VICOR

DESIGN GUIDE

WESTCOR MicroPAC

VICOR PowerBench

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Overview of Product

The MicroPAC is a factory configurable power supply providing up to 1,300 W of continuous power in a small slimline 1u package. The power supply provides up to 4 isolated outputs and combines power factor correction along with high efficiency and power density. The MicroPAC boasts a power density of 25Win³ and efficiency up to 92%, the power supply is available in a wide temperature range configuration and for harsh environments and mil-cots applications conformal coated. All configurations carry full safety agency approvals i.E. Ul60950 en60950 and are CE marked.
The MicroPAC power supply platform supports a wide range of customer power requirements and is especially suited for distributed power architectures. The design offers a small flexible cost-effective solution for applications requiring high efficiency and power density. The isolated outputs may be placed in parallel/series configurations with automatic current sharing. For applications requiring higher power levels the MicroPAC's can be configured in arrays with box to box current sharing.

Applications

- Factorized power architectures
- Distributed bus architectures
- Industrial
- Automation equipment
- Printing
- MIL-COTS applications
- Telecommunications
- Renewable energy

Standard Features

- High efficiency up to 92%
- Small Size
- High power density (25W/In^3)
- Up to 1,300 W (configuration dependent)
- Low power standby mode (Green mode)
- Universal Input (85 – 264 Vac) (47 – 400 Hz)
- DC Input (120 – 300 Vdc)
- Up to 4 Isolated outputs
- 12 V output standard
- 48 V output standard
- Aux isolated 5 V @ 500 mA bias standby supply
- Output parallel capability
- Output series capability
- Output current sharing
- MicroPAC to MicroPAC current sharing
- Power shed capability
- Vibration MIL-STD 810-F figure 514.5C-17
- Over temperature warning
- Over temperature shutdown
- Intelligent Fan control
- Field replaceable Fan
- Individual output enable / disable
- All output enables / disable capability
- TTL control signals
- Visual LED display panel
- Shock MIL-STD 810F Method 516.5 procedure 1, terminal peak saw-tooth wave, 40G 11 mS

Optional Features

- Extended temperature range -40ºC to +55ºC operation
- Conformal coated
- Power shed Mode

Mechanical Considerations

The MicroPAC power supply can be mounted on four of the six surfaces using standard 6-32 screws with a maximum torque of 7 inch-lb. When using the mounting points the maximum insertion depth of the screw into the chassis from the outside surface must not exceed 0.125″.
When considering a mounting location and/or orientation it is important not to restrict the air flow entering and exiting the MicroPAC. Air is drawn into the MicroPAC through the fan guard located next to the input power connector at the rear of the power supply and exhausts through the load side of the power supply next to the LED display panel. Westcor recommends a minimum clearance of 2″ be kept at the front and rear of the MicroPAC.
Care should be taken to minimize the output cabling as not impede the air exhausting from the MicroPAC, the output screw securing the cabling to the output terminals should be torque to 15 inc-lb not to exceed 20 inc-lb.

MicroPAC Do's and Don'ts

- Do not operate the without a secure protective earth (PE) lead connected to the input power connector.
- Do not operate the MicroPAC with AC input without inserting a correctly rated Vac fuse.
- Do not operate the MicroPAC with DC input without inserting a correctly rated Vdc fuse.
- Do not obstruct the fan air intake or air exhaust. (Care should be taken when connecting cabling).
- Do not connect or disconnect the output +Out or –Out cabling while the MicroPAC is in operation.
- Always make sure the output screws are properly torqued [15 inch-lb] before applying power.
- Run the output +Out and –Out cabling together preferably in a twisted pair configuration from the MicroPAC to the load.
- Do not attempt to repair or modify the MicroPAC power supply.
- Use correctly rated wire size for both input and output to avoid overheating and excessive voltage drop.

Terms and Acronyms

The following terms and acronyms are used throughout this document.

Acronym	Term
AML	Approved Manufacturing List
VAC	Volts Alternating Current
VDC	Volts Direct Current
BCM	Bus Converter Module
PE	Protective Earth
LED	Light Emitting Diode

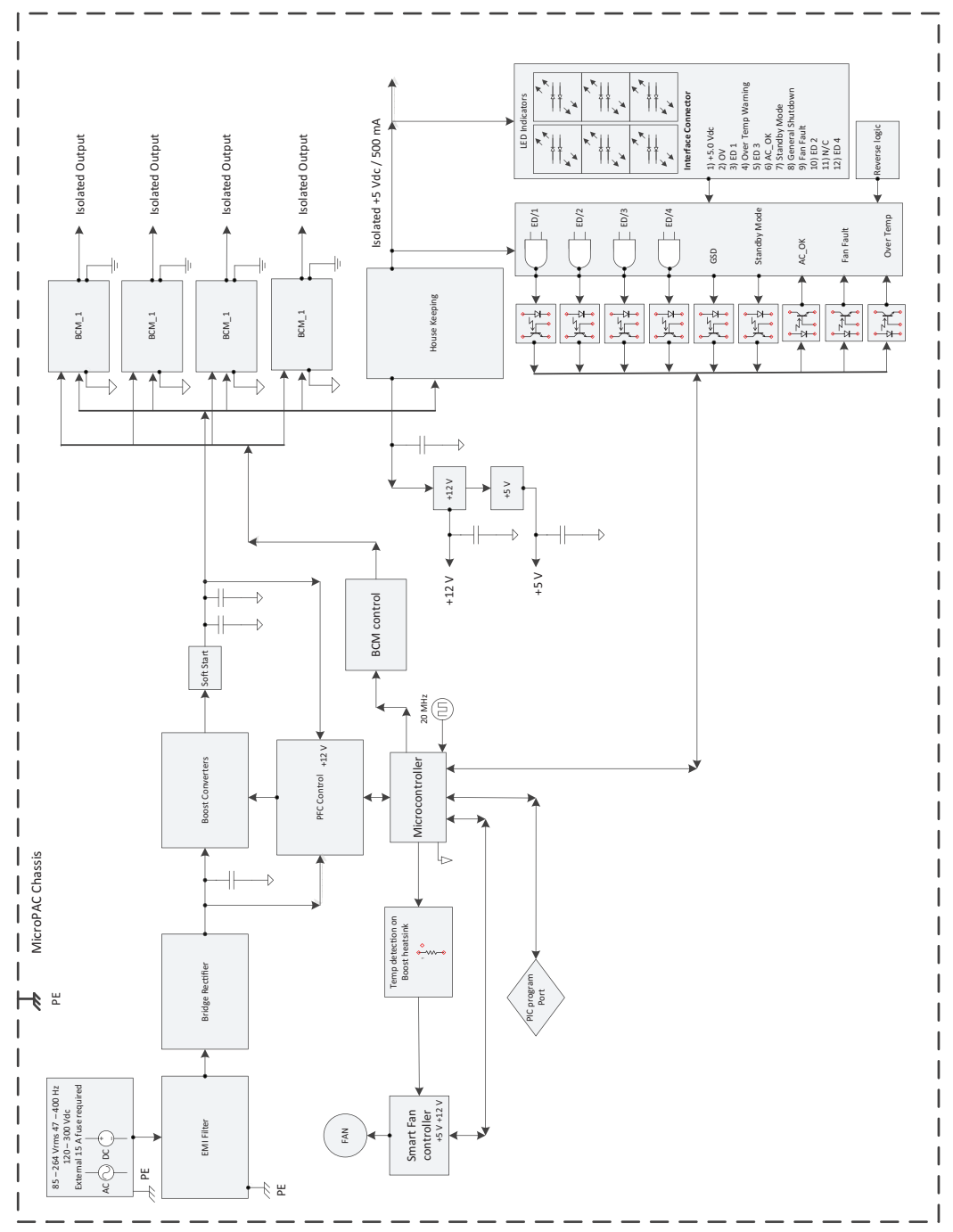
Acronym	Term
EMI	Electro-Magnetic Interference
FPA	Factorized Power Architecture
FRU	Field Replaceable Unit
GSD	General shutdown
MTBF	Mean Time Between Failure
NTC	Negative Temperature Coefficient

