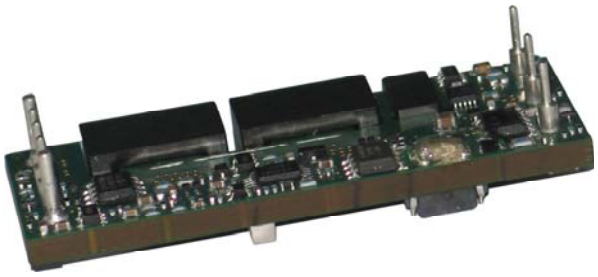
AVO100-48S1V5 DC/DC Converter

Technical Reference Note

Industry standard eighth brick: 36~75v input, 1.5V single output



Industry standard eighth brick : 2.28” × 0.9” × 0.36”

Options

- Choice of positive logic or negative logic for CNT function

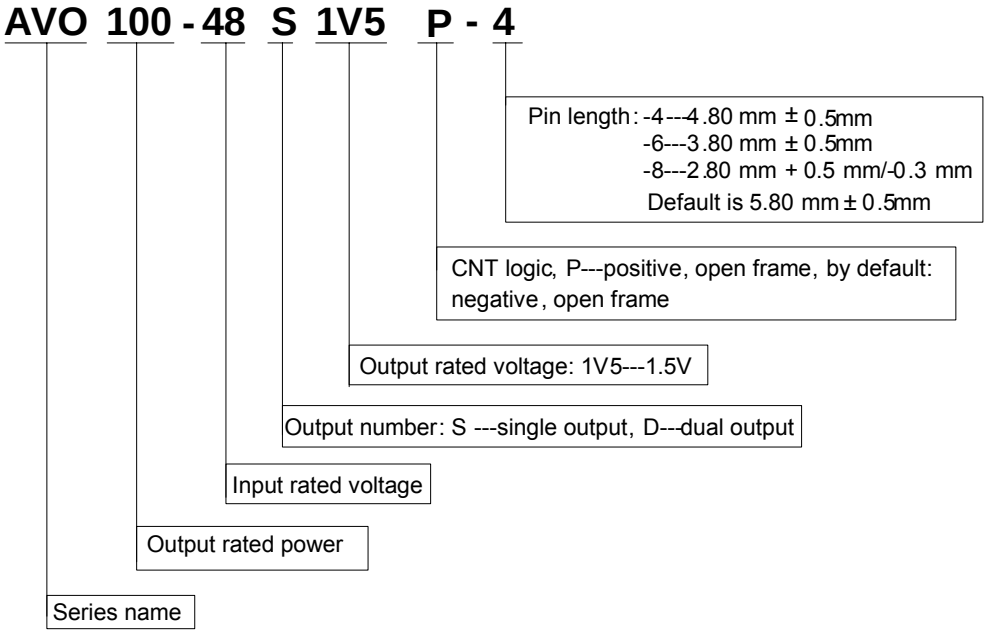
Features

- **Up to 40A output current**
- **Basic isolation**
- **Ultra high efficiency**
- **Improved thermal performance**
- **High power density**
- **Low output noise**
- **2:1 wide input voltage of 36V~75V**
- **CNT function**
- **Remote sense**
- **Trim function: +10%/-20%**
- **Input under-voltage lockout**
- **Output over-current protection**
- **Output over-voltage protection**
- **Over-temperature protection**

Description

The AVO100-48S1V5 is a new open frame DC/DC converter for optimum efficiency and power density. The series provides up to 40A output current in an industry standard eighth brick, which makes it an ideal choice for small space, high current and low voltage applications. The AVO100-48S1V5 uses an industry standard eighth brick: 57.9mm × 22.9mm × 9.1mm (2.28” × 0.9” × 0.36”) and standard pin-out configuration, provides CNT and trim functions. AVO100-48S1V5 can provide 1.5V@40A single output, and outputs are isolated from inputs. The series can achieve ultra high efficiency, and for most applications, a heatsink is not required.

Module Numbering



Electrical Specifications

Unless otherwise indicated, specifications apply over all operating input voltage and temperature conditions. Standard test condition on a single unit is as follows:

+Vin: 48V±2%
-Vin: Return pin for +Vin
CNT: Connect to -Vin
+Vout: Connect to load
-Vout: Connect to load (return)
+Sense: Connect to +Vout
-Sense: Connect to -Vout
Trim (Vadj): Open

Input Specifications

Parameter	Symbol	Min	Typ	Max	Unit	Note
Operating input voltage	VI	36	48	75	Vdc	-
Inrush transient	-	-	-	1	A2s	-
Input reflected-ripple current	II	-	20	30	mAp-p	5Hz to 20MHz: 12μH source impedance, TA=25ºC.
Supply voltage rejection (AC)	-	50	60	-	dB	120Hz

CAUTION: This power module is not internally fused. An input line fuse must always be used.

