TECHNICAL REFERENCE NOTE

ARTESYN AVO100-48S05 SERIES

100 Watts 1/8 Brick Converter

PRODUCT DESCRIPTION

Advanced Energy's Artesyn AVO100-48S05 series is a single output DC/DC converter with standard eighth-brick form factor and pin configuration. It delivers up to 20A output current with 5V output. Ultra-high efficiency 92.8% efficiency and excellent thermal performance makes it an ideal choice for use in telecom applications. It can operate over an ambient temperature range of -40°C to +85°C.

AT A GLANCE

Total Power

100 Watts

Input Voltage

36 to 75 Vdc

# of Outputs

Single

RoHS

SPECIAL FEATURES

- Delivering up to 20A output
- Ultra-high efficiency 92.8% typ. at full load
- Wide input range: 36 to 75Vdc
- Pre-bias function
- Excellent thermal performance
- No minimum load requirement
- Fixed frequency operation
- Intended for wave soldering
- RoHS 3.0 compliant
- Remote control function
- Remote output sense
- Trim function: 80% ~ 110%
- Input under voltage lockout
- Output over current protection
- Output over voltage protection
- Over temperature protection
- Industry standard eighth-brick pin-out outline
- Pin length:3.8mm

SAFETY

- IEC/EN/UL/ 60950-1
- UL/TUV
- GB4943
- CE and UKCA Mark

TYPICAL APPLICATIONS

- Datacom
- Telecommunication

MODEL NUMBERS

Standard	Output Voltage	Structure	Remote ON/OFF logic	RoHS Status
AVO100-48S05-6L	5Vdc	Open-frame	Negative	3.0
AVO100-48S05P-6L	5Vdc	Open-frame	Positive	3.0
AVO100-48S05B-6L	5Vdc	Baseplate	Negative	3.0
AVO100-48S05PB-6L	5Vdc	Baseplate	Positive	3.0
AVO100-48S05SL-6L	5Vdc	SMT, Open-frame	Negative	3.0

Order Information

AVO100	-	48	S	05	P	B	-	6	L
①		②	③	④	⑤	⑥		⑦	⑧

①	Model series	AVO: Standard eighth-brick series, 100: output power 100W
②	Input voltage	48: 36V ~ 75V input range, rated input voltage 48V
③	Output number	S: single output
④	Rated output voltage	05: 5V output
⑤	Remote ON/OFF logic	Default: negative logic; P: positive logic
⑥	Baseplate	B: with baseplate; default: open-frame; S: SMT pin; T: SMT pin and tape reel package
⑦	Pin length	6: 3.8mm pin length
⑧	RoHS status	L: RoHS 3.0

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 Non-operating -100mS	All All	$V_{IN,DC}$	- -	- -	80 100	Vdc Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	100	W
Isolation Voltage[1] Input to outputs	All		-	-	2250	Vdc
Ambient Operating Temperature	All	T_A	-40	-	+85	°C
Storage Temperature	All	T_{STG}	-55	-	+125	°C
Voltage at remote ON/OFF pin	All		-0.7	-	12	Vdc
Humidity (non-condensing) Operating Non-operating	All All		- -	- -	95 95	% %

Note 1 - 1mA for 60s, slew rate of 2000V/10s.

ELECTRICAL SPECIFICATIONS

Input Specifications

Table 2. Input Specifications

Parameter	Condition[1]	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, DC	All	$V_{IN,DC}$	36	48	75	Vdc
Turn-on Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,ON}$	31	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	3	V
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC} = 36V_{DC}$	$I_{IN,max}$	-	-	3.5	A
No Load Input Current (V_O On, I_O = 0A, I_{VSB} = 0A)	$V_{IN,DC} = 36V_{DC}$	I_{IN,no_load}	-	0.05	0.1	A
Standby Input Current	$V_{IN,DC} = 36V_{DC}$	$I_{IN,standby}$	-	0.01	0.03	A
Inrush Current Transient Rating			-	0.5	1	A^2S
Recommended Input Fuse	Fast blow external fuse recommended		-	-	10	A
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	-	100	-	uF
Input Reflected Ripple Current	Through 12uH inductor			15	-	mA
Input filter component values (C\L)	Internal values		-	4.4\3.0	-	μF\μH
Operating Efficiency	T_A=25 °C $I_O = I_{O,max}$ $I_O = 60I_{O,max}$	η	- -	92.8 92.4	- -	% %

Note 1 - Ta = 25 °C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.

ELECTRICAL SPECIFICATIONS

Output Specifications

Table 3. Output Specifications

Parameter		Condition[1]	Symbol	Min	Typ	Max	Unit
Factory Set Voltage		$V_{IN,DC}$ = 48V_{DC} I_O=$I_{O,max}$	V_O	4.93	5.00	5.07	Vdc
Total Regulation		Inclusive of line, load temperature change, warm-up drift	V_O	4.85	5.00	5.15	Vdc
Output Voltage Line Regulation		All	%V_O	-	0.1	0.2	%
Output Voltage Load Regulation		All	%V_O	-	0.2	0.5	%
Output Voltage Temperature Regulation		All	%V_O	-	-	0.02	%/^{O}C
Output Voltage Trim Range		All	V_O	4	-	5.5	V
Output Ripple, pk-pk		Measure with a 1uF ceramic capacitor in parallel with a 10uF tantalum capacitor, 0 to 20MHz bandwidth	V_O	-	40	90	mV_{PK-PK}
Output Current		All	I_O	0	-	20	A
Output DC current-limit inception[2]			I_O	22	-	32	A
V_O Load Capacitance[3]		All	C_O	220	1000	10000	uF
V_O Dynamic Response	Peak Deviation Settling Time	50%~75%~50% 25% load change slew rate = 0.1A/us	±V_O T_s	- -	80 100	- -	mV uSec
		50%~75%~50% 25% load change slew rate = 1A/us	±V_O T_s	- -	230 100	- -	mV uSec
Turn-on transient	Rise time	I_O = I_{max}	T_{rise}	-	5	30	mS
	Turn-on delay time	I_O = I_{max}	$T_{turn-on}$	-	3	30	mS
	Output voltage overshoot	I_O = 0	%V_O	-	0	-	%
Switching frequency		All	f_{SW}	280	310	360	KHz
Remote ON/OFF control (Positive logic)	Off-state voltage	All		-0.7	-	1.2	V
	On-state voltage	All		3.5	-	12	V
Remote ON/OFF control (Negative logic)	Off-state voltage	All		3.5	-	12	V
	On-state voltage	All		-0.7	-	1.2	V

Note 1 - Ta = 25 ^{O}C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.
Note 2 - Hiccup: auto-restart when over-current condition is removed.
Note 3 - High frequency and low ESR is recommended.

