AVO100-48S28

100 Watts

Eighth-brick Converter

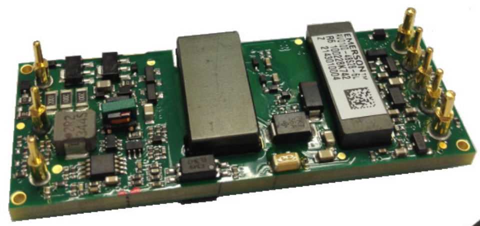
Total Power: 100 Watts
Input Voltage: 36 to 75 Vdc
# of Outputs: Single

Special Features

- Delivering up to 3.57A output
- Ultra-high efficiency 92% typ. at full load
- Wide input range: 36V ~ 75V
- Excellent thermal performance
- No minimum load requirement
- Basic isolation
- High power density
- Low output noise
- Reflow soldering-able
- RoHS 6 compliant
- Remote control function
- Remote output sense
- Trim function: 64% ~ 116%
- Input under voltage lockout
- Output over current protection
- Output short circuit protection
- Output over voltage protection
- Over temperature protection
- Industry standard eighth-brick pin-out outline

Safety

IEC/EN/UL/CSA 60950
CE Mark
UL/TUV
EN55022 Class A



Product Descriptions

The AVO100-48S28 is a single output DC/DC converter with standard eighth-brick form factor and pin configuration. It delivers up to 3.57A output current with 28V output.

The Ultra-high 92% efficiency and excellent thermal performance makes it an ideal choice for using in computing and telecommunication applications and can operate under an ambient temperature range of -40 ^{O}C ~ +85 ^{O}C, with full power available when the baseplate of the unit is kept below 100^{O}C.

Applications

This family of units has been specifically designed to support the rigors of the supply of power to radio frequency Power Amplifiers in small-cell, low power applications in Telecommunication applications.

The small form-factor, baseplate construction are exceptionally well suited for such applications where small space and contact-cooling are essential attributes required of the DCDC converter. Add this to the wide output trim range of 18V to 32V means that this unit is extremely versatile in the applications that it can address.

Typically, this unit is used along side a member of the AVD (1/16th brick) family of DCDC converters to provide the lower voltage required to supply power to digital circuitry present in such RF Power Amplifier applications.

Model Numbers

Standard	Output Voltage	Structure	Remote ON/OFF logic	RoHS Status
AVO100-48S28-6L	28Vdc	Open-frame	Negative	R6
AVO100-48S28P-6L	28Vdc	Open-frame	Positive	R6
AVO100-48S28B-6L	28Vdc	Baseplate	Negative	R6
AVO100-48S28PB-6L	28Vdc	Baseplate	Positive	R6

Ordering information

AVO100	-	48	S	28	P	B	-	6	L
①		②	③	④	⑤	⑥		⑦	⑧

①	Model series	AVO: high efficiency sixteenth brick series, 100: output power 100W
②	Input voltage	48: 36V ~ 75V input range, rated input voltage 48V
③	Output number	S: single output
④	Rated output voltage	28: 28V output
⑤	Remote ON/OFF logic	Default: negative logic; P: positive logic
⑥	Baseplate	B: with baseplate; default: open frame
⑦	Pin length	S: SMT; 6: 3.8mm ± 0.25mm
⑧	RoHS status	Y: Rohs, R5; L: RoHS, R6

Options

None

Electrical Specifications

Absolute Maximum Ratings

Stress in excess of those listed in the “Absolute Maximum Ratings” may cause permanent damage to the power supply. These are stress ratings only and functional operation of the unit is not implied at these or any other conditions above those given in the operational sections of this TRN. Exposure to any absolute maximum rated condition for extended periods may adversely affect the power supply’s reliability.

Table 1. Absolute Maximum Ratings:

Parameter	Model	Symbol	Min	Typ	Max	Unit
Input Voltage Operating -Continuous Non-operating -100mS	 All All	$V_{IN,DC}$	 - -	 - -	 80 100	 Vdc Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	100	W
Isolation Voltage[1] Input to outputs	 All		 1500	 -	 -	 Vdc
Ambient Operating Temperature	All	T_A	-40	-	+85	^{O}C
Storage Temperature	All	T_{STG}	-55	-	+125	^{O}C
Voltage at remote ON/OFF pin	All		-0.7	-	12	Vdc
Humidity (non-condensing) Operating Non-operating	 All All		 - -	 - -	 95 95	 % %

Note 1 - 1mA for 60s, slew rate of 1500V/10s.

Input Specifications

Table 2. Input Specifications:

Parameter	Conditions[1]	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, DC	All	$V_{IN,DC}$	36	48	75	Vdc
Turn-on Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,ON}$	31	-	36	Vdc
Turn-off Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,OFF}$	30	-	35	Vdc
Lockout Voltage Hysteresis	$I_O = I_{O,max}$		1	-	3	V
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC} = 36V_{DC}$	$I_{IN,max}$	-	-	4	A
Recommended Input Fuse	Fast blow external fuse recommended		-	-	8	A
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	100	-	-	uF
Input Reflected Ripple Current	Through 12uH inductor		-	25	-	mA
Operating Efficiency	T_A=25 °C $I_O = I_{O,max}$ $I_O = 50\%I_{O,max}$ $I_O = 20\%I_{O,max}$	η	 91 89 82	 92 90 84	 - - -	%

Note 1 - Ta = 25 °C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.

Output Specifications

Table 3. Output Specifications:

Parameter	Conditions[1]	Symbol	Min	Typ	Max	Unit
Factory Set Voltage	$V_{IN,DC} = 48V_{DC}$ $I_O=I_{O,max}$	V_O	27.72	28	28.28	Vdc
Total Regulation	Inclusive of line, load temperature change, warm-up drift	V_O	27.2	28	28.8	Vdc
Output Voltage Line Regulation	All	$\%V_O$	-	-	0.5	%
		V_O	-	-	140	mV
Output Voltage Load Regulation	All	$\%V_O$	-	-	0.5	%
		V_O	-	-	140	mV
Output Voltage Temperature Regulation	All	$\%V_O$	-	-	0.02	%/°C
Output Voltage Trim Range	All	V_O	18	-	32.5	V
Output Ripple, pk-pk	Measure with a 1uF ceramic capacitor in parallel with a 10uF tantalum capacitor, 0 to 20MHz bandwidth	V_O	-	30	-	mV_{PK-PK}
Output Current	All	I_O	0	-	3.57	A
Output DC current-limit inception[2]		I_O	3.75	-	6.43	A
V_O Load Capacitance[3]	All	C_O	470	1000	3300	uF
V_O Dynamic Response Peak Deviation Settling Time	25% ~ 50% ~ 25% Io,max load change slew rate = 0.1A/us	$\pm V_O$ T_s	- -	130 0	- -	mV uSec
	50% ~ 75% ~ 50% Io,max load change slew rate = 0.1A/us	$\pm V_O$ T_s	- -	95 0	- -	mV uSec
Turn-on transient: Rise time	$I_O = I_{max}$	T_{rise}	-	100	200	mS
Turn-on transient: Turn-on delay time	$I_O = I_{max}$	$T_{turn-on}$	-	20	50	mS
Turn-on transient: Output voltage overshoot	$I_O = 0$	$\%V_O$	-	-	5	%

Note 1 - Ta = 25 °C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.
Note 2 - Hiccup: auto-restart when over-current condition is removed.
Note 3 - High frequency and low ESR is recommended.