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the IPS. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter		Symbol	Min	Typ	Max	Unit	Note
Input voltage	Continuous	VI	0	-	80	Vdc	-
	Transient	VI, trans	0	-	100	Vdc	100ms
Operating ambient temperature		Ta	-40	25	85	ºC	See *Thermal Consideration*
Operating board temperature		Tc	105	-	120	ºC	The place of mark on PCB
Storage temperature		TSTG	-55	-	125	ºC	-
Operating humidity		-	5	-	95	%	-
Basic input-output isolation		-	1,500	-	-	Vdc	1mA for 5sec, slew rate of 1,500V/10sec
Output power		Po,max	-	-	60	W	-

Output Specifications

Parameter		Symbol	Min	Typ	Max	Unit	Conditions
Output ripple & noise		-	-	-	60	mVrms (f<20MHz)	(Ta: 25ºC, air velocity: 300LFM, Vin: 48V, Vonom, Ionom, 1μF @10V, X7R ceramic capacitor & 470μF @16V low ESR aluminum capacitor)
		-	-	-	60	mVp-p (f<20MHz)	(Ta: 25ºC, air velocity: 300LFM, Vin: 48V, Vonom, Ionom, 1μF @10V, X7R ceramic capacitor & 1000μF @10V low ESR aluminum capacitor)
External load capacitance		-	220	1000	20000	μF	
Output voltage setpoint		Vo,set	1.48	1.5	1.52	Vdc	Rating input@Ionom
Output regulation	Line (Vi,min to Vi,max)	-	-	-	5	mV	Temperature (Tc=-40ºC to +100ºC)
	Load (Io,min to Io,max)	-	-	-	10		
Rated output current		Io	0	-	40	A	-
Output current-limit inception (hiccup)		Io	44	-	56	A	-
Efficiency		-	86.5	88.5	-	%	Ta: 25ºC, air velocity: 300LFM, Vin: 48V, load: Ionom; forced air direction: from Vin+ to Vin-
		-	87.5	89.5	-	%	Ta: 25ºC, air velocity: 300LFM, Vin: 48V, load: 50% Ionom; forced air direction: from Vin+ to Vin-

Output Specifications (Cont)

Parameter		Symbol	Min	Typ	Max	Unit	Note
Dynamic response (all)	Peak deviation	-	-	-	50	mV	25% Ionom step from 50% Ionom, 0.1A/us, Ta=25°C,Vi=Vi,nom
	Settling time (to Vo,nom)	-	-	-	150	μsec	
	Peak deviation	-	-	-	100	mV	25% Ionom step from 50% Ionom, 1A/μS, Ta=25°C, Vi=Vi,nom
	Settling time (to Vo,nom)	-	-	-	200	μsec	
Turn-on time		-	-	-	20	msec	Io=Ionom; Vo from 10% to 90%
Output voltage overshoot*		-	-	-	5	%Vo	Io=Ionom; Ta=25°C
Switching frequency		-	-	175	-	kHz	-

Note*:

1. If decreasing the output voltage by 1.2V, the max. shutdown overshoot is 60mV (5%).
2. With no regulation of the output voltage, the max shutdown overshoot is 85mV (5.6%).
3. If increasing the output voltage by 1.65V, the max shutdown overshoot is 95mV (5.8%).

Feature Specifications

Parameter		Symbol	Min	Typ	Max	Unit	Note
Enable pin voltage	Logic low	-	-0.7	-	1.2	Vdc	-
	Logic high	-	3.5	-	12	Vdc	-
Enable pin current:	Logic low	-	-	-	1.0	mA	-
	Logic high	-	-	-	-	μA	
Output voltage adjustment range		-	80	-	110	%Vo	-
Output over-voltage (hiccup)		Voclamp	1.8	-	2.5	V	-
Over-temperature protection (auto-recovery)		-	110	-	135	°C	-
Under-voltage lockout	Turn-on point	-	31	34	36	V	-
	Turn-off point	-	30	33	35	V	
Isolation capacitance		-	-	1500	-	PF	-
Isolation resistance		-	10	-	-	MΩ	-
Calculated MTBF		-	-	2,500,000	-	Hours	Vin: 48V, Load: Ionom Board@25°C
Weight		-	-	-	-	g (oz.)	With baseplate
Vibration (sine wave)		Vibration level: 3.5mm (2 ~ 9Hz), 10m/s^2 (9 ~ 200Hz),15m/s^2 (200 ~ 500Hz) Directions and time: 3 axes (X, Y, Z), 30 minutes each Sweep velocity: 1oct / min					
Shock (half-sine wave)		Peak acceleration: 300m/s^2 Duration time: 6ms Continuous shock 3 times at each of 6 directions (±X, ±Y, ±Z)					