ELECTRICAL SPECIFICATIONS

Output Specifications

Table 3. Output Specifications, con't:						
Parameter	**Condition[1]**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Output over-voltage protection[4]	All	$\%V_O$	115	-	140	%
Output over-temperature protection[5] With baseplate Without baseplate	 All All	 T T	 - -	 123 130	 - -	 ^{O}C ^{O}C
Over-temperature hysteresis	All	T	5	-	-	^{O}C
Output voltage remote sense range	All	Vo	-	-	0.5	V
MTBF	Telcordia SR-332-2006; 80% load, 300LFM, 40 ^{O}C T_A		-	1.5	-	10^6 h

Note 4 - Hiccup: auto-restart when over-voltage condition is removed.

Note 5 - Auto recovery. See Figure 10,11 test point.

ELECTRICAL SPECIFICATIONS

AVO100-48S05 Performance Curves

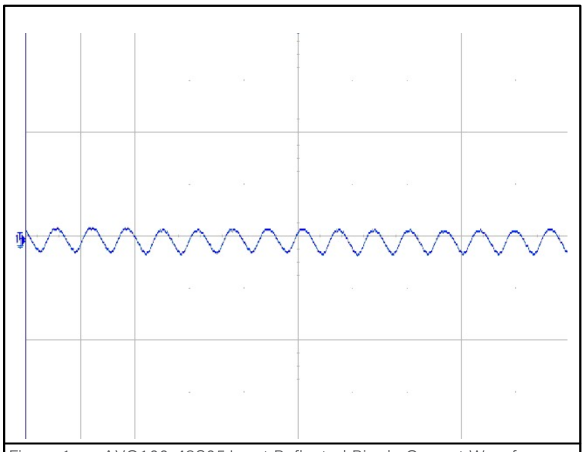


Figure 1: AVO100-48S05 Input Reflected Ripple Current Waveform

Ch 1: Iin (5uS/div, 10mA/div)

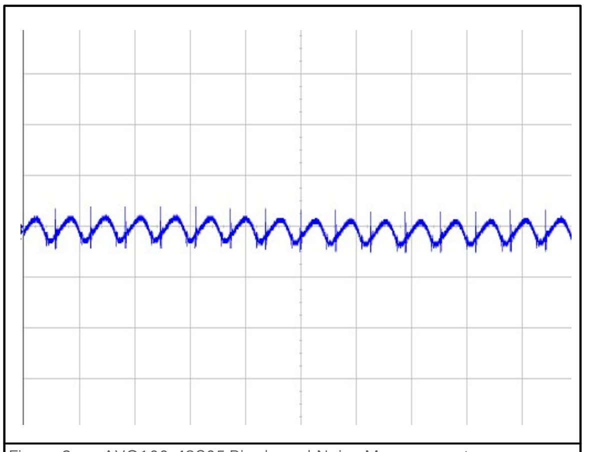


Figure 2: AVO100-48S05 Ripple and Noise Measurement

Ch 1: Vo (5uS/div, 50mV/div)

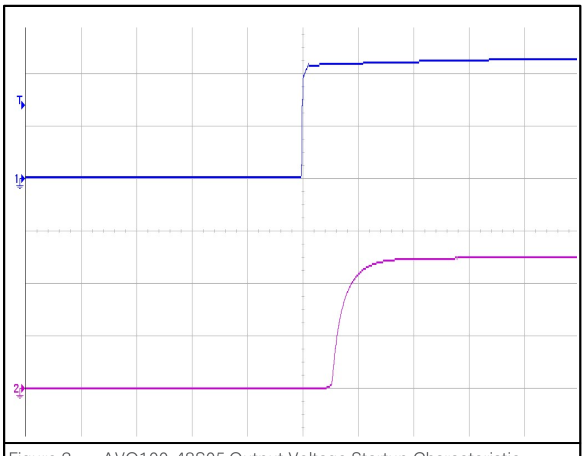


Figure 3: AVO100-48S05 Output Voltage Startup Characteristic (5mS/div)

Ch 1: Vin (20V/div) Ch 2: Vo (2V/div)

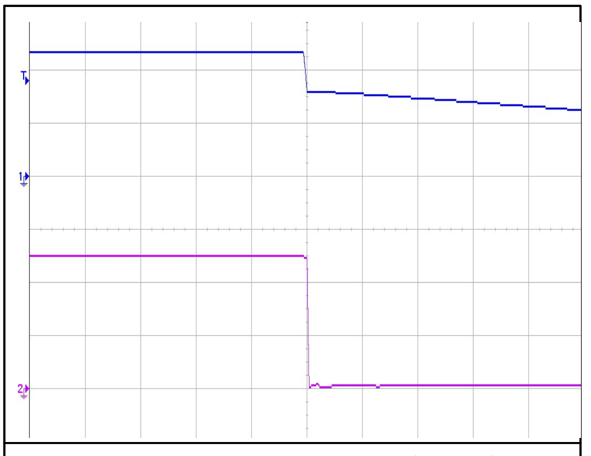


Figure 4: AVO100-48S05 Turn Off Characteristic (10mS/div)

Ch 1: Vin (20V/div) Ch 2: Vo (2V/div)

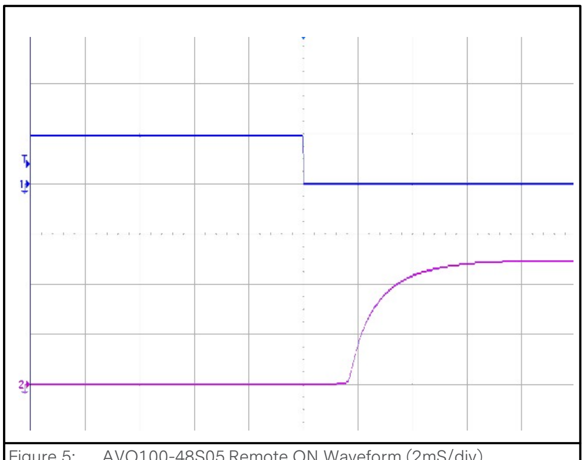


Figure 5: AVO100-48S05 Remote ON Waveform (2mS/div)

Ch 1: Remote ON (5V/div) Ch 3: Vo (2V/div)

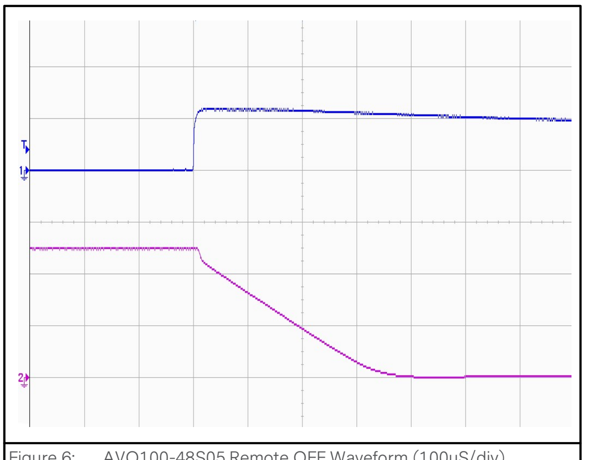


Figure 6: AVO100-48S05 Remote OFF Waveform (100uS/div)

