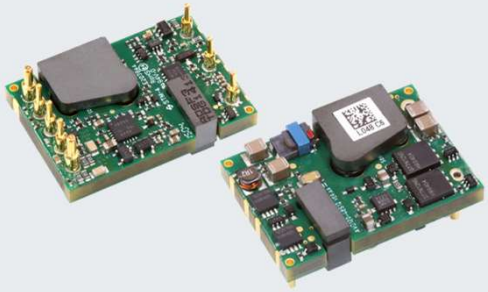
TECHNICAL REFERENCE NOTE

ARTESYN AVD120-48S12 Series

120 Watts Sixteenth-brick Converter



PRODUCT DESCRIPTION

Advanced Energy's Artesyn AVD120-48S12 is a single output DC/DC converter with standard sixteenth-brick outline and pin configuration. It delivers up to 10A output current with 12V output voltage. Above 93% ultra-high efficiency and excellent thermal performance makes it an ideal choice to supply power in telecom and datacom.

AT A GLANCE

Total Power

120 Watts

Input Voltage

36 to 75 Vdc

# of Outputs

Single

RoHS

SPECIAL FEATURES

- Delivering up to 10A output
- Ultra-high efficiency 93% typ. at full load
- Wide input range: 36V ~ 75V
- Excellent thermal performance
- No minimum load requirement
- Basic isolation
- High power density
- Low output noise
- RoHS 3.0

SAFETY

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

TYPICAL APPLICATIONS

- Telecom
- Datacom

MODEL NUMBERS

Standard	Output Voltage	Structure	Pin	Package	ROHS
AVD120-48S12TL	12Vdc	Open-frame	Bullet pin SMT	Tape reel	RoHS 3.0
AVD120-48S12-6L	12Vdc	Open-frame	Through hole	Tray	RoHS 3.0
AVD120-48S12B-6L	12Vdc	Baseplate	Through hole	Tray	RoHS 3.0

Order Information

AVD120	-	48	S	12		B	-	6	L
①		②	③	④	⑤	⑥		⑦	⑧

①	Model series	AVD: high efficiency sixteenth brick series, 120: output power 120W
②	Input voltage	48: 36V ~ 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	T: SMT, 6: 3.8mm Through Hole
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	$P_{O,max}$	-	-	120	W
Isolation Voltage[1]						
Input to output	All		-	-	1500	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		-0.3	-	5	Vdc
Humidity (non-condensing)						
Operating	All		-	-	95	%
Non-operating	All		-	-	95	%

Note 1 - 1mA for 60s, slew rate of 1500V/10s. Basic insulation, pollution degree 2

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		$V_{IN,ON}$	31		36	Vdc
Turn-off Voltage Threshold		$V_{IN,OFF}$	30		35	Vdc
Lockout Voltage Hysteresis			1		3	V
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC}$ = 36Vdc	$I_{IN,max}$	-	-	4.5	A
Recommended Input Fuse	Fast blow external fuse recommended		-	-	8	A
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	100	-	-	uF
Input Reflected Ripple Current	Through 12uH inductor			60	-	mA
Operating Efficiency	T_A = 25 °C $I_O = I_{O,max}$ I_O = 50% $I_{O,max}$	η	- -	93 92.5	- -	% %

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 $I_O = I_{O,max}$	V_O	11.8	11.95	12.2	Vdc
Total Regulation		Over sample, line, load, temperature & life	V_O	11.8	11.95	12.2	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	%/°C
Output Voltage Trim Range		All	V_O	9.6	-	13.2	V
Output Ripple, pk-pk		Measure with a 1uF ceramic capacitor in parallel with a 10uF tantalum capacitor, 0 to 20MHz bandwidth	V_O	-	50	-	mV_{PK-PK}
Output Current		All	I_O	0	-	10	A
Output DC Current-limit Inception[2]		All		11	-	20	A
V_O Load Capacitance[3]		All	C_O	220	470	4700	uF
V_O Dynamic Response	Peak Deviation Settling Time	25%~50%~25% & 50%~75%~50% slew rate = 0.1A/us	$\pm V_O$ T_s	- -	- -	60 200	mV uSec
		25%~50%~25% & 50%~75%~50% slew rate = 1A/us	$\pm V_O$ T_s	- -	- -	80 200	mV uSec
Turn-on Transient	Rise time	$I_O = I_{O,max}$	T_{rise}	-	-	50	mS
	Turn-on delay time		$T_{turn-on}$	-	-	100	mS
	Output voltage overshoot		$\%V_O$	-	-	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 °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	**Conditions**	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Output over-voltage protection (Static)[4]	All	V_O	13.5	-	18	V
Output over-voltage protection (Dynamic)[4]	All	V_O	13.5	-	19	V
Output over-temperature protection[5]	All	T	110	125	135	^{O}C
Over-temperature hysteresis	All	T	-	5	-	^{O}C
MTBF	Telcordia SR-332-2006; 80% load, 300LFM, 40 ^{O}C T_A		-	2.0	-	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

