

## AVE500-48S50-6L

### 500 Watts Half-brick Converter

**Total Power:** 500 Watts  
**Input Voltage:** 36 to 75 Vdc  
**# of Outputs:** Single

### Special Features

- Delivering up to 10A output
- Ultra-high efficiency 94.8% typ. at full load
- Wide input range: 36V ~ 75V
- Excellent thermal performance
- No minimum load requirement
- RoHS 6 compliant
- Basic isolation
- High power density
- Low output noise
- Remote control logic optional
- Remote output sense
- Trim function: 50% ~ 114%
- Input under voltage lockout
- Output over current protection
- Output short circuit protection
- Output over voltage protection
- Over temperature protection
- Industry standard half-brick pin-out outline
- With baseplate

### Safety

IEC/EN/UL/CSA 60950  
CE Mark



## Product Descriptions

The AVE500-48S50-6L is a single output DC/DC converter with standard half-brick form factor and pin configuration. It delivers up to 10A output current with 50V output. Above 94.8% ultra-high efficiency and excellent thermal performance makes it an ideal choice to supply power to a power amplifier in telecom and datacom. The aluminium 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	Mounting Hole
AVE500-48S50-6L	50Vdc	Baseplate	Negative	Threaded
AVE500-48S50P-6L	50Vdc	Baseplate	Positive	Threaded

## Ordering information

AVE500	-	48	S	50	P	-	6	L
①		②	③	④	⑤		⑥	⑦

①	Model series	AVE: series name , 500:output power 500W
②	Input voltage	48: 36V ~ 75V input range, rated input voltage 48V
③	Output number	S: single output
④	Rated output voltage	50: 50V output
⑤	Remote ON/OFF logic	Default: negative logic; P: positive logic
⑥	Pin length	6: 3.8mm pin length
⑦	RoHS status	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	$V_{IN,DC}$	-	-	80	Vdc
	Non-operating -100mS		-	-	100	Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	500	W
Isolation Voltage <sup>1</sup>	Input to outputs	All	-	-	2250	Vdc
	Input to baseplate		-	-	1500	Vdc
	Outputs to baseplate		-	-	500	Vdc
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

## Input Specifications

Table 2. Input Specifications:

Parameter	Conditions <sup>1</sup>	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, DC	All	$V_{IN,DC}$	36	48	75	Vdc
Turn-on Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,ON}$	33	-	36	Vdc
Turn-off Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,OFF}$	31	-	35	Vdc
Lockout Voltage Hysteresis	$I_O = I_{O,max}$		1	-	3	V
Maximum Input Current ( $I_O = I_{O,max}$ )	$V_{IN,DC} = 36V_{DC}$	$I_{IN,max}$	-	-	15	A
Recommended Input Fuse	Fast blow external fuse recommended		-	-	30	A
Recommended External Input Capacitance	Low ESR capacitor recommended	$C_{IN}$	470	-	-	uF
Input Reflected Ripple Current	Through 12uH inductor		-	8	-	mA
Operating Efficiency	$T_A = 25\text{ }^\circ\text{C}$ $I_O = I_{O,max}$ $I_O = 50\% I_{O,max}$ $I_O = 20\% I_{O,max}$	$\eta$	93.5 94.0 90.0	94.8 95 91.5	- - -	% % %