Ch 1: Remote OFF (5V/div) CH3: Vo (2V/div)

ELECTRICAL SPECIFICATIONS

AVO250-48S28 Performance Curves

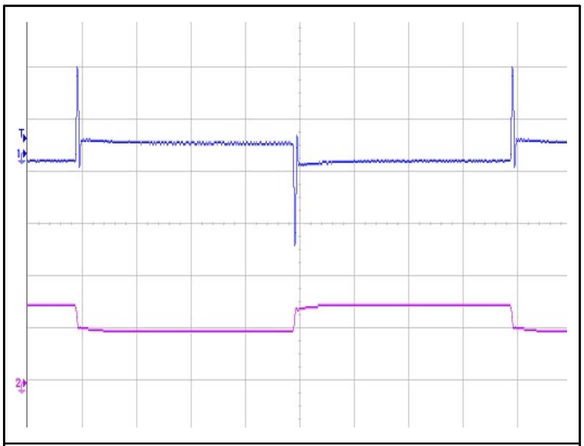


Figure 7: AVO100-48S05 Transient Response (1mS/div)
50%~75%~50% load change, 0.1A/uS slew rate, Vin = 48Vdc
Ch 1: Vo (50mV/div) Ch 3: Io (10A/div)

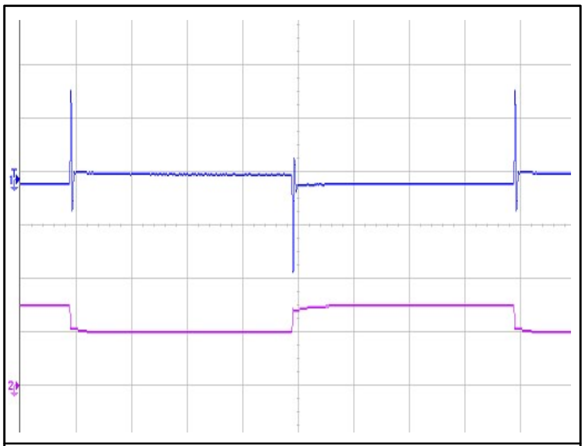


Figure 8: AVO100-48S05 Transient Response (1mS/div)
50%~75%~50% load change, 1A/uS slew rate, Vin = 48Vdc
Ch 1: Vo (100mV/div) Ch 3: Io (10A/div)

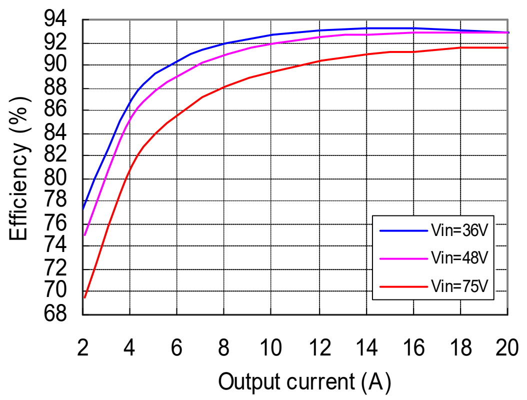


Figure 9: AVO100-48S05 Efficiency Curves @ 25 ^{O}C

Loading: Io = 10% increment to 20A

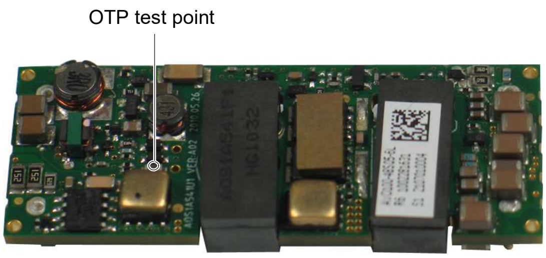


Figure 10: AVO100-48S05 OTP Test Point

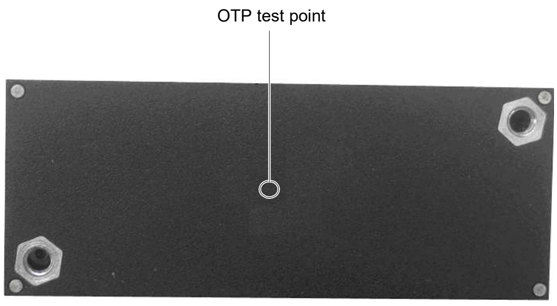


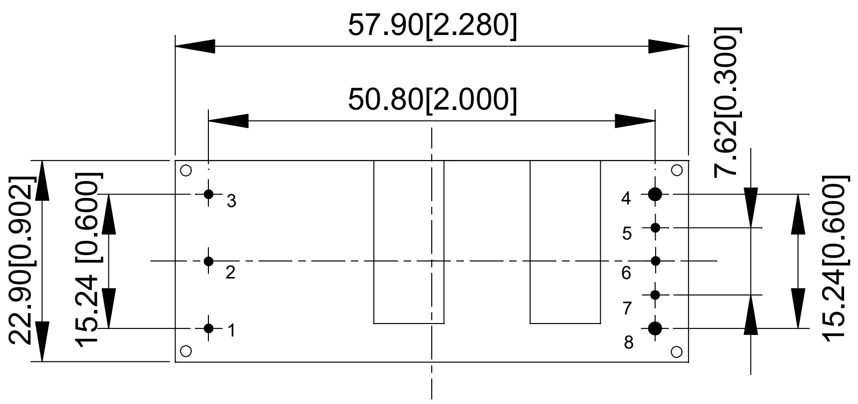
Figure 11: AVO100-48S05B OTP Test Point

MECHANICAL SPECIFICATIONS

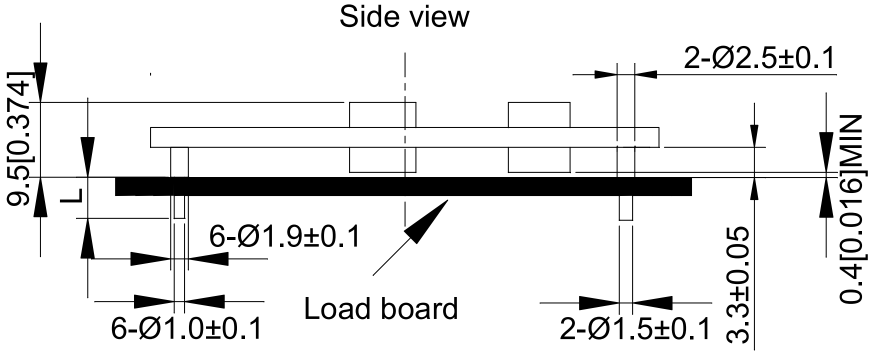
Mechanical Outlines - Open-Frame Module (mm)

AVO100-48S05

Bottom view



Side view



Unit: mm [inch]

