

AVE450B-48S28

450 Watts Half-brick Converter

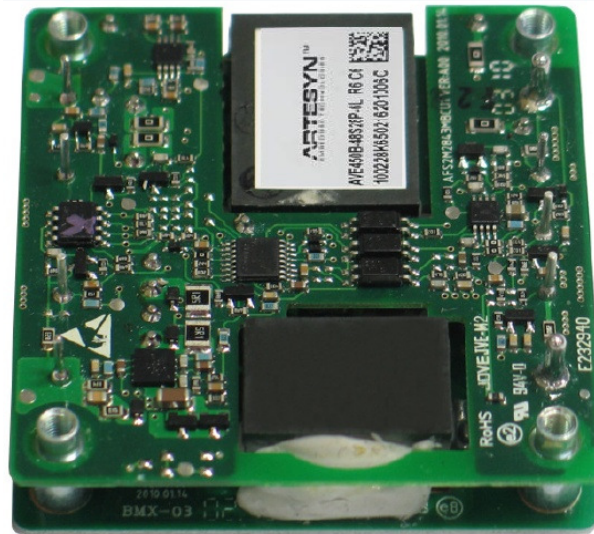
Total Power: 450 Watts
Input Voltage: 36 to 75 Vdc
of Outputs: Single

Special Features

- Delivering up to 16A output
- Ultra-high efficiency 94% typ. at full load
- Wide input range: 36V ~ 75V
- Excellent thermal performance
- No minimum load requirement
- Fixed frequency operation
- RoHS Directive(EU) 2015/863 (RoHS 3.0)
- Remote control logic optional
- mote output sense
- Trim function: -50% ~ +18%
- Input under voltage lockout
- Output over current protection
- Output over voltage protection
- Over temperature protection
- Industry standard half-brick pin-out outline
- With baseplate
- Pin length optional

Safety

IEC/EN/UL 62368-1
CE Mark
TUV



Product Descriptions

The AVE450B-48S28 is a single output DC/DC converter with standard half-brick form factor and pin configuration. It delivers up to 16A output current with 28V output. Ultra-high 94% efficiency and excellent thermal performance makes it an ideal choice to supply power to a power amplifier in telecom and datacom applications. Aluminum baseplate structure makes it possible for the module to work under -40 °C ~ +85 °C without air cooling, and baseplate operating temperature up to 100 °C.

Applications

Telecom/ Datacom

Model Numbers

Standard	Output Voltage	Structure	Remote ON/OFF logic	RoHS Status
AVE450B-48S28-6L/M	28Vdc	Baseplate	Negative	RoHS Directive(EU) 2015/863 (RoHS 3.0)
AVE450B-48S28P-6L	28Vdc	Baseplate	Positive	RoHS Directive(EU) 2015/863 (RoHS 3.0)
AVE450B-48S28-6L	28Vdc	Baseplate	Negative	RoHS Directive(EU) 2015/863 (RoHS 3.0)

Ordering information

AVE450B	-	48	S	28	P	-	6	L	/	M
①		②	③	④	⑤		⑥	⑦		⑧

①	Model series	AVE: high efficiency half-brick series, 450: output power 450W
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 control	P: Positive remote control
⑥	Pin length	6: 3.8mm pin length
⑦	RoHS status	Y: RoHS, R5, L: RoHS Directive(EU) 2015/863 (RoHS 3.0)
⑧	Mounting hole	Default: non-threaded mounting hole; M: threaded mounting hole

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	$V_{IN,DC}$	-	-	80	Vdc
	Non-operating -100mS		-	-	100	Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	450	W
Isolation Voltage ¹	All		-	-	1500	Vdc
			-	-	1500	Vdc
			-	-	500	Vdc
Isolation Resistance ²	All	R	10	-	-	Mohm
Ambient Operating Temperature	All	T_A	-40	-	+85	°C
Operating Baseplate Temperature	All	$T_{Baseplate}$	-40	-	+100	°C
Storage Temperature	All	T_{STG}	-55	-	+125	°C
Voltage at remote ON/OFF pin	All		-0.3	-	15	Vdc

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

Note 2 - Input to output, input to baseplate and output to baseplate.

