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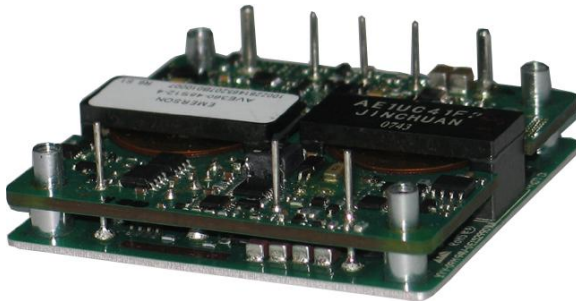
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AVE360-48S12 DC/DC Converter

Technical Reference Note

Industry Standard Half Brick: 36~75V Input, 12V Single Output



Industry Standard Half Brick: 2.4" X 2.28" X 0.5"

Features

- Delivers up to 30A output current
- Basic isolation
- Ultra High efficiency
- Improved thermal performance:
- High power density
- Low output noise
- 2:1 wide input voltage of 36-75V
- CNT function
- Remote sense
- Trim function: +10%/-10%
- Input under-voltage lockout
- Output over-current protection
- Output over-voltage protection
- Over-temperature protection

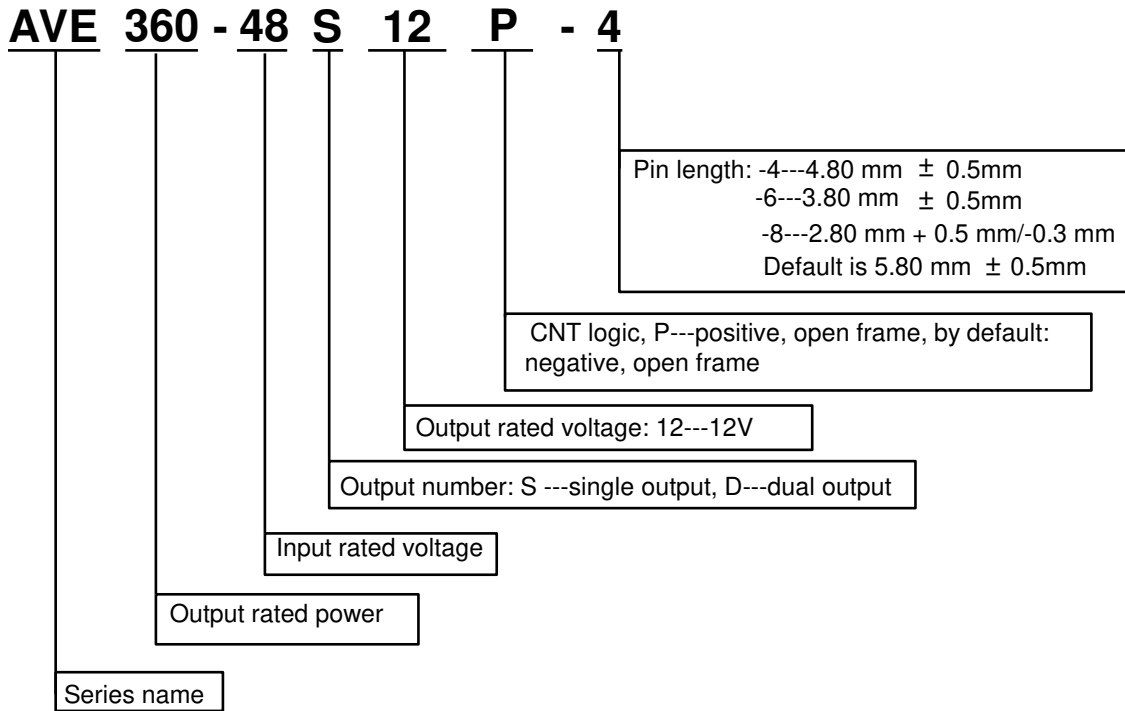
Options

- Choice of positive logic or negative logic for CNT function
- Choice of short pins or long pins

Description

The AVE360-48S12 is a new DC/DC converter for optimum efficiency and power density. AVE360-48S12 provides up to 30A output current in an industry standard Half Brick, which makes it an ideal choice for small space and high power applications. AVE360-48S12 uses an industry standard half brick 61.0mm x 57.9mm x 12.7mm (2.4"x2.28"x0.5"), provides CNT and trim functions. AVE360-48S12 can provide 12V@30A, single output and output is isolated from input.

