

## Description

The AVO120-48S12B-4 DC-DC converter is a next-generation industry standard eighth brick with optimized ultra high efficiency. This module can provide up to 10A output current at 12V output voltage, industry standard eighth brick 57.9mm × 22.9mm × 9.5mm (2.28" × 0.9" × 0.374"), which makes it an ideal choice for small space, telecom and datacom applications. The AVO120-48S12B-4 is standard eighth brick pin-out configuration, with open frame option. It provides CNT remote control, trim and sense functions, with OVP, OCP, OTP full protection method. This product can achieve ultra high efficiency of 93% at full load. For better thermal performance, a heatsink is required.

## Operational Features

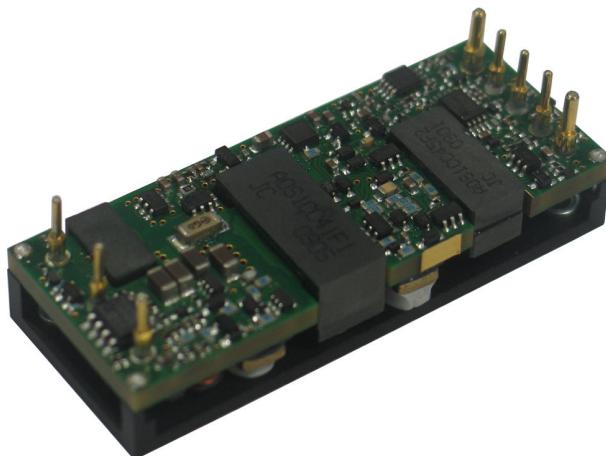
- Up to 10A output current
- Ultra-high efficiency 93% typ. at full load
- Wide input range: 36V ~ 75V
- Excellent thermal performance
- No minimum load requirement
- Pre-bias function
- RoHS 6 compliant

## Control Features

- Remote control function
- Remote output sense
- Trim function: 80% ~ 110%

## Protection Features

- Input under voltage lockout
- Output over current protection
- Output over voltage protection
- Over-temperature protection



## Mechanical Features

- Industry standard eighth brick
- Standard module with base plate
- Pin length option: 4.8mm

## Safety & EMC

- Meet safety standards UL 60950-1 2<sup>nd</sup> edition, IEC/EN 60950-1 2<sup>nd</sup> edition and GB4943
- Approved by UL and TUV
- Meet 2006/95/EEC and 93/68/EEC directives which facilitates CE marking in user's end product
- Meet conducted emission's requirements of EN55022 Class A with external filter

## Electrical Characteristics

Full operating ambient temperature range is -40°C to +85°C.

Specifications are subject to change without notice.

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
<b>Absolute max. ratings</b>					
Input voltage	Non-operating		100	V	100ms
	Operating		80	V	Continuous
Operating temperature	-40		85	°C	
Storage temperature	-55		125	°C	
Voltage at remote ON/OFF pin	-0.7		12	V	
<b>Input characteristics</b>					
Operating input voltage range	36	48	75	V	
Input under-voltage lockout	Turn-on voltage threshold	31	36	V	
	Turn-off voltage threshold	30	35	V	
	Lockout voltage hysteresis	1	3	V	
Max. input current			4.5	A	36V <sub>in</sub> , full load
No-load input current			0.1	A	
Standby input current		0	0.1	A	Remote OFF
Inrush current transient rating			1	A <sup>2</sup> s	Figure 15
Input reflected ripple current		20		mA	Through 12µH inductor; Figure 15
Recommended input fuse			10	A	Fast blow external fuse recommended; Figure 10
Recommended external input capacitance	100			µF	Low ESR capacitor recommended; Figure 10
<b>Output characteristics</b>					
Output voltage set point (standard option)	11.8	12	12.2	V	48V <sub>in</sub> , full load
Output voltage line regulation				%	
		6		mV	
Output voltage load regulation				%	
		10		mV	
Output voltage temperature regulation			0.02	%/°C	