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	$I_O = I_{O,max}$	$V_{IN,ON}$	32	34	36	Vdc
Turn-off Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,OFF}$	30	32	35	Vdc
Lockout Voltage Hysteresis	$I_O = I_{O,max}$		1	2	-	V
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC} = 36V_{DC}$	$I_{IN,max}$	-	-	14	A
No-load Input Current	All	$I_{IN,no-load}$	-	-	0.2	A
Standby Input Current	Remote OFF	$I_{IN,standby}$	-	0.01	0.1	A
Recommended Input Fuse	Fast blow external fuse recommended		-	-	30	A
Input Filter Component Values (C\L)	Internal values		-	10\0.7	-	uF\uH
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	470	-	-	uF
Input Reflected Ripple Current	Through 12uH inductor		-	50	600	mA
Operating Efficiency	$T_A = 25\text{ }^{\circ}\text{C}$ $I_O = I_{O,max}$ $I_O = 50\%I_{O,max}$	η	-	94 94.5	-	% %

Note 1 - $T_a = 25\text{ }^{\circ}\text{C}$, airflow rate = 400 LFM, $V_{in} = 48\text{Vdc}$, nominal V_{out} unless otherwise noted. All electrical specification is guaranteed above 35V input voltage after module turn on.

Output Specifications

Table 3. Output Specifications:

Parameter	Condition ¹	Symbol	Min	Typ	Max	Unit	
Factory Set Voltage	$T_A=25\text{ }^\circ\text{C}$ $V_{IN,DC} = 48V_{DC}$ $I_O=I_{O,max}$	V_O	27.72	28	28.28	Vdc	
Output Voltage Line Regulation	All	$\%V_O$	-	0.05	0.2	%	
Output Voltage Load Regulation	All	$\%V_O$	-	0.1	0.5	%	
Output Voltage Temperature Regulation	All	V_O	-	5.6	-	mV/°C	
Total output voltage range (Over sample, line, load, temperature & life)	All	V_O	27.16	28	28.84	V	
Output Voltage Trim Range	All	V_O	14	-	33	V	
Output Ripple, pk-pk	20MHz bandwidth	V_O	-	100	200	mV _{PK-PK}	
Output Current	All	I_O	0	-	16	A	
Output DC current-limit inception ²		I_O	16.8	-	22	A	
V_O Load Capacitance ³	All	C_O	680	1000	4400	uF	
V_O Dynamic Response	Peak Deviation Settling Time ⁴	50% ~ 75% ~ 50% $I_{O,max}$ slew rate = 0.1A/us	$\pm V_O$	-	200	500	mV
			T_s	-	60	500	uS
Turn-on transient	Rise time	$I_O = I_{max}$	T_{rise}	-	50	100	mS
	Turn-on delay time	$I_O = I_{max}$	$T_{turn-on}$	-	50	100	mS
	Output voltage overshoot	$I_O = 0$	$\%V_O$	-	0	5	%
Switching frequency	All	f_{sw}	260	290	320	KHz	
Remote ON/OFF control (positive logic)	Off-state voltage	All	-0.3	-	0.8	V	
	On-state voltage	All	2.0	-	15	V	
Remote ON/OFF control (Negative logic)	Off-state voltage	All	2.0	-	15	V	
	On-state voltage	All	-0.3	-	0.8	V	
Output over-voltage protection ⁵	All	$\%V_O$	125	130	150	%	
Output over-temperature protection ⁶	All	T	103	110	120	°C	
Over-temperature hysteresis	All	T	-	10	-	°C	

Output Specifications

Note 1 - $T_a = 25\text{ }^\circ\text{C}$, airflow rate = 400 LFM, $V_{in} = 48\text{Vdc}$, nominal V_{out} unless otherwise noted. All electrical specification is guaranteed above 35V input voltage after module turn on.

Note 2 - First foldback then hiccup

Note 3 - High frequency and low ESR is recommended. **Caution:** External output capacitor must be present for normal operation.

Note 4 - Recovery to within 1% $V_{o, nom}$

Note 5 - Latch off. Reset by power on or remote on. Note 6 - Auto recovery.