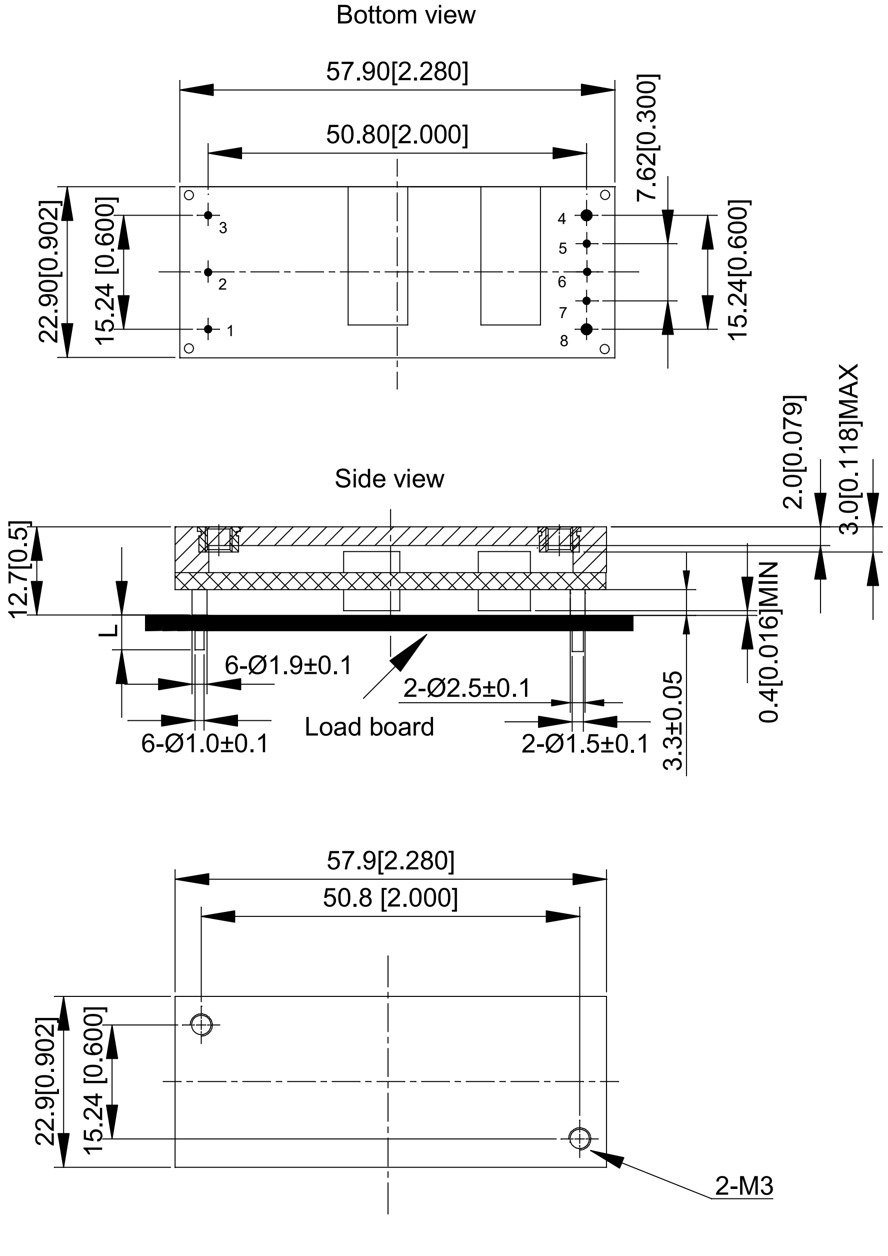
Bottom view: pin on upside

Tolerance: X.Xmm ± 0.5mm [X.X in. ± 0.02in.]
X.XXmm ± 0.25mm [X.XX in. ± 0.01in.]

MECHANICAL SPECIFICATIONS

Mechanical Outlines - Baseplate Module (mm)

AVO100-48S05B



Unit: mm [inch]   Bottom view: pin on upside

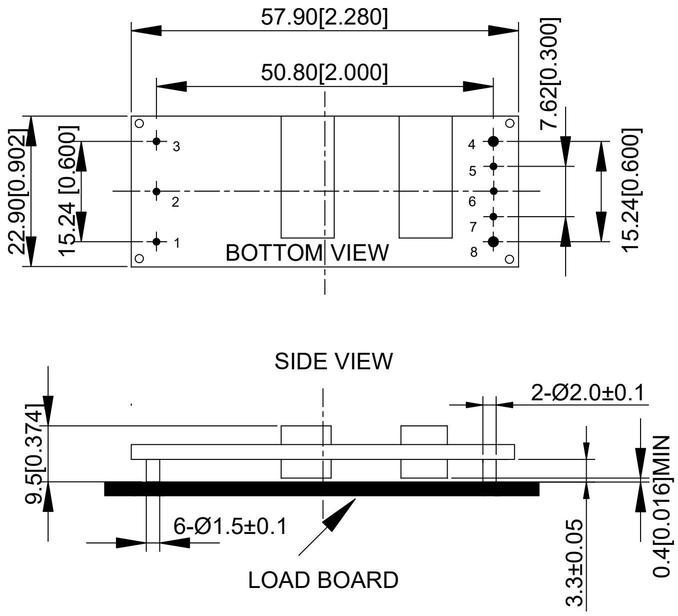
Tolerance: X.Xmm ± 0.5mm [X.X in. ± 0.02in.]
X.XX mm± 0.25mm [X.XX in. ± 0.01in.]

Note: Depth penetration into base plate, of M3 screws used at baseplate mounting holes, not to exceed maximum of 3.0mm.

MECHANICAL SPECIFICATIONS

Mechanical Outlines - SMT Module (mm)

AVO100-48S05SL

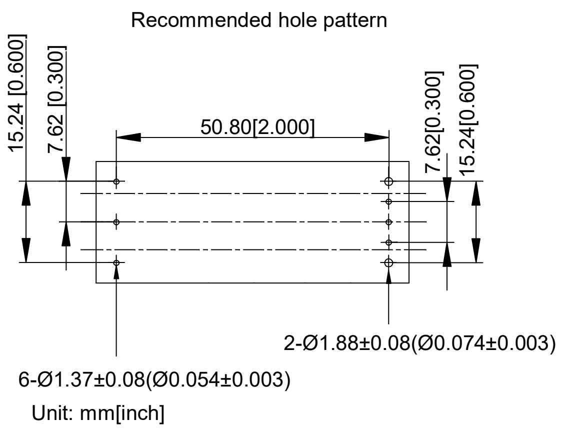


UNIT: mm[inch]   BOTTOM VIEW: pin on upside

TOLERANCE: X.Xmm±0.5mm[X.X in.±0.02in.]
X.XXmm±0.25mm[X.XX in.±0.01in.]

Recommended Hole Pattern

Through hole with diameter 1.37mm (0.054 inch) is recommended for pin1, pin2, pin3, pin5, pin6 and pin7 soldering. Through hole with diameter 1.88mm (0.074 inch) is for pin4 and pin8.