AVD120-48S12 Performance Curves

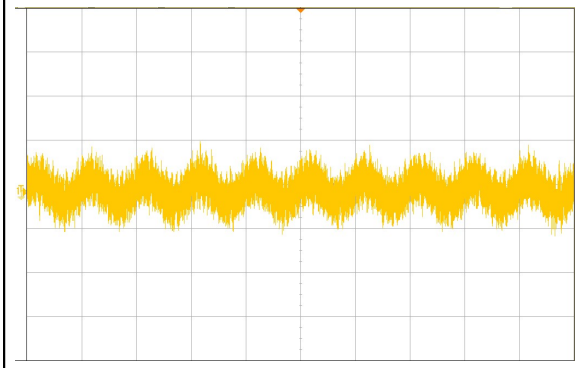


Figure 1: AVD120-48S12 Input Reflected Ripple Current Waveform

Ch 1: Iin (20uS/div, 20mA/div)

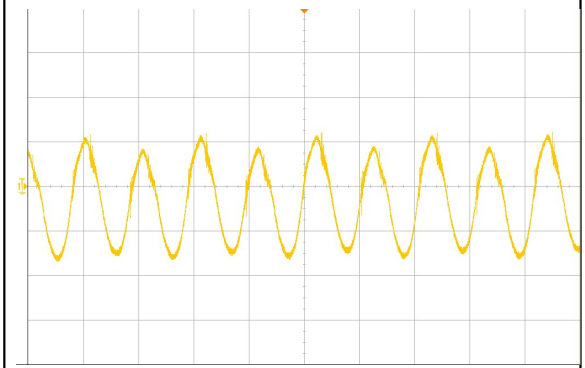


Figure 2: AVD120-48S12 Ripple and Noise Measurement

Ch 1: Vo (2uS/div, 20mV/div)

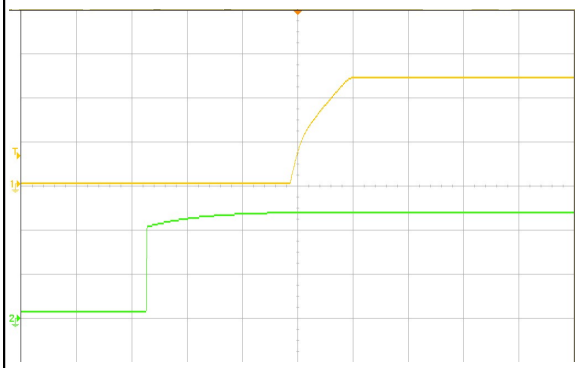


Figure 3: AVD120-48S12 Output Voltage Startup Characteristic (20mS/div)

Ch 1: Vo (5V/div) Ch 2: Vin (20V/div)

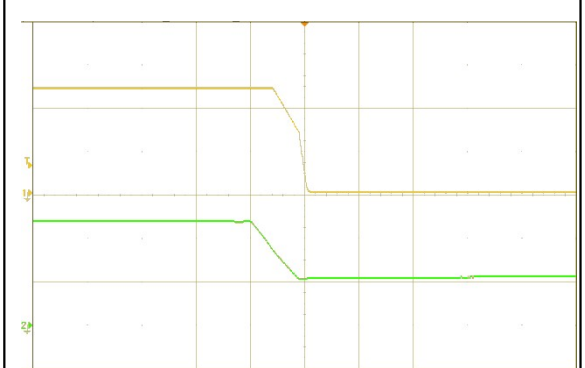


Figure 4: AVD120-48S12 Turn Off Characteristic (1mS/div)

Ch 1: Vo (5V/div) Ch 2: Vin (20V/div)

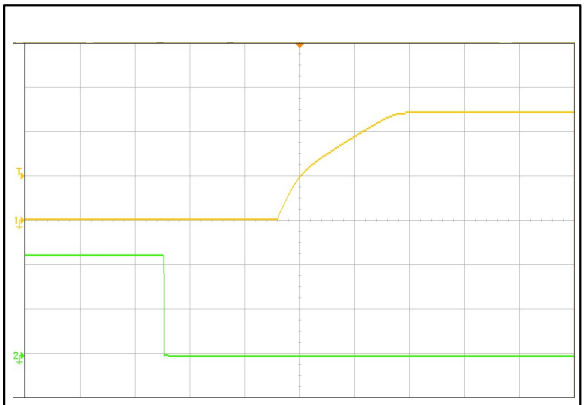


Figure 5: AVD120-48S12 Remote ON Waveform (10mS/div)