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions	
Total output voltage range	11.6	12	12.4	V	Over sample, line, load, temperature & life	
Output voltage ripple and noise		65		mVpp	Figure 2 20MHz bandwidth; Figure 15	
Output voltage ripple and noise		65		mVpp	Ta:25°C, Air velocity: 300LFM, Vin: 48V, Vnom, Inom, 10u tantalum(ESR≤100 mΩ)// 1u ceramic capacitor, output<=12V)	
Operating output current range	0		10	A		
Output DC current-limit inception	10.5		18	A	Hiccup: auto-restart when over-current condition is removed	
Vout pre-bias level			90	%V <sub>o</sub>		
Output capacitance	100		6000	μF	High frequency and low ESR is recommended	
<b>Dynamic characteristics</b>						
Dynamic response	25% ~ 50% ~ 25% I <sub>o,max</sub> , 0.1A/μs		100		mV	Figure 4 Test condition: 25°C, nominal input voltage, see Figure 10
	Setting time		150		μs	Recovery to within 1% V <sub>o,nom</sub>
	25% ~ 50% ~ 25% I <sub>o,max</sub> , 1A/μs		150		mV	Figure 5 Test condition: 25°C, nominal input voltage, see Figure 10
	Setting time		150		μs	Recovery to within 1% V <sub>o,nom</sub>
Turn-on transient	Rise time		15		ms	Full load, Figure 6
	Turn-on delay time		50		ms	
	Output voltage overshoot		0		%V <sub>o</sub>	
<b>Efficiency</b>						
100% load		93		%	Figure 1	
50% load		93		%	Figure 1	
20% load		89.5		%	Figure 1	

## Electrical Characteristics (Continued)

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
<b>Isolation characteristics</b>					
Isolation voltage (conditions: 1mA for 60s, slew rate of 2000V/10s)	2000			V	Basic insulation, pollution degree 2, input to output
	1000			V	Basic insulation, pollution degree 2, input to baseplate
	1000			V	Basic insulation, pollution degree 2, output to baseplate
<b>Feature characteristics</b>					
Switching frequency		165		kHz	
Remote ON/OFF control (positive logic)	Off-state voltage	-0.7		1.2	V
	On-state voltage	3.5		12	V
Remote ON/OFF control (negative logic)	Off-state voltage	3.5		12	V
	On-state voltage	-0.7		1.2	V
Output voltage trim range	9.6		13.2	V	<i>Trim Characteristics</i> , see Figure 14
Output voltage remote sense range			1	V	
Output over-voltage protection	13.8		19	V	Hiccup: auto-restart when over-voltage condition is removed
Over-temperature shutdown	112	121	130	°C	Auto recovery; over-temperature protection (OTP) test point: see TEST POINT 1 in Figure 16
Over-temperature hysteresis	5			°C	
<b>Reliability characteristics</b>					
Calculated MTBF (telcordia)		1.5		10 <sup>6</sup> h	Telcordia SR-332-2006; 80% load, 300LFM, 40°C T <sub>a</sub>

## Electromagnetic compatibility requirements

Test Item	Regulations	Criteria	Notes & Conditions
Conducted Emission	EN 55022 DC input port, Class A Limits		
Immunity to Electrostatic Discharge	IEC/EN61000-4-2 Enclosure Port, Level 3	B	
Immunity to Electrical Fast Transient	IEC/EN61000-4-4 DC input port, Level 3	B	
Immunity to Surges	IEC/EN61000-4-5 DC input port Line to Ground (earth): 600V Line to Line: 600V	B	See EMC test conditions
Immunity to Continuous Conducted Interference	IEC/EN61000-4-6 DC input port, Level 2	A	
Immunity To Voltage Dips and short interruptions and voltage variations	EN 61000-4-29 DC input port	B	

Criterion A: Normal performance during and after test.

Criterion B: For EFT and surges, low-voltage protection or reset is not allowed. Temporary output voltage fluctuation ceases after disturbances ceases, and from which the EUT recovers its normal performance automatically. For Dips and ESD, output voltage fluctuation or reset is allowed during the test, but recovers to its normal performance automatically after the disturbance ceases.

Criterion C: Temporary loss of output, the correction of which requires operator intervention.

Criterion D: Loss of output which is not recoverable, owing to damage to hardware.

## Qualification Testing

Parameter	Unit (pcs)	Test condition
Halt test	4 ~ 5	T <sub>a,min</sub> -10°C to T <sub>a,max</sub> +10°C, 5°C step, V <sub>in</sub> = min to max, 0 ~ 105% load
Vibration	3	Frequency range: 5Hz ~ 20Hz, 20Hz ~ 200Hz, A.S.D: 1.0m <sup>2</sup> /s <sup>3</sup> , -3db/oct, axes of vibration: X/Y/Z. Time: 30min/axis
Mechanical shock	3	30g, 6ms, 3axes, 6directions, 3time/direction
Thermal shock	3	-40°C to 100°C, unit temperature 20cycles
Thermal cycling	3	-40°C to 55°C, temperature change rate: 1°C/min, cycles: 2cycles
Humidity	3	40°C, 95%RH, 48h
Solder ability	15	IPC J-STD-002C-2007