Acronym	Term
PFC	Power Factor Correction
PCB	Printed Circuit Board
PS	Power Supply
PSM	Power Shed Mode
PC	Performance Criteria
RoHS	Restriction of Hazardous Substances

Brief Technical Description

The MicroPAC power supply is designed to operate using a single phase voltage source input between 85 Vrms and 264 Vrms or 120 to 300 V dc source. The basic building blocks of the MicroPAC are an EMI filter, Power Factor Correction stage, cooling fan, and housekeeping, associated microcontroller circuits along with customer interfaces and galvanic isolated outputs and control signals.

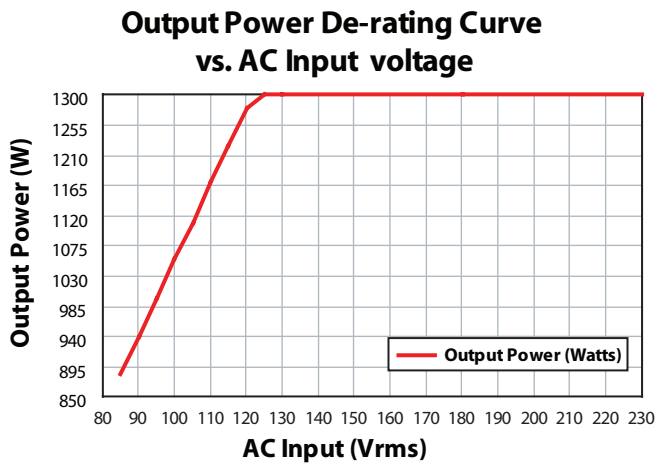
Figure 1:
Simple Block Diagram



Output Power De-rating Curve

The MicroPAC is designed to operate from a single electrical phase; as such it can be operated directly from a normal wall outlet socket. These sockets are normally rated for 12 A continuous current draw and 15 A peak current draw. With this in mind it is necessary to institute a power de-rating curve to maintain the operational range of the MicroPAC within these boundaries.

Figure 2:
Output Power De-rating Curve
vs.
AC Input Voltage



MicroPAC to MicroPAC Current Sharing

The MicroPAC power supplys with the same output voltages can be placed in parallel arrays by connecting the output positive (+) and return (-) rails to the respective positive and return rails of the next MicroPAC. If individual MicroPAC's are configured in an array it is necessary to make sure all MicroPAC are powered up at the same time. Pin 2 (0V +5V return) of the customer interface connector should be daisy chained together on each MicroPAC in the array. The GSD signal Pin 8 should also be daisy chained together and be used to turn on all outputs at the same time. The current sharing is achieved by using the droop sharing method and produces in the order of 5 –10% Current sharing accuracy. (Contact factory for details).

It is important to note that following good cable routing and symmetry is critical for good current sharing and load balancing.

MicroPAC Power Shed Mode

1.1.1 Introduction to the MicroPAC Power Shed Mode

The aim of the power shed mode is to increase the overall light load efficiency of the MicroPAC. This is achieved by minimizing the power dissipation when light load or no load conditions are present on the MicroPAC output.

The original concept of improving light load efficiency for VI Chip Bus Converter arrays was developed by Mr. Ankur Patel (Vicor Product Line Engineer).

The following is an alternative method of power shedding incorporated within the MicroPAC.

1.1.2 Power Shed Mode Prerequisites

- Slots 1 to 4 must be populated
- All outputs must be the same voltage
- All slots must be configured in a parallel array
- Current rate slew rate not to exceed 20.8 A/s
- The PSM is not suitable for constant dynamic loads

1.1.3 Configuring Power Shed Mode

The Power Shed Mode is factory configured.

1.1.4 Power Shedding Bands

There are four operational modes for the power shedding scheme.