Output Specifications

Table 3. Output Specifications, con't:

Parameter		Conditions[1]	Symbol	Min	Typ	Max	Unit
Switching frequency		All	f_{SW}	-	280	-	KHz
Remote ON/OFF control (positive logic)	Off-state voltage	All		-0.7		1.2	V
	On-state voltage	All		3.5	-	12	V
Remote ON/OFF control (Negative logic)	Off-state voltage	All		3.5	-	12	V
	On-state voltage	All		-0.7	-	1.2	V
Output over-voltage protection[4]		All	$\%V_O$	120	-	145	%
Output over-temperature protection[5]		All	T	100	110	130	^{O}C
Over-temperature hysteresis		All	T	5	-	-	^{O}C
MTBF		Telcordia SR-332-2006; 80% load, 300LFM, 40 ^{O}C T_A		-	1.5	-	10^6 h

Note 4 - Hiccup: auto-restart when over-voltage condition is removed.
Note 5 - Auto recovery.

AVO100-48S28-6L Performance Curves

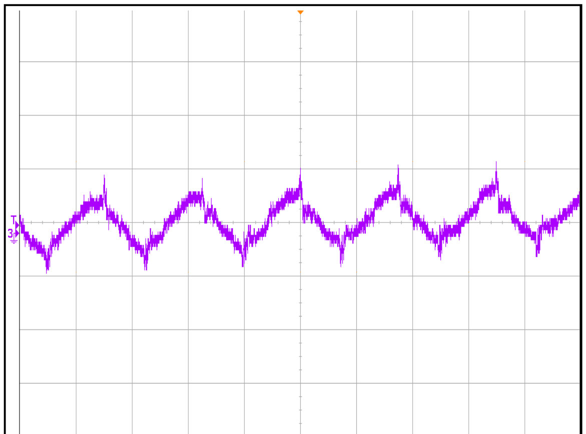


Figure 1: AVO100-48S28-6L Input Reflected Ripple Current Waveform

Ch 3: Iin (2uS/div, 10mA/div)

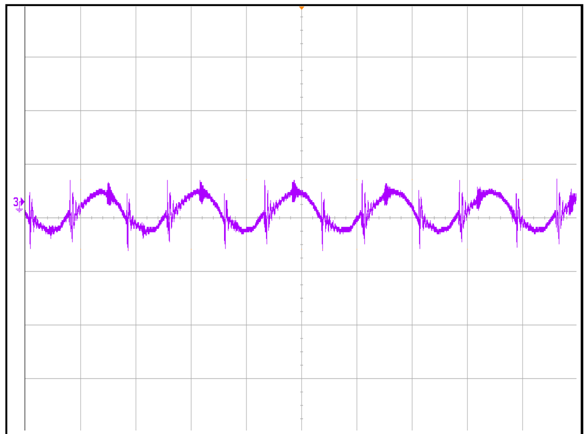


Figure 2: AVO100-48S28-6L Ripple and Noise Measurement

Ch 3: Vo (2us/div, 20mV/div)

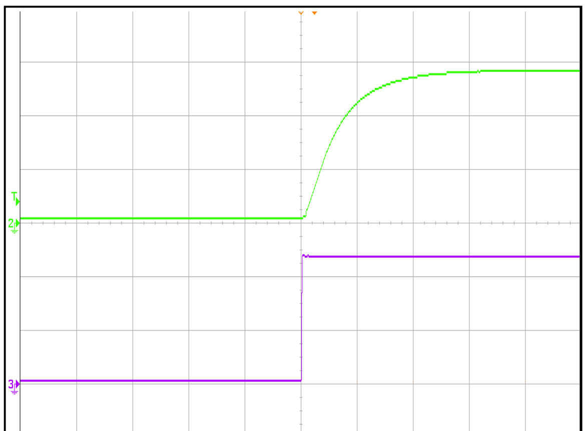


Figure 3: AVO100-48S28-6L Turn on Characteristic (100mS/div)

Ch 2: Vo (10V/div) Ch 3: Vin (20V/div)

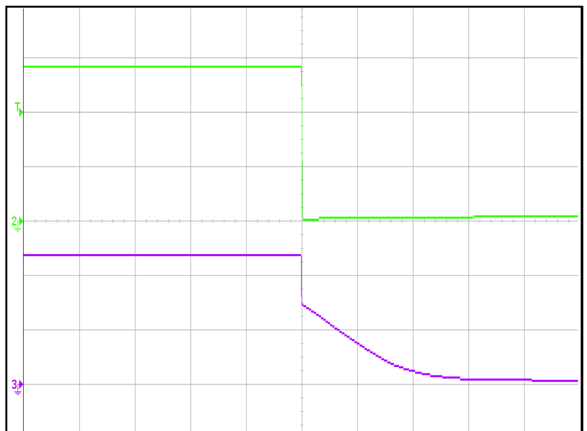


Figure 4: AVO100-48S28-6L Turn Off Characteristic (200mS/div)

Ch 2: Vo (10V/div) Ch 3: Vin (20V/div)

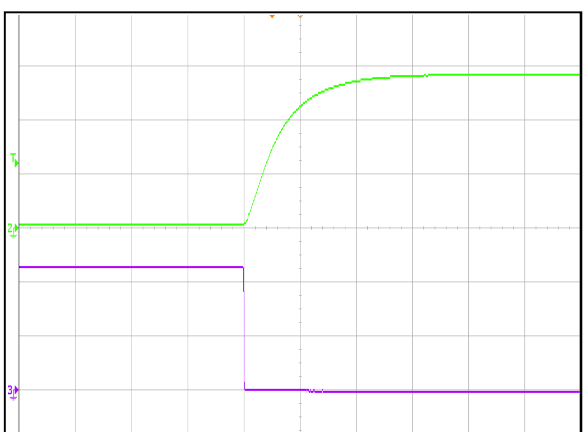


Figure 5: AVO100-48S28-6L Remote ON Waveform (100mS/div)

Ch 2: Vo (10V/div) Ch 3: Remote ON (2V/div)

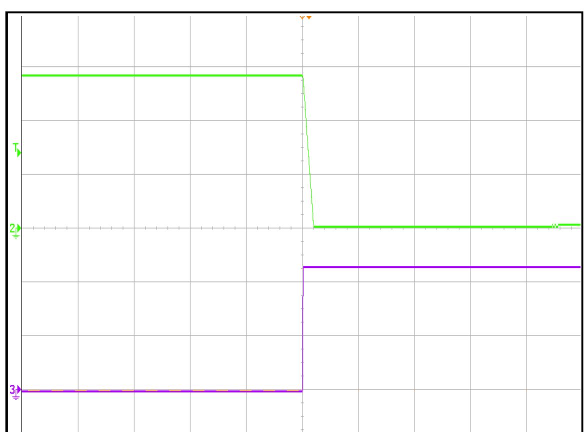


Figure 6: AVO100-48S28-6L Remote OFF Waveform (20mS/div)

Ch 2: Vo (10V/div) CH 3: Remote OFF (2V/div)

