TECHNICAL REFERENCE NOTE

ARTESYN AVD85-48S12 Series

84 Watts Sixteenth-brick Converter

PRODUCT DESCRIPTION

Advanced Energy's Artesyn AVD85-48S12 is a single output DC/DC converter with standard sixteenth-brick form factor and pin configuration. It delivers up to 7A output current with 12V output. Ultra-high 92% efficiency and excellent thermal performance makes it an ideal choice for use in computing and telecommunication applications and can operate over an ambient temperature range of -40 ^{O}C to +85 ^{O}C.

AT A GLANCE

Total Power

84 Watts

Input Voltage

36 to 75 Vdc

# of Outputs

Single

RoHS

SPECIAL FEATURES

- Delivering up to 7A output current
- Ultra high efficiency 92% typ. at full load
- 2:1 wide input voltage: 36V to 75V
- Excellent thermal performance
- No minimum load requirement
- Basic isolation
- High power density
- Low output noise
- RoHS 3.0
- Remote control function (negative logic)
- Remote output sense
- Trim function: 80% to 110%
- Input under voltage lockout
- Output over current protection
- Output short circuit protection
- Output over voltage protection
- Over-temperature protection
- Industry standard sixteenth-brick pin-out outline
- SMT or PTH version available

SAFETY

UL	UL/CSA 60950-1
TUV	EN 62368-1
CE	EN 62368-1

TYPICAL APPLICATIONS

- Telecom
- Datacom

MODEL NUMBERS

Standard	Output Voltage	Structure	Remote ON/OFF logic	ROHS
AVD85-48S12-6L	12Vdc	Open-frame	Negative	RoHS 3.0
AVD85-48S12B-6L	12Vdc	Baseplate	Negative	RoHS 3.0
AVD85-48S12TL	12Vdc	SMT, Open-frame	Negative	RoHS 3.0

Order Information

AVD85	-	48	S	12	P	B	-	6	L
①		②	③	④	⑤	⑥		⑦	⑧

①	Model series	AVD: high efficiency sixteenth brick series
②	Input voltage	48: 36V to 75V input range, rated input voltage 48V
③	Output number	S: single output
④	Rated output voltage	12: 12V output
⑤	Remote ON/OFF logic	Default: negative logic; P: positive logic
⑥	Baseplate	B: with baseplate; default: open frame
⑦	Pin length	6: 3.8mm±0.25mm S: SMT pin T: SMT pin and tape reel package 4: 4.8mm±0.25mm
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	All	$V_{IN,DC}$	-	-	80	Vdc
Non-operating -100mS	All		-	-	100	Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	84	W
Isolation Voltage[1]						
Input to output	Open frame module		1500	-	-	Vdc
Input to baseplate	Baseplate module		1500	-	-	Vdc
Outputs to baseplate	Baseplate module		1500	-	-	Vdc
Ambient Operating Temperature	All	T_A	-40	-	+85	^{O}C
Storage Temperature	All	T_{STG}	-55	-	+125	^{O}C
Voltage at remote ON/OFF pin	All		-0.3	-	5	Vdc
Humidity (non-condensing)						
Operating	All		-	-	95	%
Non-operating	All		-	-	95	%

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

ELECTRICAL SPECIFICATIONS

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	$I_O = I_{O,max}$	$V_{IN,ON}$	31	-	36	Vdc
Turn-off Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,OFF}$	30	-	35	Vdc
Lockout Voltage Hysteresis	$I_O = I_{O,max}$		1	-	3	V
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC}$ = 36Vdc	$I_{IN,max}$	-	-	3	A
No-load input current			-	0.06	-	A
Standby input current	Remote OFF		-	0.01	-	A
Recommended Input Fuse	Fast blow external fuse recommended		-	-	5	A
Input filter component values (C\L)			-	0\1.2	-	uF\uH
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	-	100	-	uF
Input Reflected Ripple Current	Through 12uF inductor		-	-	60	mA
Operating Efficiency	T_A = 25 °C $I_O = I_{O,max}$ $I_O = 50\%I_{O,max}$	η	- -	92 92	- -	% %

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		Conditions[1]	Symbol	Min	Typ	Max	Unit
Factory Set Voltage		$V_{IN,DC}$ = 48Vdc I_O = 50%$I_{O,max}$	V_O	11.8	12	12.2	Vdc
Total Regulation		Over sample, line, load, temperature & life	V_O	11.6	-	12.4	Vdc
Output Voltage Line Regulation		All	%V_O	-	-	0.2	%
Output Voltage Load Regulation		All	%V_O	-	-	0.5	%
Output Voltage Temperature Regulation		All	%V_O	-	-	0.02	%/^{O}C
Output Voltage Trim Range		All	V_O	9.6	-	13.2	V
Output Ripple, pk-pk		20MHz bandwidth	V_O	-	100	-	mV_{PK-PK}
Output Current		All	I_O	0	-	7	A
Output DC Current-limit Inception[2]		All	I_O	11	-	15.5	A
V_O Load Capacitance[3]		All	C_O	100	470	4700	uF
V_O Dynamic Response	Peak Deviation Settling Time[4]	50% ~ 75% ~ 50% load change slew rate = 0.1A/µs	±V_O T_s	- -	150 100	- -	mV uSec
		50% ~ 75% ~ 50% load change slew rate = 1A/µs	±V_O T_s	- -	200 100	- -	mV uSec
Turn-on Transient	Rise time	I_O = $I_{O,max}$	T_{rise}	-	-	50	mS
	Turn-on delay time	I_O = $I_{O,max}$	$T_{turn-on}$	-	-	100	mS
	Output voltage overshoot	I_O = 0	%V_O	-	-	5	%
Switching Frequency		All	f_{SW}	230	240	250	KHz
Remote ON/OFF Control (Positive logic)	Off-state voltage	All		-0.3	-	1.2	V
	On-state voltage	All		3.5	-	5	V
Remote ON/OFF Control (Negative logic)	Off-state voltage	All		3.5	-	5	V
	On-state voltage	All		-0.3	-	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 are recommended.
Note 4 - Recovery to within 1% Vo, nom

ELECTRICAL SPECIFICATIONS

Output Specifications

Table 3. Output Specifications Con't

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Output over-voltage protection[5]	All	$\%V_O$	112.5	-	158.3	%
Output over-temperature protection[6]	All	T	110	125	135	^{O}C
Over-temperature hysteresis	All	T	5	-	-	^{O}C
+ Sense	All	%Vo	-	-	5	%
- Sense	All	%Vo	-	-	5	%
MTBF	Telcordia SR-332-2006; 80% load, 300LFM, 40 ^{O}C T_A		-	2.0	-	10^6 h

Note 5 - Hiccup: auto-restart when over-voltage condition is removed.
Note 6 - Auto recovery.

