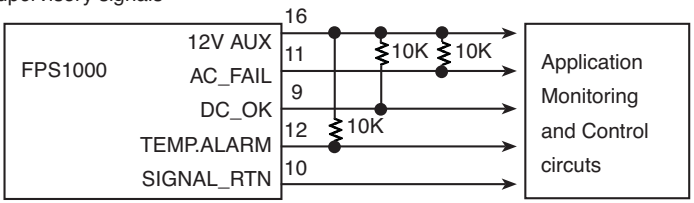


Fig 1-4

Note: AC_FAIL, DC_OK and TEMP.ALARM are open collector signals. See Table 1

2. PARALLEL OPERATION

2.1. Remote sensing and current balance

Up to 8 FPS1000 units of the same output voltage rating can be connected in parallel. By connecting the CS signal between the paralleled units, automatic current balance is achieved, with +/-10% accuracy

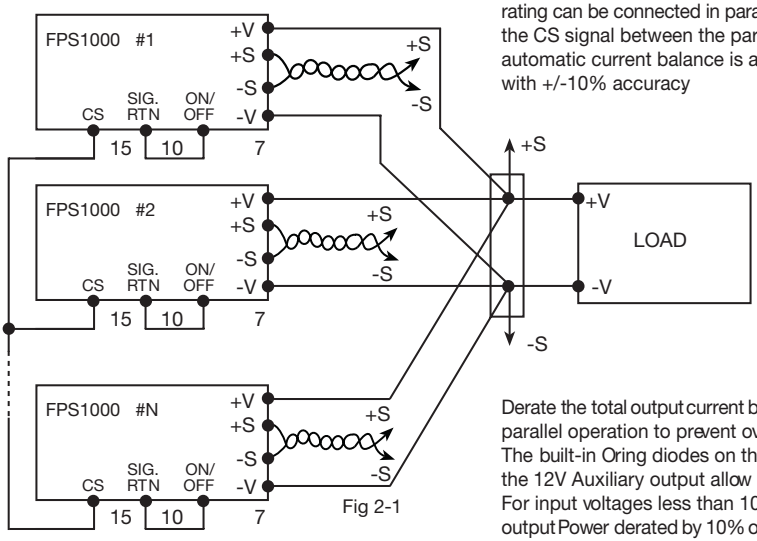


Fig 2-1

Derate the total output current by 10% when using parallel operation to prevent overload condition. The built-in Oring diodes on the main output and the 12V Auxiliary output allow N+1 operation. For input voltages less than 100Vac, maximum output Power derated by 10% of the Power rating.

2.2. Output voltage trimming

For best accuracy and current balance, each unit should be trimmed separately as shown in Fig 1-2. The parallel units can be trimmed also by a single trimmer as shown in Fig 2-2.