AVO100-48S28-6L Performance Curves

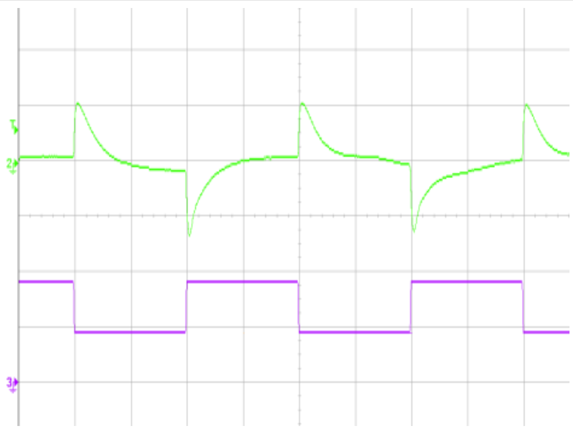


Figure 7: AVO100-48S28-6L Transient Response (2mS/div)
25%~50%~25% load change, 0.1A/uS slew rate,
Ch 2: Vo (100mV/div) Ch 3: Io (1A/div)

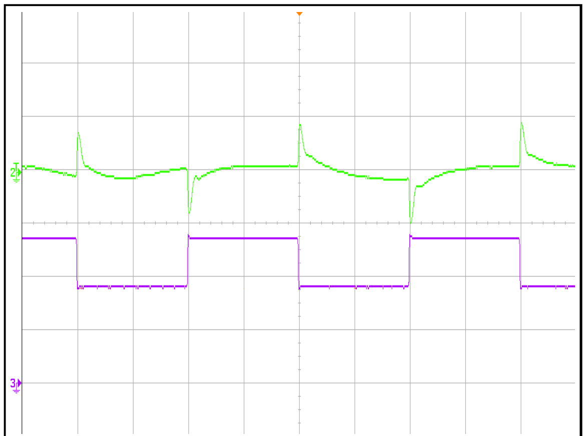


Figure 8: AVO100-48S28-6L Transient Response (2mS/div)
50%~75%~50% load change, 0.1A/uS slew rate,
Ch 2: Vo (100mV/div) Ch 3: Io (1A/div)

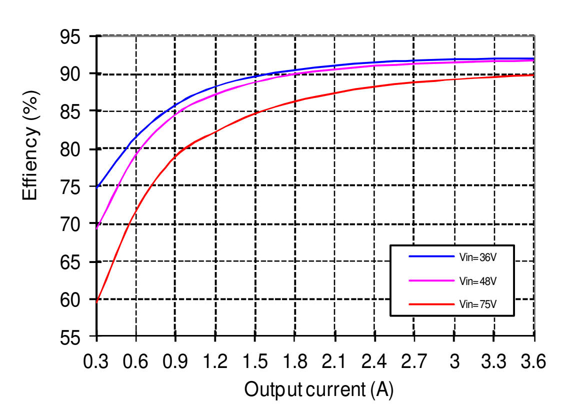


Figure 9: AVO100-48S28-6L Efficiency Curves
@ 25 degC, 400LFM, Vo = 28V
Loading: Io = 10% increment to 3.6A

AVO100-48S28B-6L Performance Curves

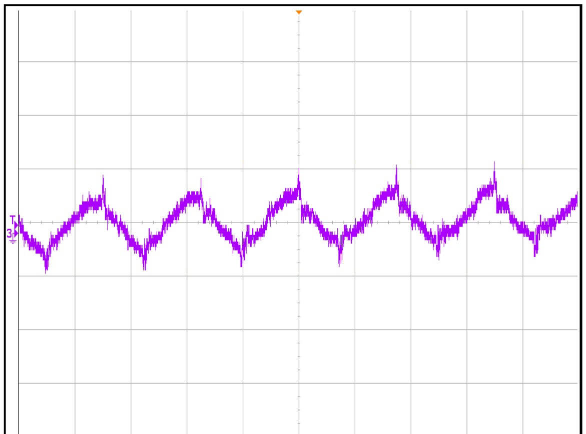


Figure 10: AVO100-48S28B-6L Input Reflected Ripple Current Waveform
Ch 3: Iin (2uS/div, 10mA/div)

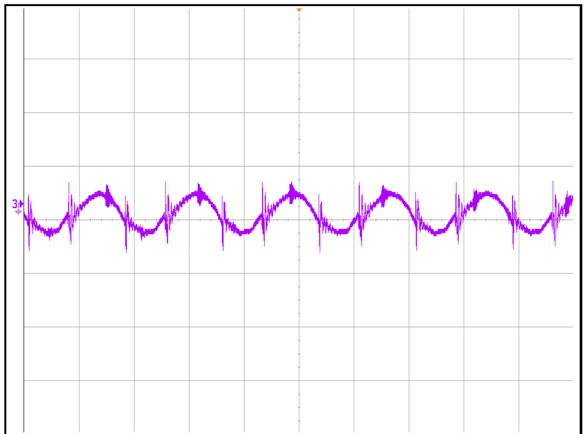


Figure 11: AVO100-48S28B-6L Ripple and Noise Measurement
Ch 3: Vo (2us/div, 20mV/div)

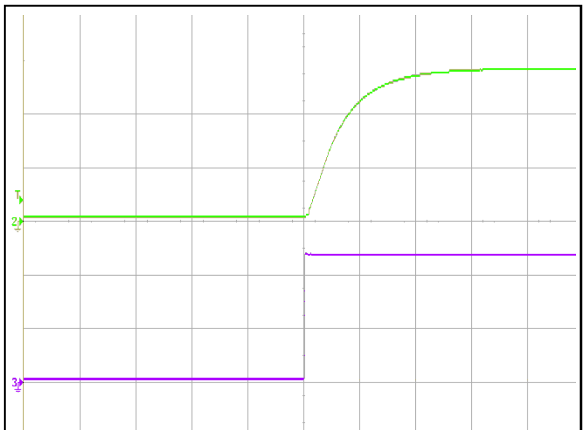


Figure 12: AVO100-48S28B-6L Turn on Characteristic (100mS/div)
Ch 2: Vo (10V/div) Ch 3: Vin (20V/div)

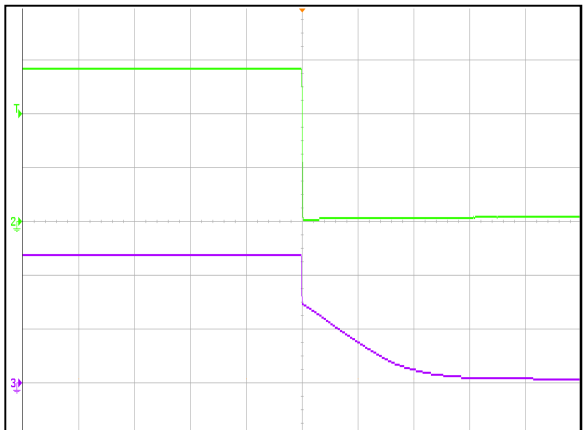


Figure 13: AVO100-48S28B-6L Turn Off Characteristic (200mS/div)
Ch 2: Vo (2V/div) Ch 3: Vin (20V/div)

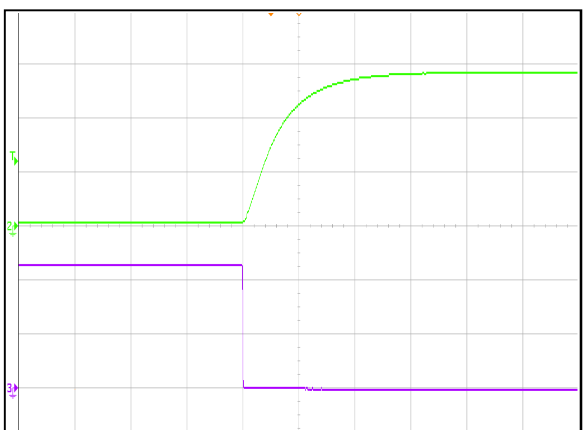


Figure 14: AVO100-48S28B-6L Remote ON Waveform (100mS/div)
Ch 2: Vo (10V/div) Ch 3: Remote ON (2V/div)

