

AVE450-48S50-6L

450 Watts Half-brick Converter

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

Special Features

- Delivering up to 9A output
- Ultra-high efficiency 95.0% 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 AVE450-48S50-6L is a single output DC/DC converter with standard half-brick form factor and pin configuration. It delivers up to 9A output current with 50V output. Above 95.0 % 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 |
|------------------|----------------|-----------|---------------------|---------------|
| AVE450-48S50-6L | 50Vdc | Baseplate | Negative | Threaded |
| AVE450-48S50P-6L | 50Vdc | Baseplate | Positive | Threaded |

Ordering information

| | | | | | | | | |
|--------|---|----|---|----|---|---|---|---|
| AVE450 | - | 48 | S | 50 | P | - | 6 | L |
| ① | | ② | ③ | ④ | ⑤ | | ⑥ | ⑦ |

| | | |
|---|----------------------|--|
| ① | Model series | AVE: series name , 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 | 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 | $P_{O,max}$ | - | - | 450 | W | |
| Isolation Voltage ¹ | All | | - | - | 2250 | Vdc | |
| | | | Input to outputs | - | - | 1500 | Vdc |
| | | | Input 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 ¹ | Symbol | Min | Typ | Max | Unit |
|--|---|--------------|----------------------|----------------------|-------------|-------------|
| Operating Input Voltage, DC | All | $V_{IN,DC}$ | 36 | 48 | 75 | Vdc |
| Turn-on Voltage Threshold | $I_O = I_{O,max}$ | $V_{IN,ON}$ | 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 ($I_O = I_{O,max}$) | $V_{IN,DC} = 36V_{DC}$ | $I_{IN,max}$ | - | - | 14.5 | 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 | $T_A = 25^\circ C$ $I_O = I_{O,max}$ $I_O = 50\% I_{O,max}$ $I_O = 20\% I_{O,max}$ | η | 93.5 94.0 90.0 | 95.0 95.2 91.5 | - - - | % % % |

Note 1 - $T_a = 25^\circ C$, airflow rate = 400 LFM, $V_{in} = 48V_{dc}$, 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 | $T_A=25\text{ }^\circ\text{C}$ $V_{IN,DC} = 48V_{dc}$ $I_O = 50\% I_{O,max}$ | 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 | 51.5 | V |
| Output Voltage Trim Range | All | V_O | 25 | - | 57 | V |
| Output Ripple, pk-pk | 20MHz bandwidth | V_O | - | 120 | - | mV_{PK-PK} |
| Output Current | All | I_O | 0 | - | 9 | A |
| Output DC current-limit inception ² | | I_O | 10 | - | 13 | A |
| V_O Load Capacitance ³ | All | C_O | 470 | 1000 | 3300 | μF |
| V_O Dynamic Response Peak Deviation | slew rate = 0.1A/us 25% ~ 50% ~ 25% 50% ~ 75% ~ 50% $I_{O,max}$ | | - | 400 | - | mV |
| | | | - | 350 | - | mV |
| Turn-on transient | Rise time | T_{rise} | - | 180 | - | mS |
| | Turn-on delay time | $T_{turn-on}$ | - | 75 | - | mS |
| | Output voltage overshoot | $\%V_O$ | - | | 5 | % |
| Switching frequency | All | f_{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 ⁴ | All | V_O | 60 | - | 75 | V |
| Output over-temperature protection ⁵ | 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, $V_{in} = 48V_{dc}$, 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 ¹ | 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 _A | | - | 1.5 | - | 10 ⁶ h |

AVE450-48S50-6L Performance Curves

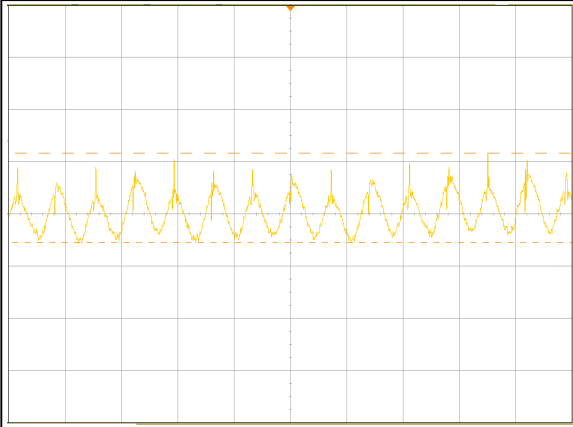


Figure 1: AVE450-48S50-6L Input Reflected Ripple Current Waveform
Ch 1: lin (5uS/div, 5mA/div)