## Characteristic Curves

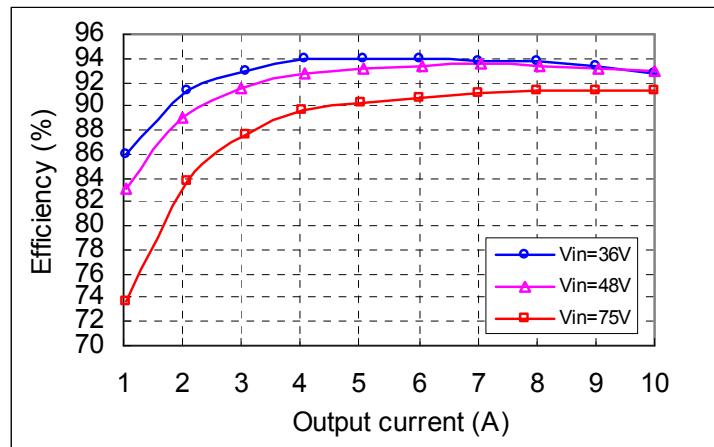


Figure 1 Efficiency vs. output current,  $T_a=25^\circ\text{C}$ ,  $V_o=12\text{V}$ , Air velocity=300LFM

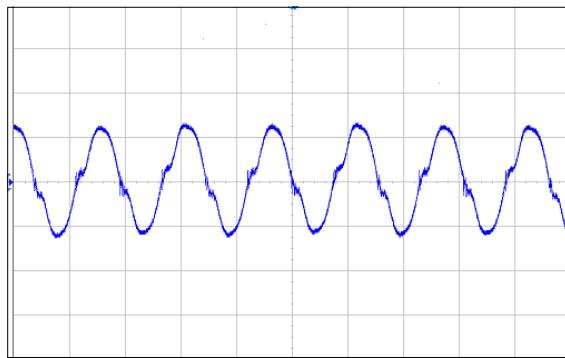


Figure 2 Output ripple & noise (2μs/div, 20mV/div), see Figure 15 for test configuration

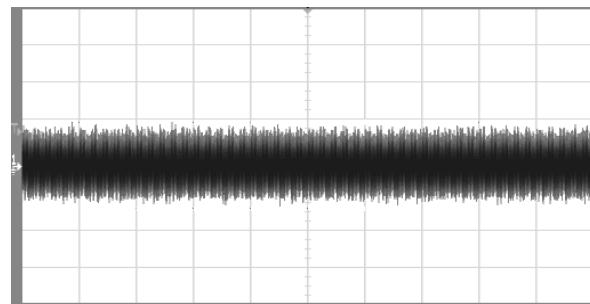


Figure 3 Input reflected ripple current (100ms/div, 10mA/div), see Figure 15 for test configuration

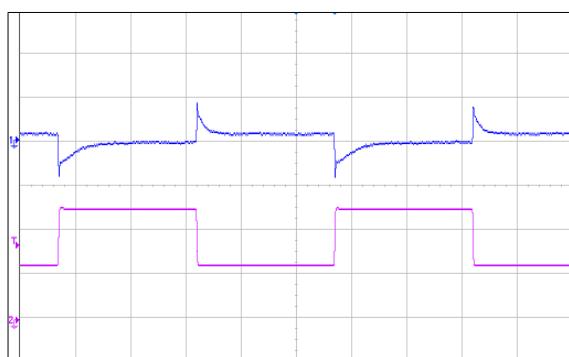


Figure 4 Dynamic response for 25% load step (25% ~ 50% ~ 25%) and 0.1A/μs slew rate, (2ms/div), see Figure 10 for test configuration; CH1-output voltage (100mV/div); CH2-output current (2A/div)

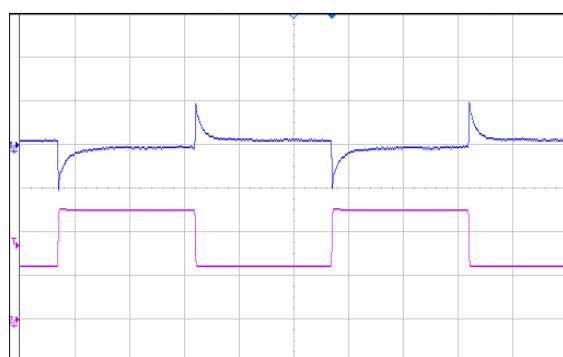


Figure 5 Dynamic response for 25% load step (25% ~ 50% ~ 25%) and 1A/μs slew rate, (2ms/div), see Figure 10 for test configuration; CH1-output voltage (100mV/div); CH2-output current (2A/div)

