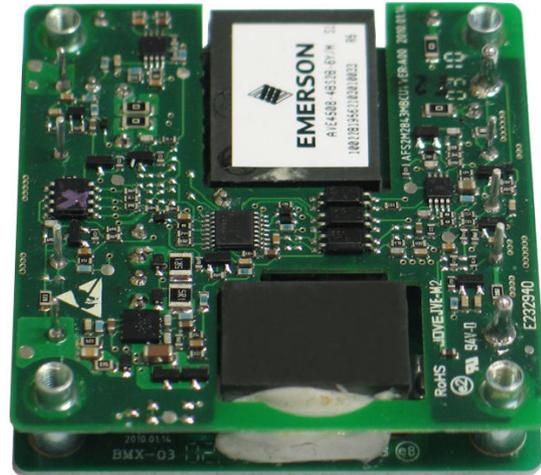


## Description

AVE450B-48S28-6Y/M is a single output DC-DC converter with standard half-brick outline and pin configuration. It delivers up to 16A output current with 28V output voltage. Above 94% ultra-high efficiency and excellent thermal performance make 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.



## Operational Features

- Up to 16A output current
- Ultra-high efficiency 94% typ. at full load
- Wide input range: 36V ~ 75V
- Excellent thermal performance
- No minimum load requirement
- Fixed frequency operation
- RoHS 5 compliant

## Control Features

- Remote control function (negative or positive logic optional)
- Remote output sense
- Trim function: -50% ~ +18%

## Protection Features

- Input under voltage lockout
- Output over current protection
- Output over voltage protection
- Over temperature protection

## Mechanical Features

- Industry standard half-brick pin-out outline
- With baseplate
- Pin length option: 3.8mm

## Safety & EMC

- Meets Basic insulation requirements of EN60950
- UL60950 recognized and certified to IEC/EN60950
- Meets 2006/95/EC and 93/68/EEC directives which facilitates CE Marking in user's end product
- All materials meet UL94,V-0 flammability rating
- Meets conducted emissions requirements of FCC Class A and EN55022 Class A with external filter

## Electrical Characteristics

Full operating ambient temperature range is -40°C to +85°C.

Specifications are subject to change without notice.

| Parameter                                  |                            | Min.  | Typ.   | Max.  | Unit  | Notes & conditions                                 |
|--|----------------------------|-------|--------|-------|-------|--|
| <b>Absolute max. ratings</b>               |                            |       |        |       |       |  |
| Input voltage                              | Non-operating              |       |        | 100   | V     | 100ms  |
|  | Operating                  |       |        | 80    | V     | Continuous   |
| Operating temperature                      |                            | -40   |        | 85    | °C    |  |
| Storage temperature                        |                            | -55   |        | 125   | °C    |  |
| Voltage at remote ON/OFF pin               |                            | -0.3  |        | 15    | V     |  |
| <b>Input characteristics</b>               |                            |       |        |       |       |  |
| Operating input voltage range              |                            | 36    | 48     | 75    | V     |  |
| Input under-voltage lockout                | Turn-on voltage threshold  | 32    | 34     | 36    | V     |  |
|  | Turn-off voltage threshold | 30    | 32     | 35    | V     |  |
|  | Lockout voltage hysteresis | 1     | 2      |       | V     |  |
| Max. input current                         |                            |       |        | 14    | A     | 36V <sub>in</sub> , full load                      |
| No-load input current                      |                            |       |        | 0.2   | A     |  |
| Standby Input current                      |                            |       | 0.01   | 0.1   | A     | Remote OFF   |
| Input reflected ripple current             |                            |       | 50     | 600   | mA    | Through 12μH inductor; see application note        |
| Recommended input fuse                     |                            |       |        | 30    | A     | External fast blow fuse recommended; see Figure 10 |
| Input filter component values (C/L)        |                            |       | 10\0.7 |       | μF\μH | Internal values                                    |
| Recommended external input capacitance     |                            | 470   |        |       | μF    | Low ESR capacitor recommended; see Figure 10       |
| <b>Output characteristics</b>              |                            |       |        |       |       |  |
| Output voltage set point (standard option) |                            | 27.72 | 28     | 28.28 | V     | 48V <sub>in</sub> , full load, 25°C                |
| Output voltage line regulation             |                            |       | 0.05   | 0.2   | %     |  |
|  |                            |       | 14     | 56    | mV    |  |
| Output voltage load regulation             |                            |       | 0.1    | 0.5   | %     |  |
|  |                            |       | 28     | 140   | mV    |  |