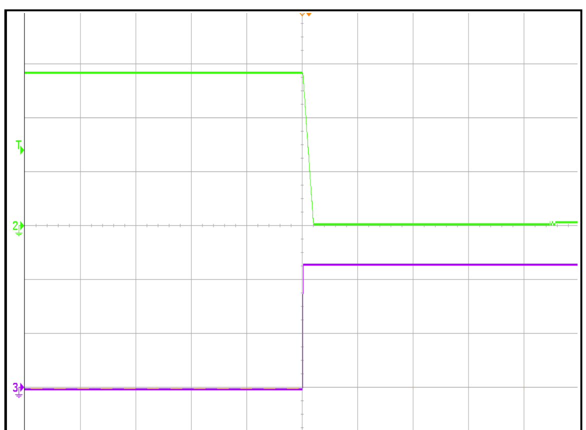


Figure 15: AVO100-48S28B-6L Remote OFF Waveform (20mS/div)
Ch 2: Vo (10V/div) CH3: Remote OFF (2V/div)

AVO100-48S28B-6L Performance Curves

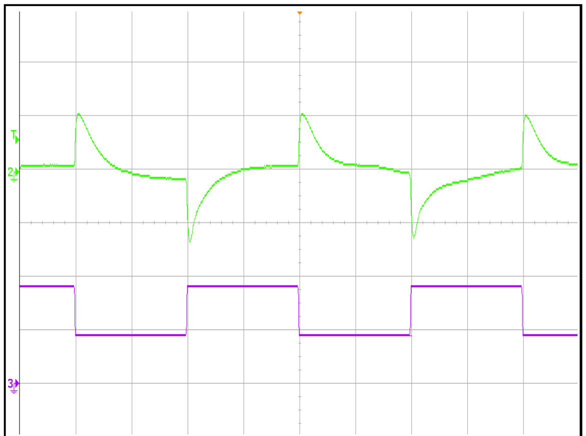


Figure 16: AVO100-48S28B-6L Transient Response (2mS/div)
25%~50%~25% load change, 0.1A/uS slew rate,
Ch 2: Vo (100mV/div) Ch 3: Io (1A/div)

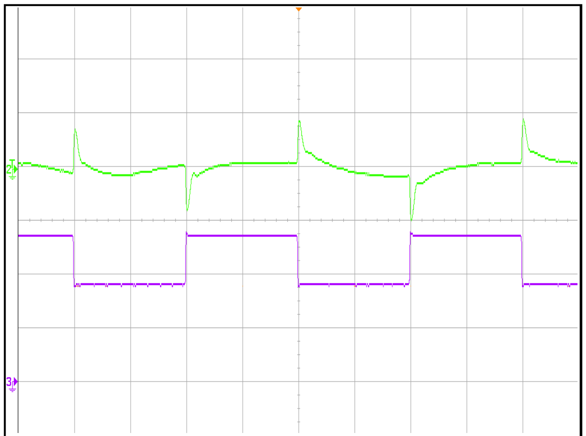


Figure 17: AVO100-48S28B-6L Transient Response (2mS/div)
50%~75%~50% load change, 0.1A/uS slew rate,
Ch 2: Vo (100mV/div) Ch 3: Io (1A/div)

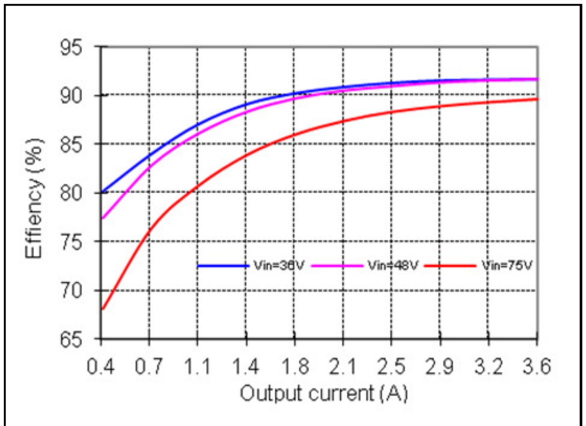
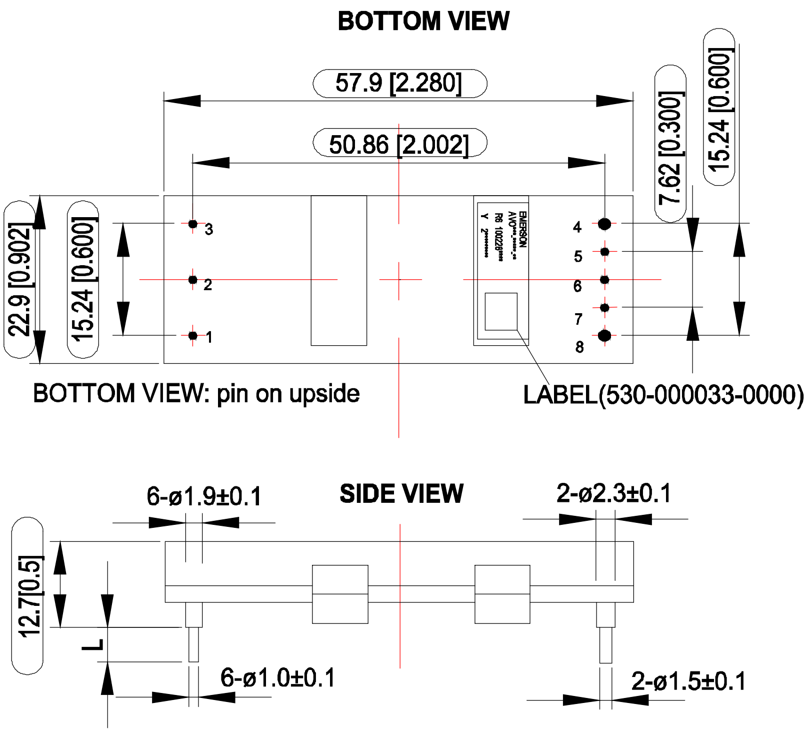


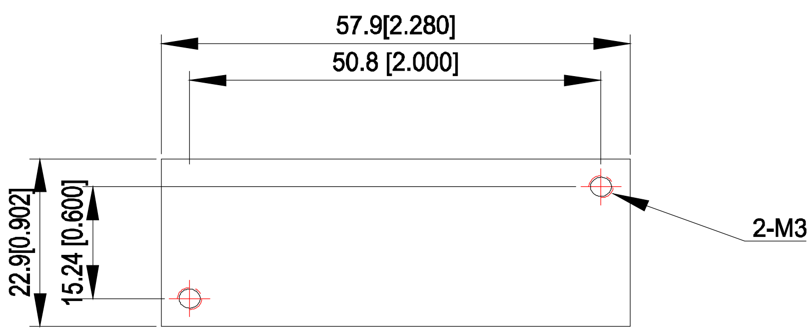
Figure 18: AVO100-48S28-6L Efficiency Curves
@ 25 degC, 400LFM, Vo = 28V
Loading: Io = 10% increment to 3.6A

Mechanical Specifications

Mechanical Outlines – Baseplate Module

AVO100-48S28B-6L





.