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 following:

- Ta: 25°C
- +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	-	-	-	2	A2s	-
Input Reflected-ripple Current	II	-	50	80	mAp-p	5Hz to 20MHz: 12μH source impedance, TA = 25°C.

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	°C	See Thermal Consideration
Operating Board Temperature		Tc		-	135	°C	Near temperature sensor Rt
Storage Temperature		TSTG	-55	25	125	°C	-
Operating Humidity		-	5	-	95	%	-
Basic Input-Output Isolation		-	1,500	-	-	Vdc	1mA for 5 sec, slew rate of 1,500V/10sec
Output Power		Po,max	-	-	360	W	-

Output Specifications

Parameter		Symbol	Min	Typ	Max	Unit	Conditions
Output Ripple& Noise		-	-	-	300	mVp-p (f<20MHz)	Whole range
External Load Capacitance		-	680	2200	10000	μF	(Ta: 25°C, Vin: 48V, 30000μF can start-up)
Output Voltage Setpoint		Vo,set	11.8	12	12.2	Vdc	Rating input@ Ionom
Output Regulation	Line (Vi,min to Vi,max)	-	-	-	0.3	%Vo	Whole range
	Load (Io = Io,min to Io,max)	-	-	-	0.5	%Vo	
	Temperature Regulation (Whole range)	-	-	-	0.02	%Vo/°C	
Rated Output Current		Io	0	10	30	A	-
Output Current-limit Inception (Hiccup)		Io	31.5	-	45	A	-
Efficiency		-	93	94	-	%	Ta: 25°C, Air velocity: 300LFM, Vin: 48V, Load: Ionom; forced air direction: from Vin+ to Vin-
Efficiency		-	93	94	-	%	Ta: 25°C, Air velocity: 300LFM, Vin: 48V, Load: 70% Ionom; forced air direction: from Vin+ to Vin-

Output Specifications (Cont)

Parameter		Symbol	Min	Typ	Max	Unit	Note
Dynamic Response (all)	Peak Deviation	-	-	-	600	mV	25% I _{onom} step from 50% I _{onom} , 0.1A/μS
	Settling Time (to V _{o,nom})	-	-	-	400	μsec	
Turn-On Time		-	-	-	100	msec	I _o = I _{onom} ; V _o from 10% to 90%
Output Voltage Overshoot		-	-	-	5	%V _o	I _o = I _{onom} ; T _A = 25°C
Switching Frequency		-	-	280	-	KHz	-

Feature Specifications

Parameter		Symbol	Min	Typ	Max	Unit	Note
Enable pin voltage:	Logic Low	-	-0.7	-	1.2	Vdc	-
	Logic High	-	3.5	-	5	Vdc	-
Enable pin current:	Logic Low	-	-	-	1.0	mA	-
	Logic High	-	-	-	-	μA	-
Output Voltage Adjustment Range*		-	90	-	110	%Vo	-
Output Over-voltage Protection (Static)		Voclamp	14	-	16.5	V	Hiccup
Under-voltage Lockout	Turn-on Point	-	31	34	36	V	-
	Turn-off Point	-	30	33	35	V	-
Isolation Capacitance		-	-	-	-	PF	-
Isolation Resistance		-	10	-	-	MΩ	-
Calculated MTBF		-	-	2,000,000	-	Hours	Vin: 48V, Load: Ionom Board@25oC
Weight		-	-	72	-	g(oz.)	-
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

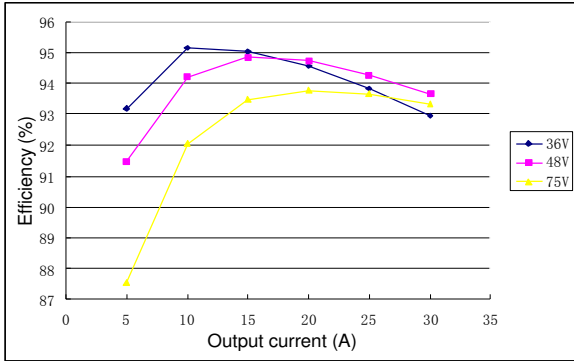


Fig. 1 AVE360-48S12 Typical Efficiency
 Ta: 25°C, Air velocity: 300LFM, Vin: 48V, Load: Ionom;
 forced air direction: from Vin+ to Vin-