| Parameter   |  | Min.  | Typ. | Max.  | Unit    | Notes & conditions  |
|---|--|-------|------|-------|---------|---|
| Output voltage temperature regulation                               |  |       | 5.6  |       | mV/°C   |   |
| Total output voltage range  |  | 27.16 | 28   | 28.84 | V       | Over sample, line, load, temperature & life               |
| Output voltage ripple and noise                                     |  |       | 100  | 200   | mVpp    | 20MHz bandwidth; see Figure 2                             |
| Operating output current range                                      |  | 0     |      | 16    | A       |   |
| Output DC current-limit inception                                   |  | 16.8  |      | 22    | A       | First foldback then hiccup, see Figure 9                  |
| Output capacitance  |  | 680   | 1000 | 4400  | μF      | High frequency and low ESR capacitor is recommended       |
| <b>Dynamic characteristics</b>                                      |  |       |      |       |         |   |
| Dynamic response  | 50% ~ 75% ~ 50%<br>$I_{o,max}$ , 0.1A/μs |       | 200  | 500   | mV      | 25°C, nominal input voltage, see Figure 4                 |
|   | Setting time                             |       | 60   | 500   | μs      | Recovery to within 1% $V_{o,nom}$                         |
| Turn-on transient   | Rise time                                |       | 50   | 100   | ms      | See Figure5   |
|   | Turn-on delay time                       |       | 50   | 100   | ms      |   |
|   | Output voltage overshoot                 |       | 0    | 5     | % $V_o$ |   |
| <b>Efficiency</b>   |  |       |      |       |         |   |
| 100% load   |  |       | 94   |       | %       | See Figure 1  |
| 50% load  |  |       | 94.5 |       | %       | See Figure 1  |
| <b>Isolation characteristics</b>                                    |  |       |      |       |         |   |
| Isolation voltage (conditions: 1mA for 60s, slew rate of 1500V/10s) |  | 1500  |      |       | V       | Basic insulation, pollution degree 2, input to output     |
|   |  | 1500  |      |       | V       | Basic insulation, pollution degree 2, input to baseplate  |
|   |  | 500   |      |       | V       | Basic insulation, pollution degree 2, output to baseplate |

## Electrical Characteristics (Continued)

| Parameter                              |                   | Min. | Typ. | Max. | Unit                    | Notes & conditions   |
|--|-------------------|------|------|------|-------------------------|--|
| <b>Feature characteristics</b>         |                   |      |      |      |                         |  |
| Switching frequency                    |                   | 260  | 290  | 320  | kHz                     |  |
| Remote ON/OFF control (positive logic) | Off-state voltage | -0.3 |      | 0.8  | V                       | See Figure 7 and Figure 8                                    |
|  | On-state voltage  | 2.0  |      | 15   | V                       |  |
| Remote ON/OFF control (negative logic) | Off-state voltage | 2.0  |      | 15   | V                       |  |
|  | On-state voltage  | -0.3 |      | 0.8  | V                       |  |
| Output voltage trim range              |                   | 14   |      | 33   | V                       | See <i>Trim Characteristics</i> of <i>Application Note</i>   |
| Output voltage remote sense range      |                   |      |      | 0.5  | V                       |  |
| Output over-voltage protection         |                   | 125  | 130  | 150  | %V <sub>o,no</sub><br>m | Latch off. Reset by power on or remote on                    |
| Over-temperature shutdown              |                   | 100  | 110  | 120  | °C                      | Auto recovery;<br>Test point: see Figure 18                  |
| Over-temperature hysteresis            |                   |      | 10   |      | °C                      |  |
| <b>Reliability characteristics</b>     |                   |      |      |      |                         |  |
| Calculated MTBF (telcordia)            |                   |      | 1.5  |      | 10 <sup>6</sup> h       | Telcordia SR-332-2006; 80% load, 300LFM, 40°C T <sub>a</sub> |

Caution: External output capacitor must be present for normal operation.