ELECTRICAL SPECIFICATIONS

AVD85-48S12 Performance Curves

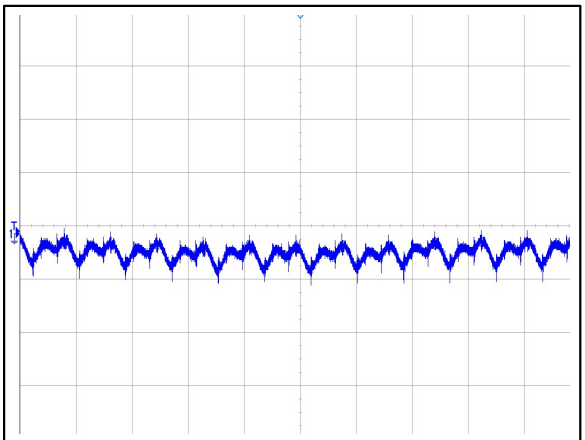


Figure 1: AVD85-48S12 Input Reflected Ripple Current Waveform
(5us/div)
Ch 1:Iin (5mA/div)

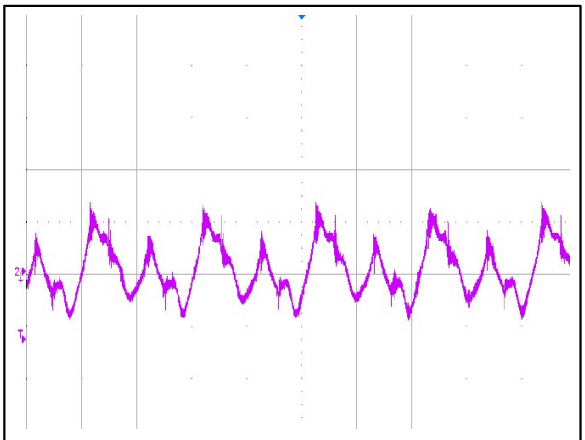


Figure 2: AVD85-48S12 Output Ripple and Noise
(2us/div)
Ch 2: Vo (20mV/div)

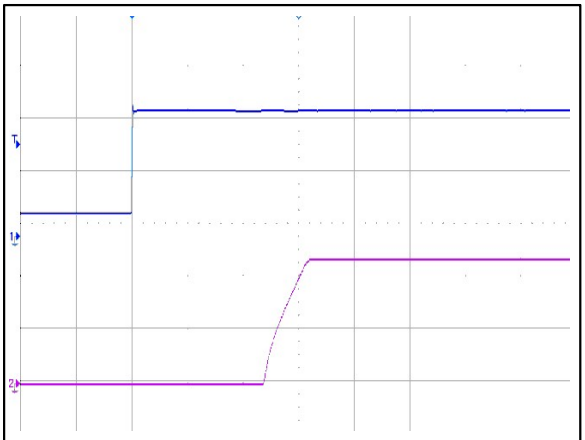


Figure 3: AVD85-48S12 Output Voltage Startup by Power On
(10ms/div)
Ch 1: Vin (20V/div) Ch 2: Vo (5V/div)

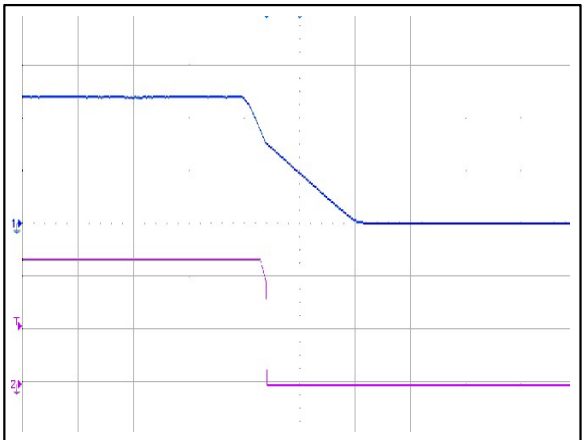


Figure 4: AVD85-48S12 Output Voltage Shut Down by Power Off
(50ms/div)
Ch 1: Vin (20V/div) Ch 2: Vo (5V/div)

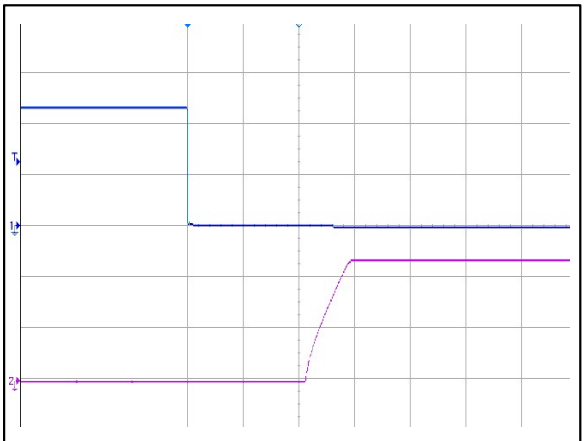


Figure 5: AVD85-48S12 Output Voltage Startup by Remote On
(10ms/div)
Ch 1: Remote ON (2V/div) Ch 2: Vo (5V/div)