Table 3. Output Specifications, con't:

Parameter	Condition ¹	Symbol	Min	Typ	Max	Unit
Output voltage remote sense range	All		-	-	0.5	V
MTBF	Telcordia SR-332-2006; 80% load, 300LFM, 40 $^\circ\text{C}$ T_A		-	1.5	-	10^6 h

AVE450B-48S28 Performance Curves

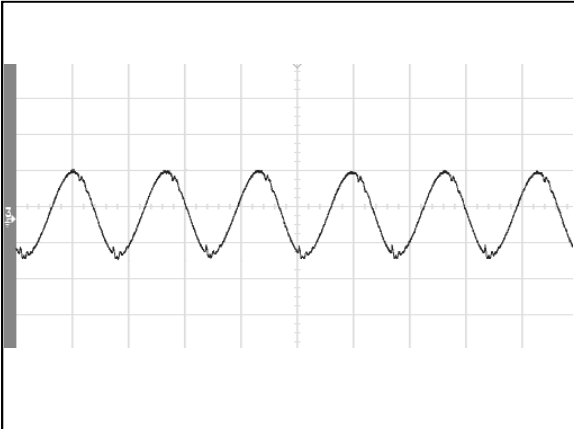


Figure 1: AVE450B-48S28 Input Reflected Ripple Current Waveform
Ch 1: Iin (2uS/div, 25mA/div)

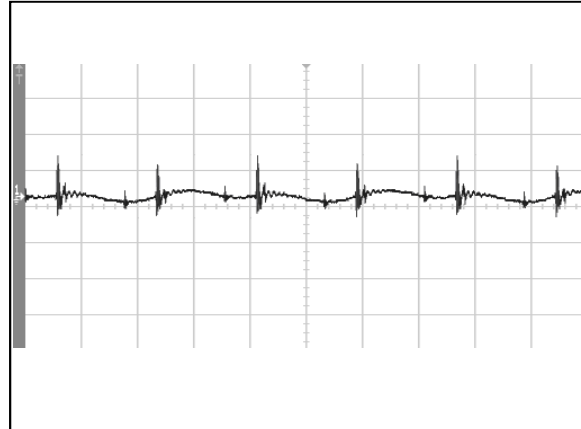


Figure 2: AVE450B-48S28 Ripple and Noise Measurement
Ch 1: Vo (2uS/div, 50mV/div)

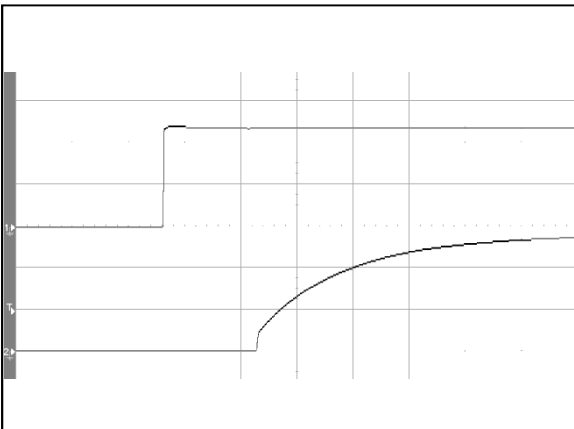


Figure 3: AVE450B-48S28 Output Voltage Startup Characteristic (20mS/div)
Ch 1: Vin (20V/div) Ch 2: Vo (10V/div)

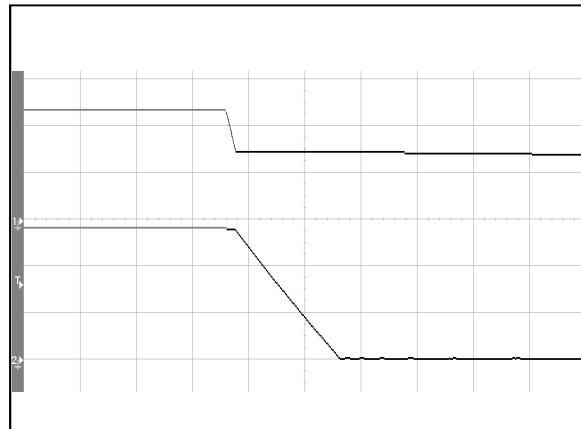


Figure 4: AVE450B-48S28 Turn Off Characteristic (5mS/div)
Ch 1: Vin (20V/div) Ch 2: Vo (10V/div)