MECHANICAL SPECIFICATIONS

Pin Designations

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

Pin Size

Device code suffix	Pin size
-4	4.8mm±0.25mm
-6	3.8mm±0.25mm
-8	2.8mm±0.25mm
None	5.8mm±0.25mm

ENVIRONMENTAL SPECIFICATIONS

EMC Immunity

AVO250-48S28 series power supply is designed to meet the following EMC immunity specifications.

Table 4. Environmental Specifications		
Document	**Description**	**Criteria**
EN55022, Class A Limits	Conducted and Radiated EMI Limits	/
IEC/EN 61000-4-2, Level 3	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test. Enclosure Port	B
IEC/EN 61000-4-6, Level 2	Electromagnetic Compatibility (EMC) - Testing and measurement techniques, Continuous Conducted Interference. DC input port	B
IEC/EN 61000-4-4, Level3	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 ports	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.

Recommend EMC Filter Configuration

See figure 18

ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The AVO250-48S28 series module 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 AVO100-48S05 series module

Standard	Agency	Description
UL/CSA 60950	UL+CUL	US and Canada Requirements
EN60950	TUV	European Requirements
IEC60950		European Requirements
GB4943		China Requirements
CE	CE	CE Marking
UKCA	UKCA	UK Requirements

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature

The AVO100 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 – Open-Frame module

The converter is designed to operate in different thermal environments and sufficient cooling must be provided. Proper cooling can be verified by measuring the temperature at the test points as shown in the figure 10. The temperature at these test points should not exceed the maximum values in Table 7.

For a typical application, forced airflow direction is from Vin- to Vin+, Figure 12 shows the derating of output current vs. ambient air temperature at different air velocity.

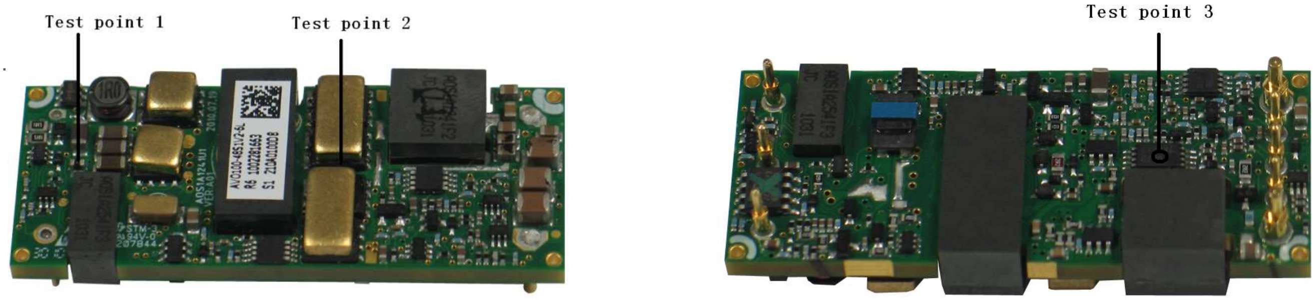


Figure 10: Temperature test point

Table 6. Temperature limit of the test point	
Test Point	**Temperature Limit**
Test point 1	124 °C
Test point 2	130 °C
Test point 3	118 °C

ENVIRONMENTAL SPECIFICATIONS

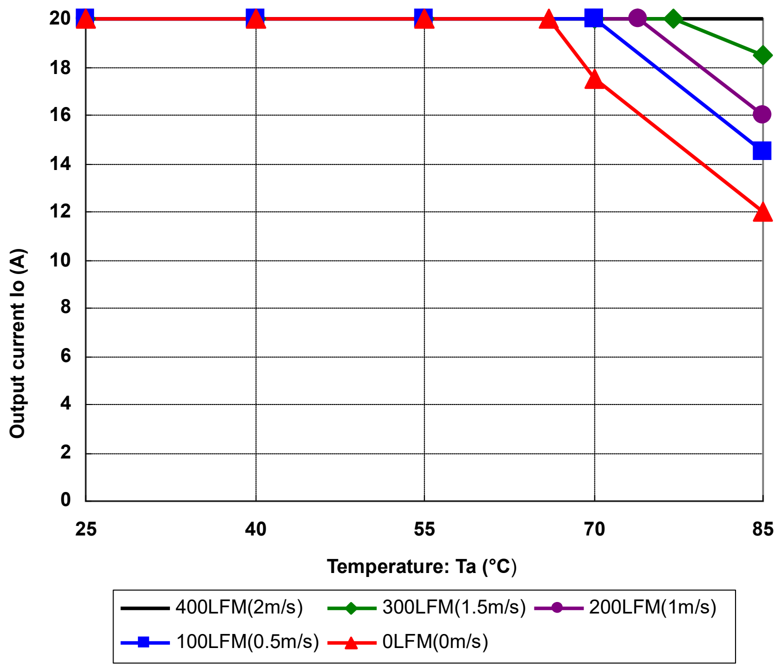


Figure 12: Derating curve

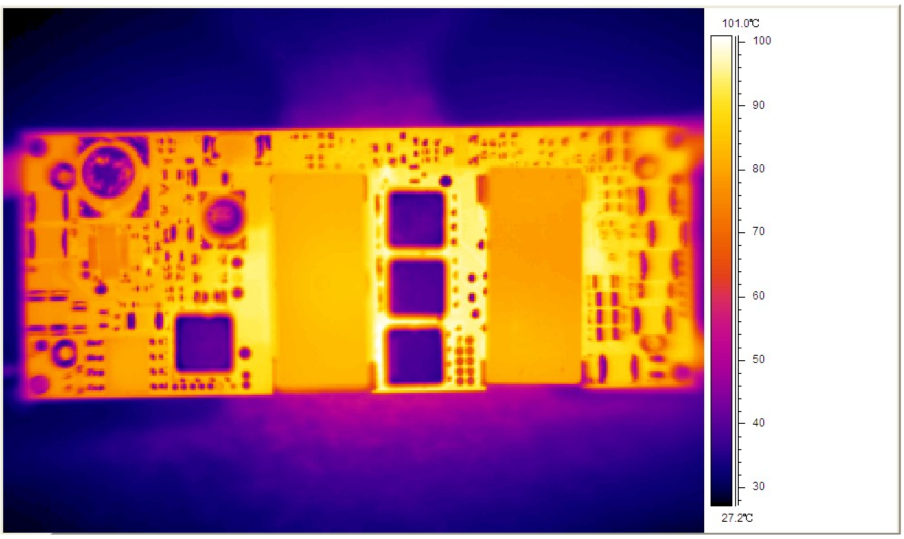


Figure 13: Thermal image, 48V_{in}, 5V_o, full load, room temperature, 100LFM (air flowing from pin 1 to pin 3)

ENVIRONMENTAL SPECIFICATIONS

Thermal Considerations –Baseplate module

The cooling can be verified by measuring the temperature at the test points. The temperature at these points should not exceed the maximum values in Table 8.

For a typical application converter is designed to operate in different thermal environments and sufficient cooling must be provided. Proper, forced airflow direction is from Vin- to Vin+, Figure 15 shows the derating of output current vs. ambient air temperature at different air velocity.