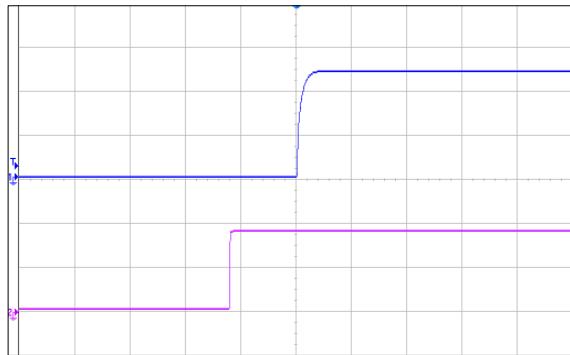


Figure 6 Output voltage startup by power on, (50ms/div), see Figure 10 for test configuration; CH1-output voltage (5V/div); CH2-input voltage (20V/div)

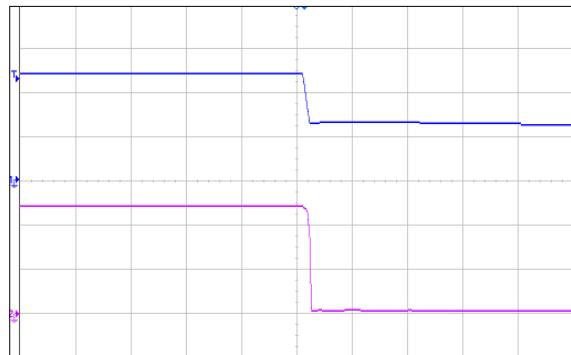


Figure 7 Output voltage shut down by power off, (10ms/div), see Figure 10 for test configuration; CH1-input voltage (20V/div); CH2-output voltage (5V/div)

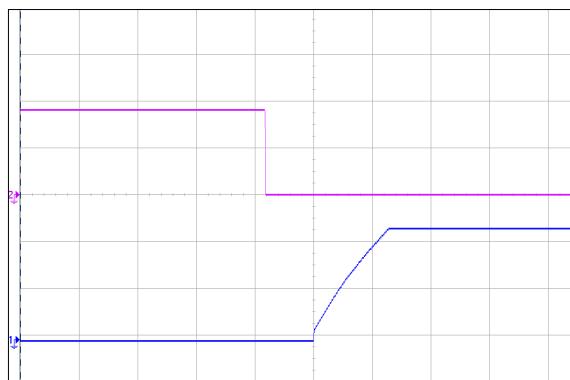


Figure 8 Output voltage startup by remote ON, (100ms/div) ,see Figure 11 for test configuration; CH1-output voltage (5V/div); CH2-remote ON (2V/div)

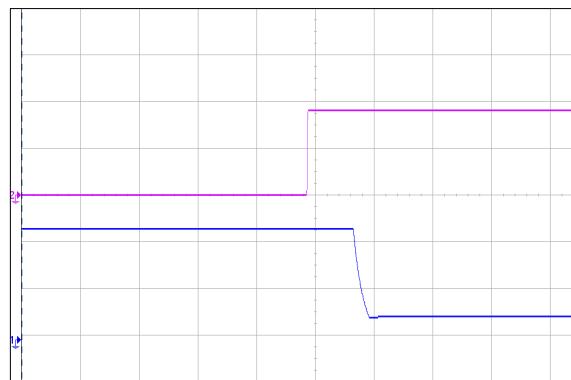


Figure 9 Output voltage shutdown by remote OFF, (100ms/div) ,see Figure 11 for test configuration; CH1-output voltage (5V/div); CH2-remote OFF voltage (2V/div)

## Application Note

### Typical Application

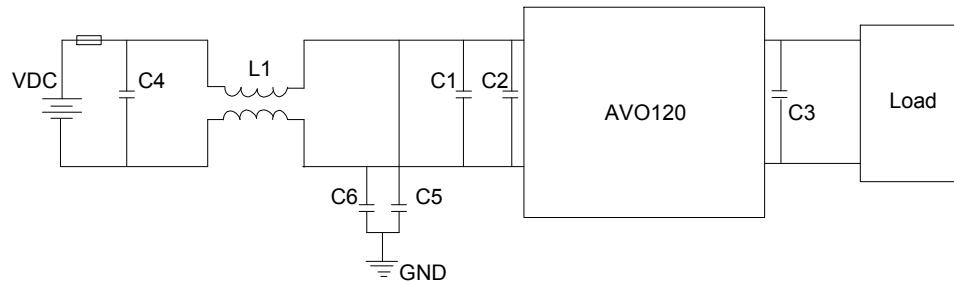


Figure 10 Typical application

C4: SMD ceramic-100V-1000nF-X7R-1210

C1: SMDceramic-100V-100nF- $\pm$ 10%-X7R-1206

C2: 100 $\mu$ F/100V electrolytic capacitor, High frequency and low ESR

C3: 470 $\mu$ F/100V electrolytic capacitor, High frequency and low ESR

C5, C6: SMD ceramic- 47nF/1000V/X7R-1210

L1: 1320 $\mu$ H- $\pm$ 25%-4A-R5K-21 $\times$ 21 $\times$ 12.5mm

### Remote ON/OFF

Either positive or negative remote ON/OFF logic is available in AVO120-48S12B-4. The logic is CMOS and TTL compatible.