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 <sup>1</sup>	Symbol	Min	Typ	Max	Unit
Factory Set Voltage	$T_A=25\text{ }^\circ\text{C}$ $V_{IN,DC} = 48\text{Vdc}$ $I_O = 50\% I_{O,max}$	$V_O$	49.5	50.0	50.5	Vdc
Output Voltage Line Regulation	All	$\%V_O$	-	-	0.5	%
Output Voltage Load Regulation	All	$\%V_O$	-	-	0.5	%
Output Voltage Temperature Regulation	All	$V_O$	-	-	0.02	$\% / ^\circ\text{C}$
Total output voltage range (Over sample, line, load, temperature & life)	All	$V_O$	48.5	50.0	51.5	V
Output Voltage Trim Range	All	$V_O$	25	-	57	V
Output Ripple, pk-pk	20MHz bandwidth	$V_O$	-	120	-	$\text{mV}_{\text{PK-PK}}$
Output Current	All	$I_O$	0	-	10	A
Output DC current-limit inception <sup>2</sup>		$I_O$	11	-	13	A
$V_O$ Load Capacitance <sup>3</sup>	All	$C_O$	470	1000	330	$\mu\text{F}$
$V_O$ Dynamic Response Peak Deviation	slew rate = 0.1A/us 25% ~ 50% ~ 25% 50% ~ 75% ~ 50% $I_{O,max}$		-	340	-	mV
			-	350	-	mV
Turn-on transient	Rise time	$T_{\text{rise}}$	-	180	-	mS
	Turn-on delay time	$T_{\text{turn-on}}$	-	75	-	mS
	Output voltage overshoot	$\%V_O$	-	0	5	%
Switching frequency	All	$f_{\text{SW}}$	-	280	-	KHz
Remote ON/OFF control (positive logic)	Off-state voltage	All	-0.3	-	0.8	V
	On-state voltage	All	2.4	-	15	V
Remote ON/OFF control (Negative logic)	Off-state voltage	All	2.4	-	15	V
	On-state voltage	All	-0.3	-	0.8	V
Output over-voltage protection <sup>4</sup>	All	$V_{O1}$	60	-	75	V
Output over-temperature protection <sup>5</sup>	All	T	105	115	125	$^\circ\text{C}$
Over-temperature hysteresis	All	T	5	-	-	$^\circ\text{C}$

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.

Note 4 - Latch. Note 5 – Auto recovery.

## Output Specifications

Table 3. Output Specifications, con't:

Parameter	Condition <sup>1</sup>	Symbol	Min	Typ	Max	Unit
Output voltage remote sense range	All		-	-	0.5	V
MTBF	Telcordia SR-332-2006; 80% load, 300LFM, 40 °C T <sub>A</sub>		-	1.5	-	10 <sup>6</sup> h

## AVE500-48S50-6L Performance Curves

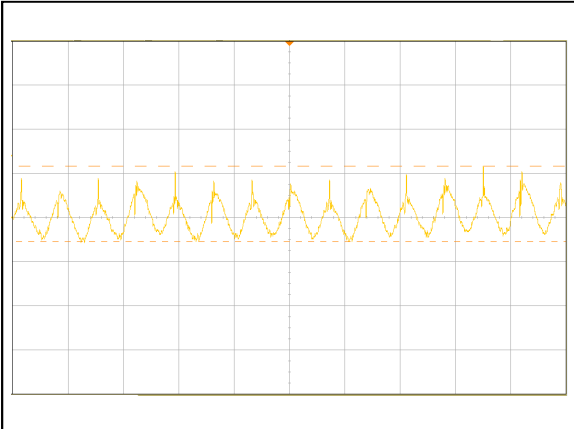


Figure 1: AVE500-48S50-6L Input Reflected Ripple Current Waveform  
Ch 1: lin (5 $\mu$ S/div, 5mA/div)

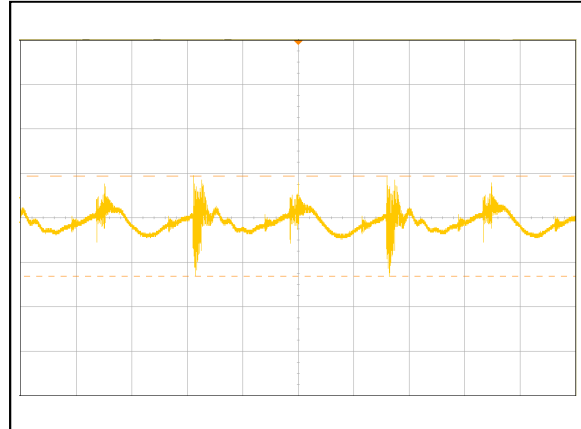


Figure 2: AVE500-48S50-6L Ripple and Noise Measurement  
Ch 1: Vo (2 $\mu$ S/div, 50mV/div)