Characteristic Curves

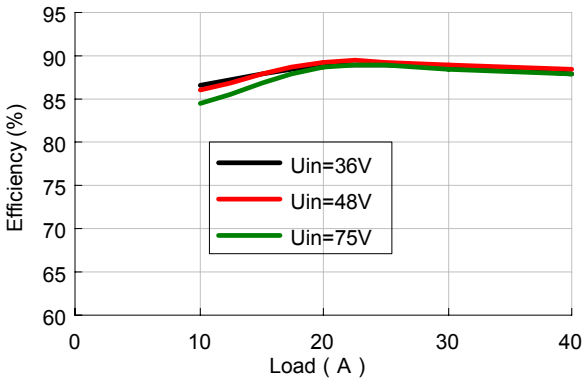


Figure 1 Typical efficiency of AVO100-48S1V5

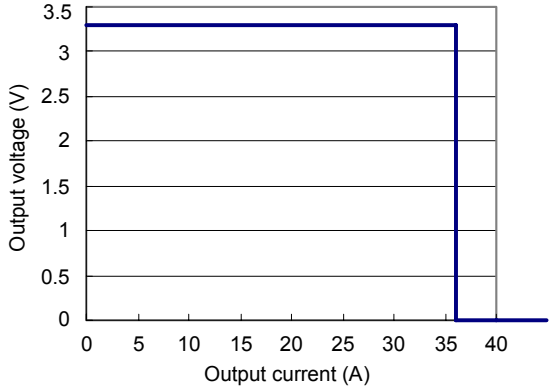


Figure 2 Typical output over-current AVO100-48S1V5

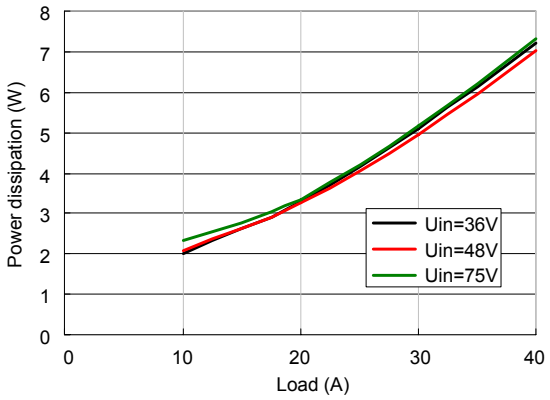


Figure 3 Typical power dissipation AVO100-48S1V5

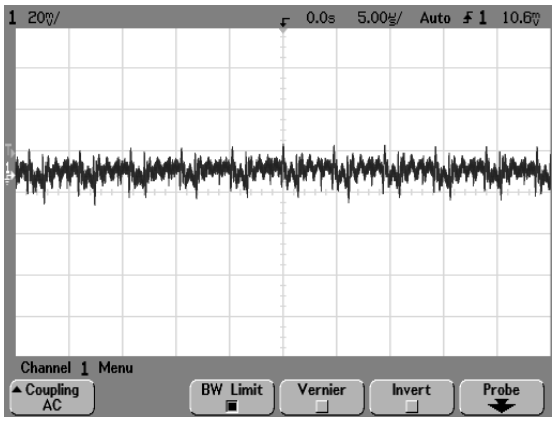


Figure 4 Typical output ripple voltage AVO100-48S1V5

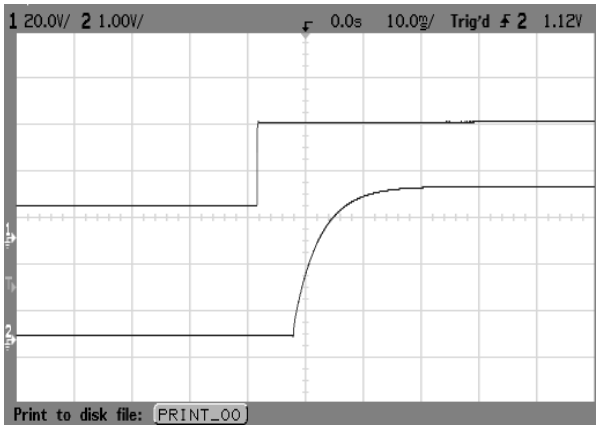


Fig. 5 AVO100-48S1V5 typical start-up from power on

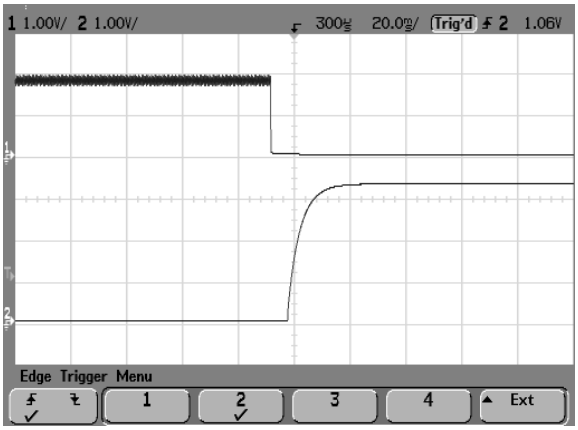


Fig. 6 AVO100-48S1V5 typical start-up from CNT on

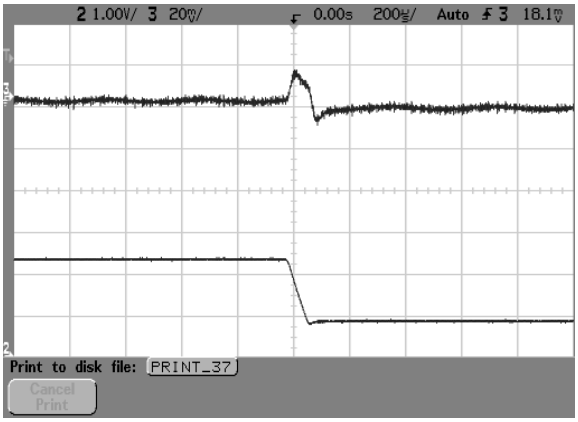


Figure 7 AVO100-48S1V5 typical transient response to step decrease, load change from 50% to 25%, of full load room temperature, 48Vdc Input, (ΔIo/Δt=0.1A/1μs)