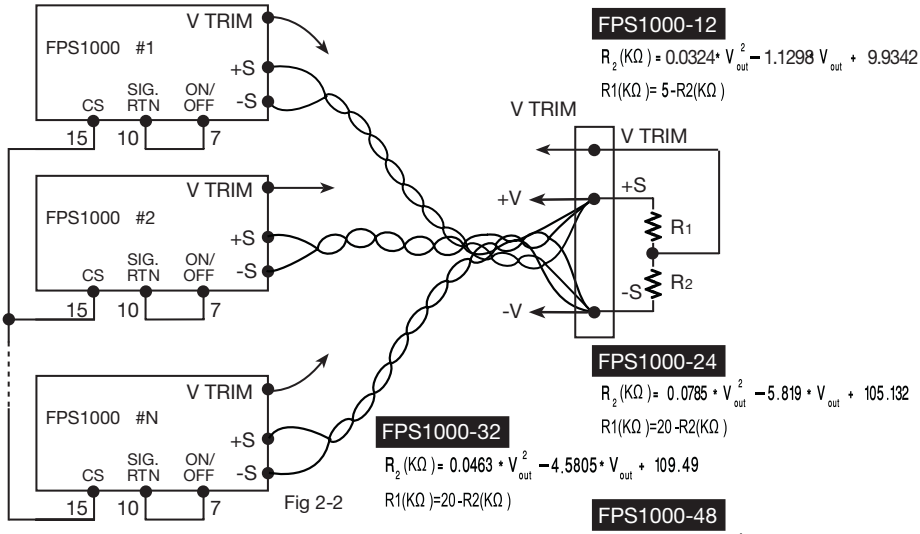


Fig 2-2

FPS1000-12

$R_2(K\Omega) = 0.0324 * V_{out}^2 - 1.1298 V_{out} + 9.9342$

$R1(K\Omega) = 5 - R2(K\Omega)$

FPS1000-24

$R_2(K\Omega) = 0.0785 * V_{out}^2 - 5.819 * V_{out} + 105.132$

$R1(K\Omega) = 20 - R2(K\Omega)$

FPS1000-32

$R_2(K\Omega) = 0.0463 * V_{out}^2 - 4.5805 * V_{out} + 109.49$

$R1(K\Omega) = 20 - R2(K\Omega)$

FPS1000-48

$R_2(K\Omega) = 0.0497 * V_{out}^2 - 7.2795 * V_{out} + 259.04$

$R1(K\Omega) = 50 - R2(K\Omega)$

2.3. On/off control

On/off control can be made via separate control for individual units (refer to Fig 1-3), or via single control as shown in Fig 2-3.

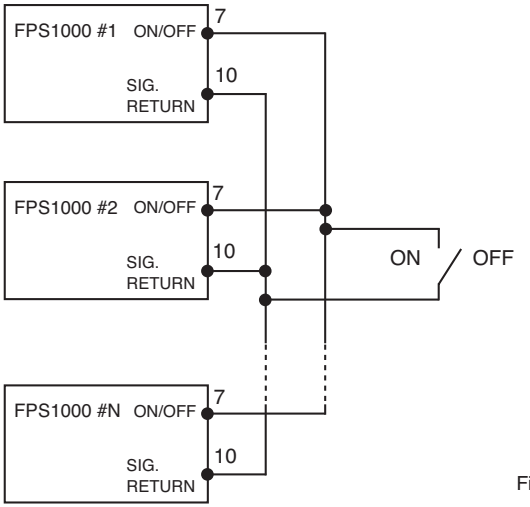


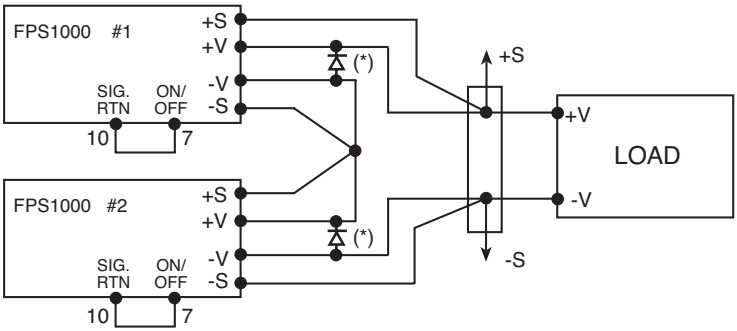
Fig 2-3

3. SERIES OPARATION

Up to 3 units can be used for increased output voltage
It is recommended that diodes be connected in parallel with each unit output to prevent revese voltage. Each diode should be rated to at least the power supply rated output voltage and output current.

CAUTION

Series operation is not applicable for units with I^2C bus option.



(*) Diodes are user supplied

Fig 3-1

4. FRONT PANEL INDICATORS.

1. AC OK Green LED: On when input voltage ≥ 85Vac, Off when Input voltage < 85Vac
2. DC OK Green LED: On when output voltage Vout ≥ 80% +/-5% of Vo rated
   Off when output voltage Vout < 80% +/-5% of Vo rated
3. DC FAIL Red LED: On when output voltage Vout ≤ 80% +/-5% of Vo rated
   Off when output voltage Vout > 80% +/-5% of Vo rated