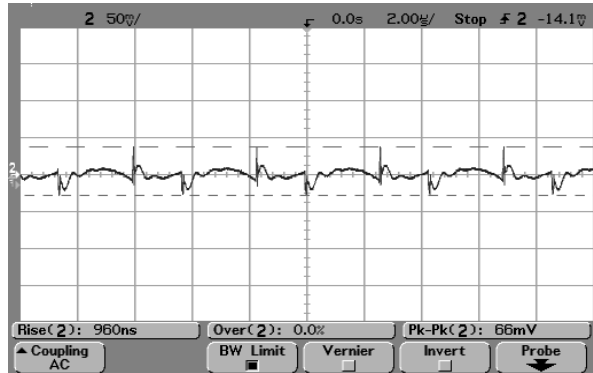


Fig. 2 AVE360-48S12-4 Typical Output Ripple Voltage
 Ta: 25°C, Air velocity: 300LFM, Vin: 48V, Vonom, Ionom,
 10μ tantalum (ESR≤100 mΩ)// 1μ ceramic capacitor

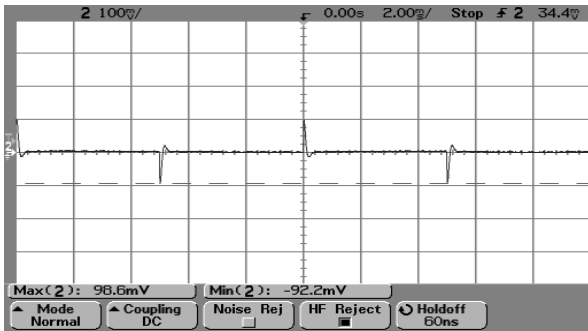


Fig. 3 AVE360-48S12-4 Typical Transient Response to
 Ta: 25°C, Air velocity: 300LFM, forced air direction:
 from Vin+ to Vin-. Vin: 48V, Vonom, 25% Ionom step
 step from 50% Ionom, 0.1A/μs”, the external capacitor
 should be “10μ tantalum (ESR≤100 mΩ) // 1μ ceramic
 capacitor

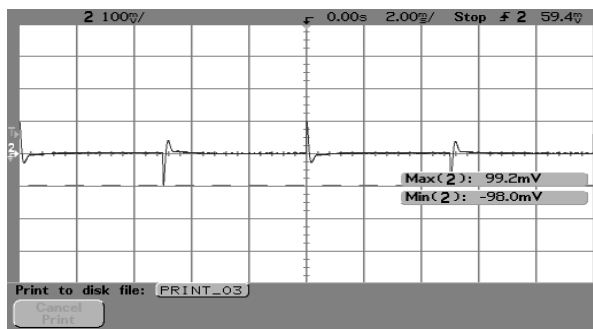


Fig. 4 AVE360-48S12-4 Typical Transient Response to
 Ta: 25°C, Air velocity: 300LFM, forced air direction:
 from Vin+ to Vin-. Vin: 48V, Vonom, 50% Ionom
 from 75% Ionom, 0.1A/μs”, the external capacitor
 should be “10μ tantalum (ESR≤100 mΩ) // 1μ ceramic
 capacitor