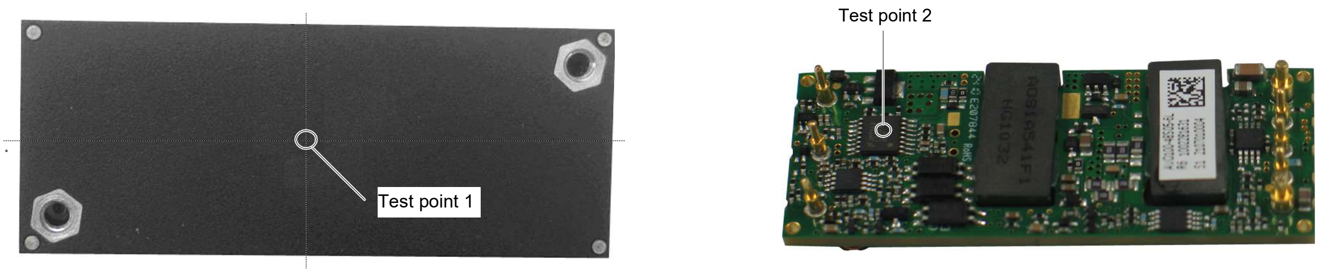


Figure 14: Temperature test point

Table 7. Temperature limit of the test point	
Test Point	**Temperature Limit**
Test point 1	116 °C
Test point 2	118 °C

The converter can also operate with a smaller heatsink and sufficient airflow. The heatsink is shown in Figure 15.

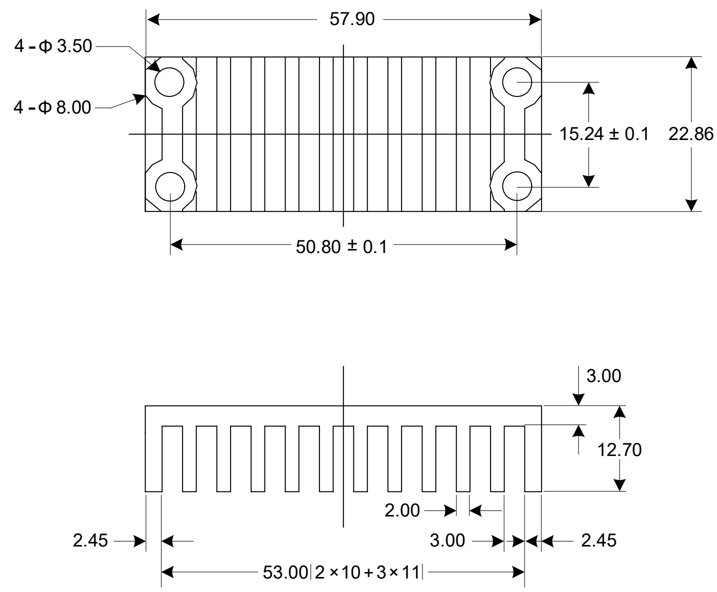


Figure 15: Heatsink (Unit:mm)

ENVIRONMENTAL SPECIFICATIONS

Figure 16 shows the derating output current vs. ambient air temperature at different air velocity with a heatsink, the heatsink specification is shown in Figure15. The typical test condition is shown in Figure 17.

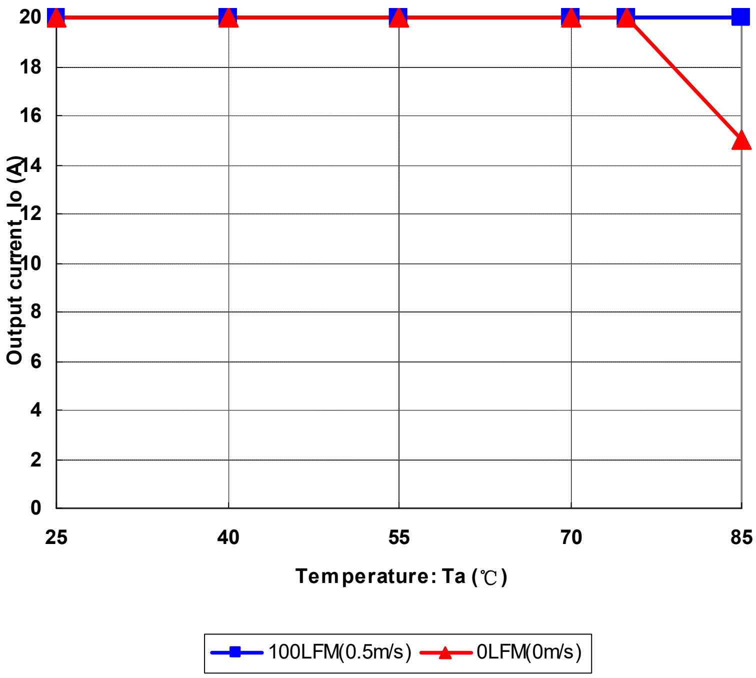


Figure 16: Derating curve

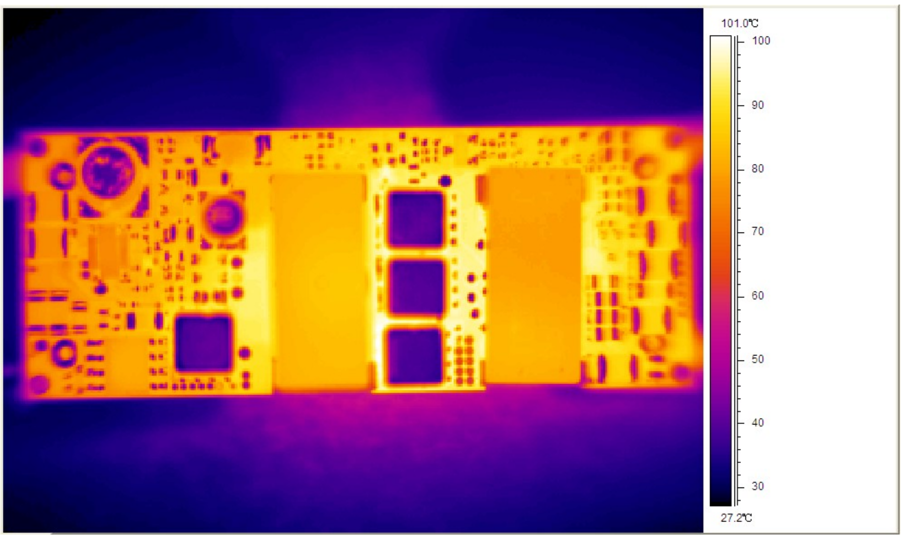


Figure 17: Thermal image, 48V_{in}, 5V_o, full load, room temperature, 100LFM (air flowing from pin 1 to pin 3)

ENVIRONMENTAL SPECIFICATIONS

Qualification Testing

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

APPLICATION NOTES

Typical Application

Below is the typical application of the AVO100-48S05 series power supply.