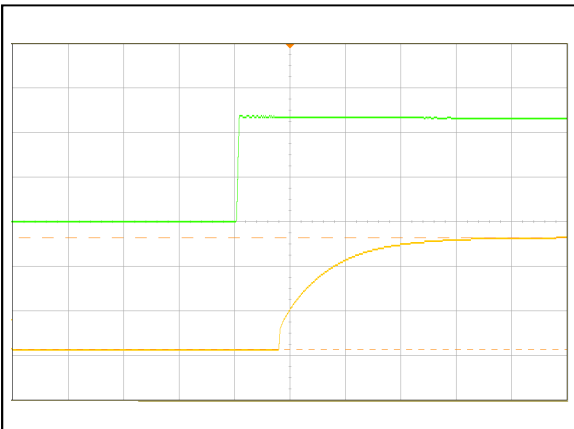


Figure 3: AVE500-48S50-6L Output Voltage Startup Characteristic (100mS/div)  
Ch 1: Vin (20V/div) Ch 2: Vo (20V/div)

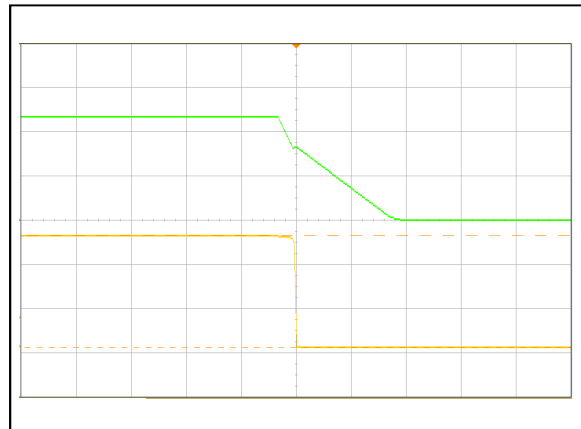


Figure 4: AVE500-48S50-6L Turn Off Characteristic (50mS/div)  
Ch 1: Vin (20V/div) Ch 2: Vo (20V/div)

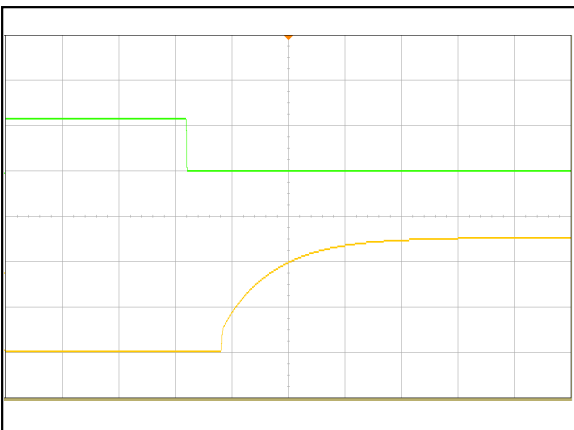


Figure 5: AVE500-48S50-6L Remote ON Waveform (100mS/div)  
Ch 1: Remote ON (5V/div) Ch 2: Vo (20V/div)

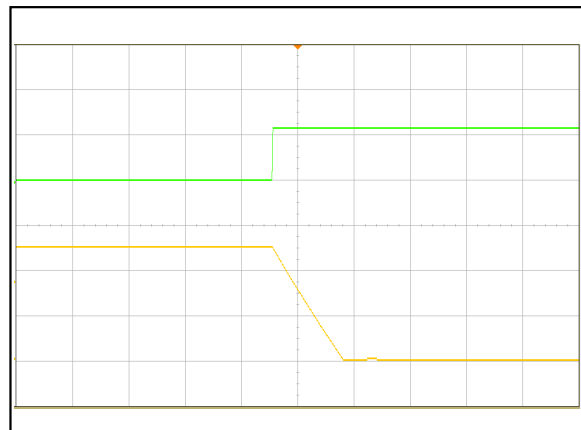


Figure 6: AVE500-48S50-6L Remote OFF Waveform (2mS/div)  
Ch 1: Remote OFF (5V/div) CH3: Vo (20V/div)