Category	Customer Load	Output
1	0.0 – 250 W	Output 1, active
2	250 – 500 W	Output 1 and 2, active
3	500 – 750 W	Output1, 2 and 3 active
4	750 – 1200 W/1300 W	Output 1, 2, 3 and 4 active

1.1.5 Power Shed Mode Functional Description

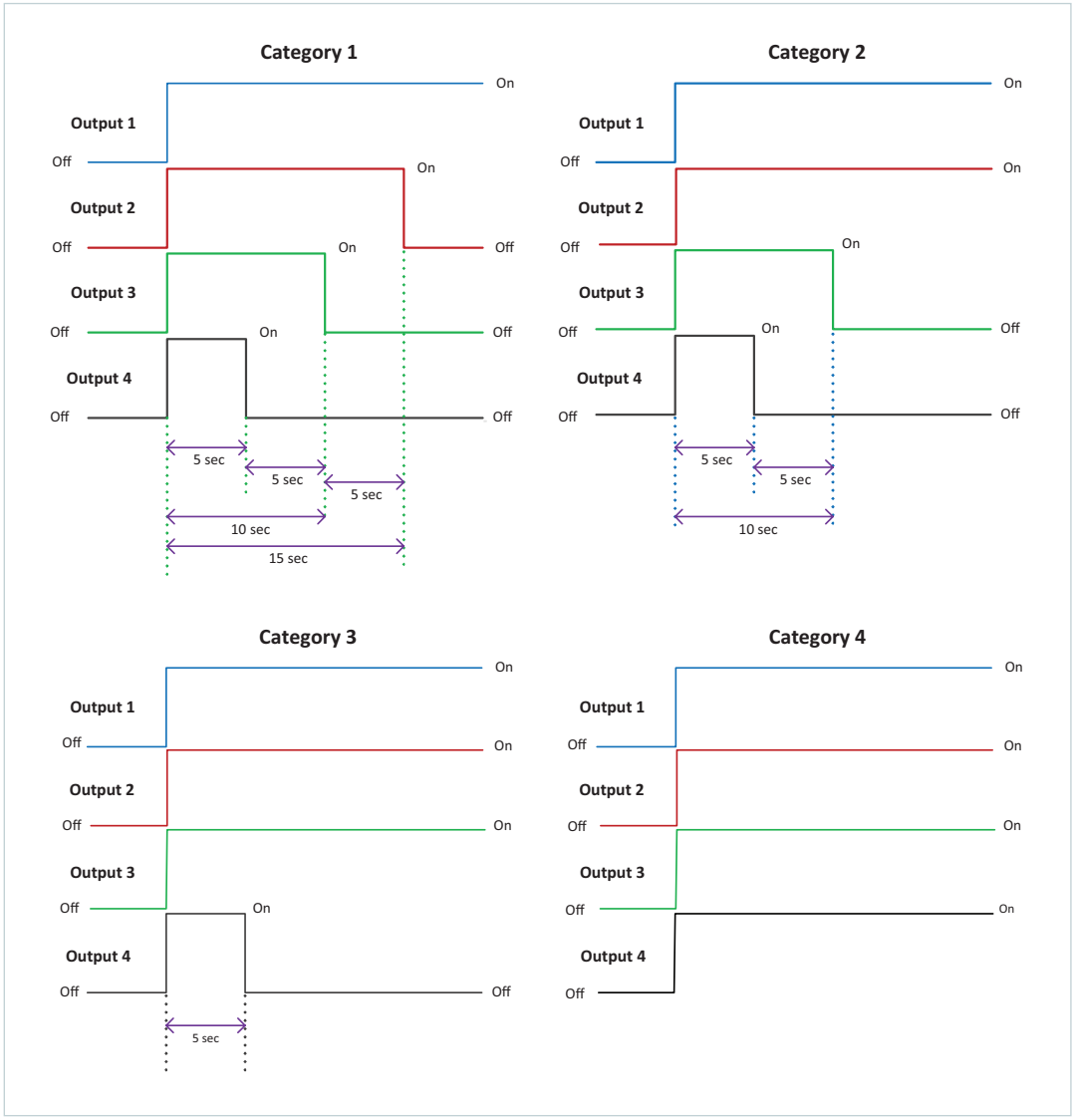
On power up with the power shed function enabled all four output channels are initially enabled, channel one to four LED's should be illuminated. Circuitry internal to the MicroPAC monitors the amount of current drawn from the MicroPAC and is proportional to the customer load.

If the load falls into category 1, the following will be observed.
After 5 seconds output 4 will turn off, after 10 seconds output 3 will turn off, after 15 seconds output 2 will turn off.

If the customer load falls into category 2, the following will be observed.
After 5 seconds output 4 will turn off, after 10 seconds output 3 will turn off, output 1 and 2 will remain on.

If the customer load falls into category 3, the following will be observed.
After 5 seconds output 4 will turn off, output 1, 2 and 3 will remain on.
If the customer load falls into category 4, all output will remain on.

Figure 3:
Power Shed



1.1.6 Shoot First, Ask Questions Later

When the MicroPAC is operating in categories 1 to 3 and detects an increase in load current applied to the output which incurs into the next power band the internal microcontroller will turn all outputs on, regardless of the actual amount of load added. (Shoot first ask question later) with all the outputs enabled, the microcontroller will turn off redundant outputs

In the Power Shed Mode this is a constant cycle of detecting output load and continually adjusting the outputs to satisfy that need.

1.1.7 No Load Power Dissipation with and without Power Shed Mode

Figure 4:
Plotted to the right is the average no load power dissipation when using four 12 V outputs. With the power shed enabled the average power dissipation is about 7.05 W; With the power shed disabled the power dissipation is around 28.20 W