Performance Curves – Startup Characteristics

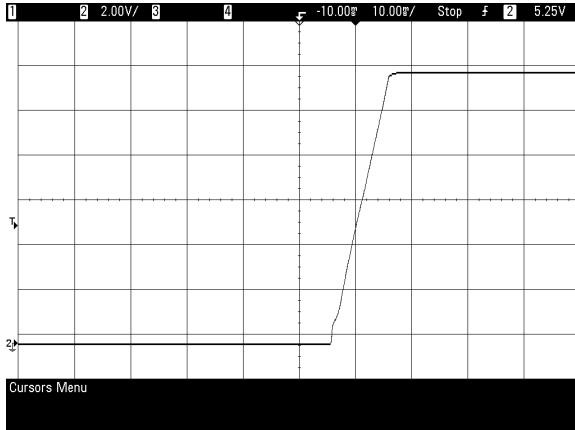


Figure 5 Typical start-up from power on

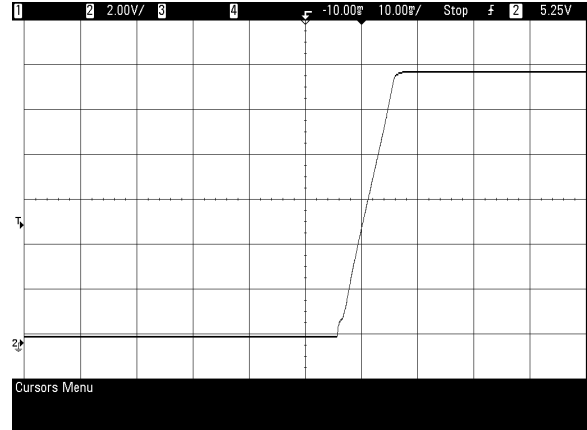


Figure 6 Typical start-up from CNT on

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	ON

N--- means "Negative Logic"

P--- means "Positive Logic"

L--- means "Low Voltage", $-0.7V \leq L \leq 1.2V$

H--- means "High Voltage", $3.5V \leq H \leq 5V$

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.

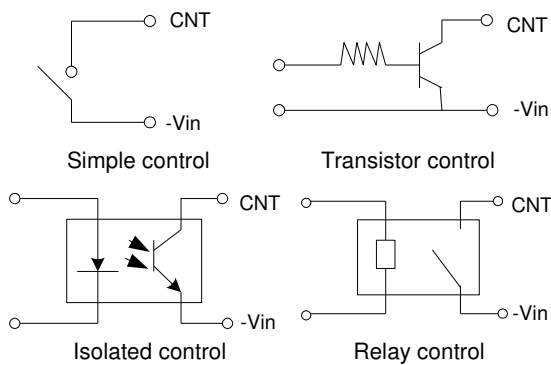


Figure 7 CNT circuits

Remote Sense

AVE360-48S12 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 AVE360-48S12 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 8, 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 and turn off. 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 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.

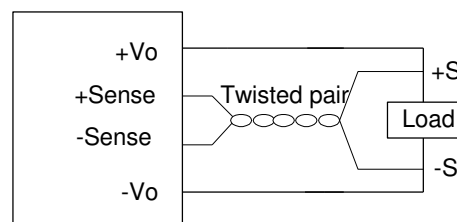


Figure 8 Sense connection

Trim

The +Vo output voltage of AVE360-48S12 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 9).

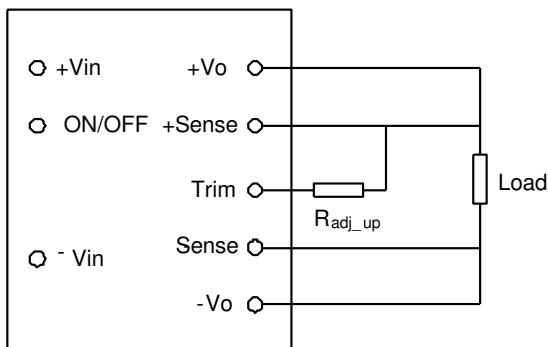


Figure 9 Trim up circuit

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

$$R_{adj-up} = \left(\frac{V_{o,nom} * (100 + \Delta\%)}{1.225 * \Delta\%} - \frac{(100 + 2 * \Delta\%) V_{o,nom}}{\Delta\%} \right) K\Omega$$

Where,

$$\Delta\% = \left| \frac{V_{o,nom} - V_{desired}}{V_{o,nom}} \right| \times 100$$

$V_{desired}$ = Desired output voltage set point (V).

V_{trim} tolerance less than $\pm 2\%$,
 R_{adj} tolerance is $\pm 1\%$

Note that the trim-up function is valid only when the input is above 38V.