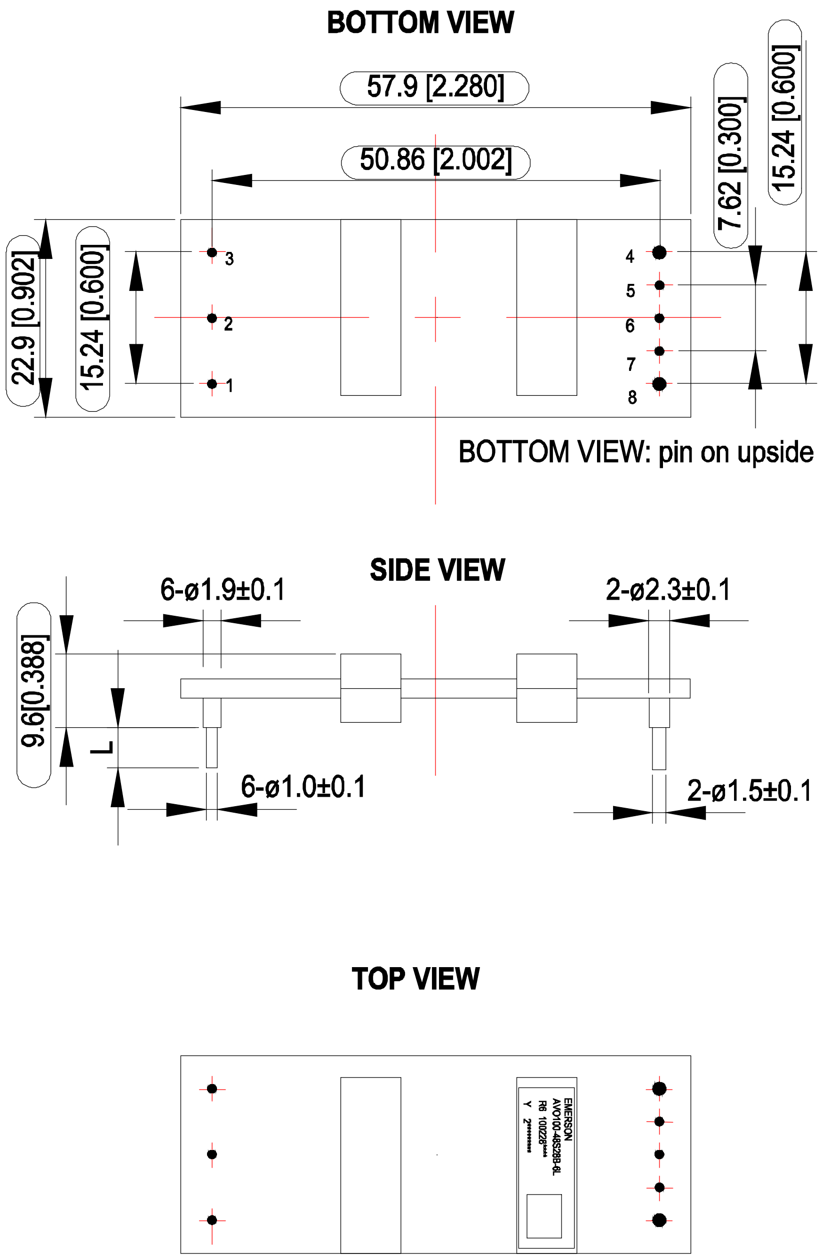
UNIT: mm[inch]   BOTTOM VIEW: pin on upside

TOLERANCE: X.Xmm±0.5mm[X.X in.±0.02in.]
X.XXmm±0.25mm[X.XX in.±0.01in.]

Notes: Dimensions whitin the box are critical dimensions.

Mechanical Outlines – Open Frame Module

AVO100-48S28-6L



UNIT: mm[inch] L=3.8±0.25mm

TOLERANCE: X.Xmm±0.5mm[X.X in.±0.02in.]
X.XXmm±0.25mm[X.XX in.±0.01in.]

Notes: Dimensions whitin the box are critical dimensions.

Pin Length Option

Device code suffix	L
-4	4.8mm ± 0.25 mm
-6	3.8mm ± 0.25 mm
-8	2.8mm ± 0.25 mm
None	5.8mm ± 0.25 mm

Pin Designations

Pin No	Name	Function
1	Vin+	Positive input voltage
2	Remote On/Off	ON/OFF control terminal
3	Vin-	Negative input voltage
4	Vo-	Negative output voltage
5	S-	Negative remote sense
6	Trim	Output voltage trim
7	S+	Positive remote sense
8	Vo+	Positive output voltage

Environmental Specifications

EMC Immunity

AVO100-48S28 power supply is designed to meet the following EMC immunity specifications:

Table 4. Environmental Specifications:

Document	Criteria	Description
EN55022, Class A Limits	A	Conducted and Radiated EMI Limits
IEC/EN 61000-4-2, Level 3	B	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test. Enclosure Port
IEC/EN 61000-4-6, Level 2	A	Electromagnetic Compatibility (EMC) - Testing and measurement techniques, Continuous Conducted Interference. DC input port
IEC/EN 61000-4-4, Level3	B	Electromagnetic Compatibility (EMC) - Testing and measurement techniques, Electrical Fast Transient. DC input port.
IEC/EN 61000-4-5	B	Electromagnetic Compatibility (EMC) - Testing and measurement techniques, Immunity to surges - 600V common mode and 600V differential mode for DC input ports
EN61000-4-29	B	Electromagnetic Compatibility (EMC) - Testing and measurement techniques, Voltage Dips and short interruptions and voltage variations. DC input port

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 the 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.

Environmental Specifications

EMC Test Conditions

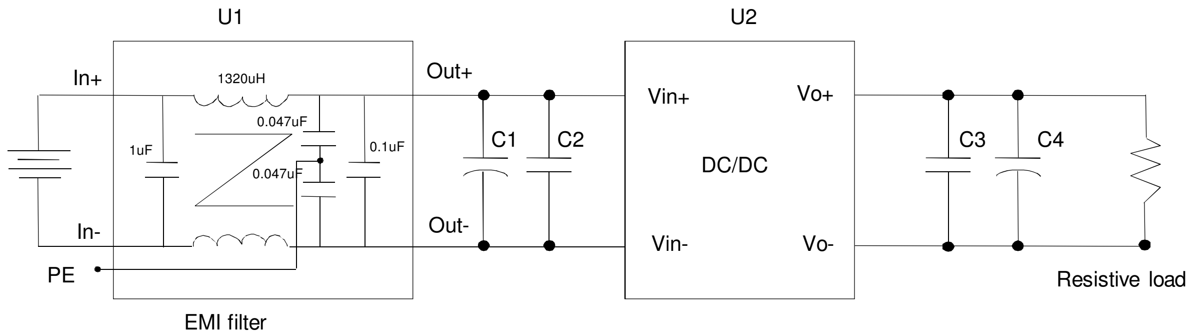


Figure 19 EMC test configuration

U1: Input EMC filter

U2: Module to test, AVO100-48S28-6L / AVO100-48S28B-6L

C1 ~ C4: See Figure 31

Safety Certifications

The AVO100-48S28 power supply is intended for inclusion in other equipment and the installer must ensure that it is in compliance with all the requirements of the end application. This product is only for inclusion by professional installers within other equipment and must not be operated as a stand alone product.