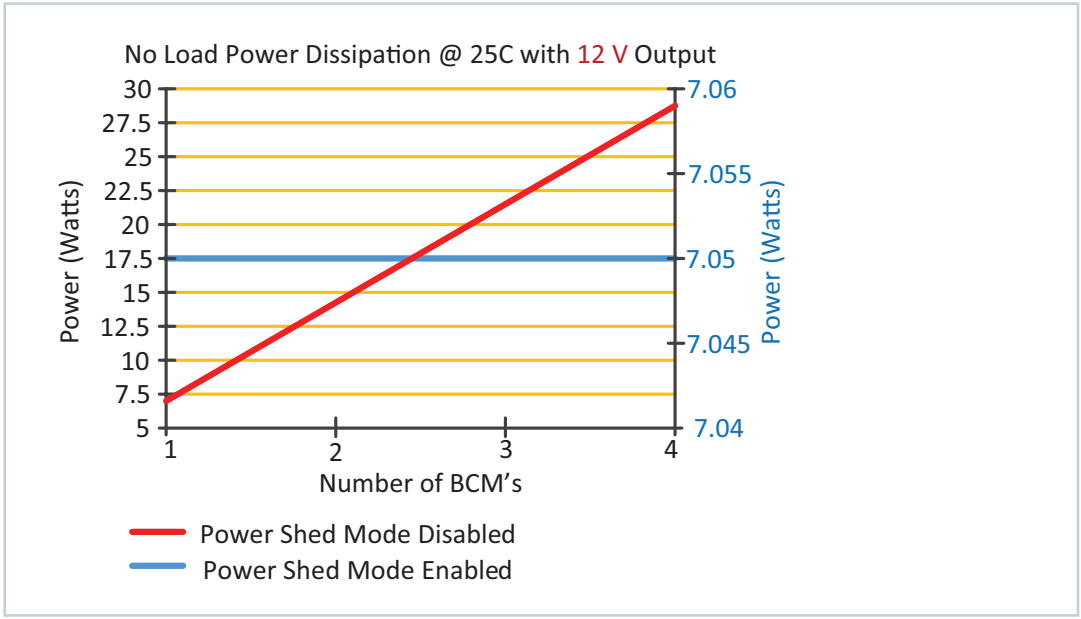
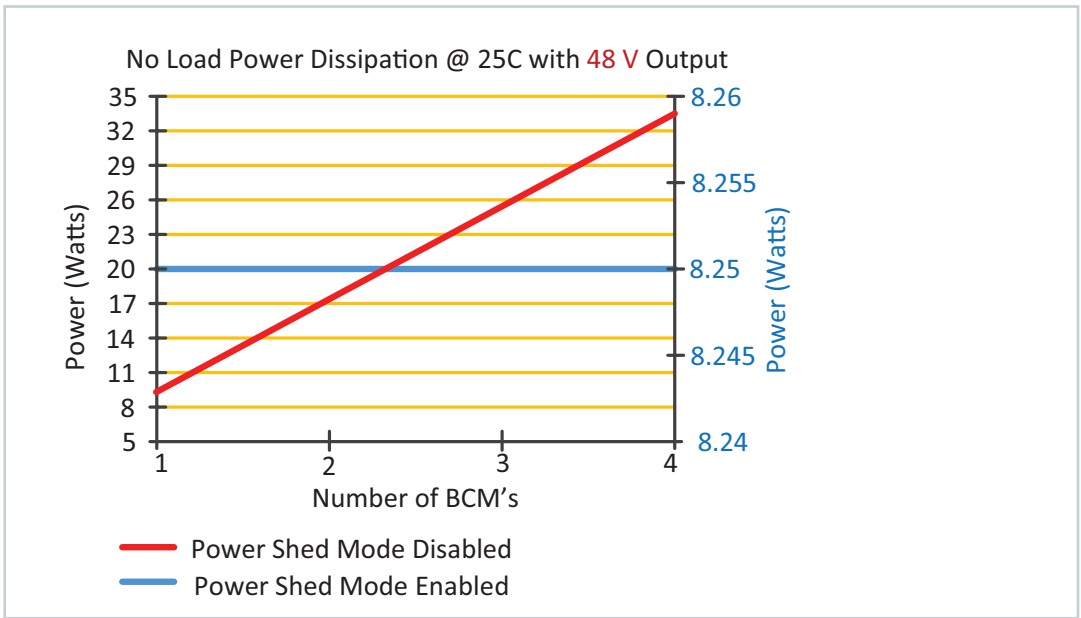


Figure 5:
Plotted to the right is the average no load power dissipation when using four 48 V outputs. With the power shed enabled the average power dissipation is about 8.25 W; With the power shed disabled the power dissipation is around 33 W.



Customer Interface Connector Kit (19-130066)

Material List

Item	QTY	Description	Westcor Part Number	Vendor #	Vendor Part Number
1	1	CONN HOUSING 12 POS MINITEK	63-00168-12	FCI	90311-012LF
2	12	TERM FEM CRIMP 26-30 AWG	63-00167-01	FCI	77138-101LF
		CRIMP TOOL FOR ITEM 2	----------	FCI	HT-151/RCY21151
3	1	CONN HOUSING 3 POS W/LATCH	63-00084-03	MOLEX	39-01-4030
4	3	TERM FEM CRIMP 16 AWG	63-00125-01	MOLEX	45750-3211
		CRIMP TOOL FOR ITEM 4	----------	MOLEX	11-01-0199

Field Replacement Unit

Field Replacement Unit

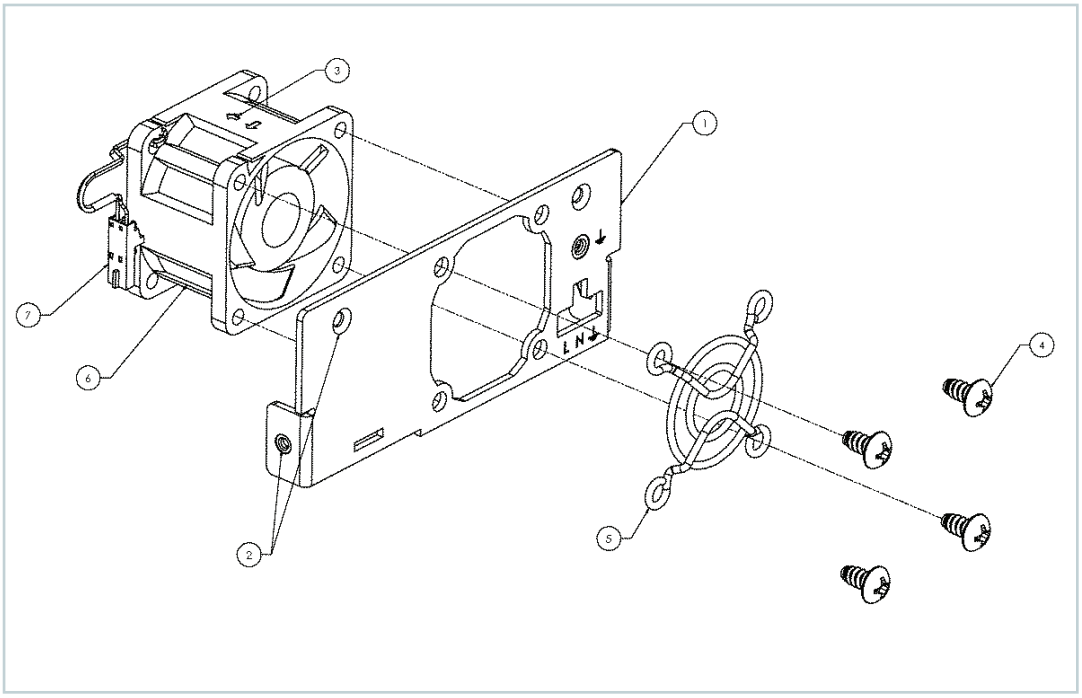
Item	QTY	Description	Westcor Part Number
1	1	ASSY FAN AVC DV-12M 40X28MM 14.4 CFM	10-130240-01
2	1	ASSY FAN SANYO DENKI -40C J-SPEED 40X28MM 18.4 CFM	10-130241-01