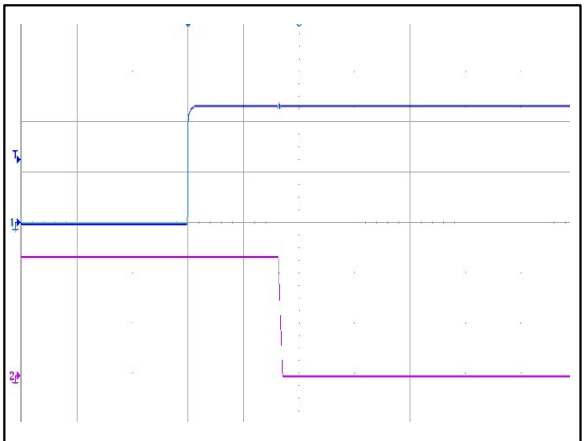


Figure 6: AVD85-48S12 Output Voltage Startup by Remote Off
(10ms/div)
Ch 1: Remote ON (2V/div) Ch 2: Vo (5V/div)

ELECTRICAL SPECIFICATIONS

AVD85-48S12 Performance Curves

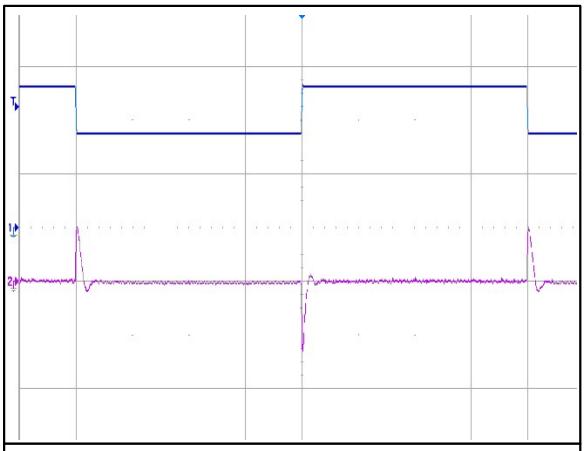


Figure 7: AVD85-48S12 Transient Response (1ms/div)
50%~75%~50% load change, 0.1A/µs slew rate
Ch 1: Io (2A/div) Ch 2: Vo (50mV/div)

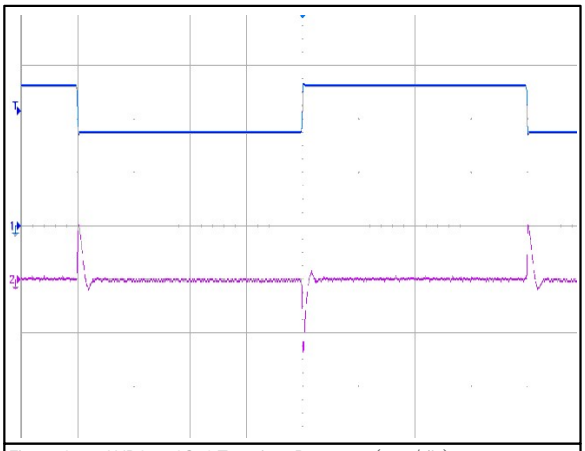


Figure 8: AVD85-48S12 Transient Response (1ms/div)
50%~75%~50% load change, 1A/µs slew rate
Ch 1: Io (2A/div) Ch 2: Vo (50mV/div)

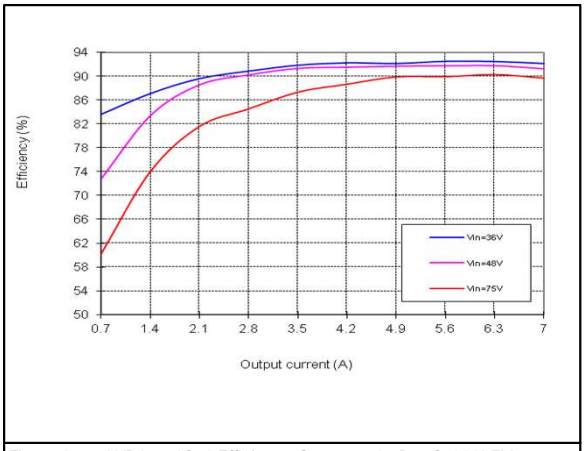


Figure 9: AVD85-48S12 Efficiency Curves @ 25 DegC, 200LFM
Io = 10% increment to 7A
Vo = 12V

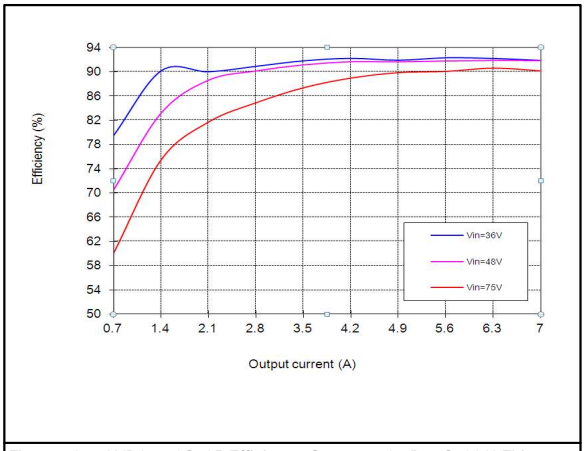
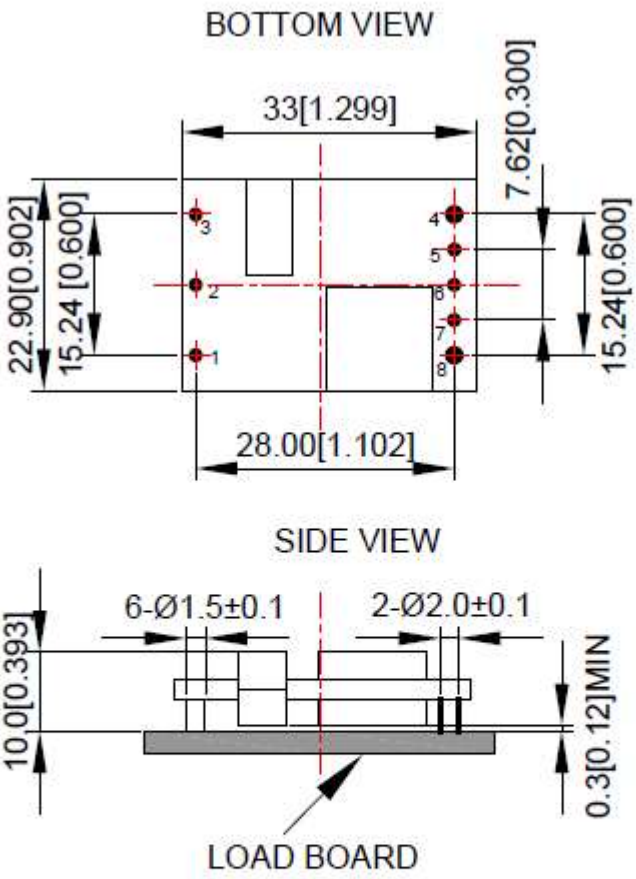