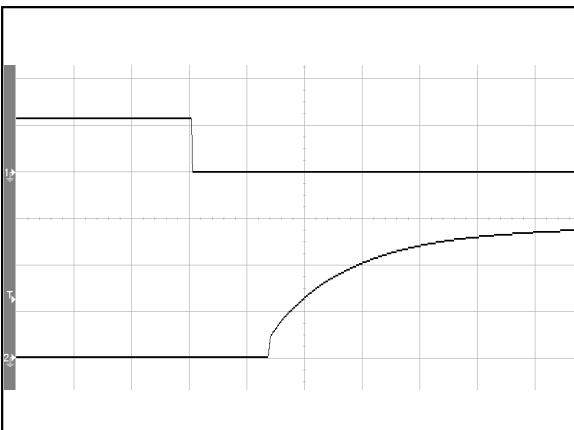


Figure 5: AVE450B-48S28 Remote ON Waveform (20mS/div)
Ch 1: Remote ON (5V/div) Ch 2: Vo (10V/div)

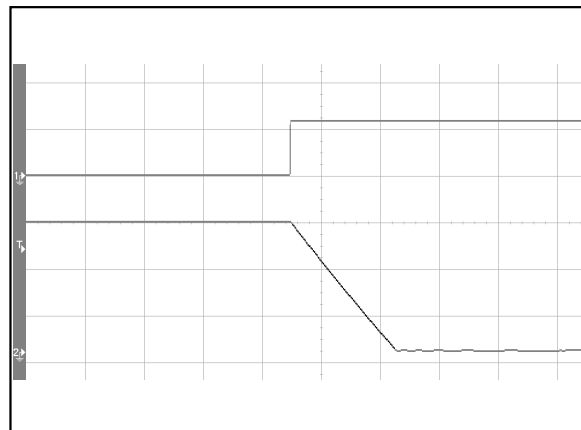


Figure 6: AVE450B-48S28 Remote OFF Waveform (2mS/div)
Ch 1: Remote OFF (5V/div) CH3: Vo (10V/div)

AVE450B-48S28 Performance Curves

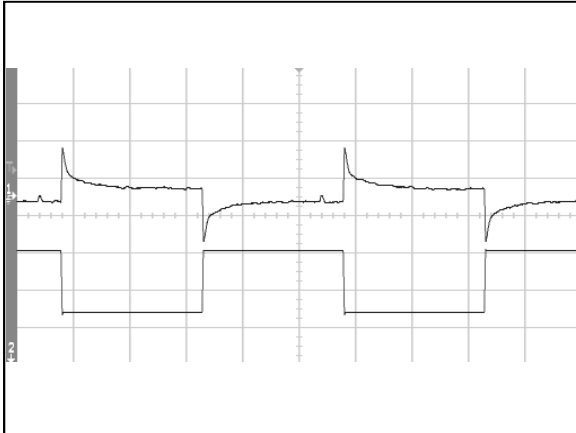


Figure 7: AVE450B-48S28 Transient Response (2mS/div)
 50%~75%~50% load change, 0.1A/uS slew rate,
 Ch 1: Vo (200mV/div) Ch 2: Io (5A/div)