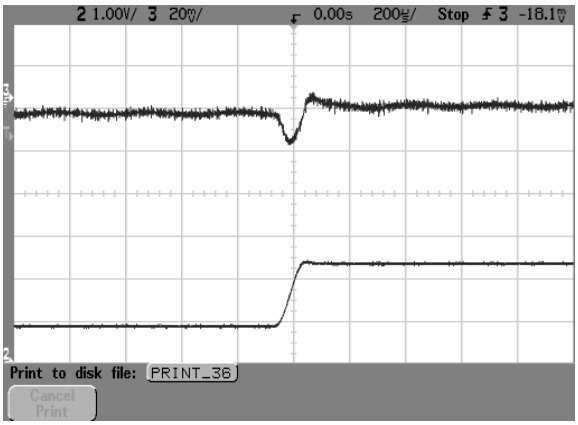


Figure 8 AVO100-48S1V5 typical transient response to step increase, load change from 50% to 75%, of full load room temperature, 48Vdc Input, (ΔIo/Δt=0.1A/1μs)

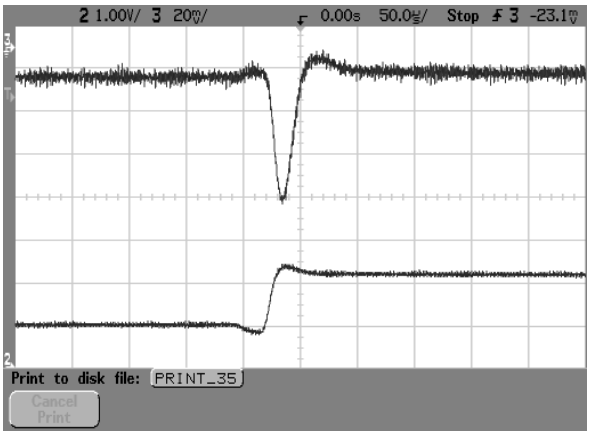


Figure 9 AVO100-48S1V5 typical transient response to step increase, load change from 50% to 75% of full load, room temperature, 48Vdc Input, (ΔIo/Δt=1A/1μs), room temperature, Io=Io,max

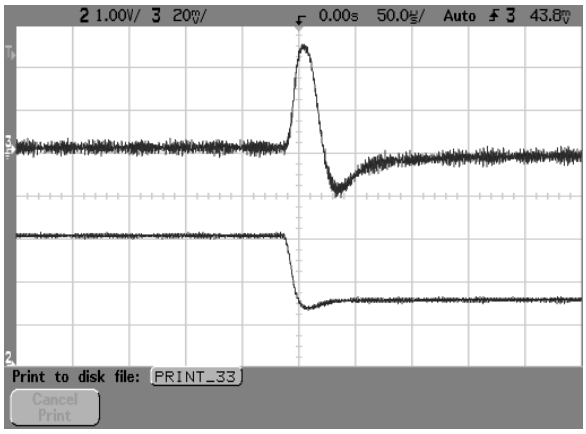


Figure 10 AVO100-48S1V5 typical transient response to step decrease, load change from 50% to 25% of full load, room temperature, 48Vdc Input, (ΔIo/Δt=1A/1μs), room temperature, Io=Io,max

Feature Description

CNT Function

Two CNT logic options are available. The CNT logic, CNT voltage and the module working state are as the following table.

	L	H	OPEN
N	ON	OFF	OFF
P	OFF	ON	OFF

N--- means “Negative Logic”
P--- means “Positive Logic”
L--- means “Low Voltage”, -0.7V≤L≤1.2V
H--- means “High Voltage”, 3.5V≤H≤12V
ON--- means “Module is on”, OFF--- means “Module is off”
Open--- means “CNT pin is left open “
Note: when CNT is left open, V_{CNT} may reach 6V.
Figure 7 shows a few simple CNT circuits.

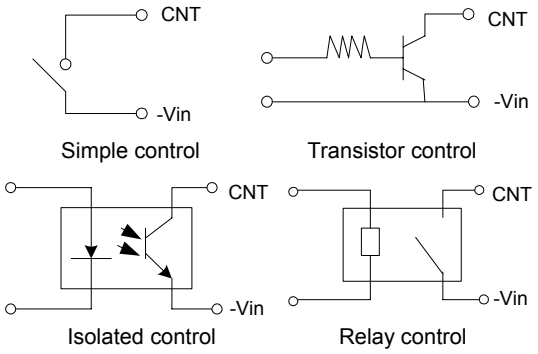


Figure 11 CNT circuits

Remote Sense

The AVO100-48S1V5 converter can remotely sense both lines of its output which moves the effective output voltage regulation point from the output terminals of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the AVO100-48S1V5 in order to compensate for voltage drops in distribution and maintain a regulated voltage at the point of load.
When the converter is supporting loads far away, or is used with undersized cabling, significant voltage drop can occur at the load. The best defense against such drops is to locate the load close to the converter and to ensure adequately sized cabling is used. When this is not possible, the converter can compensate for a drop of up to 10%Vo, through use of the sense leads.
When used, the +Sense and -Sense leads should be connected from the converter to the point of load as shown in Figure 12, using twisted pair wire, or parallel pattern to reduce noise effect. The converter will then regulate its output voltage at the point where the leads are connected. Care should be taken not to reverse the sense leads. If reversed, the converter will trigger OVP protection.
When not used, the +Sense lead must be connected with +Vo, and -Sense with -Vo. Although the output voltage can be increased by both the remote sense and the trim, the maximum increase for the output voltage is not the sum of both.
The maximum increase is the larger of either the remote sense or the trim.
Note that at elevated output voltages the maximum power rating of the module remains the same, and the output current capability will decrease correspondingly.