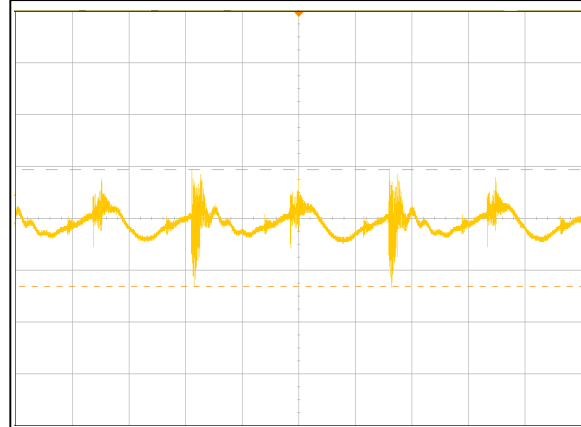


Figure 2: AVE450-48S50-6L Ripple and Noise Measurement
Ch 1: Vo (2uS/div, 50mV/div)

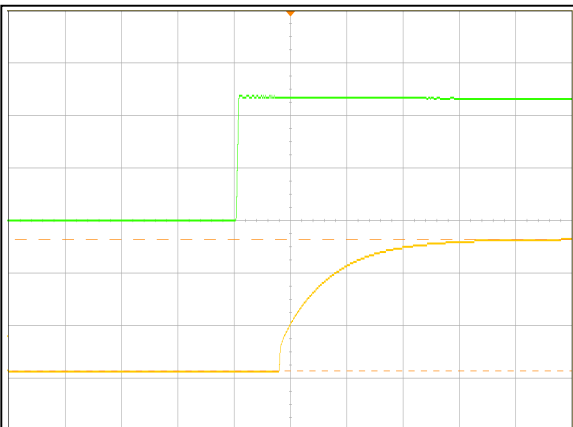


Figure 3: AVE450-48S50-6L Output Voltage Startup Characteristic(100mS/div)
Ch 1: Vo (20V/div) Ch 2: Vin (20V/div)

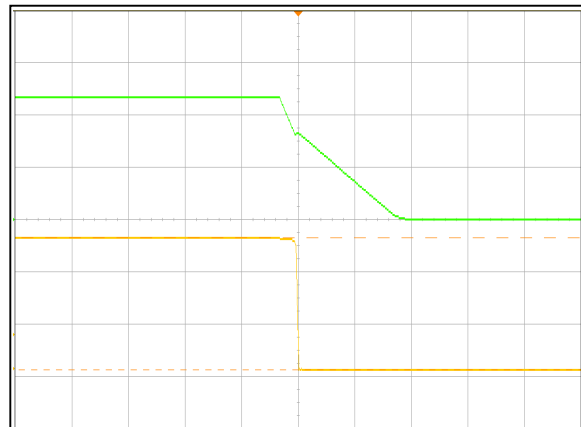


Figure 4: AVE450-48S50-6L Turn Off Characteristic (50mS/div)
Ch 1: Vo (20V/div) Ch 2: Vin (20V/div)

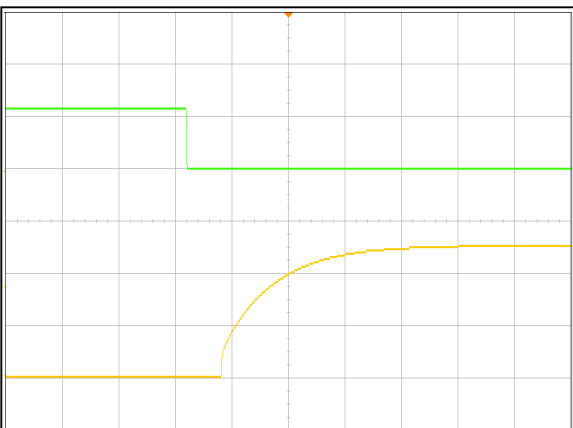


Figure 5: AVE450-48S50-6L Remote ON Waveform (100mS/div)
Ch 1: Vo (20V/div) Ch 2: Remote ON (5V/div)