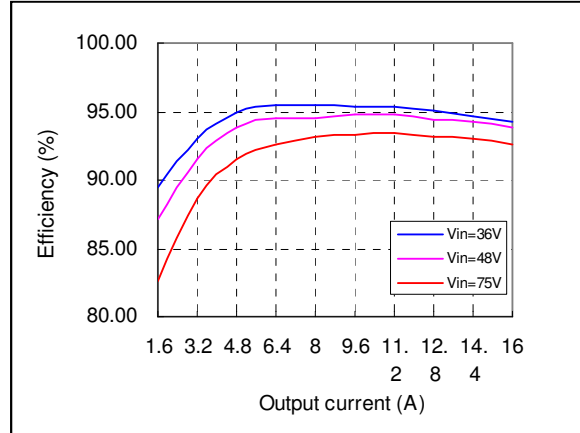


Figure 8: AVE450B-48S28 Efficiency Curves @ 25 °C

Loading: Io = 10% increment to 16A

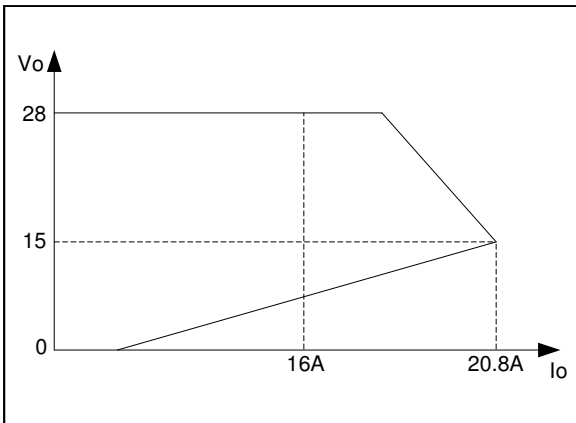
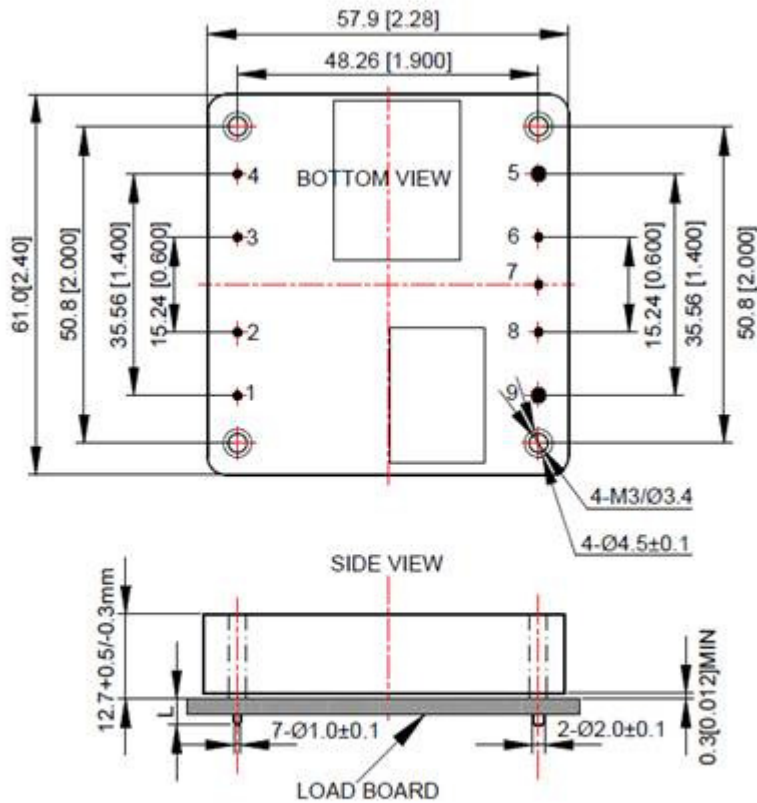


Figure 9: AVE450B-48S28 Over-current Protection Characteristics.

For reference only

Mechanical Specifications

Mechanical Outlines



UNIT: mm[inch] BOTTOM VIEW: pin on upside
 TOLERANCE: X.Xmm±0.5mm[X.XX in ±0.02in.]
 X.XXmm±0.25mm[X.XXX in ±0.01in.]

Pin Length Option

Device code suffix	L
-4	4.8mm ±0.5 mm
-6	3.8mm ±0.5 mm
-8	2.8mm ±0.5 mm
None	5.8mm ±0.5 mm

Pin Designations

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

Environmental Specifications

EMC Immunity

AVE450B-48S28 series power supply is designed to meet conducted emission's requirements of EN55022 Class B with external filter.

EMC Filter Configuration

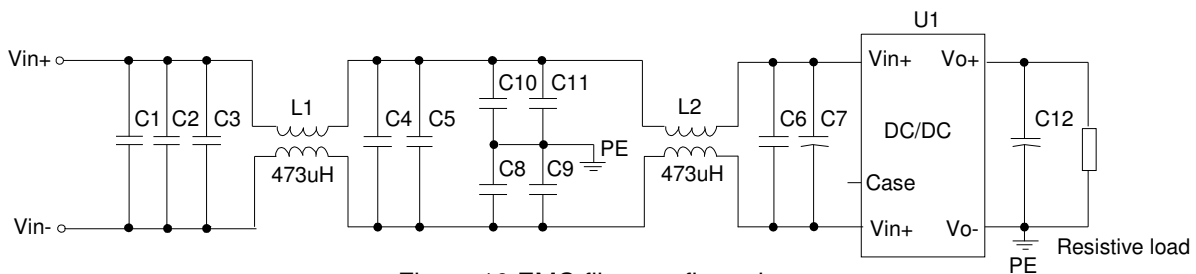


Figure 10 EMC filter configuration

U1: Module to test, AVE450B-48S28

C1 ~ C5: 1uF/100V X7R ceramic capacitor, P/N: C3225X7R2A105KT (TDK) or equivalent caps