Table 5. Safety Certifications for AVO100-48S28 power supply system:

Document	File #	Description
UL/CSA 60950		US and Canada Requirements
EN60950		European Requirements
IEC60950		International Requirements
CE		CE Marking

Operating Temperature

The AVO100-48S28 power supplies will start and operate within stated specifications at an ambient temperature from -40 ^{O}C to 85 ^{O}C under all load conditions. The storage temperature is -55 ^{O}C to 125 ^{O}C.

Thermal Considerations – Open-frame module

The converter is designed to operate in different thermal environments and sufficient cooling must be provided. Proper cooling of the DC/DC converter can be verified by measuring the temperature at the test point as shown in the Figure 20. The temperature at this point should not exceed the max values in the table 6.

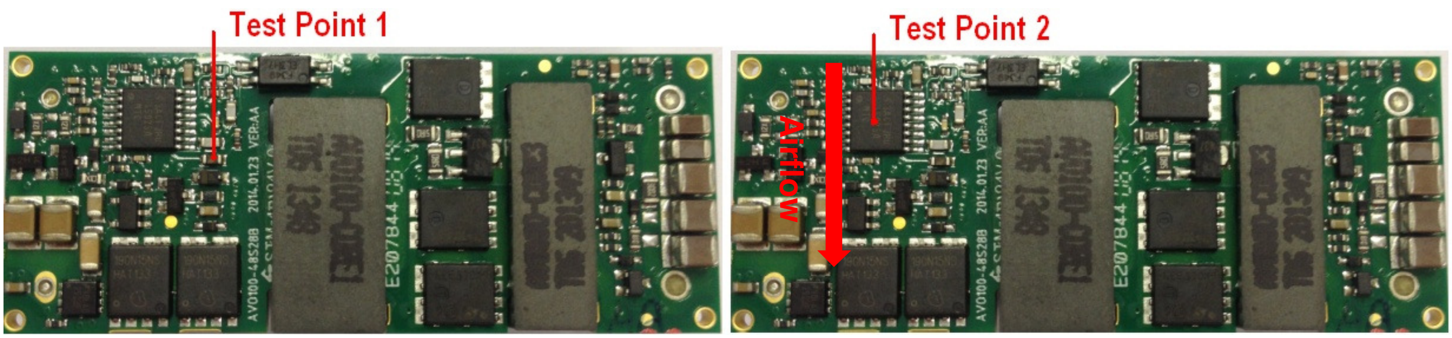


Figure 20 Temperature test point

Table 6. Temperature limit of the test point:

Test Point	Temperature Limit
Test point 1	127 ^{O}C
Test point 2	110 ^{O}C

For a typical application, figure 21 shows the derating of output current vs. ambient air temperature at different air velocity.

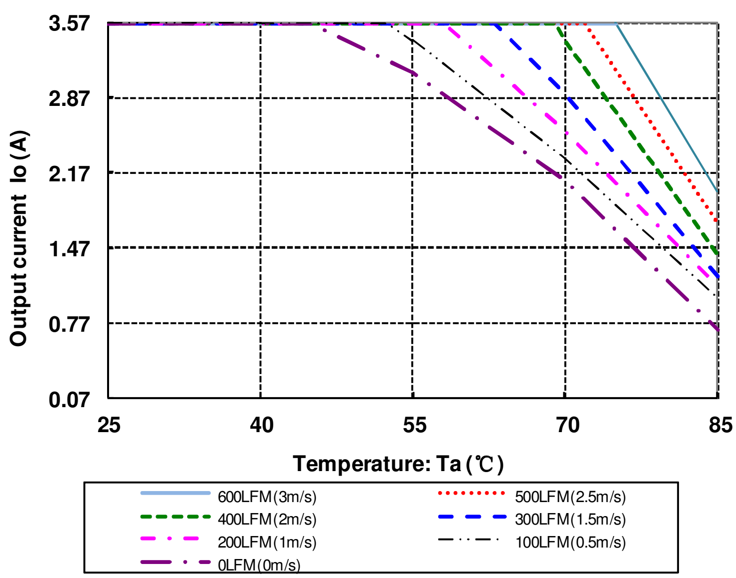


Figure 21 Output power derating, 48V_{in}, air flowing across the converter from pin 3 to pin 1

Thermal Considerations –Base plate module

The converter can both operate in two different modes.

Mode 1: The converter can operate in an enclosed environment without forced air convection. Cooling of the converter is achieved mainly by conduction from the baseplate to a heat sink. The converter can deliver full output power at 85 ^{O}C ambient temperature provided the baseplate temperature is kept the max values 100 ^{O}C.

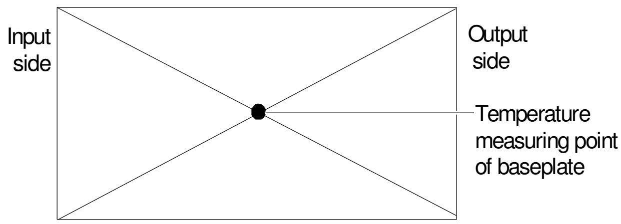


Figure 22 Temperature test point on base plate

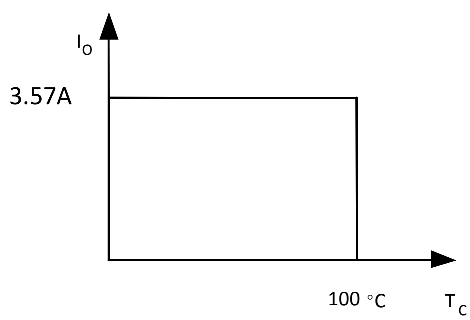
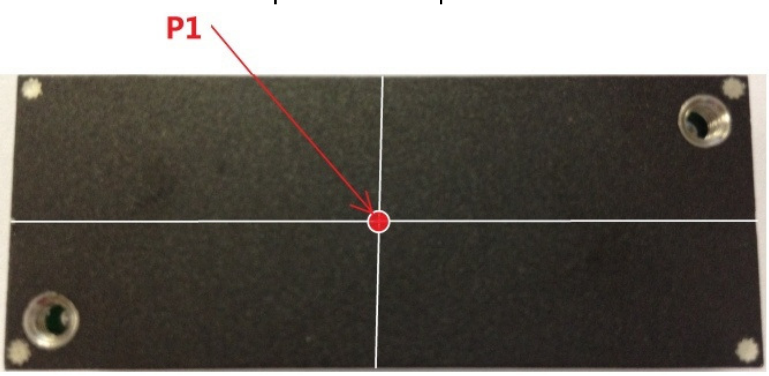


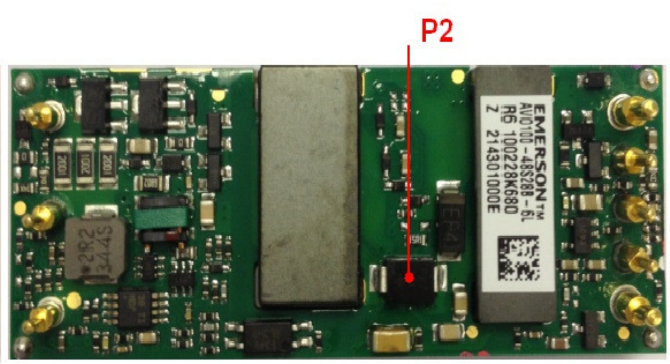
Figure 23 Output power derating curve, Tc: temperature test point on baseplate, see Figure 22

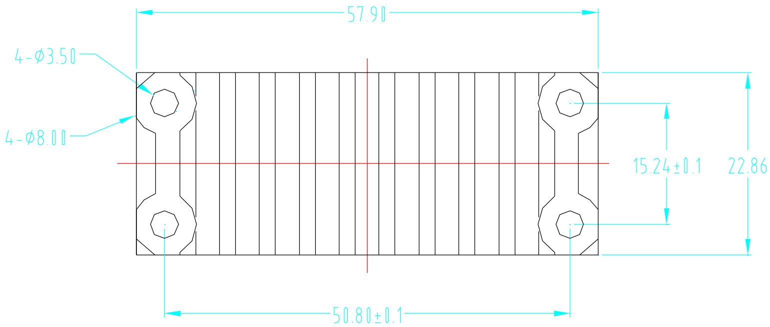
Mode 2: The converter is designed to operate in different thermal environments and sufficient cooling must be provided. Proper cooling of the DC/DC converter can be verified by measuring the temperature at the test point as shown in the Figure 24. The temperature at this point should not exceed the max values in the table 7.