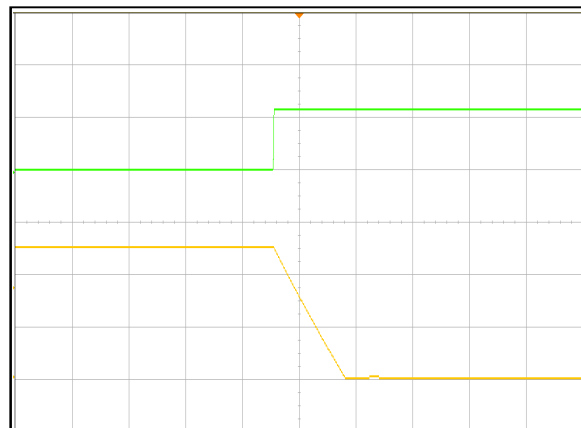


Figure 6: AVE450-48S50-6L Remote OFF Waveform (2mS/div)
Ch 1: Vo (20V/div) Ch 2: Remote ON (5V/div)

AVE450-48S50-6L Performance Curves

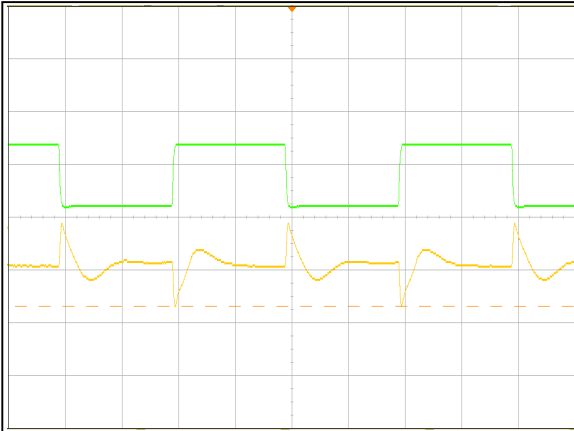


Figure 7: AVE450-48S50-6L Transient Response (5mS/div)
 25%~50%~25% load change, 0.1A/uS slew rate,
 Ch 1: Vo (500mV/div) Ch 2: Io (2A/div)

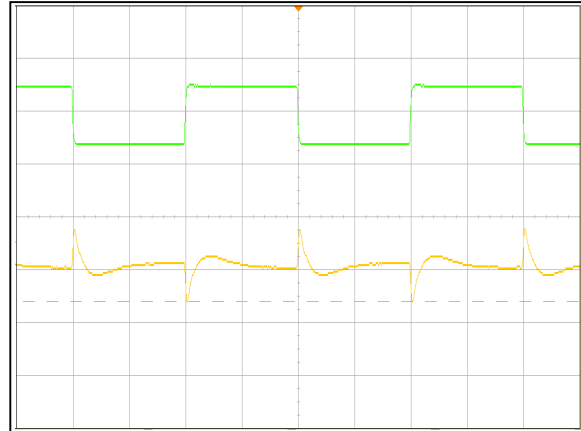


Figure 8: AVE450-48S50-6L Transient Response (5mS/div)
 50%~75%~50% load change, 0.1A/uS slew rate,
 Ch 1: Vo (500mV/div) Ch 2: Io (2A/div)