C6: 0.1uF/100V X7R ceramic capacitor, P/N: 12101C104JAT2A (AVX) or equivalent caps

C8 ~ C11: 0.22uF/630V X7R ceramic capacitor, P/N: 2220CC224KA11A (AVX) or equivalent caps

C7: 470µF/100V electrolytic capacitor, P/N: UPM2A471MHD (Nichicon) or equivalent caps

C12: 470uF/50V(PMM) and 220uF/50V(PMM) in parallel

Case: Not connected

Safety Certifications

The AVE450B-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 4. Safety Certifications for AVE450B-48S28 series power supply system

Document	File #	Description
UL 62368-1		US Requirements
EN62368-1		European Requirements
IEC62368-1		International Requirements
CE		CE Marking
UL94		US Requirements

Operating Temperature

The AVE450B-48S28 series power supplies will start and operate within stated specifications at an ambient temperature from $-40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$ under all load conditions. The storage temperature is $-55\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$.

Thermal Considerations

The converter can operate in a enclosed environment without forced air convection. Cooling of the converter is achieved mainly by conduction from the baseplate to a heatsink. The location of the baseplate temperature test point is shown in Figure 11. Figure 12 shows the derating output current vs. baseplate temperature.

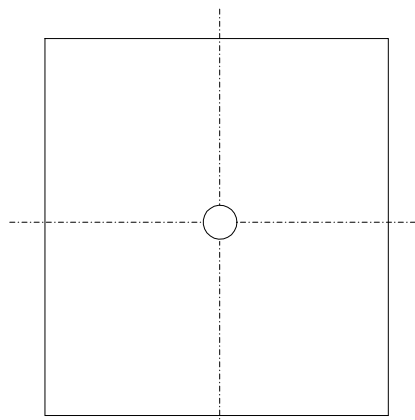


Figure 11 Temperature test point

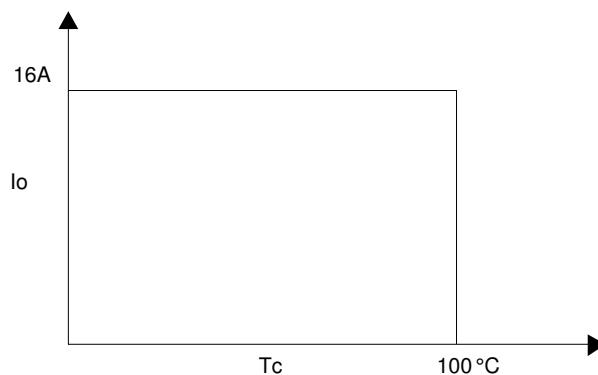


Figure 12 Output power derating,

Tc: temperature test point on baseplate, see Figure 11 for test configuration

Qualification Testing

Parameter	Unit (pcs)	Test condition
Halt test	4-5	$T_{a,min} - 10\text{ }^{\circ}\text{C}$ to $T_{a,max} + 10\text{ }^{\circ}\text{C}$, $5\text{ }^{\circ}\text{C}$ step, $V_{in} = \text{min to max}$, $0 \sim 105\%$ load
Vibration	3	Frequency range: $5\text{Hz} \sim 20\text{Hz}$, $20\text{Hz} \sim 200\text{Hz}$, A.S.D: $1.0\text{m}^2/\text{s}^3$, -3db/oct , axes of vibration: X/Y/Z. Time: 30min/axes
Mechanical Shock	3	30g , 6ms , 3axes , 6directions , 3time/direction
Thermal Shock	3	$-40\text{ }^{\circ}\text{C}$ to $100\text{ }^{\circ}\text{C}$, unit temperature 20cycles
Thermal Cycling	3	$-40\text{ }^{\circ}\text{C}$ to $55\text{ }^{\circ}\text{C}$, temperature change rate: $1\text{ }^{\circ}\text{C/min}$, cycles: 2cycles
Humidity	3	$40\text{ }^{\circ}\text{C}$, $95\%\text{RH}$, 48h
Solder Ability	15	IPC J-STD-002C-2007

Application Notes

Typical Application

Below is the typical application of the AVE450B-48S28 series power supply.