## AVE500-48S50-6L Performance Curves

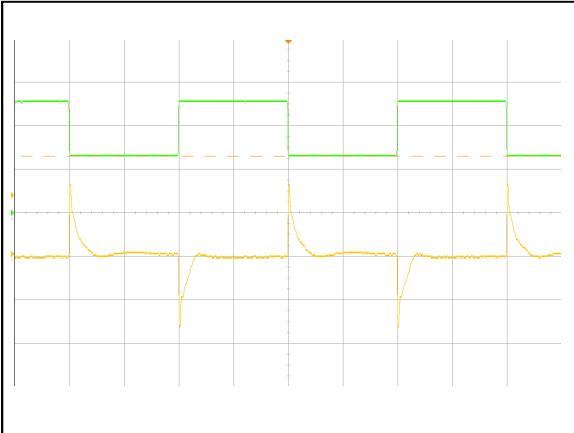


Figure 7: AVE500-48S50-6L Transient Response (5mS/div)  
 25%~50%~25% load change, 0.1A/uS slew rate,  
 Ch 1: Vo (200mV/div) Ch 2: Io (2A/div)

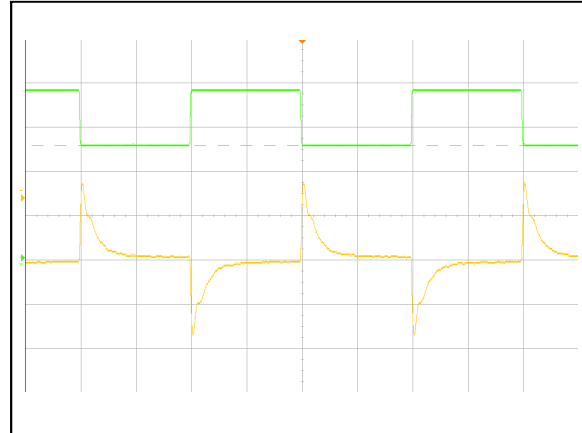


Figure 8: AVE500-48S50-6L Transient Response (2mS/div)  
 50%~75%~50% load change, 0.1A/uS slew rate,  
 Ch 1: Vo (200mV/div) Ch 2: Io (2A/div)