Trim down

With an external resistor between the TRIM and -SENSE pins, the output voltage set point decreases (see Figure 10).

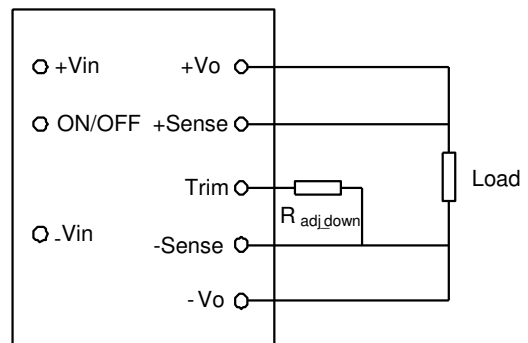


Figure 10 Trim down circuit

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

$$R_{adj-down} = \left(\frac{100}{\Delta\%} - 2 \right) K\Omega$$

Where,

$$\Delta\% = \left| \frac{V_{o,nom} - V_{desired}}{V_{o,nom}} \right| \times 100$$

$V_{desired}$ = Desired output voltage set point (V).

V_{trim} tolerance less than $\pm 2\%$,
 R_{adj} tolerance is $\pm 1\%$

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.

Minimum Load Requirements

There is no minimum load requirement for the AVE360-48S12 module.

Parameter	Device	Symbol	Typ	Unit
Minimum Load	12V	IMIN	0	A

Output Over-current Protection

AVE360-48S12 DC/DC converter feature foldback current limiting as part of their Over-current Protection (OCP) circuits. When output current exceeds 105 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 11. C1 ranges from 680µF to 10000µF, the recommended value for C1 is 2200µF.

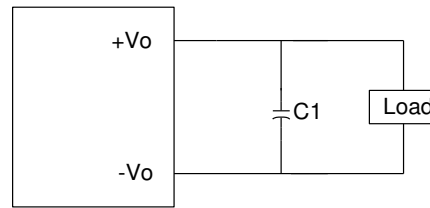


Figure 11 Output ripple filter

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 12.

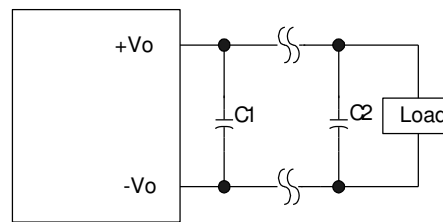


Figure 12 Output ripple filter for a distant load

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 13. 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 14.

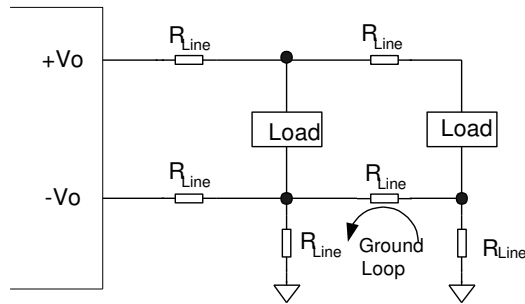


Figure 13 Ground loops

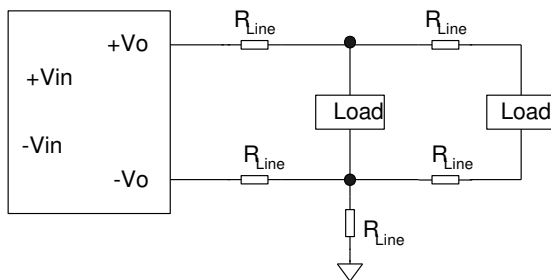


Figure 14 Single point ground

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 hiccup 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

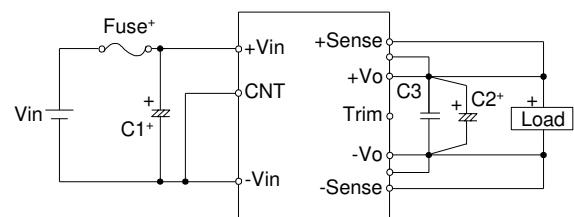


Figure 15 Typical application

F1: Fuse*: Use external fuse (fast blow type) for each unit.