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

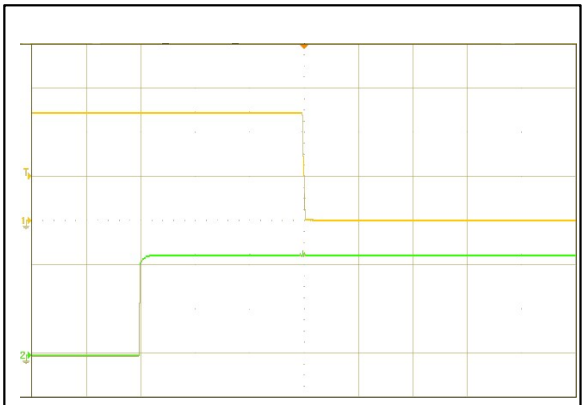


Figure 6: AVD120-48S12 Remote OFF Waveform (5mS/div)

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

ELECTRICAL SPECIFICATIONS

AVD120-48S12 Performance Curves

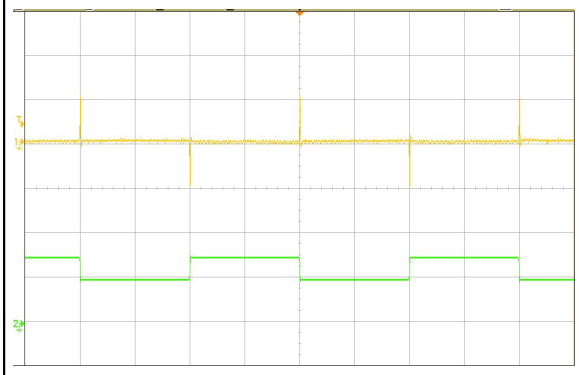


Figure 7: AVD120-48S12 Transient Response (2mS/div)
50%~75%~50% load change, 0.1A/uS slew rate
Ch 1: Vo (50mV/div) Ch 2: Io (5A/div)

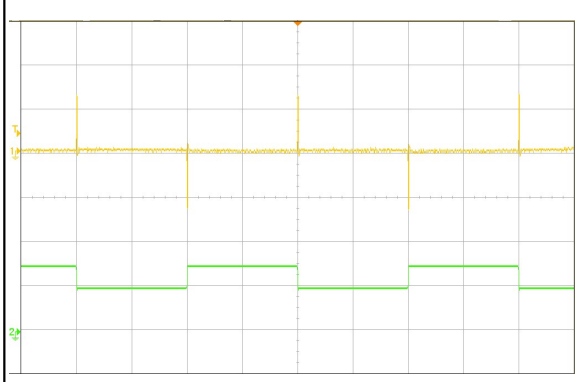


Figure 8: AVD120-48S12 Transient Response (2mS/div)
50%~75%~50% load change, 1A/uS slew rate
Ch 1: Vo (50mV/div) Ch 2: Io (5A/div)

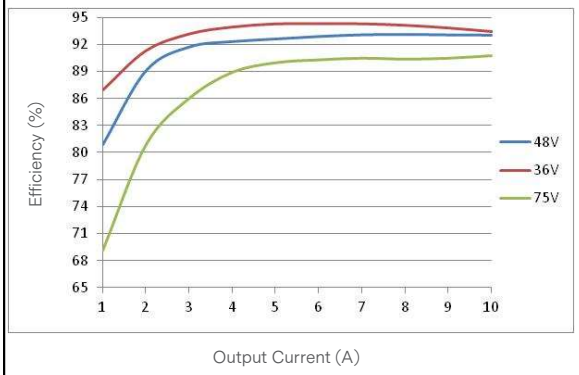


Figure 9: AVD120-48S12 Efficiency Curves @ 25 °C, 200LFM, Vo=12V
Loading: Io = 10% increment to 10A