Figure 10: AVD85-48S12B Efficiency Curves @ 25 DegC, 200LFM
Io = 10% increment to 7A
Vo = 12V

MECHANICAL SPECIFICATIONS

Mechanical Outlines – Open-Frame Module with SMT Pin

AVD85-48S12TL



UNIT: mm[inch]

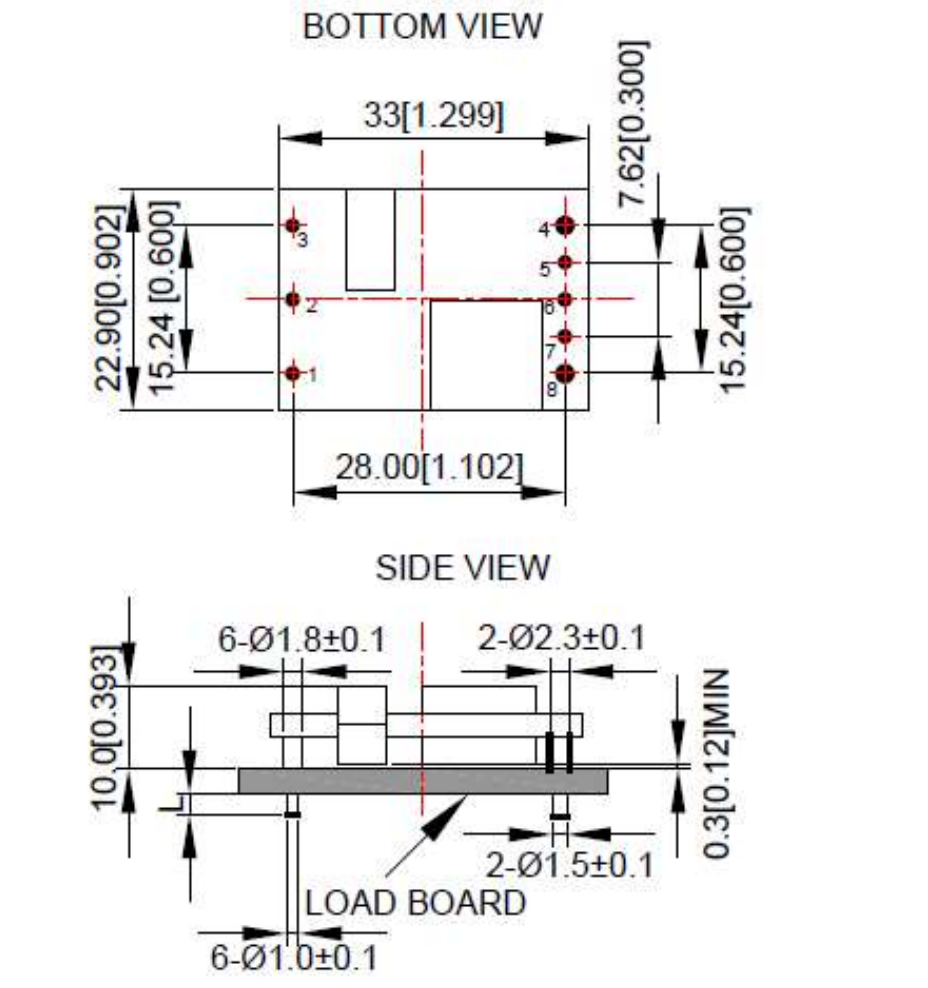
BOTTOM VIEW: pin on upside

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

MECHANICAL SPECIFICATIONS

Mechanical Outlines – Open Frame Module

AVD85-48S12-6L



UNIT: mm[inch]