5. MOUNTING METHOD.

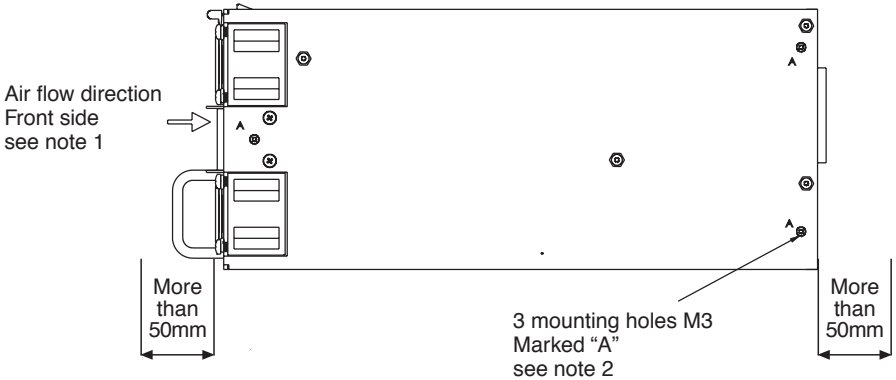


Fig 5-1

1. Forced air cooling allow minimum 50mm of unrestricted air space at the rear of the unit do not obsruct air flow to the unit front panel
2. Mounting screws must not penetrate more than 3mm into the unit.

I²C BUS INTERFACE OPTION

INTRODUCTION

The I²C interface option includes facilities to monitor operating parameters of the power supply. 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…).

ADDRESSING (A0, A1, A2).

Three address lines allow up to eight FPS1000 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 it to "0 or leaving the address line open to set it to "1".

SERIAL CLOCK

This line is clocked by the processor which controls the I²C bus. It should be connected to +5V (referenced to -Sense) via a pull-up resistor of 2KΩ. Pull-up resistor can be tuned depending on the application bus.
Refer to next page "PULL-UP RESISTOR SELECTION". The I²C interface is designed to run with a serial clock speed of 100KHz.

SERIAL DATA

This line is a bidirectional data line. It should be connected to +5V (referenced to -Sense) via a pull-up resistor of 2KΩ. Pull-up resistor can be tuned depending on the application bus. Refer to next page "PULL-UP RESISTOR SELECTION".

PULL-UP RESISTOR SELECTION

Figure 1 shows the internal section of I2C used in FPS series. There are 3 I²C ICs. Only one is shown as an example.

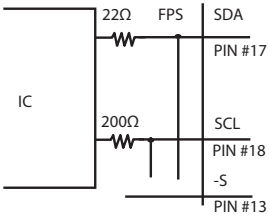


Fig. 1

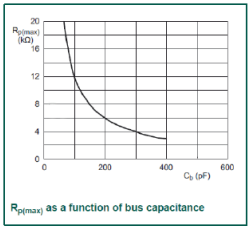


Fig. 2

For minimum pullup resistor selection, use the following equation, V_{DD} in FPS is 5V. V_{OL} (max) is 0.4V & I_{OL} is 3mA. So $R_{P\,(min)}$ is 1.53 kOhm

$$R_{P\,(min)} = \frac{V_{DD}\text{-}V_{OL}\,(max)}{I_{OL}}$$

Each of the 3 ICs adds some capacitance to the bus. The total capacitance generated by the 3 ICs in each power supply is about 25pF. Considering about 50pF extra capacitance for parasitic capacitance, wire capacitance and capacitance of master, the total capacitance seen with 1 supply can be about 75pF.
Please use figure 2 for selecting the external pull up resistor.

Maximum Pull up resistor can be between 12k ohm to 5k ohm depending on how many units are connected in the rack.
Ex - If one unit is connected, pull up resistor value can be 12k ohm max
If eight units are connected, pull up resistor value can be 5k ohm max
(Total capacitance of eight supplies will be 25 x 8 =200 pF + 50pF = 250pF).

OPERATION AND FUNCTIONS

1. DIGITAL STATUS

Digital status functions are provided by a PCF8574, 8-bit Register. It provides a single 8-bit word when read by the I²C controller.
Fault is indicated by "1" and Good level is indicated by "0". The register information is as follows:

BIT	FUNCTION	MEANING
0	Output Fail	Output voltage is < 80% +/-5% of Vo rated
1	Over Temperature Protection	Internal temperature is over 80°C. Supply turns off.
2	Temperature Alarm	Internal temperature is over 70°C. Supply is on.
3	Fan Fail	Failure of an internal fan.
4	AC Input Fail	Input voltage < 85Vac
5	Not Used	Always "0".
6	Not Used	Always "0".
7	Not Used	Always "0".