The following figure is the equivalent internal circuit and reference in AVO120-48S12B-4.

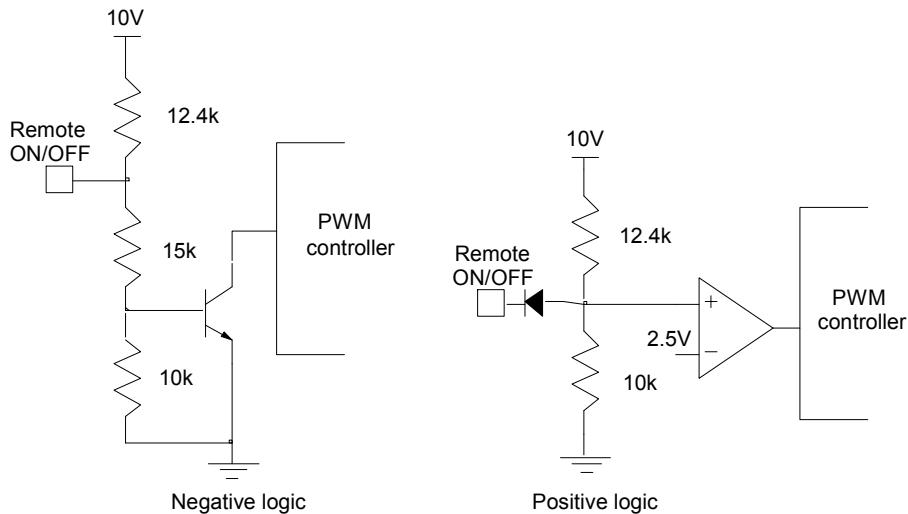


Figure 11 Remote ON/OFF internal diagram

## Trim Characteristics

Connecting an external resistor between Trim pin and  $V_o-$  pin will decrease the output voltage. While connecting it between Trim and  $V_o+$  will increase the output voltage. The following equations determine the external resistance to obtain the trimmed output voltage.

$$R_{adj\_down} = \left( \frac{511}{\Delta\%} - 10.22 \right) k\Omega$$

$$R_{adj\_up} = \left( \frac{511V_{out}(100 + \Delta\%)}{V_{ref}\Delta\%} - \frac{511}{\Delta\%} - 10.22 \right) k\Omega$$

$R_{adj\_down}$  : Value of external adjustment resistor which shall be connected between Trim and  $-Sense$  for trimming down.

$\Delta\%$  : Output voltage change rate against nominal output voltage.

$R_{adj\_up}$  : Value of external adjustment resistor which shall be connected between Trim and  $+Sense$  for trimming up.

$V_{out}$ : Nominal output voltage.

$V_{ref} = 1.225$  V

When trimming up, the output current should be decreased accordingly so as not to exceed the maximum output power and the minimum input voltage should be increased as shown in the following figures.

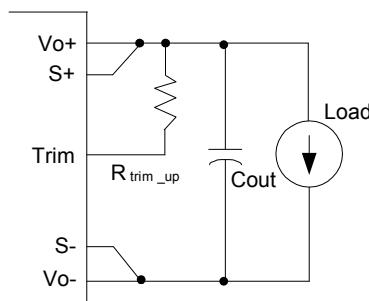


Figure 12 Trim up

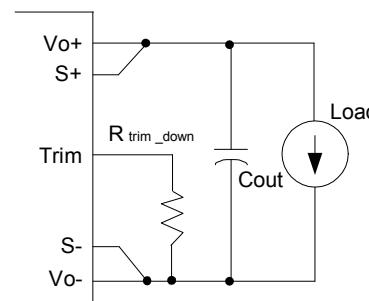


Figure 13 Trim down

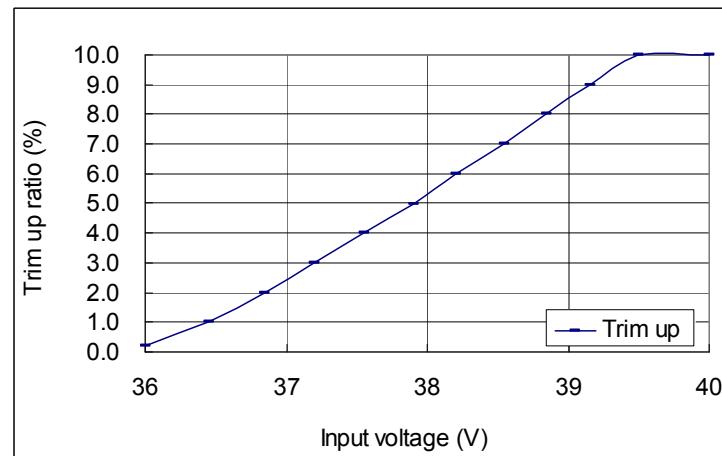


Figure 14 Trim up curve at full power

## Sense Characteristics

If the load is far from the unit, connect S+ and S- to the terminal of the load respectively to compensate the voltage drop on the transmission line.