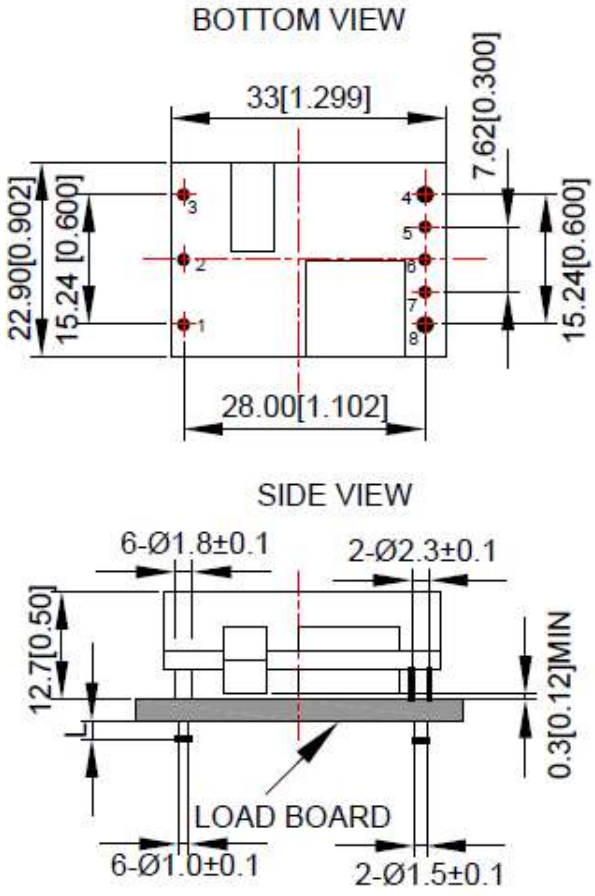
BOTTOM VIEW: pin on upside

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

MECHANICAL SPECIFICATIONS

Mechanical Outlines – Base plate Module

AVD85-48S12B-6L



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

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

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

MECHANICAL SPECIFICATIONS

Pin Length Option

Device code suffix	L
-4	4.8mm±0.2mm
-6	3.8mm±0.2mm
-8	2.8mm±0.2mm
None	5.8mm±0.2mm

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	Sense-	Negative remote sense
6	Trim	Output voltage trim
7	Sense+	Positive remote sense
8	Vo+	Positive output voltage

ENVIRONMENTAL SPECIFICATIONS

EMC Immunity

AVD85-48S12 power supply is designed to meet the following EMC immunity specifications:

Table 4. Environmental Specifications		
Document	Description	Criteria
EN55032, 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	A
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	B
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: 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.

EMC test conditions

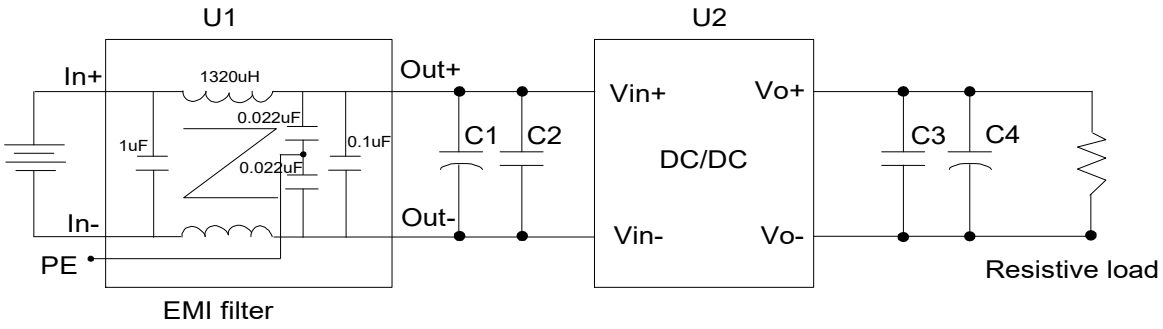


Figure 11 EMC test configuration

U1: Input EMC filter

U2: Module to test, AVD85-48S12

C1 ~ C4: See Figure 16

ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The AVD85-48S12 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 AVD85-48S12 power supply system

Standard	Agency	Description
UL 60950-1, 2nd Edition, 2014-10-14; CAN/CSA C22.2 No. 60950-1-07, 2nd Edition, 2014-10	UL+CUL	US and Canada Requirements
EN 62368-1:2014/A11:2017	TUV-SUD	European Requirements
EN 62368-1:2014/A11:2017	CE	CE Marking

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature

The AVD120 series power supplies will start and operate within stated specifications at an ambient temperature from -40 ^{O}C to 85 ^{O}C under all load conditions. The storage temperature is -55 ^{O}C to 125 ^{O}C

Thermal Considerations – Open-Frame Module

The converter is designed to operate in different thermal environments and sufficient cooling must be provided. Proper cooling of the DC/DC converter can be verified by measuring the temperature at the test point as shown in the Figure 12. The temperature at this point should not exceed the max values in the table 6.

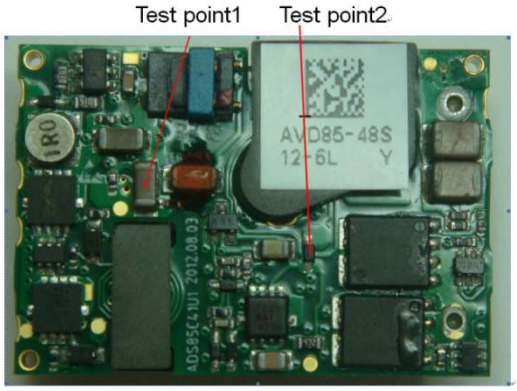


Figure 12 Temperature Test Point on FR-4 Board

Table 6. Temperature limit of the test point	
Test Point	Temperature limit
Test Point1	118 ^{O}C
Test Point2	130 ^{O}C

For a typical application, Figure 13 shows the derating of output current vs. ambient air temperature at different air velocity.