## Qualification Testing

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

## Characteristic Curves

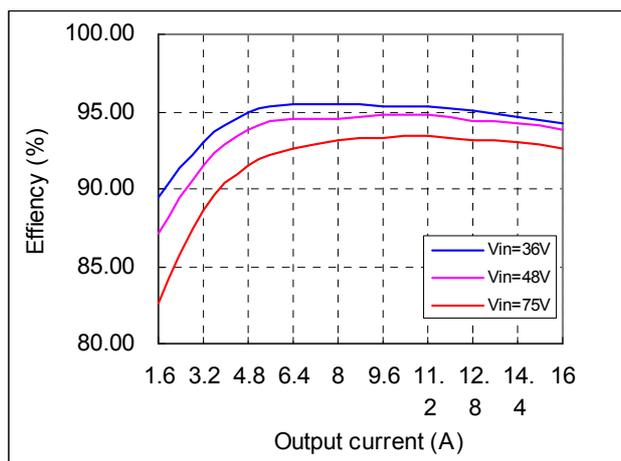


Figure 1 Efficiency and output current,  $T_a = 25^{\circ}\text{C}$ ,  $V_o = 28\text{V}$

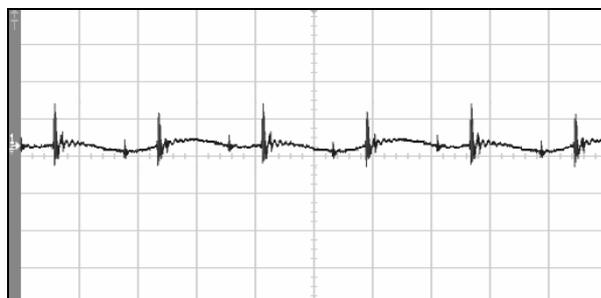


Figure 2 Output ripple & noise ( $2\mu\text{s}/\text{div}$ ,  $50\text{mV}/\text{div}$ ), see Figure 15 for test configuration

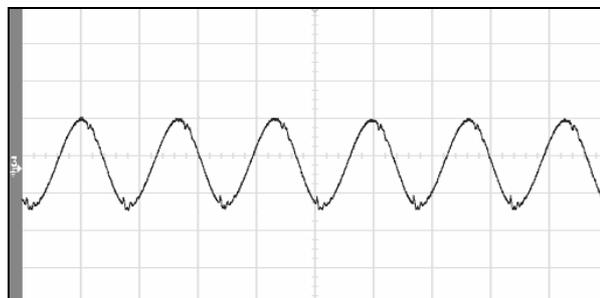


Figure 3 Input reflected ripple current ( $2\mu\text{s}/\text{div}$ ,  $25\text{mA}/\text{div}$ ), see Figure 15 for test configuration

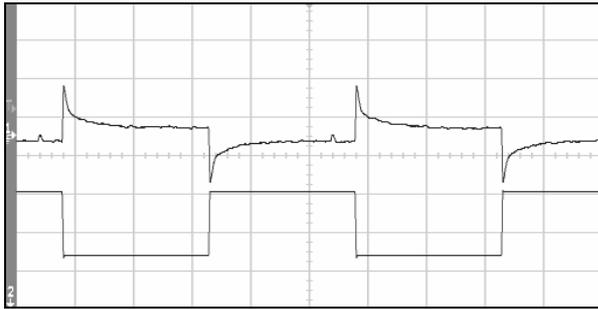


Figure 4 Dynamic response for 25% load step (50% ~ 75% ~ 50%) and 0.1A/ $\mu$ s slew rate, (2ms/div), see Figure 10 for test configuration; CH1-output voltage (200mV/div); CH2-output current (5A/div)

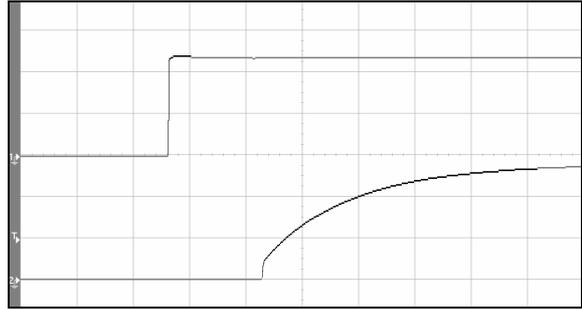


Figure 5 Output voltage startup by power on, (20ms/div), see Figure 10 for test configuration; CH1-input voltage (20V/div); CH2-output voltage (10V/div)