If the sense compensate function is not necessary, connect S+ to V<sub>o+</sub> and S- to V<sub>o-</sub> directly.

## Input Ripple & Inrush Current And Output Ripple & Noise Test

### Configuration

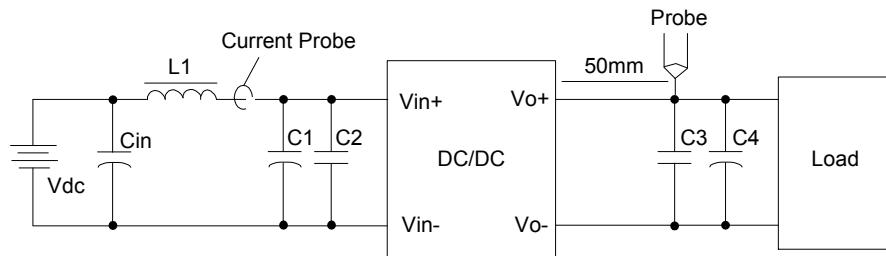


Figure 15 Input ripple & inrush current, output ripple & noise test configuration

Vdc: DC power supply

L1: 12 $\mu$ H

Cin: 220 $\mu$ F/100V typical

C1 ~ C4: See Figure 10

Note: It is recommended to use a coaxial cable with series 50 $\Omega$  resistor and 0.68 $\mu$ F ceramic capacitor or a ground ring of probe to test output ripple & noise.

## EMC Test Conditions

See Figure10.

## Thermal Considerations

The converter is designed to operate in different thermal environments and sufficient cooling must be provided. Proper cooling can be verified by measuring the temperature at the test points. The temperature at this point should not exceed the max values in Table 1.

For a typical application, forced airflow direction is from  $V_{in-}$  to  $V_{in+}$ . Figure 18 shows the derating of output current vs. ambient air temperature at different air velocity.

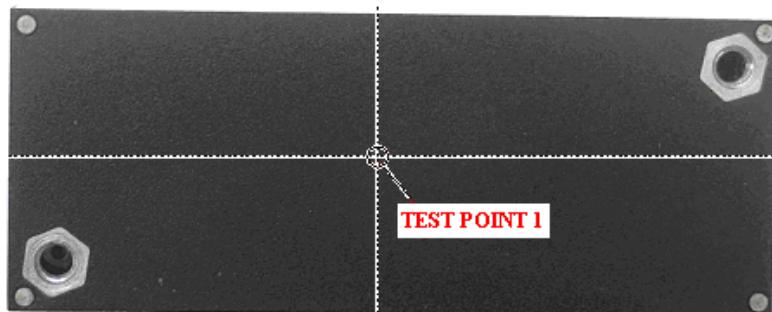


Figure 16 Thermal test point (top)



Figure 17 Thermal test point (bottom)

Table 1 Temperature test point

Test point	Temperature limit
TEST POINT 1	99°C
C2B TEST POINT	118°C

The converter can also operate with a smaller heatsink and sufficient airflow. The heatsink is shown in Figure 18.