Field Replacement Unit Instructions.

- Remove input power connector.
  (this should never be attempted with the input power cable inserted)
- Remove output power connections
- Remove four screws, from the back panel (ref 1) two either side (ref; 2)
- Remove back panel (ref 1)
- Pull back the insulating material to gain access to the fan connector (ref 7)
- Depress the latching point on the fan connector (ref 7)
- The connector is polarized and removes vertically from the PCB housing
- Remove four screws (ref 4). The fan guard and fan are now free from the back panel.
- Insert new fan, making sure the arrow (ref 3) is pointed in the direction shown.
  (Towards the inside of the MicroPAC)
- Replace fan guard in the correct orientation (ref 5)
- Replace 4 screws (ref 4). The torque on these screw should be 5-6 inch-lb. (Friction tight)
- Insert fan connector (ref 7) into the fan housing.
  When inserted correctly you will not be able to remove without depressing the latch
- Fold the insulating material back
- Replace the back panel (ref 1) making sure the fan wire is routed to the side of the fan.
- Replace the four screws (ref 2). The torque on these screw is 5-6 inch-lb
- Never apply power to the MicroPAC until all of the reassembly is complete.

Estimated replacement time 15 minutes

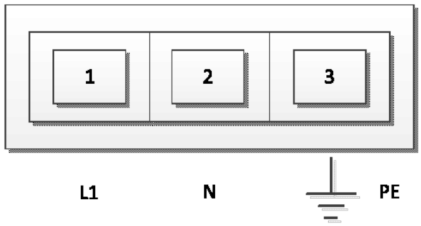
Figure 5:
Fan Assembly



Customer Interface

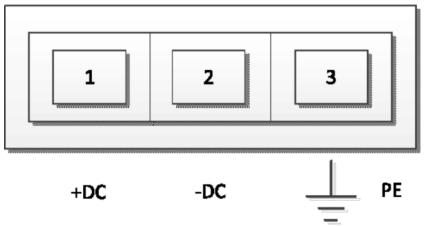
1.1.8 Input Power Connector Pin Designation (AC Use Only)

Pin	Designation
1	Live (L1)
2	Neutral (L2)
3	Protective Earth (PE)



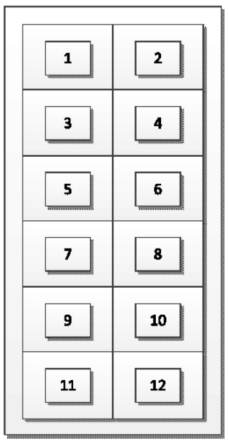
1.1.9 Input Power Connector Pin Designation (DC Use Only)

Pin	Designation
1	+ DC (L1)
2	- DC (L2)
3	Protective Earth (PE)



1.1.10 Customer Interface Pin Designation

Pin	Designation
1	+5V
2	0V (+5V RETURN)
3	ED 1
4	Overtemperature warning/Overtemperature shutdown
5	ED 3
6	AC-OK
7	STANDBY MODE
8	GENERAL SHUTDOWN
9	FAN FAULT
10	ED 2
11	N/C
12	ED 4



J2 Customer Interface Signals

All customer interface signals are referenced to the auxiliary +5V return (pin 2)

1.1.11 Auxiliary Supply

Pin 1 An auxiliary +5V supply output is available with a maximum output of 500 mA (2.5 W).

Pin 2 0 V; this is the return for the above +5V.

1.1.12 ED/1 Enable/Disable Output Channel One

Pin 3 **ED/1:** This pin is normally at +5V potential, this enables output channel one. To disable output one this pin should be shorted to pin 2. If the output is disabled LED 1 will illuminate on the LED display until the output is enabled.

1.1.13 Over Temperature Warning (Non Latching)

Pin 4 This pin is normally at +5V potential when referenced to pin 2. At approximately 50°C ambient temperature the over temperature warning signal will be pulled low, the fault LED indicator will illuminate solid yellow. This is just a warning that you are approximately +5°C away from the maximum operating temperature of the MicroPAC. No other action by the power supply will be taken.

1.1.14 Over Temperature Shutdown (Latching)

Pin 4 The same pin is used as the over temperature warning.
At approximately +56°C the over temperature shutdown is triggered, the fault LED previously illuminated a solid yellow due to the over temperature warning will now begin to flash at approximately 2 Hz. All outputs will be disabled. The power supply will go into a shutdown mode; however the fan will be left running to cool the unit, the MicroPAC will remain in shutdown mode until the temperature reaches an acceptable level and the power is recycled.

1.1.15 ED/3 Enable/Disable Output Channel Three

Pin 5 **ED/3:** This pin is normally at +5V potential, this enables output channel three. To disable channel three this pin should be shorted to pin 2. If the output is disabled LED 3 will illuminate on the LED display until the output is enabled.

1.1.16 Power

Pin 6 If the AC or DC power input is present the pin is normally at +5V potential when referenced to pin 2. The blue power LED will illuminate. If the AC or DC input is lost pin 6 will fall to logic level zero and the blue power LED will turn off. This will allow a minimum 10 mS power loss warning to the customer.