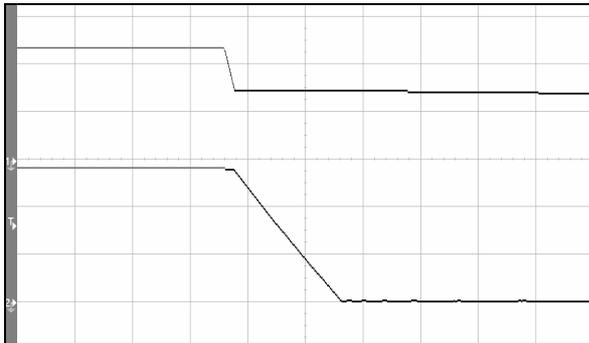


Figure 6 Output voltage shut down by power off, (5ms/div), see Figure 10 for test configuration; CH1-input voltage (20V/div); CH2-output voltage (10V/div)

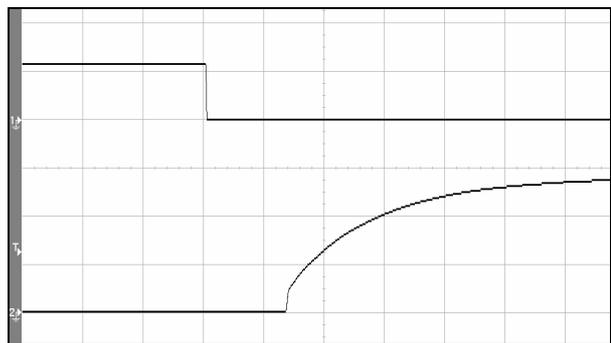


Figure 7 Output voltage startup by remote ON, (20ms/div), see Figure 10 for test configuration; CH1-remote ON (5V/div); CH2-output voltage (10V/div)



Figure 8 Output voltage shutdown by remote OFF, (2ms/div), see Figure 10 for test configuration; CH1-remote OFF voltage (5V/div); CH2-output voltage (10V/div)

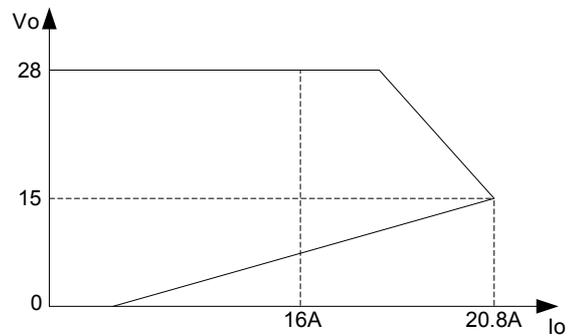


Figure 9 Over-current protection characteristics. For reference only

# Application Note

## Typical Application

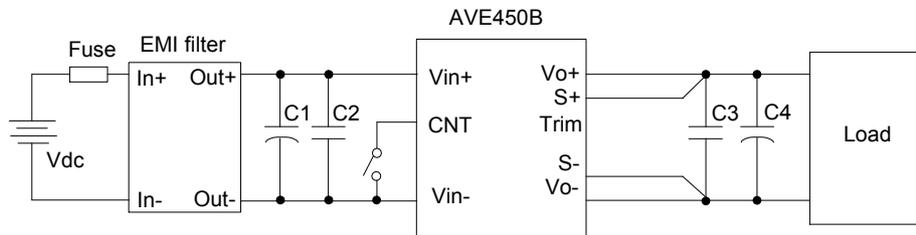


Figure 10 Typical application

- C1: 470 $\mu$ F/100V electrolytic capacitor, P/N: UPW2A471MHD (Nichicon) or equivalent
- C2, C3: 1 $\mu$ F/100V X7R ceramic capacitor, P/N: C3225X7R2A105KT0L0U (TDK) or equivalent
- C4: 680 $\mu$ F electrolytic capacitor, P/N: UUD1H681MNL1GS (Nichicon) or equivalent
- 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-48S28-6Y/M. The logic is CMOS and TTL compatible.