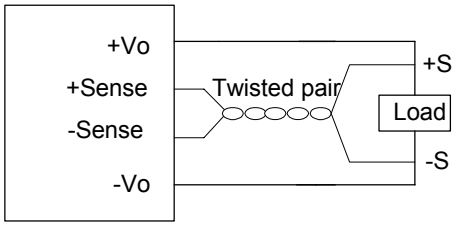


Figure 12 Sense connections

Trim

The +Vo output voltage of the AVO100-48S1V5 can be trimmed using the trim pin provided. Applying a resistor to the trim pin through a voltage divider from the output will cause the +Vo output to increase by up to 10% or decrease by up to 20%. Trimming up by more than 10% of the nominal output may activate the OVP circuit or damage the converter. Trimming down more than 20% can cause the converter to regulate improperly. If the trim pin is not needed, it should be left open.

Trim up

With an external resistor connected between the TRIM and +Sense pins, the output voltage set point increases (see Figure 13).

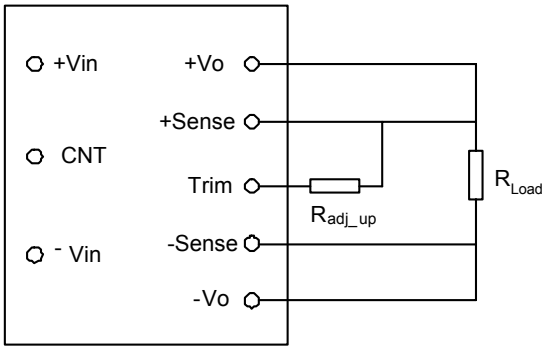


Figure 13 Trim up circuit

The following equation determines the required external-resistor value to obtain a percentage output voltage change of %.

For output voltage: 1.5V

$$R_{adj-up} = \frac{5.11 \times V_o \times (100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{511}{\Delta\%} - 10.22(k\Omega)$$

Trim down

With an external resistor between the TRIM and -Sense pins, the output voltage set point decreases (see Figure 14).

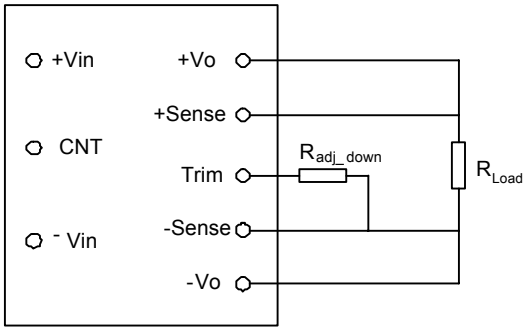


Figure 14 Trim down circuit

The following equation determines the required external-resistor value to obtain a percentage output voltage change of %.

For output voltage: 1.5V

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

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim.

Note that at elevated output voltages the maximum power rating of the module remains the same, and the output current capability will decrease correspondingly.

Minimum Load Requirements

There is no minimum load requirement for the AVO100-48S1V5 module.

Parameter	Device	Symbol	Typ	Unit
Minimum load	1.5V	IMIN	0	A

Output Over-Current Protection

AVO100-48S1V5 DC/DC converters feature foldback current limiting as part of their Over-current Protection (OCP) circuits. When output current exceeds 110 to 140% of rated current, such as during a short circuit condition, the module will work on intermittent mode, also

can tolerate short circuit conditions indefinitely. When the over-current condition is removed, the converter will automatically restart.

Output Capacitance

High output current transient rate of change (high di/dt) loads may require high values of output capacitance to supply the instantaneous energy requirement to the load. To minimize the output voltage transient drop during this transient, low Equivalent Series Resistance (ESR) capacitors may be required, since a high ESR will produce a correspondingly higher voltage drop during the current transient.

When the load is sensitive to ripple and noise, an output filter can be added to minimize the effects. A simple output filter to reduce output ripple and noise can be made by connecting a capacitor C1 across the output as shown in Figure 15. The recommended value for the output capacitor C1 is 1000μF.

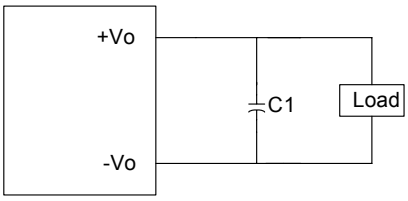


Figure 15 Output ripple filter

Extra care should be taken when long leads or traces are used to provide power to the load. Long lead lengths increase the chance for noise to appear on the lines. Under these conditions C2 can be added across the load, with a 1μF ceramic capacitor C2 in parallel generally as shown in Figure 16.

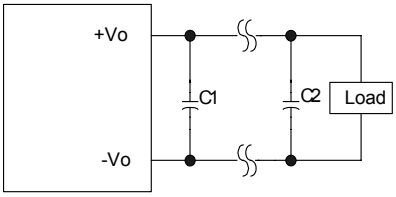


Figure 16 Output ripple filter for a distant load

Decoupling

The converter does not always create noise on the power distribution system. High-speed analog or digital loads with dynamic power demands can cause noise to cross the power inductor back onto the input lines. Noise can be reduced by decoupling the load. In most cases, connecting a 10μF ceramic capacitor in parallel with a 0.1μF ceramic capacitor across the load will decouple it. The capacitors should be connected as close to the load as possible.