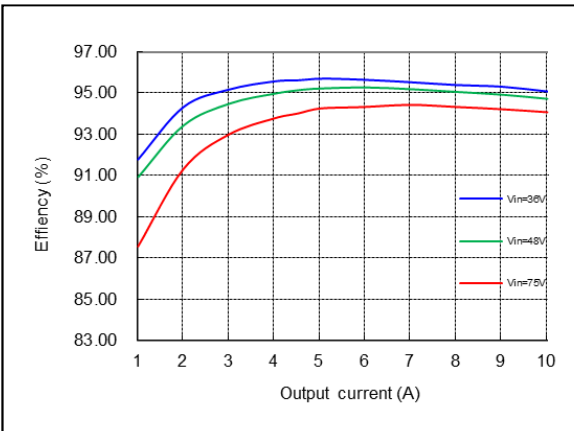


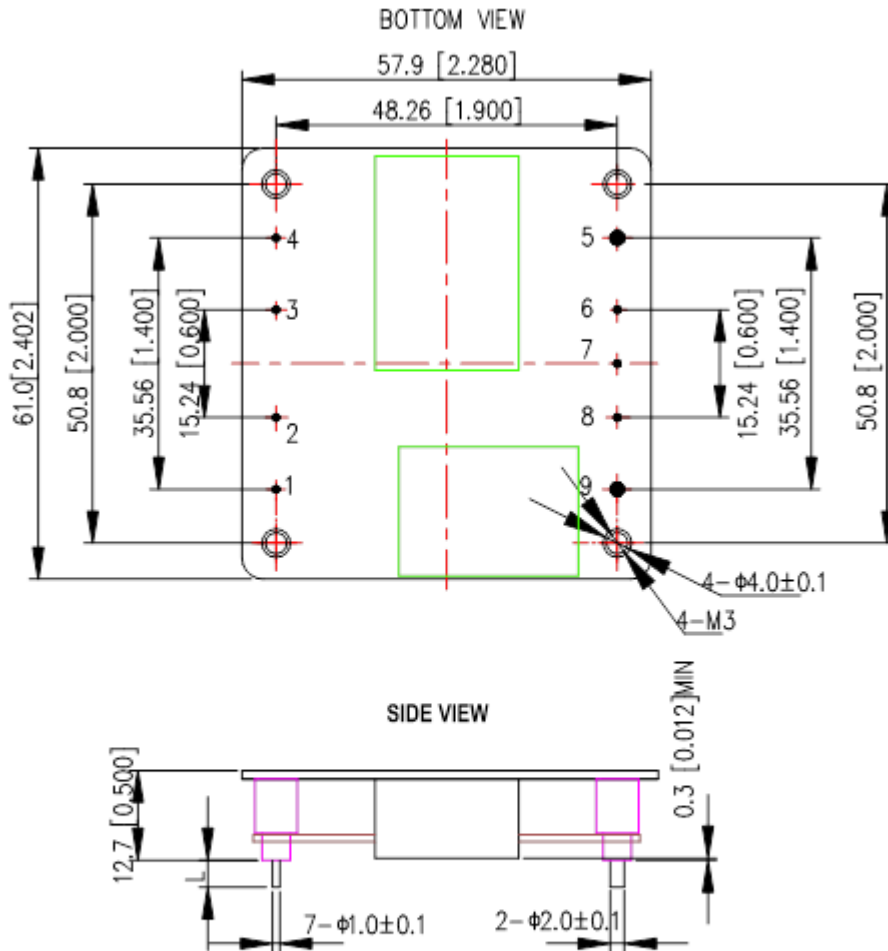
Figure 9: AVE500-48S50-6L Efficiency Curves @ 25 °C

Loading: Io = 10% increment to 10A



## Mechanical Specifications

### Mechanical Outlines



UNIT: mm[inch]

BOTTOM VIEW: pin on upside

TOLERANCE: X.Xmm $\pm$ 0.5mm[X.XX in. $\pm$ 0.02in.]

X.XXmm $\pm$ 0.25mm[X.XXX in. $\pm$ 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

AVE500-48S50-6L power supply is designed to meet the following EMC immunity specifications:

Table 4. Environmental Specifications:

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

Criterion A: Normal performance during and after test.

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

For Dips and ESD, output voltage fluctuation or reset is allowed during the test, but recovers to its normal performance automatically after the disturbance ceases.

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

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

## Safety Certifications

The AVE500-48S50-6L 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 AVE500-48S50-6L series power supply system

Document	File #	Description
UL 60950		US Requirements
EN60950		European Requirements
IEC60950		International Requirements
CE		CE Marking
UL94		US Requirements

## Operating Temperature

The AVE500-48S50-6L series power supplies will start and operate within stated specifications at an ambient temperature from -40 °C to 85 °C under all load conditions. The storage temperature is -55 °C to 125 °C.

## Thermal Considerations

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 heatsink. The converter can deliver full output power at 85 °C ambient temperature provided the baseplate temperature is kept below the max values in the Table 6. The location of the baseplate temperature test point is shown in Figure 10.