Figure 11 is the detailed internal circuit and reference in AVE450B-48S28-6Y/M.

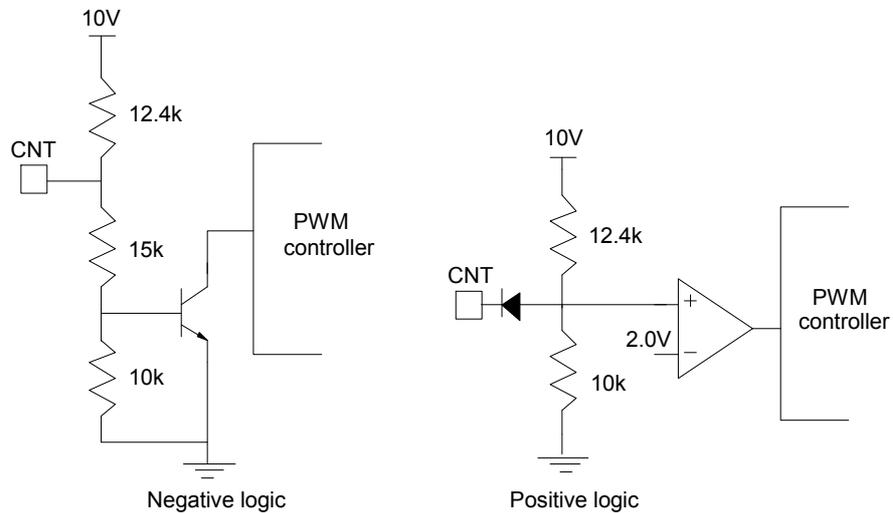


Figure 11 Remote ON/OFF internal diagram

### Trim Characteristics

Connecting an external resistor between Trim and  $V_o-$  will decrease the output voltage, while connecting it between Trim and  $V_o+$  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

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

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.

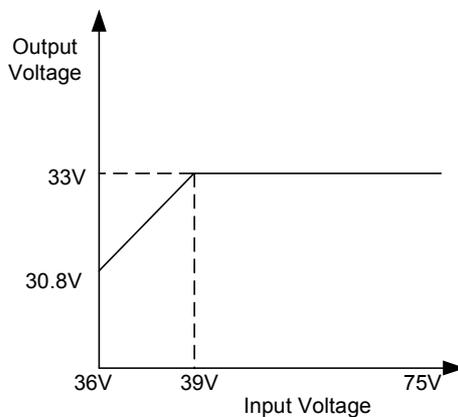


Figure 12 Max. adjustable output voltage vs. input voltage

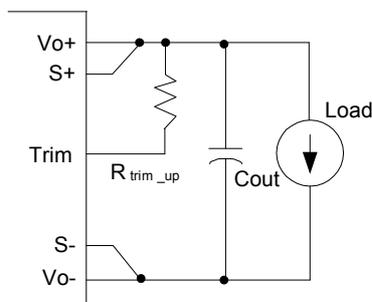


Figure 13 Trim up

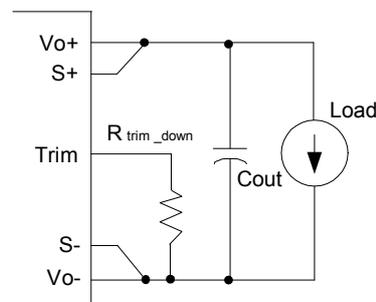


Figure 14 Trim down

### 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 10 for details.

If the sense compensate function is not necessary, short S+ to V<sub>o+</sub> and S- to V<sub>o-</sub> respectively.