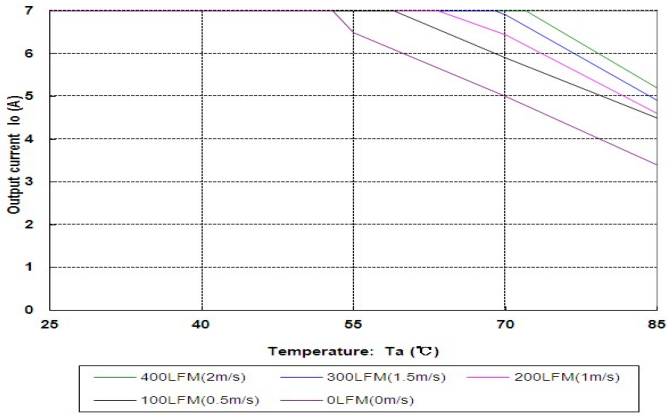


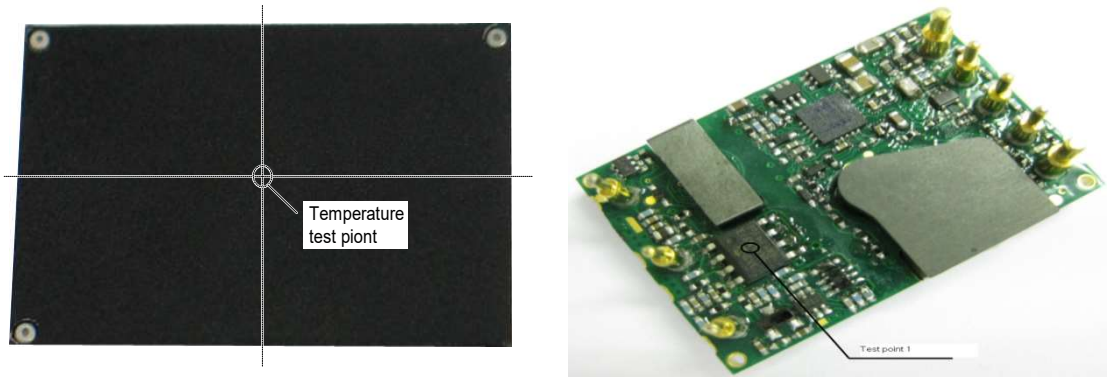
Figure 13 Output power derating, 48Vin, air flowing across the converter from pin 3 to pin 1

ENVIRONMENTAL SPECIFICATIONS

Thermal Considerations – Base Plate Module

The converter is designed to operate in different thermal environments and sufficient cooling must be provided.

Proper cooling of the DC/DC converter can be verified by measuring the temperatures at the test points shown in the Figure 14. The temperatures at these points should not exceed the maximal values in Table 7.



Temperature test point on base plate

Temperature test point on FR-4 board

Figure 14 Temperature Test Point

Table 7. Temperature limit of the test point

Test Point	Temperature limit
Test Point	114 °C
Test Point1	113 °C

The converter can operate with a smaller heatsink and sufficient airflow. Figure 15 shows the derating output current vs. ambient air temperature at different air velocity with a specified heatsink.

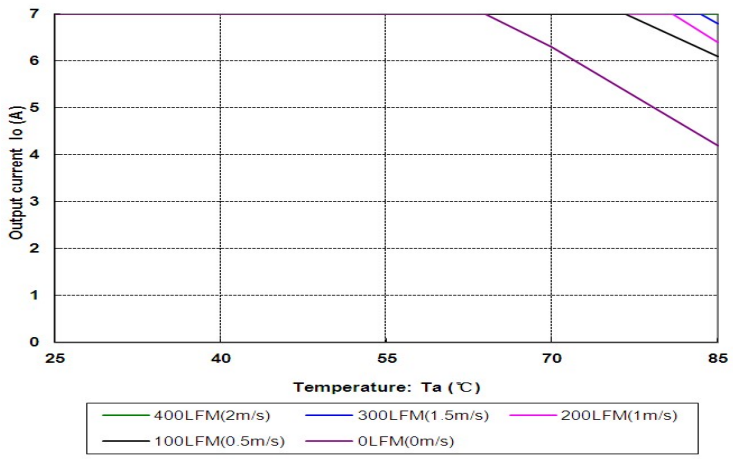


Figure 15 Output power derating, 48Vin (air flowing across the converter from pin 1 to pin 4)

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/axes
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 AVD85-48S12 series power supply.

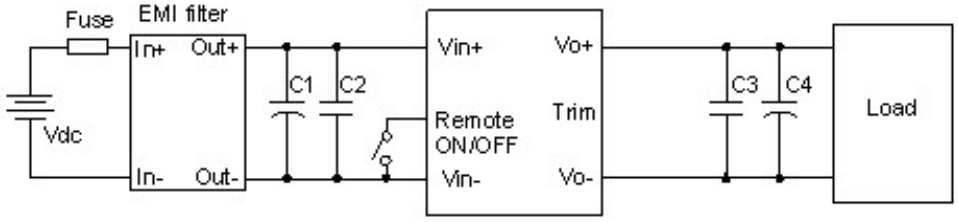


Figure 16 Typical application

C1: 100uF/100V electrolytic capacitor; P/N: UPW2A101MHD (Nichicon) or equivalent caps

C2: 2.2uF/100V X7R ceramic capacitor, P/N:GRM32ER72A225KA35L(MURATA)or equivalent caps

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

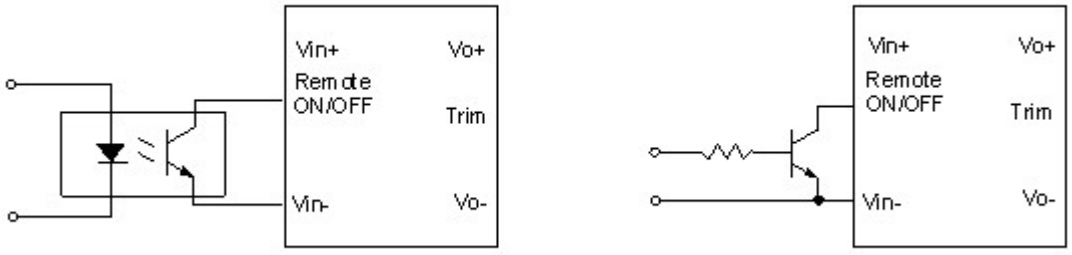
C4:470uF electrolytic capacitor, P/N: UPM1E471MHD (Nichicon) or equivalent caps

Fuse: External fast blow fuse with a rating of 5A. The recommended fuse model is 0451005.MRSN from LITTLEFUSE.

APPLICATION NOTES

Remote ON/OFF

Negative remote ON/OFF logic is available in AVD85-48S12. The logic is CMOS and TTL compatible. The voltage between pin Remote ON/OFF and pin Vin- must not exceed the range listed in Table 3 to ensure proper operation. The external remote ON/OFF circuit is highly recommended as shown in Figure 17.