For 12V output: 30A (Pout=360W)

C1: Recommended input capacitor C1 $\geq 100\mu\text{F}/100\text{V}$ electrolytic or ceramic type capacitor.

C2: Recommended $-40^\circ\text{C} \sim 100^\circ\text{C}$ uses: 2,200 $\mu\text{F}/25\text{V}$ (electrolytic capacitor)

C3: Recommended 10 $\mu\text{F}/25\text{V}$

Fusing

The AVE360-48S12 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 for the AVE360-48S12 are shown as following list.

For 12V output : 30A (Pout=360W)

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 16. 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.

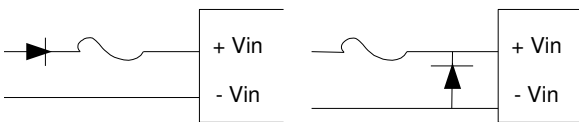


Figure 16 Reverse polarity protection circuit

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. AVE360-48S12 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

AVE360-48S12 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 17.

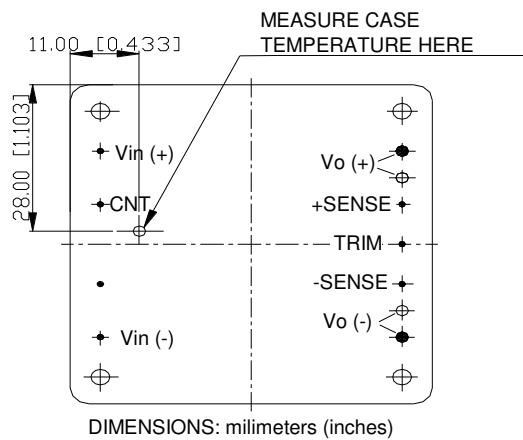


Figure 17 Temperature measurement location

The module should work under 85°C ambient for the reliability of operation and the board temperature must not exceed 112°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: $PD = PI - PO$

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

Also, module efficiency (η) is defined as the following equation: $\eta = PO / PI$

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

$$PD = PO (1 - \eta) / \eta$$

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 are given in Figure 19.

Module Derating

Experiment Setup

From the experiment setup shown in Figure 18, the derating curves shown in Figure 19 can be drawn. Note that the Printed Wiring Board (PWB) and the module must be mounted vertically. The Passage has a rectangular cross-section. The clearance between the facing PWB and the top of the module is kept 13 mm (0.5 in.) constantly.

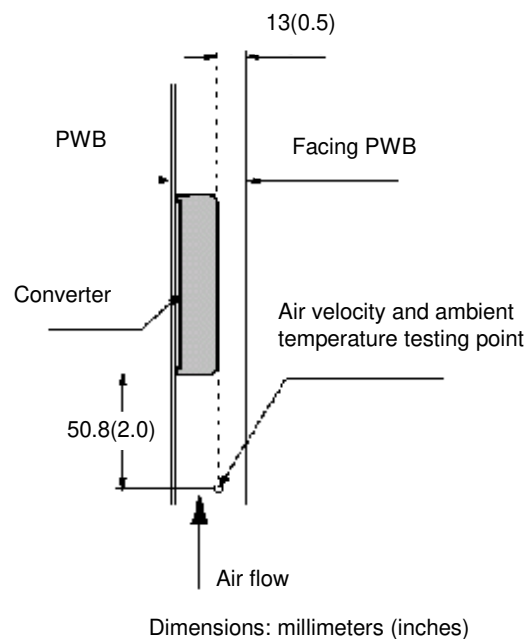


Figure 18 Experiment setup

Forced Convection

Figure 19 shows the change of the module output current with the change of ambient temperature. In the test, the airflow was

created with externally adjustable fans. A heatsink should be fitted in the case the input voltage is 36V or 75V.