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

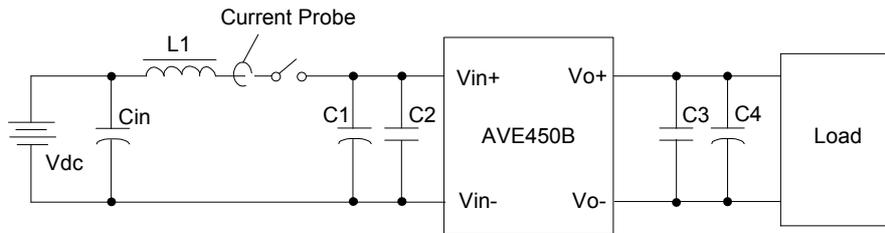


Figure 15 Inrush current, input and output ripple & noise test configuration

Vdc: DC power supply

L1: 12μH inductor

Cin: 220μF/100V electrolytic capacitor

C1 ~ C4: See Figure 10

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

### EMC Filter Configuration

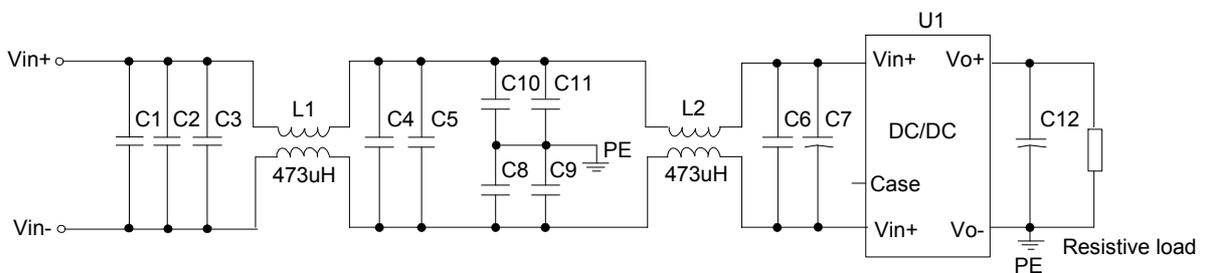


Figure 16 EMC test configuration

U1: Module to test, AVE350B-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

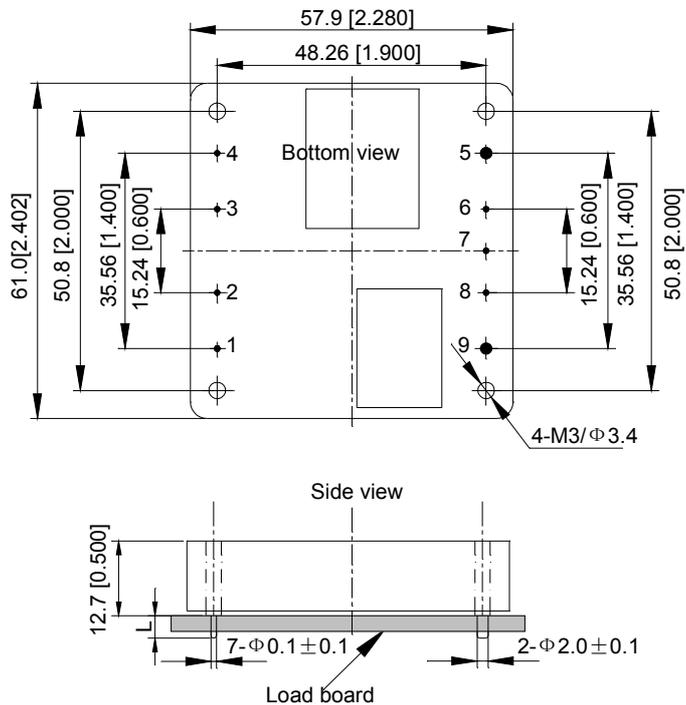
C8 ~ C11: 0.22uF/630V X7R ceramic capacitor, P/N: 2220CC224KA11A (AVX) or equivalent caps

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

C12: 680uF/50V electrolytic capacitor, P/N: UUD1H681MNL1GS (Nichicon) or equivalent PE: Connect to Vo-

Case: Not connected

Mechanical Diagram



Unit: mm[inch]      Bottom view: pin on upside  
 Tolerance: X.Xmm ± 0.5mm[X.X in. ± 0.02in.]  
 X.XXmm ± 0.25mm[X.XX in. ± 0.01in.]