PCF8574 slave address:

Bit	7	6	5	4	3	2	1	0
Value	0	1	0	0	A2	A1	A0	R/W

2. EEPROM FUNCTIONS

A 256 bytes EEPROM is included in the I²C option. The EEPROM type is AT24C02 and it is programmed at the factory with the following data:

ADDRESS	BYTES	DATA
0	4	Number of fields
4	16	Manufacturer
20	20	Serial number
40	16	Revision
56	16	Country of manufacture
72	16	Model name
88	16	Output voltage
104	16	Date of manufacture
254	2	Checksum

The slave EEPROM address is:

Bit	7	6	5	4	3	2	1	0
Value	1	0	1	0	A2	A1	A0	R/W

3. ANALOG FUNCTIONS

Analogue functions are provided by a single PCF8591, 4-channel 8-bit A/D converter. When this device is read by the serial bus controller it provides an 8-bit word with the following information:
Channel 1: Output voltage, channel 2: Output current, channel 3: Internal temperature.

The PCF8591 slave address is:

Bit	7	6	5	4	3	2	1	0
Value	1	0	0	1	A2	A1	A0	R/W

The PCF8591 device initially requires a control byte to be written to the configuration register. The control byte is as follows:

Bit	7	6	5	4	3	2	1	0
Value	0	A	0	0	0	B	C	D

When a single channel is to be read, A,B,C and D should be determined as follows:

A/D channel	A	B	C	D
Voltage	0	0	0	0
Current	0	0	0	1
Temperature	0	0	1	0

To read all channels with a single control byte, A and B have to be "1", C and D have to be "0". This control byte sets the A/D so that on every read data from each channel is read. Note that on each read. a conversion is started for a particular channel and the result which will be displayed and will be of the previous read. (i.e. the previous channel).
Thus second read cycle gives result of the actual channel.
Note: the first result from a sequence of reads should not be considered.

A/D SCALING

The A/D readback has to be scaled to obtain a correct value for the voltage, current and the temperature. Note that the voltage reading is made inside the power supply unit before the "Oring" diode and is typically 0.5V higher than the actual output voltage.
The following scaling should be employed:

VALUE=BYTE VALUExRESOLUTION

Refer to the following table for the scaling of the A/D channels:

FPS1000-12/S	Range	Resolution	Accuracy
Voltage	0~15V	0.0586 V/Bit	+/-2% of full scale
Current	0~80A	0.312 A/Bit	+/-10% of full scale
Temperature	0~100°C	0.391°C/Bit	+/-3°C of full scale

FPS1000-24/S	Range	Resolution	Accuracy
Voltage	0~30V	0.1171V/Bit	+/-2% of full scale
Current	0~50A	0.1953A/Bit	+/-10% of full scale
Temperature	0~100°C	0.391°C/Bit	+/-3°C of full scale

FPS1000-32/S	Range	Resolution	Accuracy
Voltage	0~40V	0.1563V/Bit	+/-2% of full scale
Current	0~50A	0.1953A/Bit	+/-10% of full scale
Temperature	0~100°C	0.391°C/Bit	+/-3°C of full scale

FPS1000-48/S	Range	Resolution	Accuracy
Voltage	0~60V	0.2344V/Bit	+/-2% of full scale
Current	0~25A	0.0977A/Bit	+/-10% of full scale
Temperature	0~100°C	0.391°C/Bit	+/-3°C of full scale

The measurement range is from 0 to the maximum value listed in the range column. The resolution or scale of reading is linear over the entire range and provides a linear output on the A/D converter.

Model: FPS1000-48 /S
Measurements and calculation examples
Output voltage readback
1. Output voltage (at the output terminals): 48.0V
2. Voltage before the "Oring" diode: 48.0V+0.5V=48.5V
3. Hex readback: CE (1100 1110).
4. Convert the hex readback to decimal: 206
5. Calculate measured Vout: Vout=206*0.2344=48.286V

CAUTION

Series operation is not applicable for units with I^2C bus option.