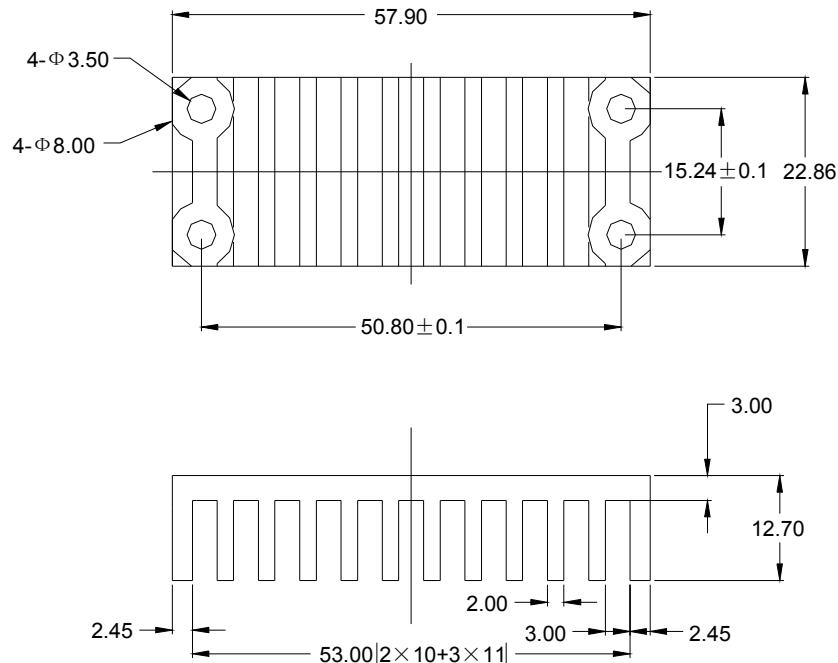


Figure 18 Heatsink

Figure 19 shows the derating output current and ambient air temperature at different air velocity with a heatsink, the heatsink spec is shown in Figure 18. The typical test condition is shown in Figure 19.

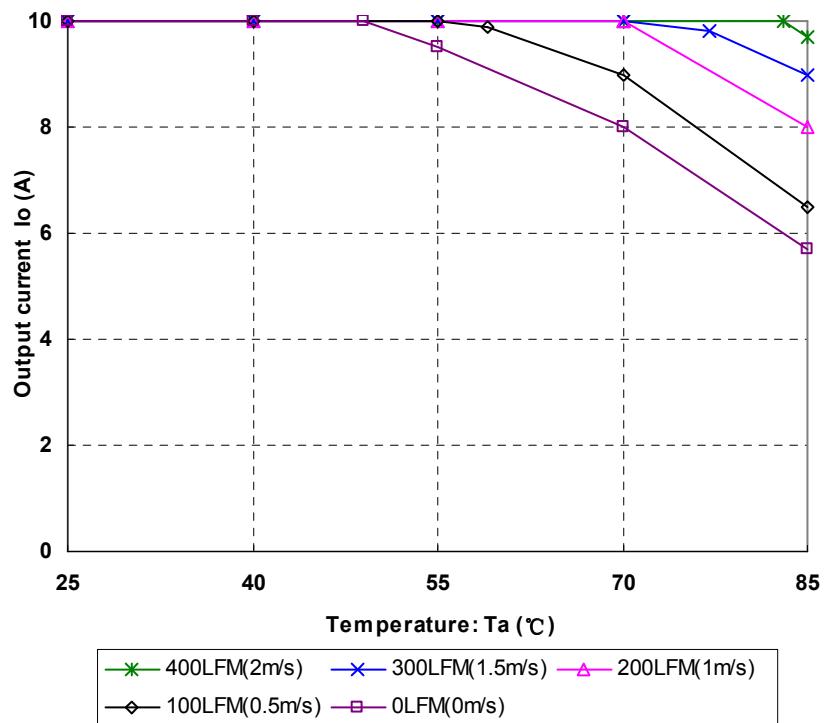
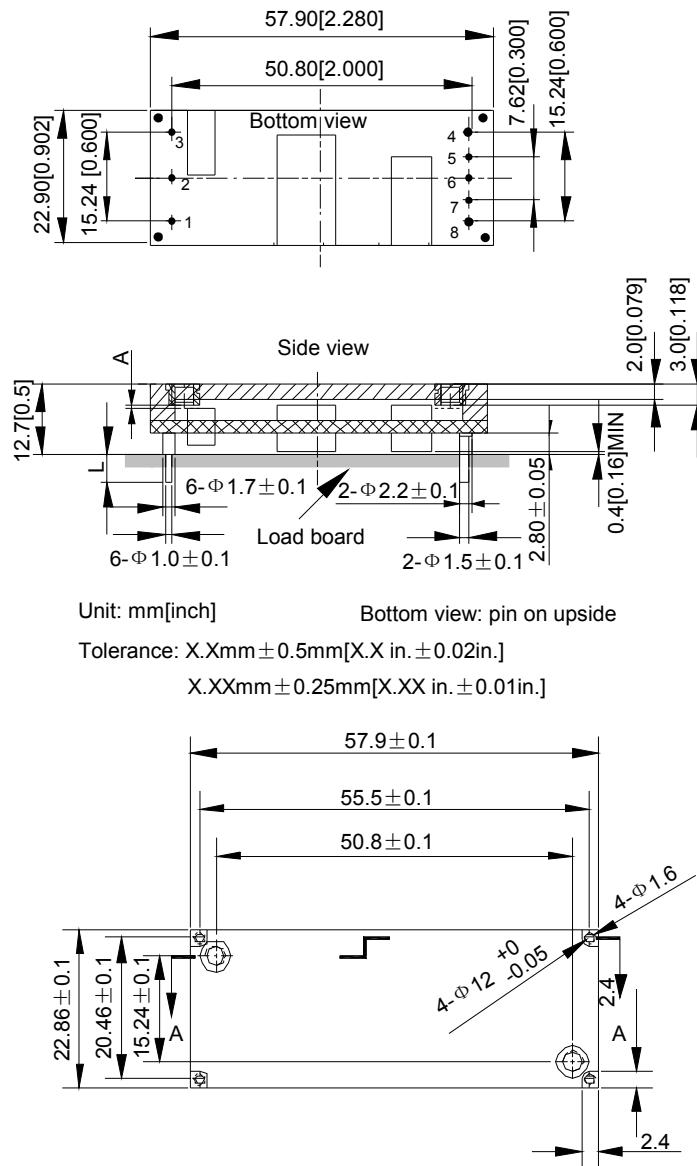