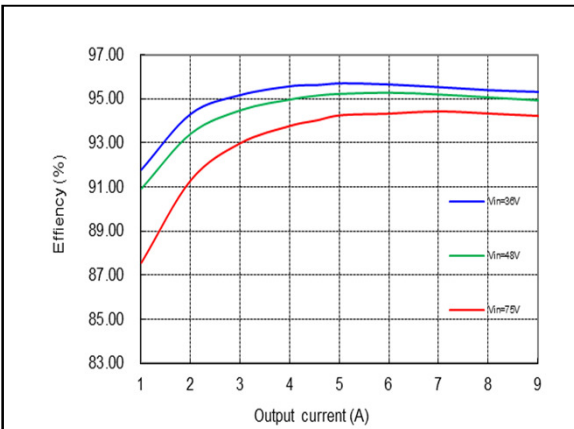
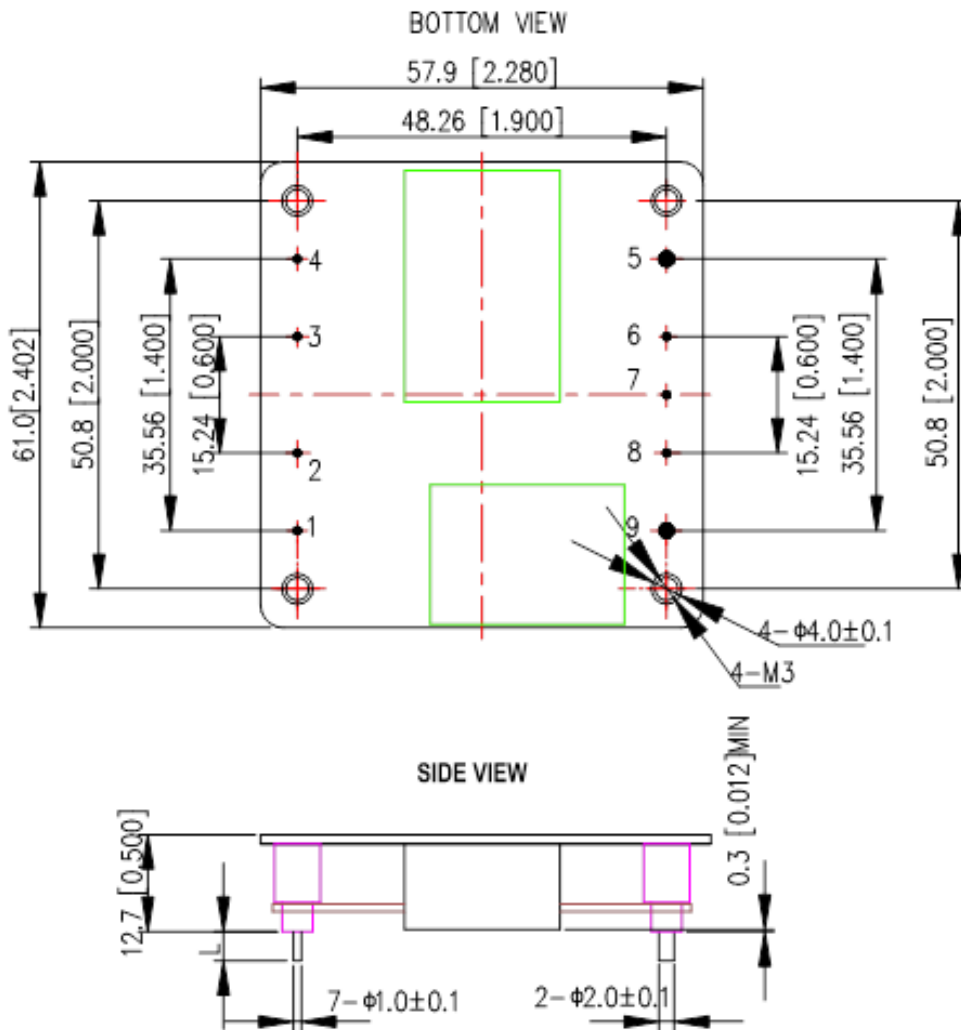


Figure 9: AVE450-48S50-6L Efficiency Curves @ 25 °C

Loading: Io = 10% increment to 9A

Mechanical Specifications

Mechanical Outlines



UNIT: mm[inch]

BOTTOM VIEW: pin on upside

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

X.XXmm ± 0.25 mm [X.XXX in. ± 0.01 in.]

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

AVE450-48S50-6L 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 AVE450-48S50-6L 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 AVE450-48S50-6L 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 AVE450-48S50-6L 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.

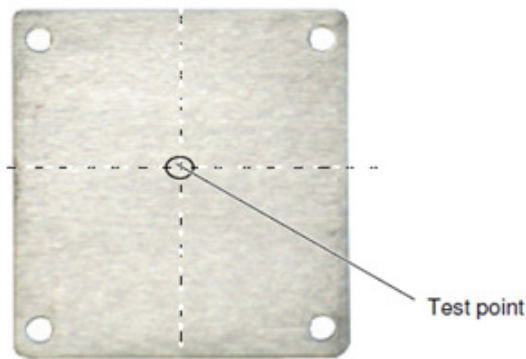


Figure 10 Temperature test point on FR-4 board

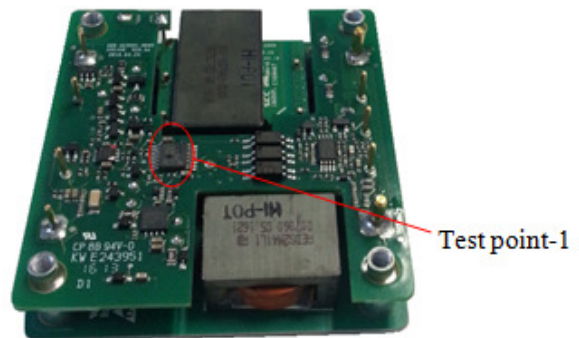


Figure 11 Temperature test points

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.