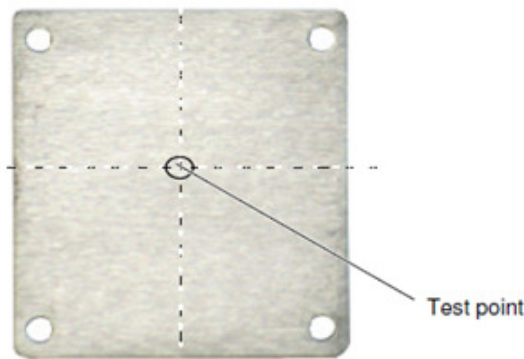


Figure 10 Temperature test point on FR-4 board

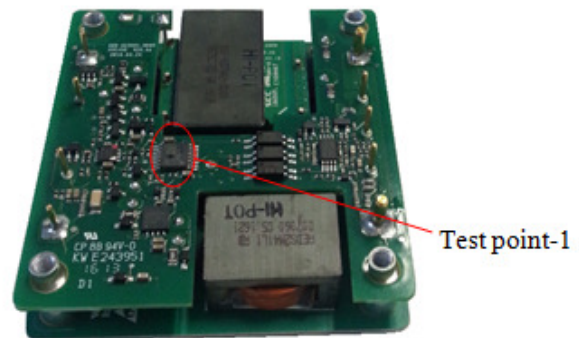


Figure 11 Temperature test points

Table 6. Temperature limit of the test points

Test Point	Temperature Limit
Test point	100 °C
Test point-1	111 °C

For a typical application, Figure 12 shows the derating of output current vs. ambient air temperature at different air velocity.

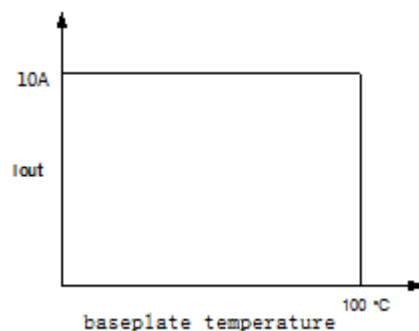


Figure 12 Output power derating at 48V<sub>in</sub>

## Qualification Testing

Parameter	Unit (pcs)	Test condition
Halt test	4-5	$T_{a,min} - 20\text{ }^{\circ}\text{C}$ to $T_{a,max} + 35\text{ }^{\circ}\text{C}$ , $5\text{ }^{\circ}\text{C}$ step, $V_{in} = \text{min to max}$ , $0 \sim 100\%$ load
Vibration	3	Frequency range: $5\text{Hz} \sim 20\text{Hz}$ , $20\text{Hz} \sim 200\text{Hz}$ , A.S.D: $1.0\text{m}^2/\text{s}^3$ , $-3\text{db/oct}$ , axes of vibration: X/Y/Z. Time: $30\text{min/axes}$
Mechanical Shock	3	$30\text{g}$ , $6\text{ms}$ , $3\text{axes}$ , $6\text{directions}$ , $3\text{time/direction}$
Thermal Shock	3	$-55\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$ , unit temperature $20\text{cycles}$
Thermal Cycling	3	$-40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$ , temperature change rate: $1\text{ }^{\circ}\text{C/min}$ , cycles: $2\text{cycles}$
Humidity	3	$40\text{ }^{\circ}\text{C}$ , $95\%\text{RH}$ , $48\text{h}$
Solder Ability	15	IPC J-STD-002C-2007

## Application Notes

### Typical Application

Below is the typical application of the AVE500-48S50-6L series power supply.

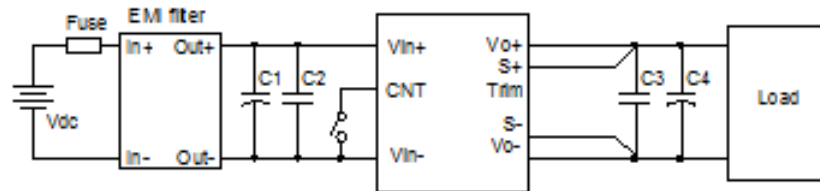


Figure 13 Typical application

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

C2: 0.1uF/100V X7R ceramic capacitor, P/N: 12101C104JAT2A (AVX) or equivalent caps

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

C4: 2\* 470μF/100V electrolytic capacitor, P/N: UPM2A471MHD (Nichicon) or equivalent caps

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

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

Note: EMI filter please refer to Figure 19.

## Remote ON/OFF

Either positive or negative remote ON/OFF logic is available in AVE500-48S50-6L. The logic is CMOS and TTL compatible.