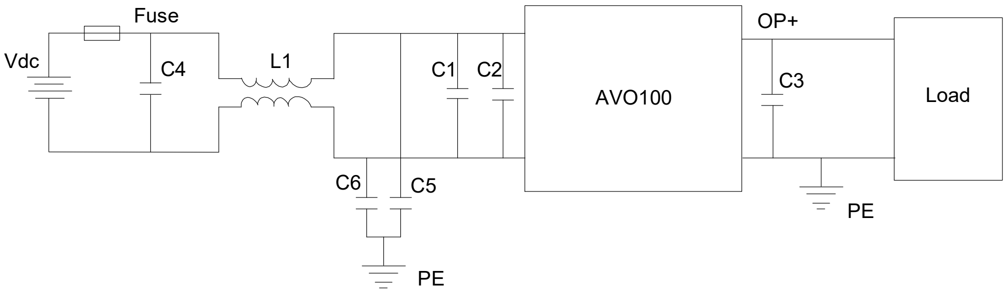


Figure 18: Typical application

Recommended input fuse: LITTLEFUSE 216010.P 10A

C4: SMD ceramic-100V-1000nF-X7R-1210

C1: SMD ceramic-100V-100nF-±10%-X7R-1206

C2: 100µF/100V electrolytic capacitor, high frequency and low ESR

C3: 1000µF/10V electrolytic capacitor, high frequency and low ESR

C5, C6: SMD ceramic-22nF/1000V/X7R-1210

L1: 1320uH-±25%-4A-R5K-21×21×12.5mm

APPLICATION NOTES

Remote ON/OFF

Negative remote ON/OFF logic is available in AVO100-48S05. Below is the detailed external circuit in AVO100-48S05.

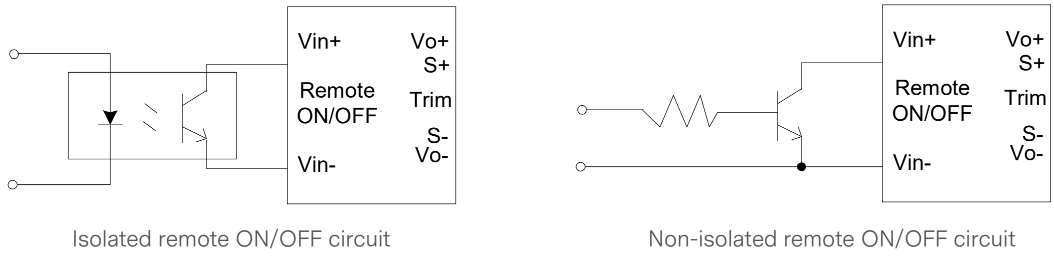


Figure 19: External Remote ON/OFF circuit

APPLICATION NOTES

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.

$$R_{adj-down} = \frac{510}{\Delta} - 10.2(K\Omega)$$

$$R_{adj-up} = \frac{5.1 \times V_{nom} \times (100+\Delta)}{1.225 \times \Delta} - \frac{510}{\Delta} - 10.2(K\Omega)$$

△:Output e rate against nominal output voltage.

$$\Delta = \frac{100 \times (V_{nom} - V_0)}{V_{nom}}$$

V_{nom}: Nominal output voltage.

For example, to get 5.5V output, the trimming resistor is

$$R_{adj-up} = \frac{5.1 \times 5 \times (100+10)}{1.225 \times 10} - \frac{510}{10} - 10.2 = 167.78(K\Omega)$$

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

$$V_O = \frac{(V_{trim} + 1.225) \times V_{norm}}{2.45}$$

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.

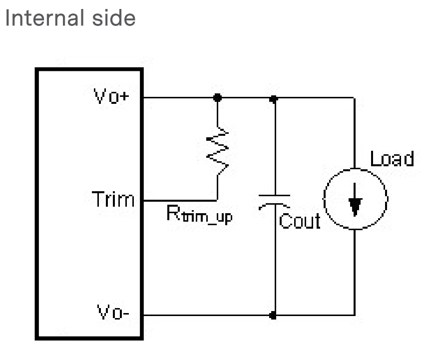


Figure 20: Trim up

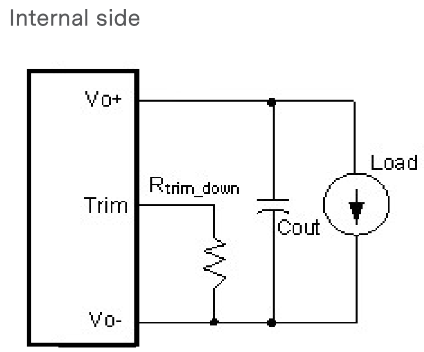


Figure 21: Trim down

APPLICATION NOTES

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

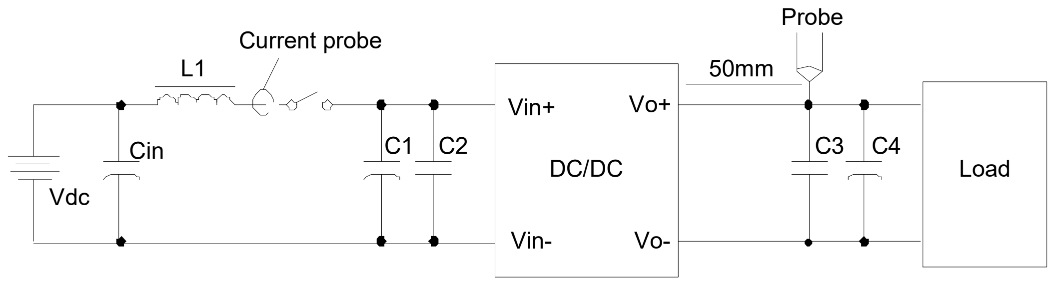


Figure 22: Input ripple & inrush current output ripple & noise test configuration

Vdc: DC power supply

L1: 12uH

Cin: 220uF/100V typical
C1: SMDceramic-100V-100nF-±10%-X7R-1206
C2: 100µF/100V electrolytic capacitor, high frequency and low ESR
C3: SMDceramic-10V-1µF-±10%-X7R-1206
C4: 1000µF/10V electrolytic capacitor, high frequency and low ESR

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

APPLICATION NOTES

Sense Characteristics

If the load is far from the unit, connect S+ and S- to the terminals of the load respectively to compensate the voltage drop on the transmission line.

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

APPLICATION NOTES

Soldering

R6 Wave 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 ^{O}C for maximum 7s.

When soldering by hand, the iron temperature should be maintained at 300 ^{O}C ~ 380 ^{O}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.