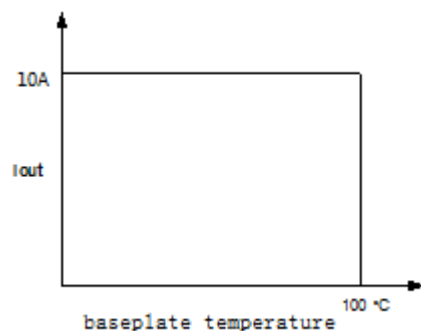


Figure 12 Output power derating at 48V_{in}

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: $1.0\text{m}^2/\text{s}^3$, -3db/oct , axes of vibration: X/Y/Z. Time: 30min/axes |
| Mechanical Shock | 3 | 30g , 6ms , 3axes , 6directions , 3time/direction |
| Thermal Shock | 3 | $-55\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$, unit temperature 20cycles |
| Thermal Cycling | 3 | $-40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$, 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 AVE450-48S50-6L series power supply.

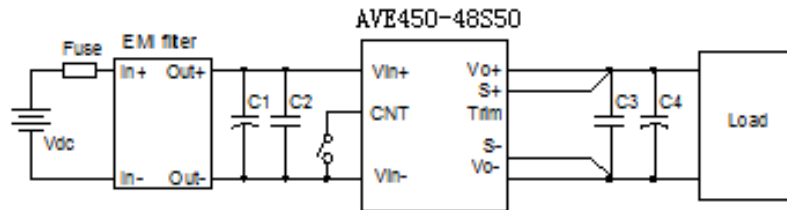


Figure 13 Typical application

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 $T_a < 0\text{ }^{\circ}\text{C}$.

Note: EMI filter please refer to Figure 19.

Remote ON/OFF

Either positive or negative remote ON/OFF logic is available in AVE450-48S50-6L. The logic is CMOS and TTL compatible.

Figure 14 is the detailed internal circuit and reference in AVE450-48S50-6L.

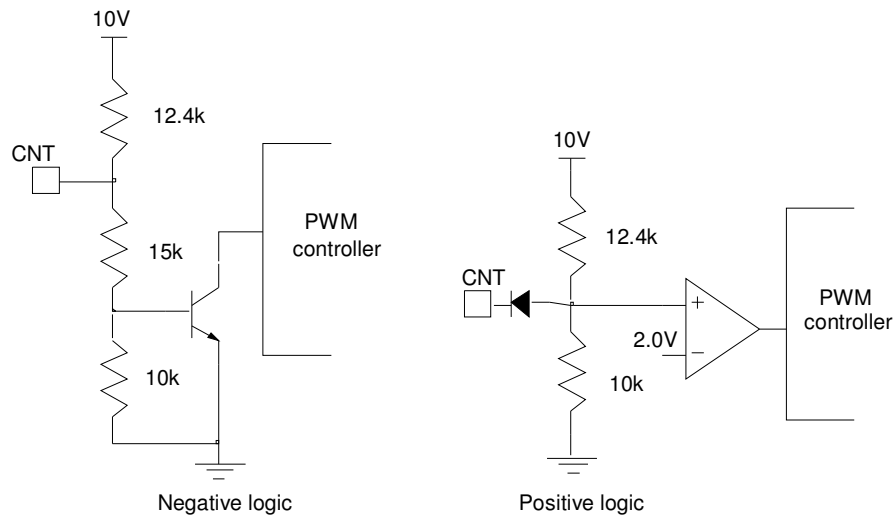


Figure 14 Remote ON/OFF internal diagram

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.

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

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

Δ : 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.