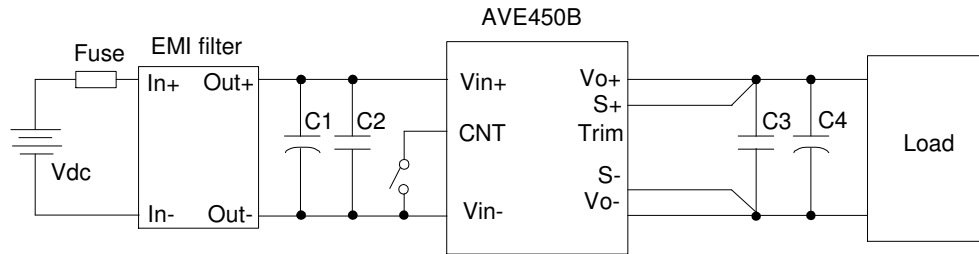


Figure 13 Typical application

C1: 470uF/100V electrolytic capacitor, P/N: UPW2A471MHD (Nichicon) or equivalent caps

C2, C3: 1uF/100V X7R ceramic capacitor, P/N: C3225X7R2A105KT0L0U (TDK) or equivalent caps

C4: 470uF/50V(PMM) and 220uF/50V(PMM) in parallel

Fuse: 30A fast blow fuse, P/N: 314030P (LITTLEFUSE)

Double minimum input/output capacitance is necessary for normal operation and performance in case of $T_a < 0^\circ\text{C}$.

Remote ON/OFF

Either positive or negative remote ON/OFF logic is available in AVE450B-48S28. The logic is CMOS and TTL compatible. Figure 14 is the detailed internal circuit and reference in AVE450B-48S28.

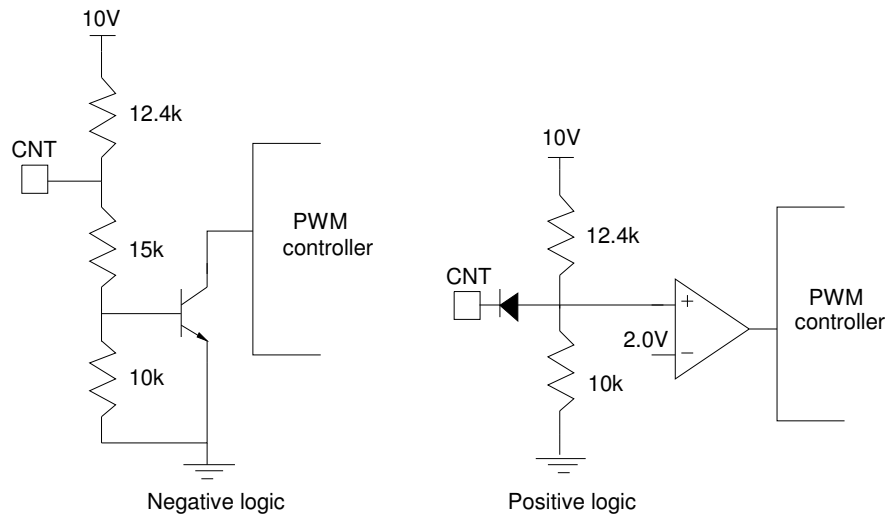


Figure 14 Remote ON/OFF internal diagram

Trim Characteristics

Connecting an external resistor between Trim and Vo- 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.

$$R_{adj_down} = \left(\frac{100\%}{\Delta\%} - 2 \right) k\Omega$$

$$R_{adj_up} = \left(\frac{V_o(100\% + \Delta\%)}{1.225 \times \Delta\%} - \frac{100\% + 2 \times \Delta\%}{\Delta\%} \right) k\Omega$$

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

V_{norm} : Nominal output voltage.

For example, to get 33V output, the trimming resistor is

$$R_{adj_up} = \left(\frac{33}{1.225 \times (33 - 28) / 28} - \frac{100\% + 2 \times (33 - 28) / 28}{(33 - 28) / 28} \right) = 143.26 k\Omega$$

The output voltage can also be trimmed by potential applied at the Trim pin.

$$V_o = (V_{trim} + 1.225) \times 11.43$$

Where V_{trim} is the potential applied at the Trim pin, and V_o is the desired output voltage.

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 figure.