Ground Loops

Ground loops occur when different circuits are given multiple paths to common or earth ground, as shown in Figure 17. Multiple ground points can slightly different potential and cause current flow through the circuit from one point to another. This can result in additional noise in all the circuits. To eliminate the problem, circuits should be designed with a single ground connection as shown in Figure 18.

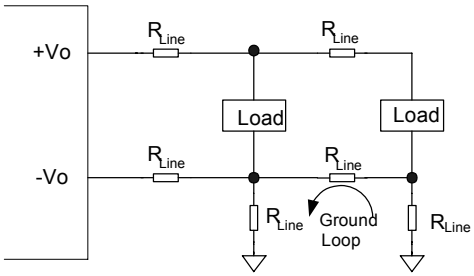


Figure 17 Ground loops

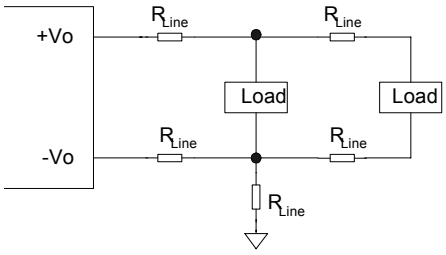


Figure 18 Single point ground

Output Over-Voltage Protection

The output over-voltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over voltage protection threshold, then the module will work on intermittent mode. When the over-voltage condition is removed, the converter will automatically restart.
The protection mechanism is such that the unit can continue in this condition until the fault is cleared.

Over-Temperature Protection

These modules feature an over-temperature protection circuit to safeguard against thermal damage. The module will work in intermittent mode when the maximum device reference temperature is exceeded. When the over-temperature condition is removed, the converter will automatically restart.

Design Consideration

Typical Application

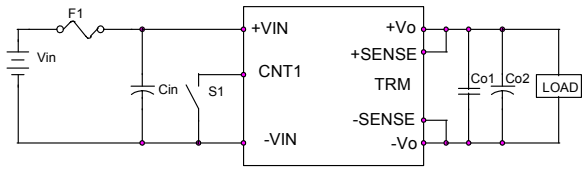


Figure 19 Typical application

F1: Fuse*: Use external fuse with a rating of 6.3A (fast blow type) for each unit.
Cin: Recommended input capacitor 100μF/100V high frequency low ESR electrolytic type capacitor .

Co1: Recommended 1μF /10V ceramic capacitor

Co2: Recommended output capacitor

Recommended 470μF/16V high frequency low ESR electrolytic type capacitor.
If Ta<-5 C: use 220μF tantalum capacitor parallel with a 470μF/ 16V high frequency low ESR electrolytic capacitor.
Note: The AVO100-48S1V5 modules cannot be used in parallel mode directly!

Fusing

The AVO100-48S1V5 power module has no internal fuse. An external fuse must always be employed! To meet international safety requirements, a 250 Volt rated fuse should be used. If one of the input lines is connected to chassis ground, then the fuse must be placed in the other input line.
Standard safety agency regulations require input fusing. Recommended fuse ratings is 5 for AVO100-48S1V5 modules.
Note: the fuse is fast blow type.

Input Reverse Voltage Protection

Under installation and cabling conditions where reverse polarity across the input may occur, reverse polarity protection is recommended. Protection can easily be provided as shown in Figure 20. In both cases the diode used is rated for 15A/100V. Placing the diode across the inputs rather than in-line with the input offers an advantage in that the diode only conducts in a reverse polarity condition, which increases circuit efficiency and thermal performance.

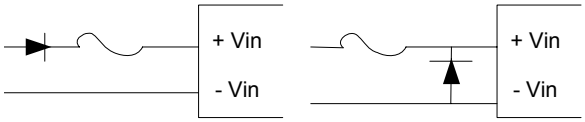


Figure 20 Reverse polarity protection circuit

EMC

For conditions where EMI is a concern, a different input filter can be used. Figure 21 shows a filter designed to reduce EMI effects. AVO100-48S1V5 can meet EN55022 CLASS A with Figure 21.

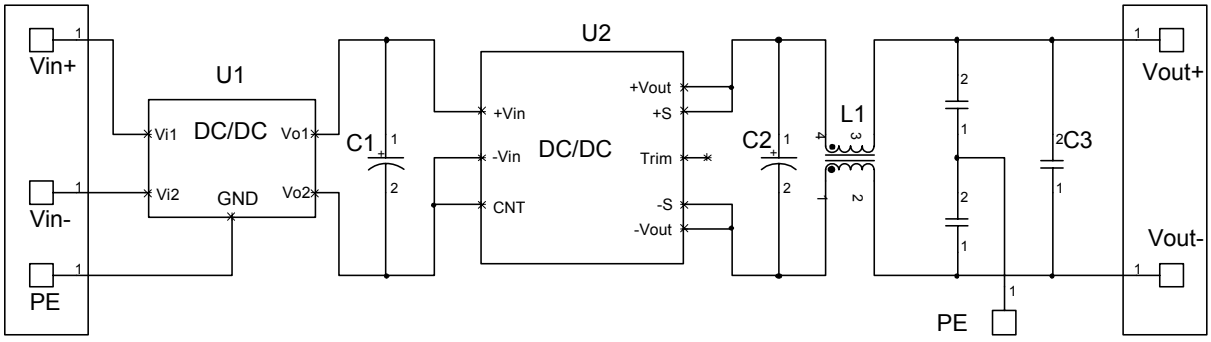


Figure 21 EMI reduction filter

Recommended values:

Component	Value/rating	Type
C1	47u/100V	low ESR aluminum capacitor
C2	1000u/10V	low ESR aluminum capacitor
U1	5A input filter	-
Red part output	-	No need

Safety Consideration

For safety-agency approval of the system in which the power module is used, the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standard, i.e., UL60950, CSA C22.2, and EN60950. AVO100-48S1V5 input-to-output isolation is a basic insulation. The DC/DC power module should be installed in end-use equipment, in compliance with the requirements of the ultimate application, and is intended to be supplied by an isolated secondary circuit. When the supply to the DC/DC power module meets all the requirements for SELV (<60Vdc), the output is considered to remain within SELV limits (level 3). If connected to a 60Vdc power system, double or reinforced insulation must be provided in the power supply that isolates the input from any hazardous voltages, including the AC mains. One input pin and one output pin are to be grounded or both the input and output pins are to be kept floating. Single fault testing in the power supply must be performed in combination with the DC/DC power module to demonstrate that the output meets the requirement for SELV. The input pins of the module are not operator accessible.

Note: Do not ground either of the input pins of the module, without grounding one of the output pins. This may allow a non-SELV voltage to appear between the output pin and ground. The circuit cannot withstand transient over-voltage.

Thermal Consideration

Technologies

AVO100-48S1V5 modules have ultra high efficiency at full load. With less heat dissipation and temperature-resistant components such as ceramic capacitors, these modules exhibit good behavior during pro-longed exposure to high temperatures. Maintaining the operating board temperature within the specified range helps keep internal component temperatures within their specifications which in turn help keep MTBF from falling below the specified rating. Proper cooling of the power modules is also necessary for reliable and consistent operation.

Basic Thermal Management

Measuring the board temperature of the module is shown in Figure 22 can verify the proper cooling.

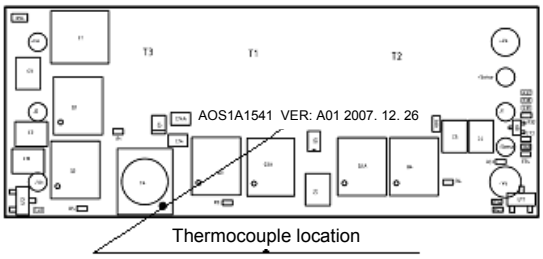


Figure 22 Temperature measurement location

The module should work under 85°C ambient for the reliability of operation and the board temperature must not exceed 120°C while operating in the final system configuration. The measurement can be made with a surface probe after the module has reached thermal equilibrium. No heatsink is mounted, make the measurement as close as possible to the indicated position. It makes the assumption that the final system configuration exists and can be used for a test environment. Note that the board temperature of module must always be checked in the final system configuration to verify proper operational due to the variation in test conditions. Thermal management acts to transfer the heat dissipated by the module to the surrounding environment. The amount of power dissipated by the module as heat (PD) is got by the equation below:

PD=PI-PO

Where PI is input power; PO is output power; PD is dissipated power.

Also, module efficiency (η) is defined as the following equation:

η=PO/PI

If eliminating the input power term, from two above equations can yield the equation below:

PD=PO (1-η)/η

The module power dissipation then can be calculated through the equation.

Because each power module output voltage has a different power dissipation curve, a plot of power dissipation versus output current over three different line voltages is given in Figure 5 and Figure 6

Module Derating

When 48V input, 55 C ambient temperature, and 200LFM airflow, AVO100-48S1V5 are rated for full power, and in this condition the board temperature can reach 120 C. For operation above ambient temperature of 55°C, output power must be derated as shown in Figure 23, meantime, airflow at least 200LFM over the converter must be provided to make the module working properly. The board temperature should be used to determine maximum temperature limits. The minimum operating temperature for the AVO100-48S1V5 is -40°C.Increasing airflow over the module enhances the heat transfer via convection. Figure 23 shows the maximum current that can

be delivered by the corresponding module without exceeding the maximum board temperature versus local ambient temperature (Ta) for natural convection（0m/s）through 2m/s (400ft./min.).

The use of output power derating curve is shown in the following example.

Example

What is the minimum airflow necessary for a AVO100-48S1V5 operating at VI=48 V, an output current of 38A, and a maximum ambient temperature of 55 C

Solution

Given: VI=48V, Io=38A, Ta=55°C

Determine airflow (v) (use Figure 23): v=1m/sec. (200ft./min.)

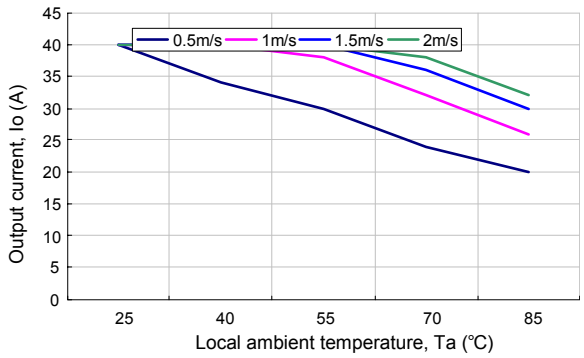


Figure 23 AVO100-48S1V5 output power derating, airflow direction from -Vin to +Vin; Vin=48V

MTBF

The MTBF, calculated in accordance with Bellcore TR-NWT-000332, is 2,500,000 hours. Obtaining this MTBF in practice is entirely possible. If the board temperature is expected to exceed +25 C, then we also advise an oriented for the best possible cooling in the air stream.