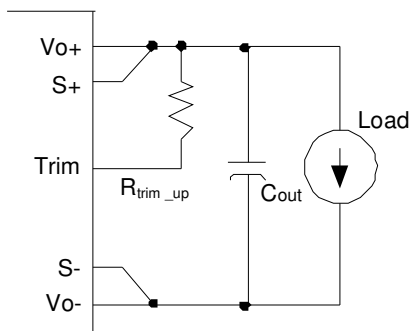


Figure 15 Trim up

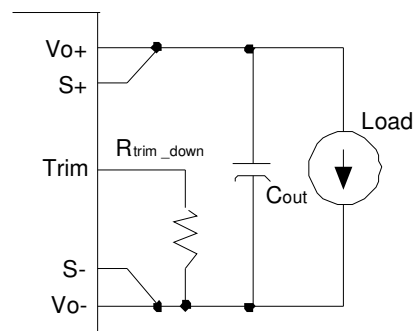


Figure 16 Trim down

For AVE450-48S50-6L, 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.

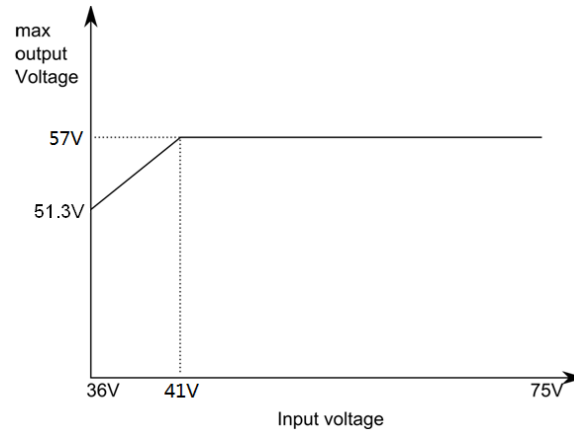


Figure 17 trimming up the output voltage

Inrush Current, Input and Output Ripple & Noise Test Configuration

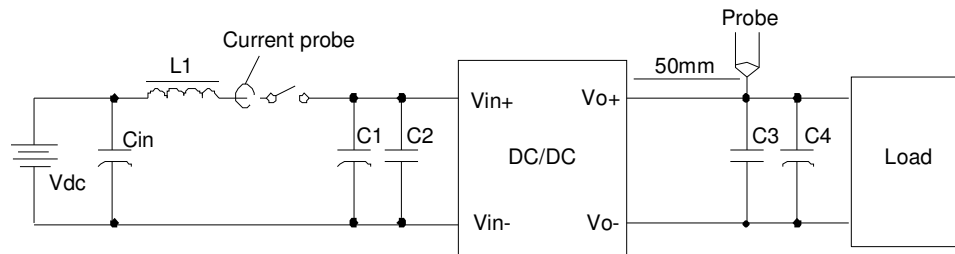


Figure 18 Input ripple & inrush current, output ripple & noise test configuration

Vdc: DC power supply

L1: 12 μ H

Cin: 220 μ F/100V typical

C1: 470 μ F/100V electrolytic capacitor, High frequency and low ESR

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

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

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

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

EMC Test Conditions

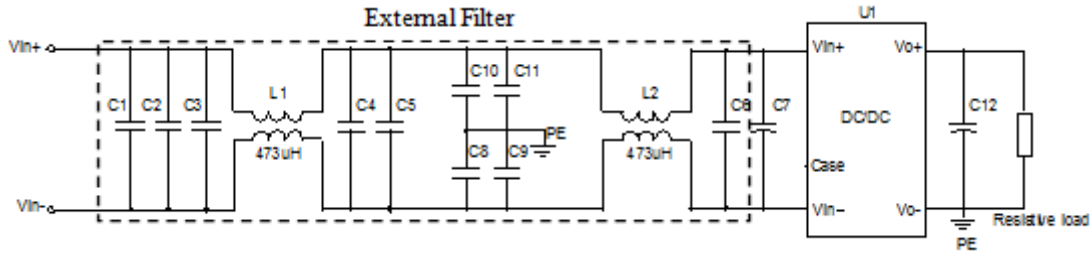


Figure 19 EMC test conditions

U1: Module to test, AVE450-48S50-6L

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

C3 ~ C5: 1 μ F/100V X7R ceramic capacitor, P/N: C3225X7R2A105K (TDK) or equivalent caps

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

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

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

C12: 2* 470 μ F/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 ⁶⁺ | PBB | PBDE |
| AVE450-48S50-6L | 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 | 04.03.2017 | First Issue | S. Dong |

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