APPLICATION NOTES

Design Of Surface Mount Solder

The diameter of pin: 1.5mm (small), 2.0mm (big)

SMD solder pad: 2.0mm (small), 2.5mm (big)

The soldermask: 5 mil bigger than the SMD solder pad

SMD solder pad copper: 3.0mm (small), 3.5mm (big)

The solder paste: 3.0mm (small), 3.5mm (big)

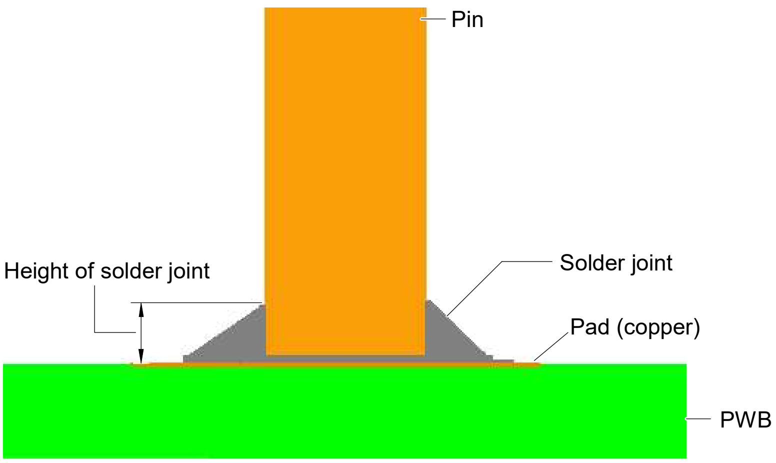


Figure 23: Surface mount solder design

APPLICATION NOTES

Package Information

Package type

moisture sensitivity level 3, moisture barrier bags.

Minimal package QTY

128 pcs.

Package disassembly

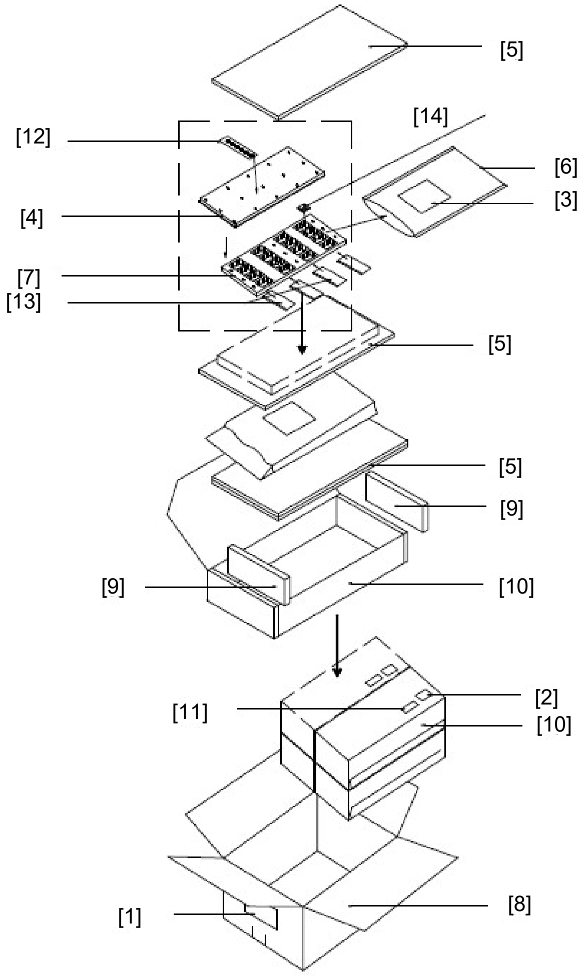


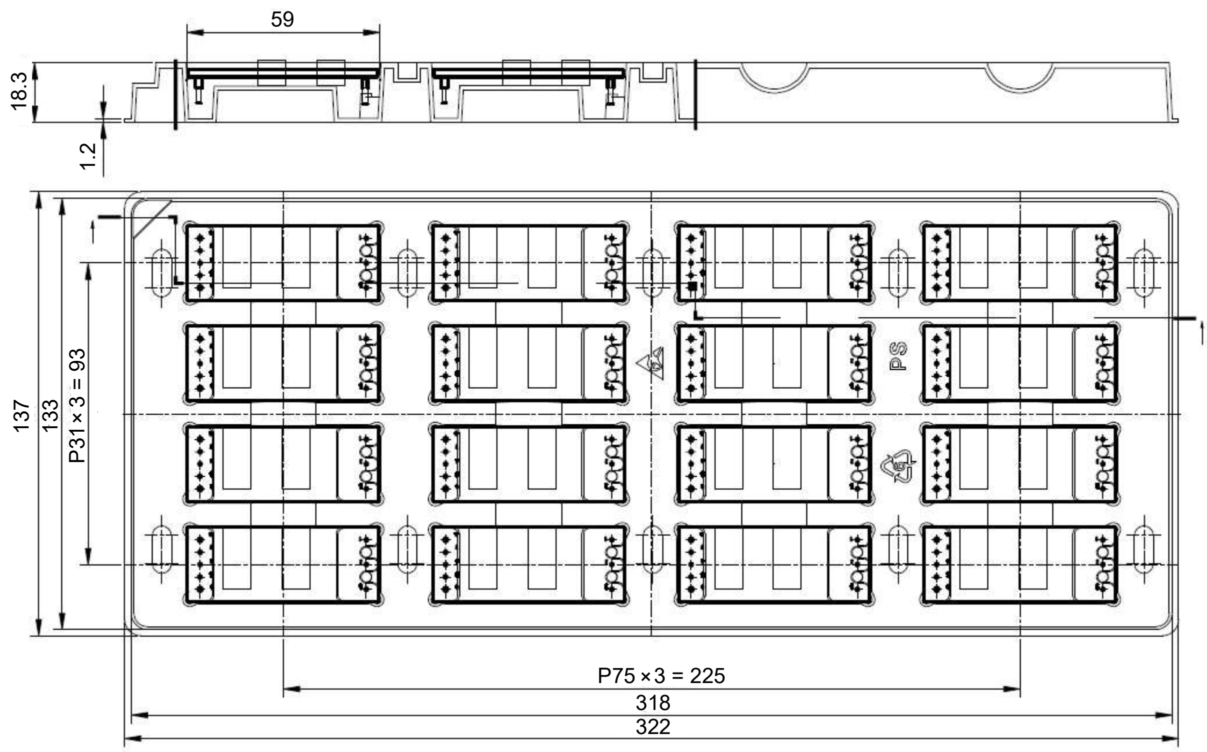
Figure 24: Package disassembly

APPLICATION NOTES

Table 8. Assemblies description

No.	Description
1	Shipping label
2	Moistureproof identification label
3	Moistureproof caution label
4	Tray cover
5	Anti-static PE foam 1
6	Moisture barrier bag
7	Tray
8	Shipping carton
9	Anti-static PE foam 2
10	Inner box
11	Model barcode label
12	Humidity indicating card
13	Desiccant
14	Model

Package tray information



RECORD OF REVISION AND CHANGES

Issue	Date	Description	Originators
1.0	07.10.2014	First issue	K. Wang
1.1	10.17.2014	Update format on page 5	K. Wang
1.2	12.16.2019	Update the soldering spec	J. Ma
1.3	03.17.2022	Update UKCA mark	E. Wang

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. AE designs and manufactures highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

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