Figure 14 is the detailed internal circuit and reference in AVE500-48S50-6L.

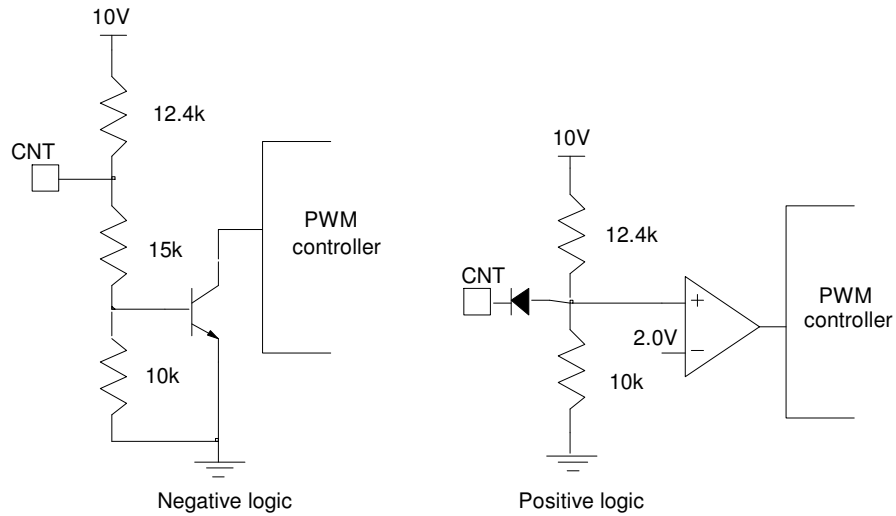


Figure 14 Remote ON/OFF internal diagram



## 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.

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

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

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

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

$V_{norm}$  : Nominal output voltage.

For example, to get 57V output, the trimming resistor is

$$\Delta = \frac{100 \times (V_o - V_{norm})}{V_{norm}} = \frac{100 \times (57 - 50)}{50} = 14$$

$$R_{adj-up} = \frac{50 \times (100 + 14)}{1.225 \times 14\%} - \frac{100\% + 2 \times 14\%}{14\%} = 323.2 (K\Omega)$$

For 1% adjustment resistor, the trimmed output voltage is guaranteed within  $\pm 2\%$ . The output voltage can also be trimmed by potential applied at the Trim pin.

$$V_o = (V_{trim} + 1.225) \times 20.38$$

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

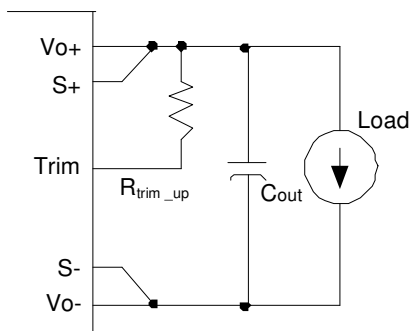


Figure 15 Trim up

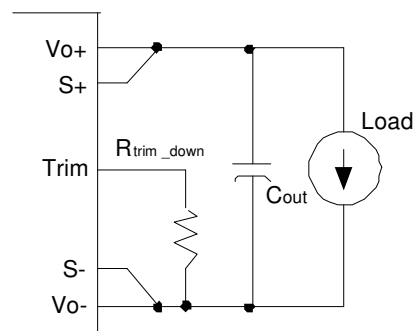


Figure 16 Trim down

For AVE500-48S50P-6L, if the sense compensate function is not necessary, connect S+ to Vo+ and S- to Vo- directly.  
When trimming up, the output current should be decreased accordingly so as not to exceed the maximum output power.  
When trimming up the output voltage, the minimum input voltage should be increased as shown in below Figure17.