Isolated remote ON/OFF circuit

Non-isolated remote ON/OFF circuit

Figure 17 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 rate against nominal output voltage.

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

V_{nom}: Nominal output voltage.

For example, to get 13.2V output, the trimming resistor is

$$\Delta = \frac{100 \times (V_{nom} - V_0)}{V_{nom}} = \frac{100 \times (13.2 - 12)}{12} = 10$$

$$R_{adj-up} = \frac{5.1 \times 12 \times (100 + 10)}{1.225 \times 10} - \frac{510}{10} - 10.2 = 488.35(K\Omega)$$

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 below figure.

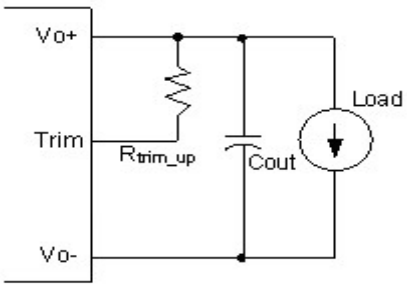


Figure 18 Trim up

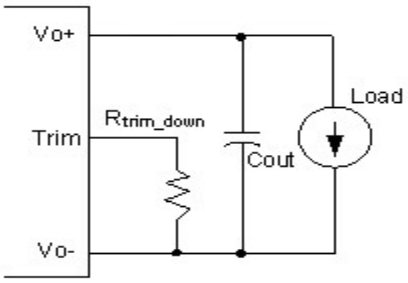


Figure 19 Trim down

APPLICATION NOTES

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

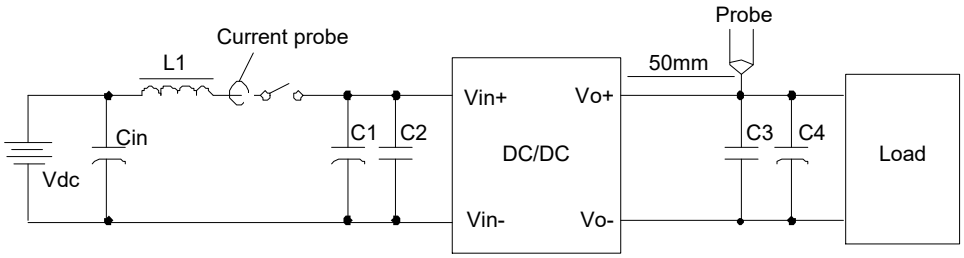


Figure 20 Input ripple & output ripple & noise test configuration

Vdc: DC power supply

L1: 12uH

Cin: 220uF/100V typical

C1 ~ C4: See Figure 16

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

APPLICATION NOTES

Over-Temperature Protection Test Points

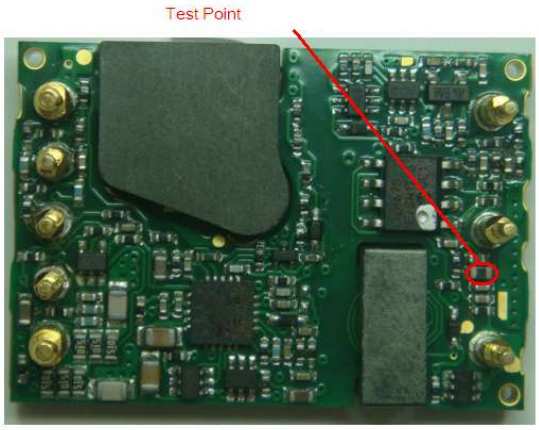


Figure 21 Open-frame OTP Test Point

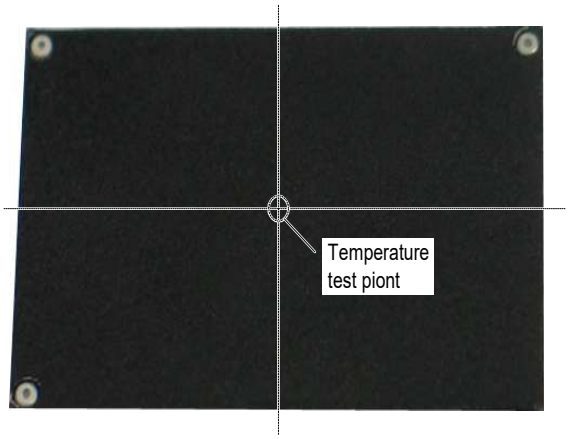


Figure 22 Base Plate OTP Test Point

APPLICATION NOTES

Package Information

Package type

Moisture sensitivity level 3, Moisture Barrier Bags

Minimal Package QTY

192 PCS

Package disassembly

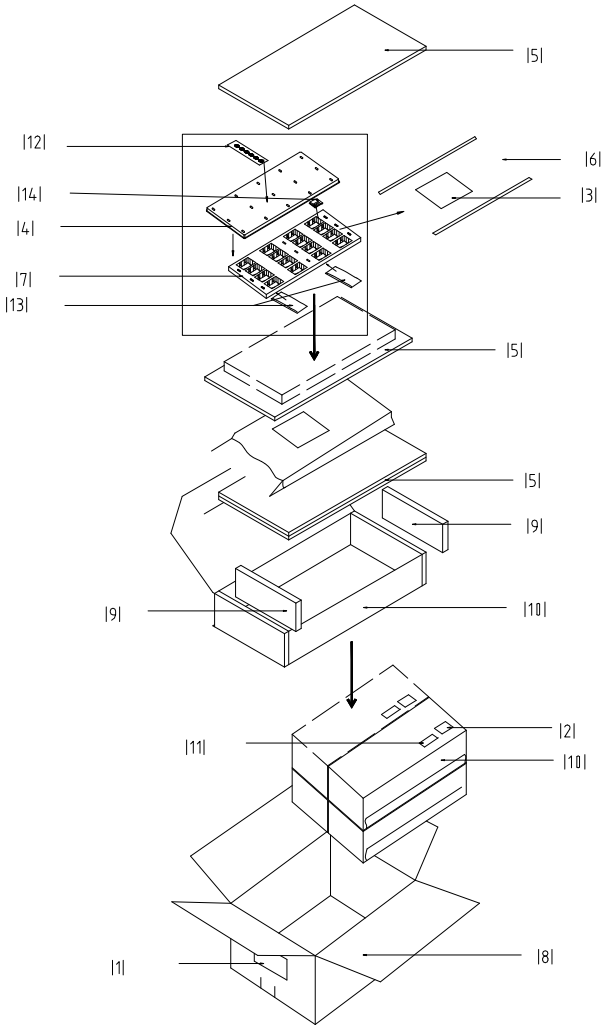


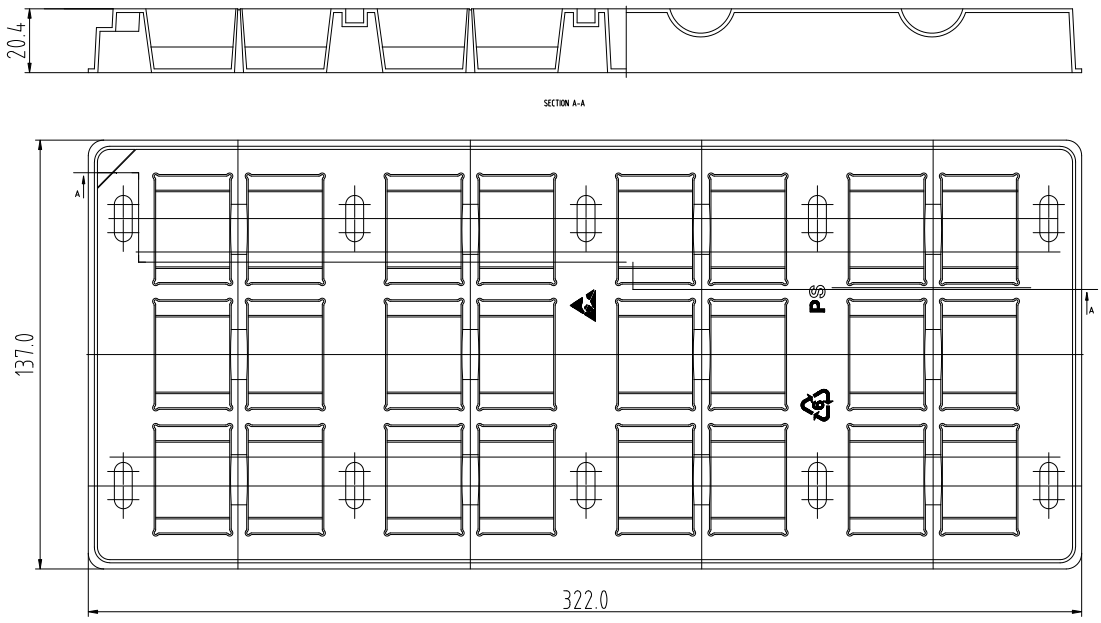