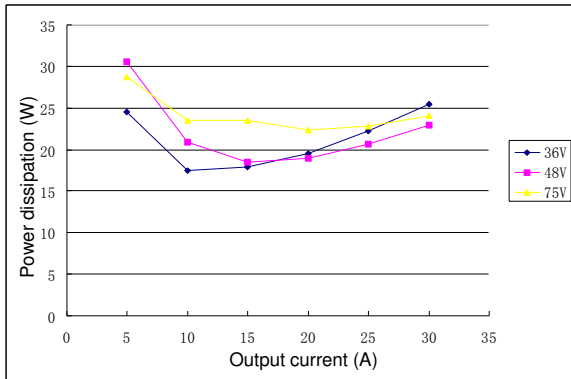


Figure 19 Forced convection power derating

Airflow direction from Vin(+) to Vin(-): Vin=36,48,75V;

Heatsink Configuration

Several standard heatsinks available for the AVE360-48S12 are shown in Figure 20 to 22.

The heatsinks mounted to the top surface of the module with screws torqued to 0.56 N-m (5 in.-lb). A thermally conductive dry pad or thermal grease is placed between the case and the heatsink to minimize contact resistance (typically 0.1°C/W to 0.3°C /W) and temperature differential.

Nomenclature for heatsink configurations is as follows:

WDxyyy40

x = fin orientation: longitudinal (L) or transverse (T)

yyy = heatsink height (in 100ths of inch)

For example, WDT5040 is a heatsink that is transverse mounted for a 61mm × 57.9mm (2.4in × 2.28in) module with a heatsink height of 0.5 in.

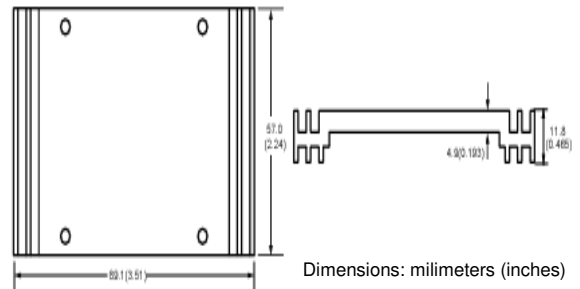


Figure 20 Non-standard heatsink

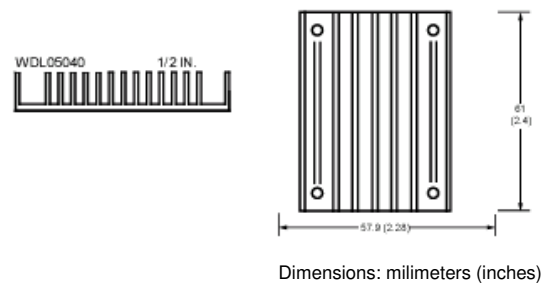


Figure 21 Longitudinal fins heatsink

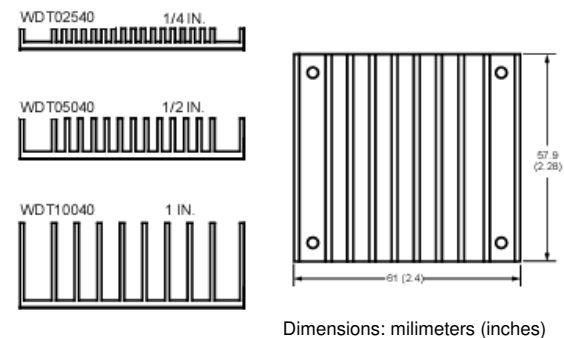


Figure 22 Transverse fins heatsink

Heatsink Mounting

A crucial part of the thermal design strategy is the thermal interface between the baseplate of the module and the heatsink. Inadequate measures taken will quickly negate any other attempts to control the baseplate temperature. For example, using a conventional dry insulator can result in a case-heatsink thermal impedance of >0.5°C/W, while use one of the recommended interface methods (using silicon grease or thermal pads) can result in a

case-heatsink thermal impedance around 0.1°C/W.