Figure 19 Output power derating, 48Vin, air flowing across the converter from  $V_{in-}$  and  $V_{in+}$

## Mechanical Diagram



As shown in the above figure, A being the protruded part of the screw connecting customer's heatsink with power module's heatsink, should be shorter than 0.5mm.

Figure 20 Mechanical diagram

### Pin length option

Device code suffix	L
-4	4.8mm±0.2mm
-6	3.8mm±0.2mm
-8	2.8mm±0.2mm
None	5.8mm±0.2mm

## Pin Designations

Pin NO.	Name	Function
1	$V_{in+}$	Positive input voltage
2	Remote ON/OFF	Remote control
3	$V_{in-}$	Negative input voltage
4	$V_{o-}$	Negative output voltage
5	S-	Negative remote sense
6	Trim	Output voltage trim
7	S+	Positive remote sense
8	$V_{o+}$	Positive output voltage

## Soldering

The product is intended for standard manual, reflow or wave soldering.

When reflow soldering is used, the temperature on pins is specified to maximum 260°C for maximum 10s.

When wave soldering is used, the temperature on pins is specified to maximum 260°C for maximum 7s.

When soldering by hand, the iron temperature should be maintained at 300°C ~ 380°C and applied to the converter pins for less than 10s. Longer exposure can cause internal damage to the converter.

Cleaning of solder joint can be performed with cleaning solvent IPA or similative.

## Assembly

The maximum length of the screw driven into heatsink is 3.3mm.

## Ordering Information

AVO120	-	48	S	12	P	B	-	4	L
①		②	③	④	⑤	⑥		⑦	⑧

①	Model series	AVO: series name , 120:output power 120W
②	Input voltage	48: 36V ~ 75V input range, rated input voltage 48V
③	Output number	S: single output
④	Rated output voltage	12:12V output
⑤	Remote ON/OFF logic	Default: negative; P: positive logic
⑥	Base plate	Default:without the baseplate;B:with baseplate
⑦	Pin length	4: 4.8mm
⑧	RoHS status	L: RoHS, R6; Y: RoHS, R5

Model number	Description
AVO120-48S12-4L	4.8mm pin length;negative on/off logic; open frame ,R6 compliant,see AVO120-48S12 TRN
AVO120-48S12P-4L	4.8mm pin length;positive on/off logic; open frame, R6 compliant, see AVO120-48S12 TRN
AVO120-48S12B-4L	4.8mm pin length;negative on/off logic;with base plate; R6 compliant
AVO120-48S12PB-4L	4.8mm pin length;positive on/off logic; with base plate; R6 compliant
AVO120-48S12-4Y	4.8mm pin length;negative on/off logic; open frame, R5 compliant, see AVO120-48S12 TRN
AVO120-48S12P-4Y	4.8mm pin length;positive on/off logic; open frame, R5 compliant, see AVO120-48S12 TRN
AVO120-48S12B-4Y	4.8mm pin length;negative on/off logic;with base plate; R5 compliant
AVO120-48S12PB-4Y	4.8mm pin length;positive on/off logic; with base plate; R5 compliant

## Hazardous Substances Announcement (RoHS Of China)

Parts	Hazardous Substances					
	Pb	Hg	Cd	Cr <sup>6+</sup>	PBB	PBDE
AVO120-48S12B-4	○	○	○	○	○	○
○: Means the content of the hazardous substances in all the average quality materials of the part is within the limits specified in SJ/T-11363-2006						
√: Means the content of the hazardous substances in at least one of the average quality materials of the part is outside the limits specified in SJ/T11363-2006						
Emerson Network Power Co., Ltd. has been committed to the design and manufacturing of environment-friendly products. It will reduce and eventually eliminate the hazardous substances in the products through unremitting efforts in research. However, limited by the current technical level, the following parts still contain hazardous substances due to the lack of reliable substitute or mature solution:						
1. Solders (including high-temperature solder in parts) contain plumbum. 2. Glass of electric parts contains plumbum. 3. Copper alloy of pins contains plumbum						

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