Figure 23 Package Disassembly

APPLICATION NOTES

Package Information

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



SOLDERING INFORMATION

Soldering

The product is intended for standard manual or wave soldering.

	Product Requirement	Product Name
R6	Wave soldering	AVD85-48S12B-6L AVD85-48S12-6L

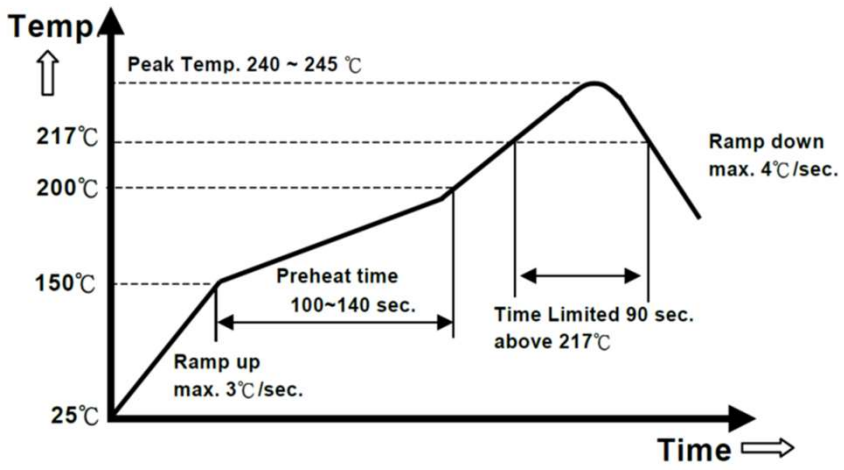
When wave soldering is used, the temperature on pins is specified to maximum 260 ^{O}C for maximum 7s.

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.

The below products are intended for standard reflow soldering.

	Product Requirement	Product Name
R6	Reflow soldering	AVD85-48S12-6L AVD85-48S12-6LT

When reflow soldering is used, Please refer to following fig for recommended temperature profile parameters.



Record of Revision and Changes

Issue	Date	Description	Originators
1.0	08.01.2014	First Issue	S. Yang
1.1	10.21.2014	Add the “condition”	S. Yang
1.2	10.25.2016	Update the mechanical drawing	K. Wang
1.3	03.15.2017	Add the EMC part which can be change to Class B	K. Wang
1.4	05.16.2018	Add the “4L” definition in page	K. Wang
1.5	07.13.2018	Add the test point in table 6	K. Wang
1.6	05.27.2019	Remove detail information for EMC Part	K. Wang
1.7	12.06.2019	Update soldering	K. Ma
1.8	02.27.2020	Update RoHS information	V. Guo
1.9	06.02.2021	Update AE template	J. Zhang

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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AVD85-48S12 - Rev.06.02.21_#1.9