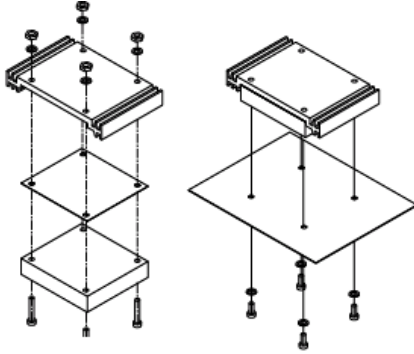


Figure 23 Heatsink mounting

Installation

Although AVE360-48S12 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

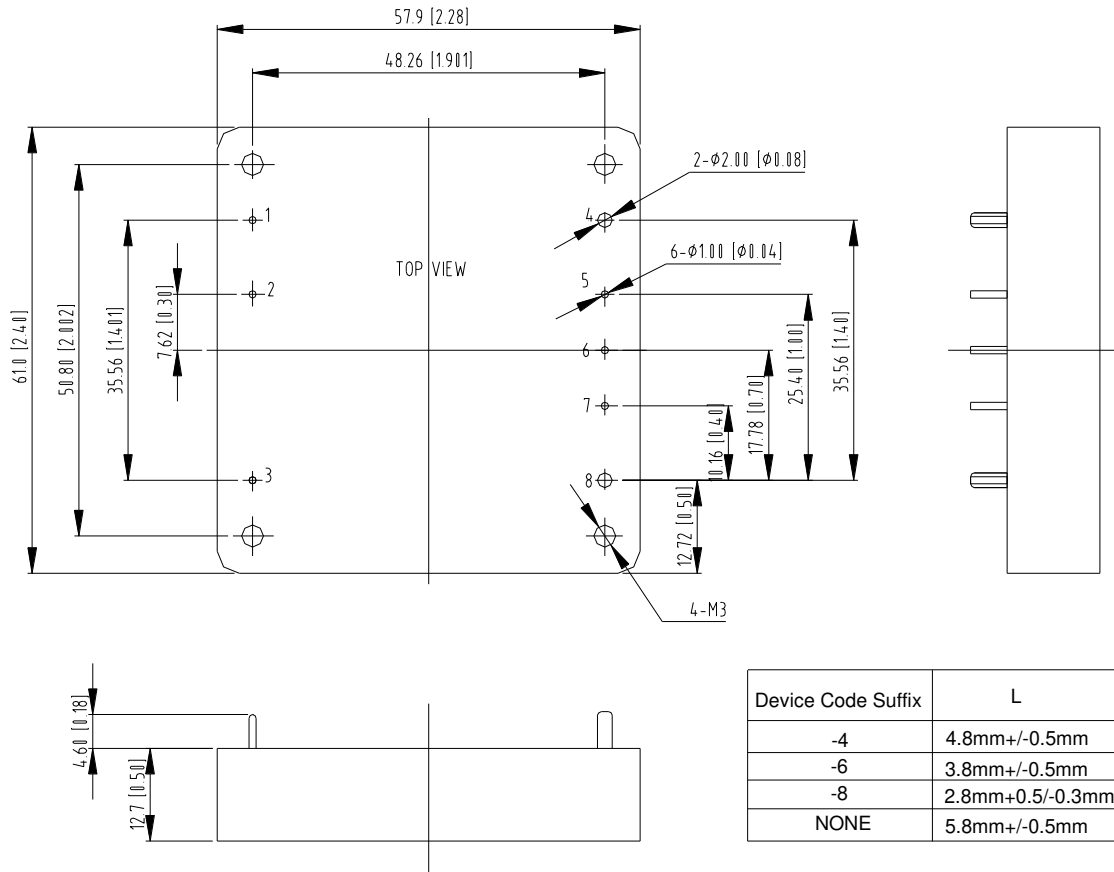
have separate airflow paths. This can keep other system equipment cooler and increase component life spans.

Soldering

AVE360-48S12 converter is compatible with standard wave soldering techniques. When wave soldering, the converter pins should be preheated for 20-30 seconds at 110°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



TOLERANCES: X.Xmm= \pm 0.5mm
X.XXmm= \pm 0.25mm

Pins Definition

Pin Number	Function	Pin Number	Function
P1	+Vin	P5	+SENSE
P2	CNT	P6	TRIM
P3	-Vin	P7	-SENSE
P4	+Vout	P8	-Vout

Ordering Information

Model Number	Input Voltage (V)	Output Voltage (V)	Output Current (A)	Ripple & Noise (mV pp, Max.)	Efficiency (%) Typ.
AVE360-48S12-4	36~75	12	30	300	94
AVE360-48S12P-4	36~75	12	30	300	94

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：AVE360-48S12