1.1.17 Standby Mode

Pin 7 This pin is normally at +5V potential when referenced to pin 2. If this pin is shorted to pin 2 the MicroPAC will enter a low power standby mode. In this mode all outputs will be disabled, the main PFC power supply will be shut-down along with the fan. The blue power LED will change to an amber color. When the short is removed the power power supply will return to normal operation and the power LED will turn to blue.

1.1.18 General Shut Down (GSD)

Pin 8 This pin is normally at +5V potential when referenced to pin 2. If this pin is shorted to pin 2 all the channels will be disabled and all four of the GSD LED's (1-4) will illuminate.

1.1.19 Fan Fault (Latching)

Pin 9 This pin is normally at +5V potential when referenced to pin 2. In the event of the fan failing the detection circuit will shut the MicroPAC down, and illuminate the fault LED red. Pin 9; will go from logic high to logic low level during this event. The MicroPAC will be latched in this condition until power is removed for 30 seconds, upon reapplying power if the fault is still persist the power supply will latch in the shut-down mode until the fault has been cleared.

1.1.20 Ed/2 Enable/Disable Output Channel Two

Pin 10 This pin is normally at +5V potential, this enables output channel two. To disable channel two this pin should be shorted to pin 2. If the output is disabled LED 2 will illuminate on the LED display until the output is enabled