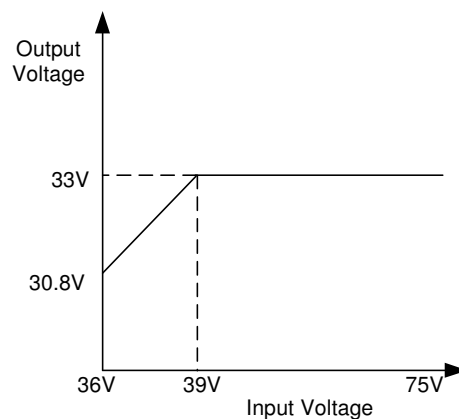


Figure 15 Max. adjustable output voltage vs. input voltage

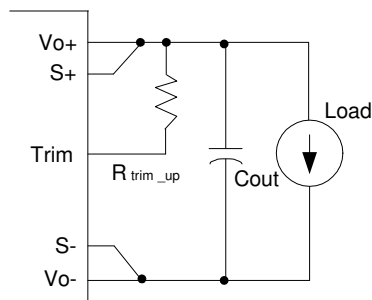


Figure 16 Trim up

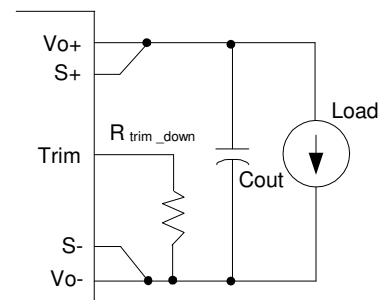


Figure 17 Trim down

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. See Figure 13 for details.

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

Inrush Current, Input and Output Ripple & Noise Test Configuration

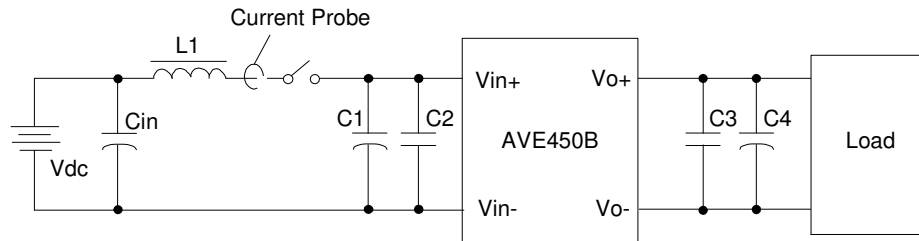


Figure 18 Inrush current, input and output ripple & noise test configuration

Vdc: DC power supply

L1: 12uH inductor

Cin: 220uF/100V electrolytic capacitor

C1 ~ C4: See Figure 13

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.

Weight

The AVE450B-48S28 series weight is 70g minimum, 85g maximum.

Soldering

The product is intended for standard manual or wave soldering.

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

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 similitive.

Record of Revision and Changes

Issue	Date	Description	Originators
1.0	08.06.2014	First Issue	V. Wei
1.1	10.13.2014	Update Note info	V. Wei
1.2	04.13.2016	Add Baseplate and PN info Add a sentence "All electrical specification is guaranteed above 35V input voltage after module turn on." Update the wave-soldering change from 260C/7S to 260C/10S Add the isolation resistance and weight information	V. Wei K. Wang
1.3	05.10.2016	Change the OTP point from 100degC to 103degC, delete table 5	K. Wang
1.4	11.02.2016	Update the Pin Length Tolerance	K. Wang
1.5	02.10.2017	Correct the C12 from 680uF to 470uF + 220uF in Parallel	K. Wang
1.6	03.06.2018	1.Update the mechanical drawing 2. EMC update to Class B	K. Wang
1.7	02.24.2020	Update RoHS information	E. Bai
1.8	05.26.2020	Update safety cert from 60950 to 62368-1	V. Guo

WORLDWIDE OFFICES

Americas

2900 South Diablo Way
 Suite B100
 Tempe, AZ 85282
 USA
 +1 888 412 7832

Europe (UK)

Ground Floor Offices
 Barberrry House, 4 Harbour Buildings
 Waterfront West, Brierley Hill
 West Midlands, DY5 1LN, UK
 +44 (0) 1384 842 211

Asia (HK)

14/F, Lu Plaza
 2 Wing Yip Street
 Kwun Tong, Kowloon
 Hong Kong
 +852 2176 3333