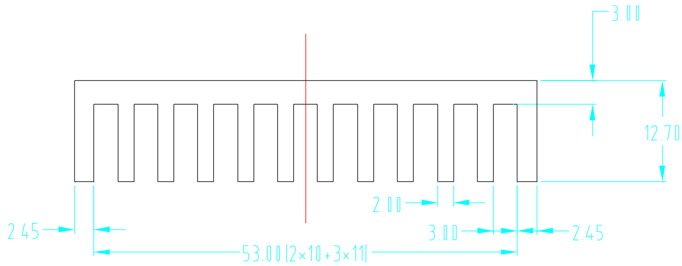
Test point on base plate



Test point on PCB







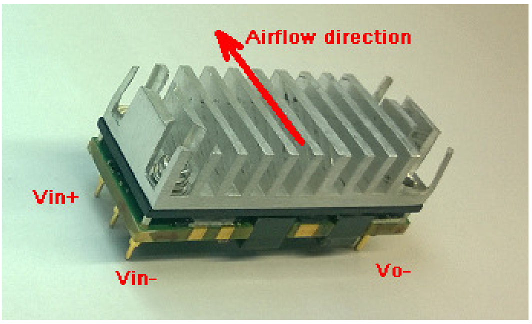


Figure 24 Temperature test point & heat sink mechanical diagram

Table 7. Temperature limit of the test point:

Test Point	Temperature Limit
Test point 1 (P1)	106 ^{O}C
Test point 2 (P2)	110 ^{O}C

For a typical application, figure 25 shows the derating of output current vs. ambient air temperature at different air velocity.

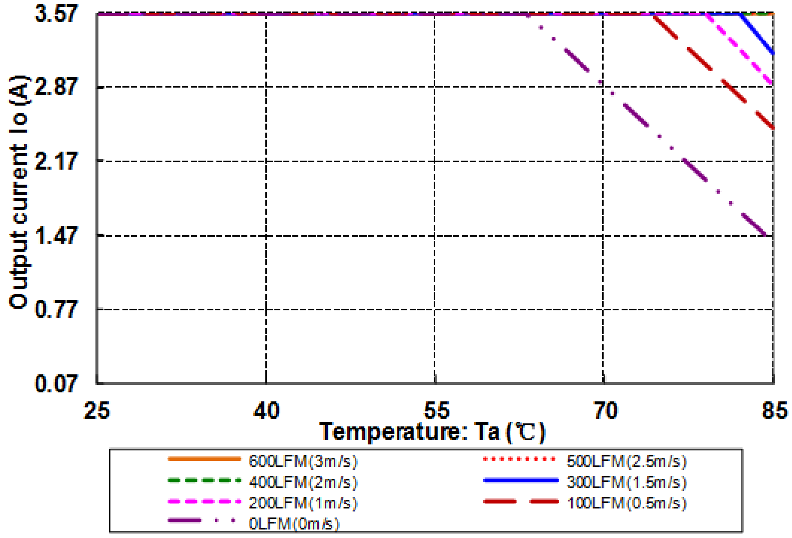


Figure 25 Output power derating, 48V_{in}, air flowing across the converter from pin 3 to pin 1

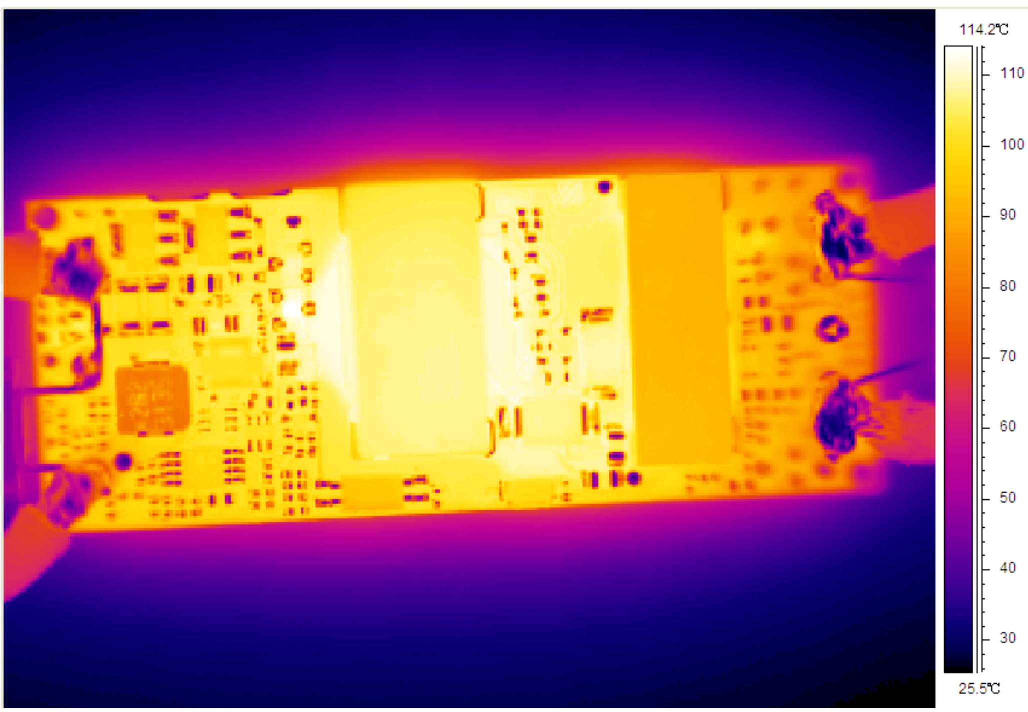


Figure 26 Thermal image, 36V_{in}, 28V_o, full load, room temperature, 200LFM

Qualification Testing

Table 8: Qualification Testing:

Parameter	Unit (pcs)	Test condition
Halt test	4 ~ 5	$T_{a,min}$-10° C to $T_{a,max}$+10° C, 5° C step, V_{in} = min to max, 0 ~ 105% load
Vibration	3	Frequency range: 5Hz ~ 20Hz, 20Hz ~ 200Hz, A.S.D: /s^3, -3db/oct, axes of vibration: X/Y/Z Time: 30 min/axes
Mechanical shock	3	30g, 6ms, 3 axes, 6 directions, 3 time/direction
Thermal shock	3	-40° C to +100° C, unit temperature 20 cycles
Thermal cycling	3	-40° C to +85° C, temperature change rate: 1° C/min, cycles: 2 cycles
Humidity	3	40° C, 95%RH, 48h
Solder ability	15	IPC J-STD-002C-2007

Application Notes

Typical Application

Below is the typical application of the AVO100-48S28 power supply.