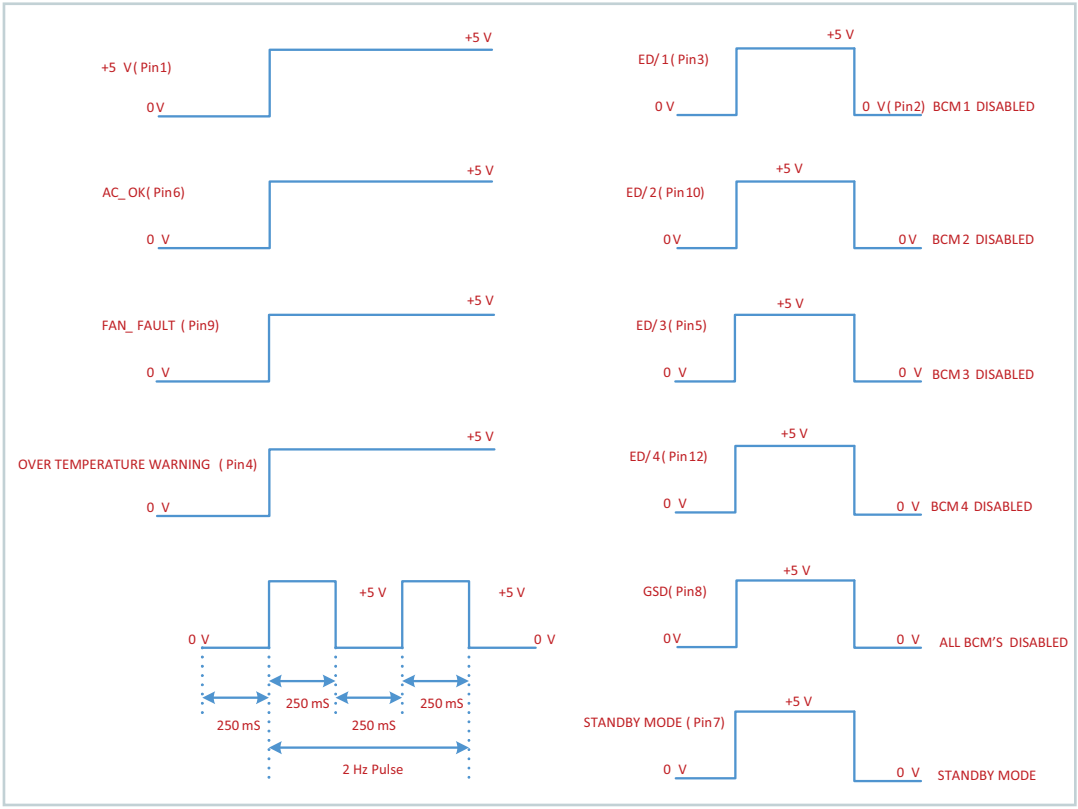
1.1.21 Not Connected

Pin 11 Pin 11 is not u sed

1.1.22 Ed/4 Enable/Disable Output Channel Four

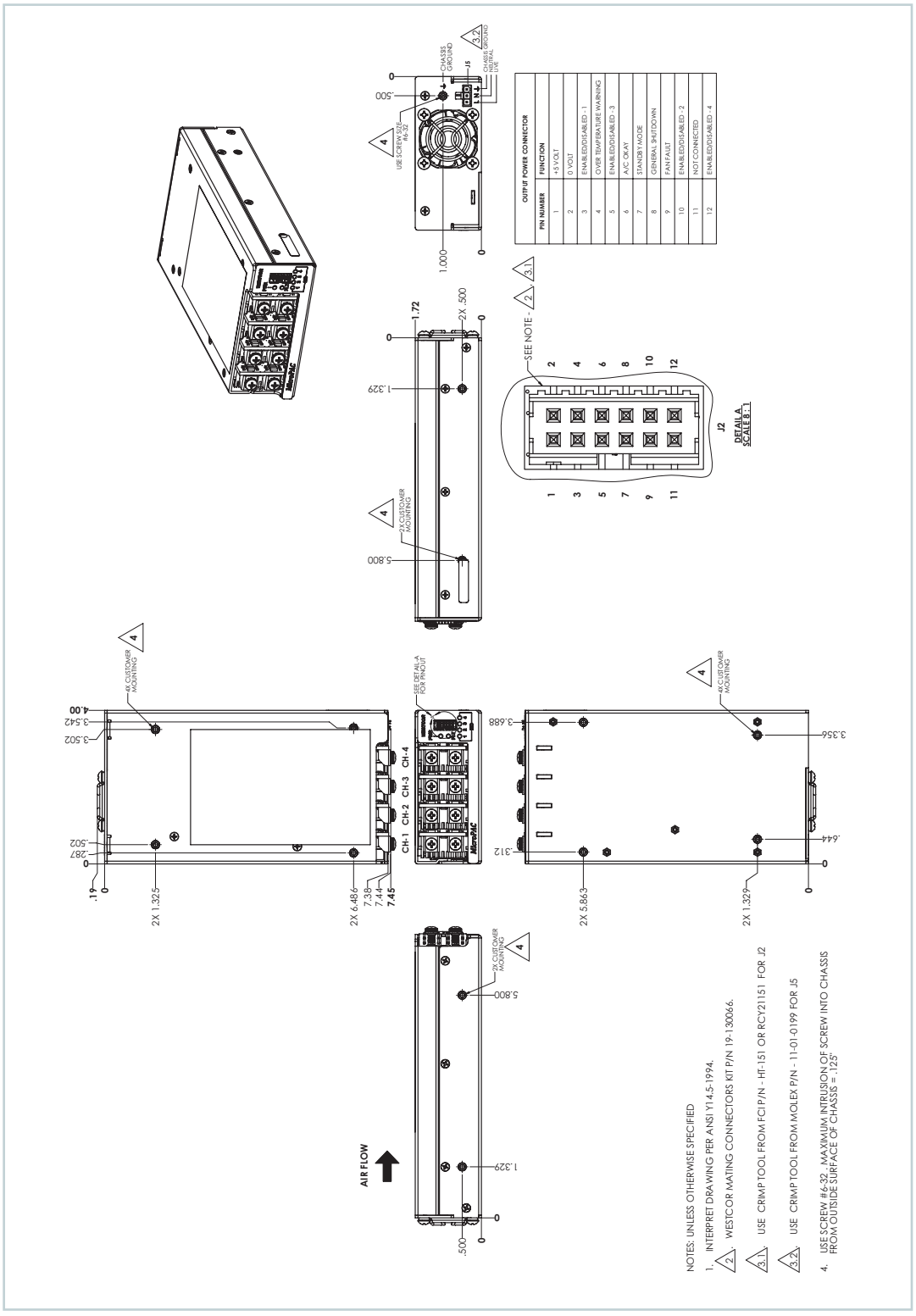
Pin 12 This pin is normally at +5V potential, this enables output channel four. To disable channel four this pin should be shorted to pin 2. If the output is disabled LED 4 will illuminate on the LED display until the output is enabled

1.1.23 Output TTL logic Signals



Mechanical

1.1.24 Physical Dimensions/Markings

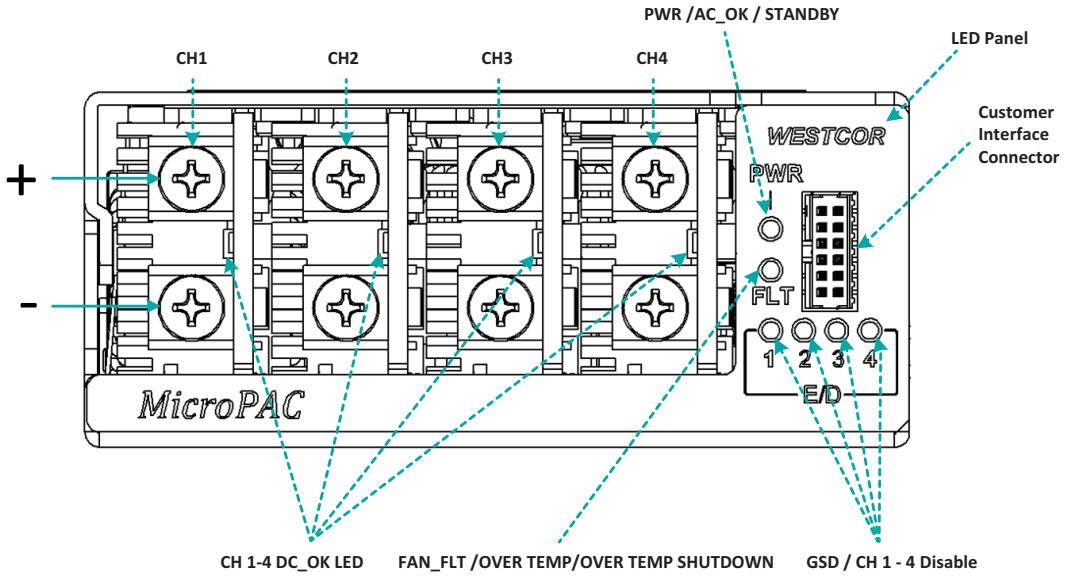


1.1.25 Physical Weight

2.15Lbs

Front Panel

1.1.26 LED Indicator Panel



1.1.27 LED Function

LED Function				
LED#	**Function 1**	**Color**	**Function 2**	**Color**
1	ED 1	Orange	GSD (General Shutdown)	Yellow/Green
2	ED 2	Orange	GSD	Yellow/Green
3	ED 3	Orange	GSD	Yellow/Green
4	ED 4	Orange	GSD	Yellow/Green
FLT	Fan Fault	Red	Overtemperature warning Overtemperature shut down	Yellow 2 Hz Flashing Yellow
PWR	AC-OK	Blue	Standby	Amber

MicroPAC Model Numbering Scheme

Model Number: UPa - bbbb - cde

Where

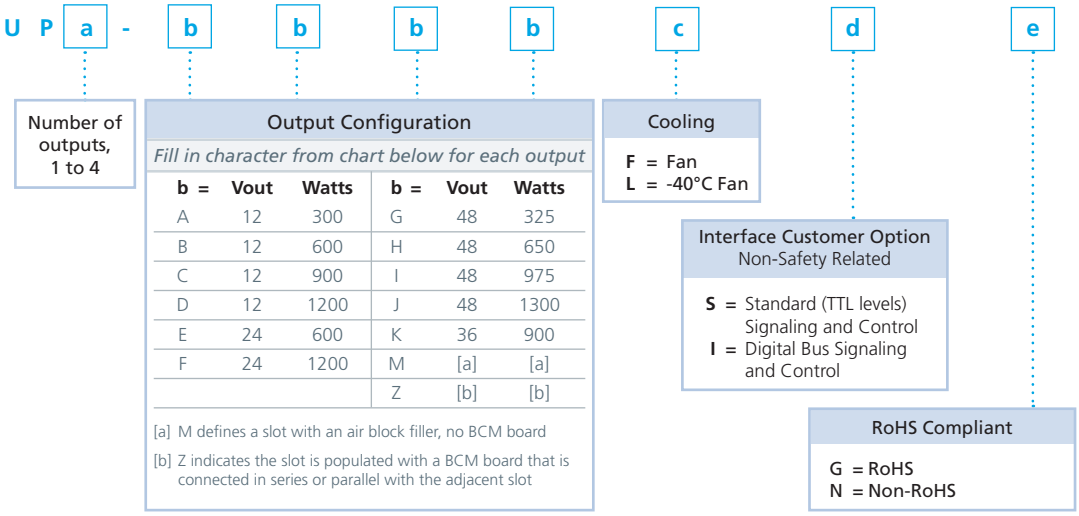
a = number of outputs from 1 to 4
b = equals a character denoting output 1 voltage and power
b = equals a character denoting output 2 voltage and power
b = equals a character denoting output 3 voltage and power
b = equals a character denoting output 4 voltage and power