Figure 17 Mechanical diagram

Pin length option

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

## Pin Designations

| Pin No. | Name      | Function                |
|---------|-----------|-------------------------|
| 1       | $V_{in+}$ | Positive input voltage  |
| 2       | CNT       | Remote ON/OFF control   |
| 3       | Case      | Case                    |
| 4       | $V_{in-}$ | Negative input voltage  |
| 5       | $V_{o-}$  | Negative output voltage |
| 6       | S-        | Negative remote sense   |
| 7       | Trim      | Output voltage trim     |
| 8       | S+        | Positive remote sense   |
| 9       | $V_{o+}$  | Positive output voltage |

## 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 7s.

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 simulative.

## 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 converter can deliver full output power at 85°C ambient temperature provided the baseplate temperature is kept below the max values in the table 1. Figure 19 shows the derating output current vs. baseplate temperature. The location of the baseplate temperature test point is shown in Figure 18.

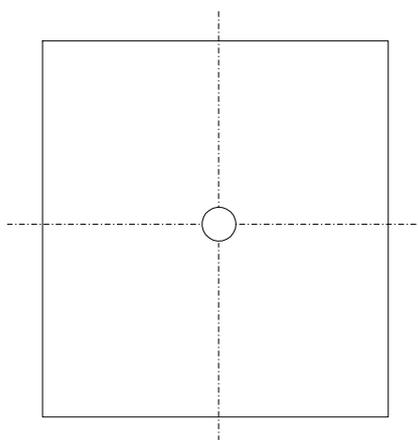


Figure 18 Temperature test point on baseplate

Table 1 Temperature limit of the test point

| Test point              | Temperature limit |
|-------------------------|-------------------|
| Test point on baseplate | 105°C             |

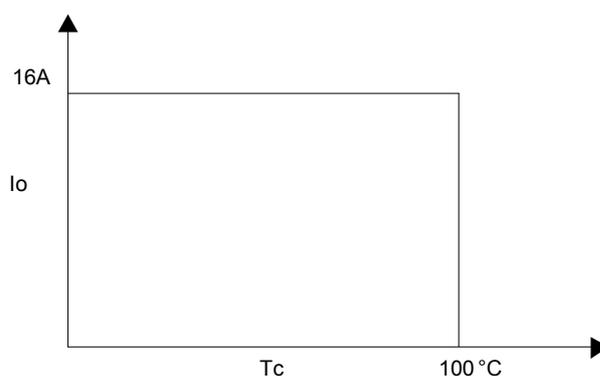


Figure 19 Output power derating, Tc: temperature test point on baseplate, see Figure 18 for test configuration

### Ordering Information

|                |          |           |          |           |          |          |          |          |          |
|----------------|----------|-----------|----------|-----------|----------|----------|----------|----------|----------|
| <b>AVE450B</b> | <b>-</b> | <b>48</b> | <b>S</b> | <b>28</b> | <b>-</b> | <b>6</b> | <b>Y</b> | <b>/</b> | <b>M</b> |
| ①              |          | ②         | ③        | ④         |          | ⑤        | ⑥        |          | ⑦        |

|   |                      |  |
|---|----------------------|--|
| 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 | Number of outputs    | S: single output   |
| ④ | Rated output voltage | 28: 28V output   |
| ⑤ | Pin length           | -6: 3.8mm  |
| ⑥ | RoHS status          | Y: RoHS, R5  |
| ⑦ | Structure            | Default: non-threaded mounting hole; M: threaded mounting hole |

| Model number       | Description   |
|--------------------|---|
| AVE450B-48S28-6Y/M | 3.8mm pin length; negative on/off logic; non-threaded mounting hole; R5 compliant |

## Hazardous Substances Announcement (RoHS of China)

| Parts   | Hazardous substances |    |    |                  |     |      |
|---|----------------------|----|----|------------------|-----|------|
|   | Pb                   | Hg | Cd | Cr <sup>6+</sup> | PBB | PBDE |
| AVE450B-48S28-6Y/M  | ○                    | ○  | ○  | ○                | ○   | ○    |
| <p>○: 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</p> <p>√: 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</p>   |                      |    |    |                  |     |      |
| <p>Emerson Network Power Co., Ltd. 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:</p> <ol style="list-style-type: none"> <li>1. Solders (including high-temperature solder in parts) contain plumbum.</li> <li>2. Glass of electric parts contains plumbum.</li> <li>3. Copper alloy of pins contains plumbum</li> </ol> |                      |    |    |                  |     |      |