Emerson Network Power can supply replacements for converters from other manufacturers, or offer custom solutions. Please contact the factory for details.

Mechanical Considerations

Installation

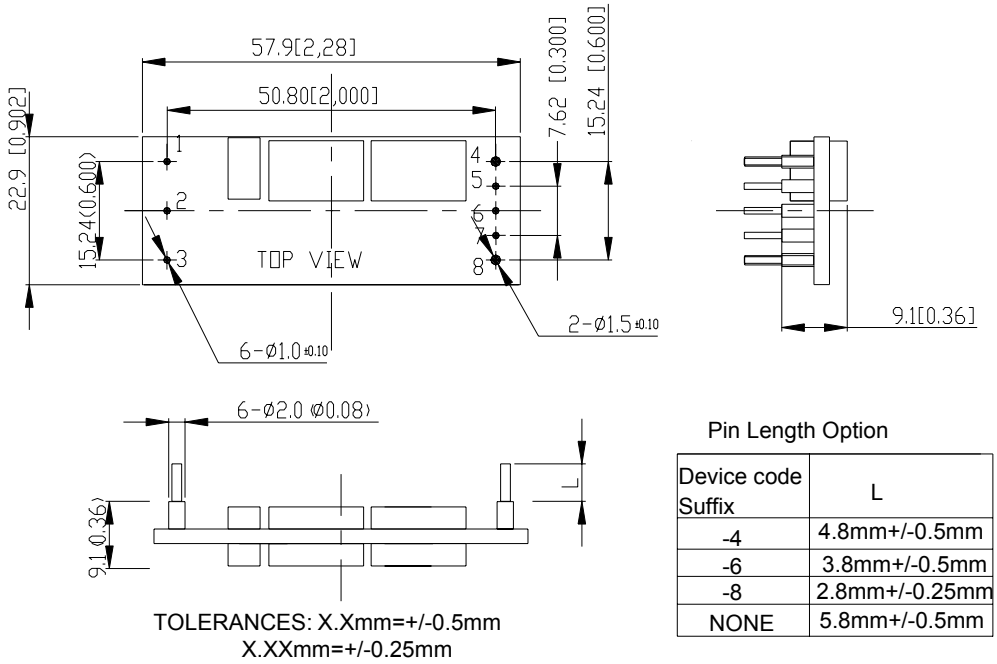
Although AVO100-48S1V5 converters can be mounted in any orientation, free air-flowing must be taken. Normally power components are always put at the end of the airflow path or have separate airflow paths. This can keep other system equipment cooler and increase component life spans.

Soldering

AVO100-48S1V5 converters are compatible with standard wave soldering techniques. When wave soldering, the converter pins should be preheated for 20~30 seconds at 120°C, and wave soldered at 260 C for less than 10 seconds.

When hand soldering, the iron temperature should be maintained at 425 C and applied to the converter pins for less than 5 seconds. Longer exposure can cause internal damage to the converter. Cleaning can be performed with cleaning solvent IPA or with water.

Mechanical Chart



Pin Length Option

Device code Suffix	L
-4	4.8mm+/-0.5mm
-6	3.8mm+/-0.5mm
-8	2.8mm+/-0.25mm
NONE	5.8mm+/-0.5mm

Tolerances: X.Xmm±0.5mm (X.XXin.±0.02in.), X.XXmm±0.25mm (X.XXXin.±0.010in.)

Notes:

1. Un-dimensioned components are for visual reference only.
2. Pins 1~3, 5~7 are 1.0mm diameter with 2.0mm diameter standoff shoulders.
3. Pins 4, 8 are 1.5mm diameter with no standoff shoulders.

Pins Definition

Pin number	Function		Pin number	Function
1	+Vin		5	+Sense
2	CNT		6	Trim
3	-Vin		7	-Sense
4	+Vo		8	-Vo

Ordering Information

Model number	Input voltage (v)	Output voltage (v)	Output current (a)	Ripple & noise (mV pp, Max.)	Efficiency (%) Typ.
AVO100-48S1V5-4	36~75	1.5	40	60	88.5
AVO100-48S1V5P-4	36~75	1.5	40	60	88.5

有毒有害物质或元素标识表

部件名称	有毒有害物质或元素					
	铅	汞	镉	六价铬	多溴联苯	多溴联苯醚
	Pb	Hg	Cd	C^{6+}	PBB	PBDE
制成板	×	○	○	○	○	○
○：表示该有毒有害物质在该部件所有均质材料中的含量在 SJ/T-11363-2006 规定的限量要求以下。 ×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T-11363-2006 规定的限量要求						
艾默生网络能源有限公司一直致力于设计和制造环保的产品，我们会通过持续的研究来减少和消除产品中的有毒有害物质。以下部件或应用中含有有毒有害物质是限于目前的技术水平无法实现可靠的替代或者没有成熟的解决方案： 1．器件的高温焊料中含有铅。 2．电子器件的玻璃中含有铅。 3．插针的铜合金中含有铅						
适用范围：AVO100-48S1V5						