One character will denote a null for an output

c, d, e will be characters denoting box level options such as fan cooling, conduction cooling, convection cooling, interfacing scheme, and rohs status.

Output Voltage and Voltage Table (bbbb)

Character	Vout	Watts	Character	Vout	Watts
A	12	300	G	48	325
B	12	600	H	48	650
C	12	900	I	48	975
D	12	1200	J	48	1300
E	24	600	K	36	900
F	24	1200	Z	Null	Null



Examples:

UP1-FZZZ-FSG Denotes a single output of 24 V 1200 W
with a standard fan, standard TTL signaling and control, RoHS compliant

UP4-AAAA-LIN Denotes 4 output unit, each output is 12 V 300 W.
The fan is a -40°C capable unit, the control bus is digital, and the unit is non-RoHS

Specifications

Input		
Input Voltage	85 – 264 Vac	DC Rating: 120 Vdc – 300 Vdc
External Fuse	(¼" x 1¼") Cooper Bussmann, ABC-15, rated 15 A Littelfuse, 505 series, rated 16 A/500 Vdc	(5 x 20 mm) Littelfuse, 216 series, rated 16 A (¼" x 1¼") Littelfuse, 505 series, rated 16 A/500 Vdc
Frequency	47 ~ 400 Hz	
Inrush Current	30 A Peak	
Efficiency	≥92% @ Full load @ 25°C ambient 48 V output	≥91% @ Full load @ 25°C ambient 12 V output
Power factor	>0.95 typ. Meets EN61000-3-2	
Turn-on time	AC on 1.5 sec TYP	
Conducted EMI	EN55022 Class B Information technology equipment — Radio disturbances characteristics — Limits and methods of measurement BS EN55022:1998; CISPR 22:1997, incorporating corrigendum	
Harmonic distortion	Meets IEC 61000-3-2	
Isolation	Meets IEC 60950	
Leakage current	<3.5 mA @ 264 Vac @ 63 Hz	
Hold up time	20 mS typical	
Warranty	2 Years	
Output		
Number of outputs	1 to 4	
Normal output voltages	12 V, 24 V, 36 V and 48 V (contact factory for details)	
Maximum output current	100 A @ 12 V	[27 A @ 48 V]
Auxiliary output	5 V @ 0.5 A 50 mV p-p	
Voltage regulation	12 V output (11.3 V ~ 12.5 V)	48 V output (45 V ~ 50 V)
Ripple and noise	12 V output (197 mV ~ 400 mV p-p)	48 V output (1.6 Vp-p)
(20 MHz bandwidth)		
Current sharing accuracy	5 to 10%	
Short circuit protection	"Fold-Back" Technique	
Over voltage protection	12 V output set point 12.5 V typical	48 V modules 50 V typical
Thermal protection	All outputs disabled when internal temperature exceeds safe operating	
Maximum load	12 V up to 1200 W	
Maximum load	48 V up to 1300 W	
Maximum load	5.0 V Aux up to 2.5 W	
Maximum load capacitance	1000 µF per 12 V output	100 µF per 48 V output

Specifications (Cont.)

Environmental	
Storage temperature	-40°C ~ +85°C
Operating temperature	-20°C ~ +55°C (Extended temperature range is available; -40°C to +55°C)
Functional shock	MIL-STD 810F Method 516.5 procedure 1, terminal peak saw-tooth wave, 40G 11 mS
Vibration	MIL-STD 810G for minimum integrity vibration
Humidity	95% non condensing
Cooling	Fan cooled (field replaceable) temperature speed control
Electromagnetic Compatibility	
	EN61000-6-1n European General EMC Immunity
IEC 61000-4-11 [50 Hz]	Voltage Dips 30% for 0.5 prd, pc C Voltage Interrupts (pc C)
IEC 61000-4-4 [TRANSIENT]	EFT/Burst ± 1 kV AC leads ± 500 V DC leads. 5/50 nsec 5 kHz rep rate (pc B)
IEC 61000-4-5 [SURGE]	Power line Surge AC in ± 2 kV CM ± 1 kV DM DC in ± 500 V CM & DM 1.2/µSec (pc B)
EN 61000-4-6 [0.15 to 80 MHz]	RF Common Mode Input leads, AC & DC leads, CDN 150 kHz to 80 MHz, 3 Vrms with 80% AM @1 kHz (pa A)
EN 61000-4-2 [ELECTROSTATIC]	Electrostatic Discharge ± 4 kV Contact ± 8 kV Discharge (pc B)
EN 61000-4-3	RF E-Field 80 MHz to 1 GHz 3 V/m with 80% AM @ 1 kHz (pc A)
EN 61000-4-8	Power Freq H-Field 3A/M @ 50 Hz (pa A)
Reliability	
FIT	TBD
Service life	5 Years
Safety & Regulatory	
UL	UL 60950-1:2007 CAN C22.2 No. 60950-1-07
CSA	CSA*60950 3rd Edition (CB Report to include all national deviations)
EN	EN 60950-1/A1:2010
IEC	60950-1-2005 2 Ed. +A1:2009

The Power Behind Performance

Vicor's comprehensive line of power solutions includes high density AC-DC and DC-DC modules and accessory components, fully configurable AC-DC and DC-DC power supplies, and complete custom power systems.

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