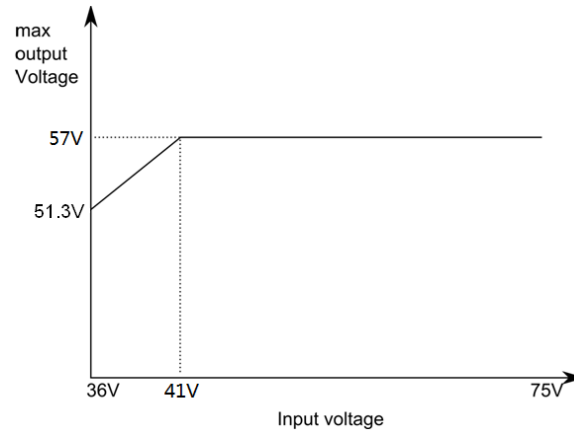


Figure 17 trimming up the output voltage

## Inrush Current, Input and Output Ripple & Noise Test Configuration

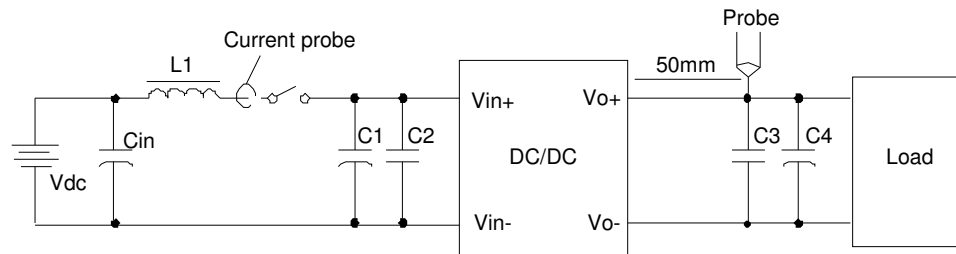


Figure 18 Input ripple & inrush current, output ripple & noise test configuration

Vdc: DC power supply

L1: 12 $\mu$ H

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

C1: 470 $\mu$ F/100V electrolytic capacitor, High frequency and low ESR

C2: 0.1 $\mu$ F/100V X7R ceramic capacitor, P/N: 12101C104JAT2A (AVX) or equivalent caps

C3: SMD ceramic-100V-1000nF-X7R-1210

C4: 2\* 470 $\mu$ F/100V electrolytic capacitor, High frequency and low ESR

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

## EMC Test Conditions

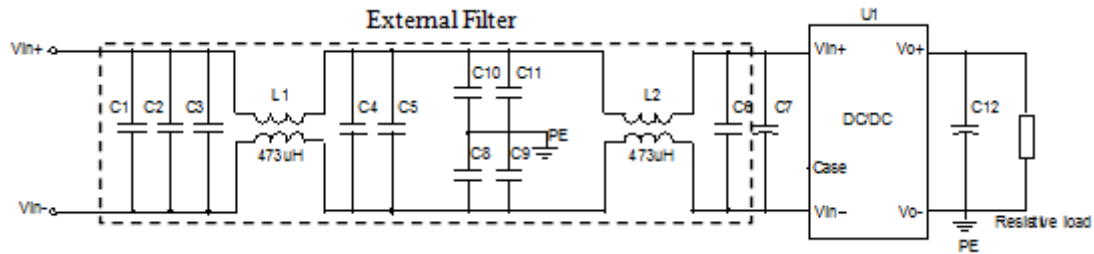


Figure 19 EMC test conditions

U1: Module to test, AVE500-48S50P-6L

C1~C2:2.2uF/100V X7R ceramic capacitor, GRM31CR72A225KA73(muRata) or equivalent caps

C3 ~ C5: 1uF/100V X7R ceramic capacitor, P/N: C3225X7R2A105K(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

C12:2\* 470μF/100V electrolytic capacitor, P/N: UPM2A471MHD (Nichicon) or equivalent caps or equivalent

PE: Connect to  $V_{o-}$

Case: Not connected

### **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.

**Hazardous Substances Announcement (RoHS of China R6)**

Parts	Hazardous Substances					
	Pb	Hg	Cd	Cr <sup>6+</sup>	PBB	PBDE
AVE500-48S50-6L	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

## Record of Revision and Changes

Issue	Date	Description	Originators
1.0	04.25.2017	First Issue	E. Wang

### WORLDWIDE OFFICES

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