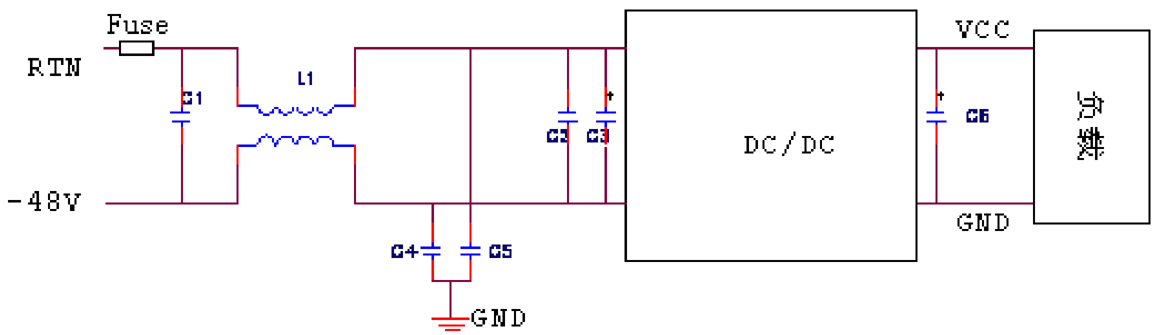


Figure 27 Typical application

C1: SMDceramic-100V-1000nF-X7R-1210

C2: SMDceramic-100V-100nF-±10%-X7R-1206

C3: 100μF/100V electrolytic capacitor; P/N: UPM1A221MED or equivalent caps

C6: 470μF/50V electrolytic capacitor; P/N: UPM1A221MED+ UPM1A471MHD or equivalent caps

C4 C5: SMD ceramic-47n/1000V/X7R- 1210

L1: 1320uH-±25%-4A-R5K-21*21*12.5mm

Fuse: External fast blow fuse with a rating of 8A. The recommended fuse model is 0314008.P from LITTLEFUSE.

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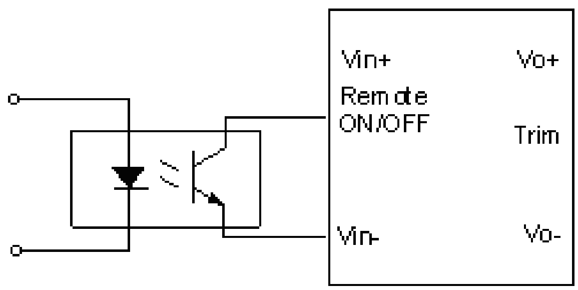
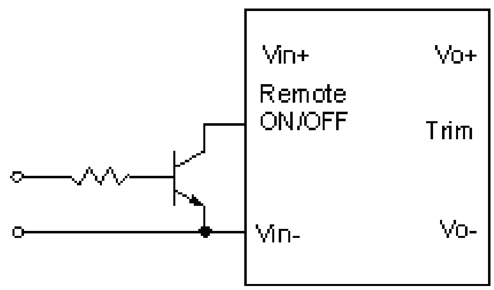
Remote ON/OFF

Negative remote ON/OFF logic is available in AVO100-48S28. The logic is CMOS and TTL compatible. The voltage between pin Remote ON/OFF and pin Vin- must not exceed the range listed in table 3 to ensure proper operation. The external Remote ON/OFF circuit is highly recommended as shown in figure 28.



Isolated remote ON/OFF circuit



Non-isolated remote ON/OFF circuit

Figure 28 External Remote ON/OFF circuit

Trim Characteristics

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

$$R_{adj\_down} = (\frac{100\%}{\Delta\%} - 2)k\Omega$$

$$R_{adj\_up} = (\frac{V_{norm}(100\% + \Delta\%)}{1.225 \times \Delta\%} - \frac{100\% + 2 \times \Delta\%}{\Delta\%})k\Omega$$

△:Output e rate against nominal output voltage.

$$\Delta = \left| \frac{100 \times (V_{norm} - V_o)}{V_{norm}} \right|$$

V_{nom}: Nominal output voltage.

For example, to get 32.5V output, the trimming resistor is

$$\Delta = \frac{100 \times (V_{norm} - V_o)}{V_{norm}} = \frac{100 \times (32.5 - 28)}{28} = 16.07$$

$$R_{adj-up} = \frac{28(100 + 16.07)}{1.225 \times 16.07} - \frac{100\% + 2 \times 16.07\%}{16.07\%} = 156.87(K\Omega)$$

For 1% adjustment resistor, the trimmed output voltage is guaranteed within ±2%.
When trimming up, the output current should be decreased accordingly so as not to exceed the maximum output power.

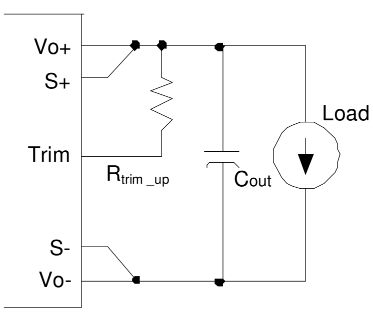


Figure 29 Trim up

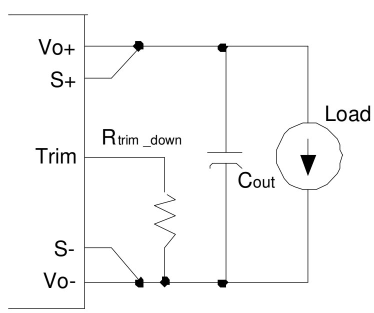


Figure 30 Trim down

If the sense compensate function is not necessary, connect S+ to Vo+ and S- to Vo- directly.

Input Ripple & Output Ripple & Noise Test Configuration

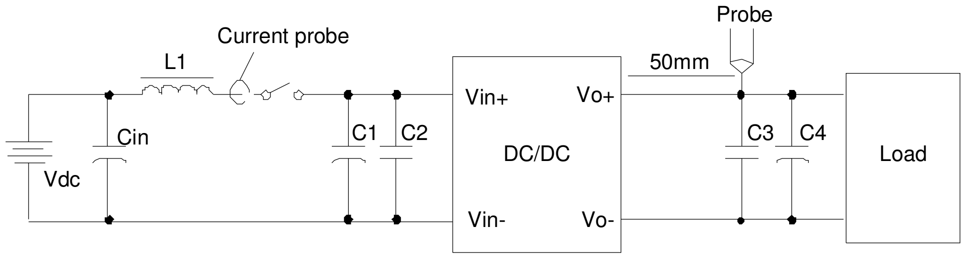


Figure 31 Input ripple & inrush current, output ripple & noise test configuration

Vdc: DC power supply

L1: 12uH

Cin: 220uF/100V typical

C1: 100μF/100V electrolytic capacitor, High frequency and low ESR

C2 C3: SMDceramic-100V-1000nF-X7R-1210

C4: 1000μF/50V electrolytic capacitor, High frequency and low ESR

Note - Using a coaxial cable with series 50ohm resistor and 0.68uF ceramic capacitor or a ground ring of probe to test output ripple & noise is recommended.

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 manual soldering is used, 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.

Hazardous Substances Announcement (RoHS of China)

Parts	Hazardous Substances					
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
AVO100-48S28-6L	x	x	x	x	x	x
AVO100-48S28B-6L	x	x	x	x	x	x

x: 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

Artesyn Embedded Technologies 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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