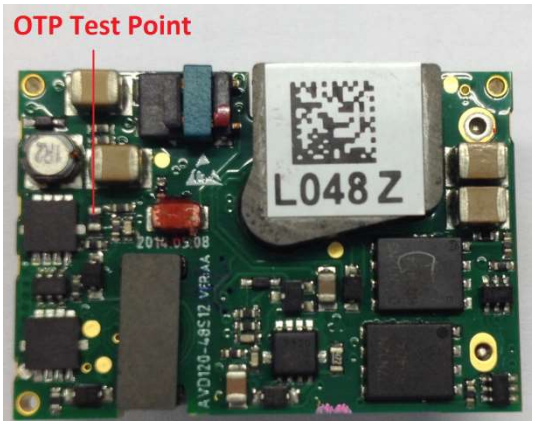


Figure 10: AVD120-48S12 OTP Test Point

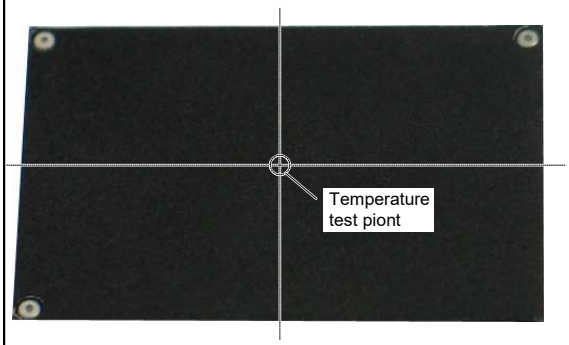
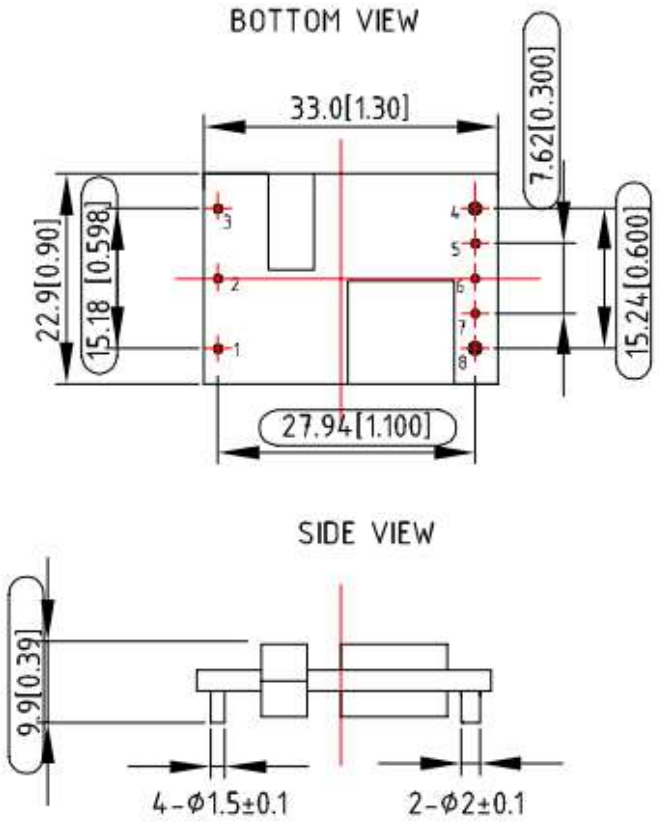


Figure 11: AVD120-48S12B OTP Test Point

MECHANICAL SPECIFICATIONS

Mechanical Outlines – Surface Mounted Module

AVD120-48S12TL



UNIT: mm[inch]

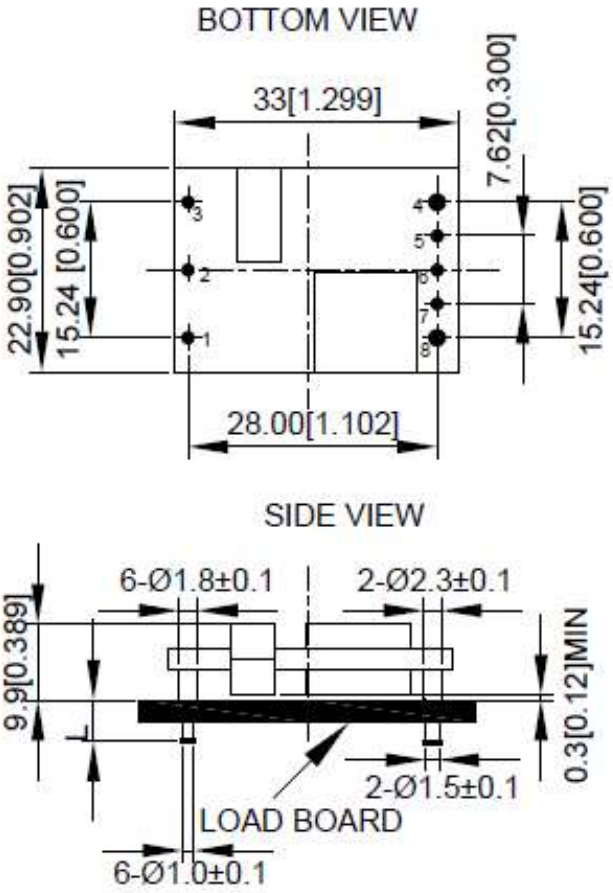
TOLERANCE: X.Xmm±0.5mm[X.XX in.±0.02in.]
X.XXmm±0.25mm[X.XXX in.±0.01in.]

BOTTOM VIEW: pin on upside

MECHANICAL SPECIFICATIONS

Mechanical Outlines – Open Frame Module

AVD120-48S12-6L



UNIT: mm[inch]

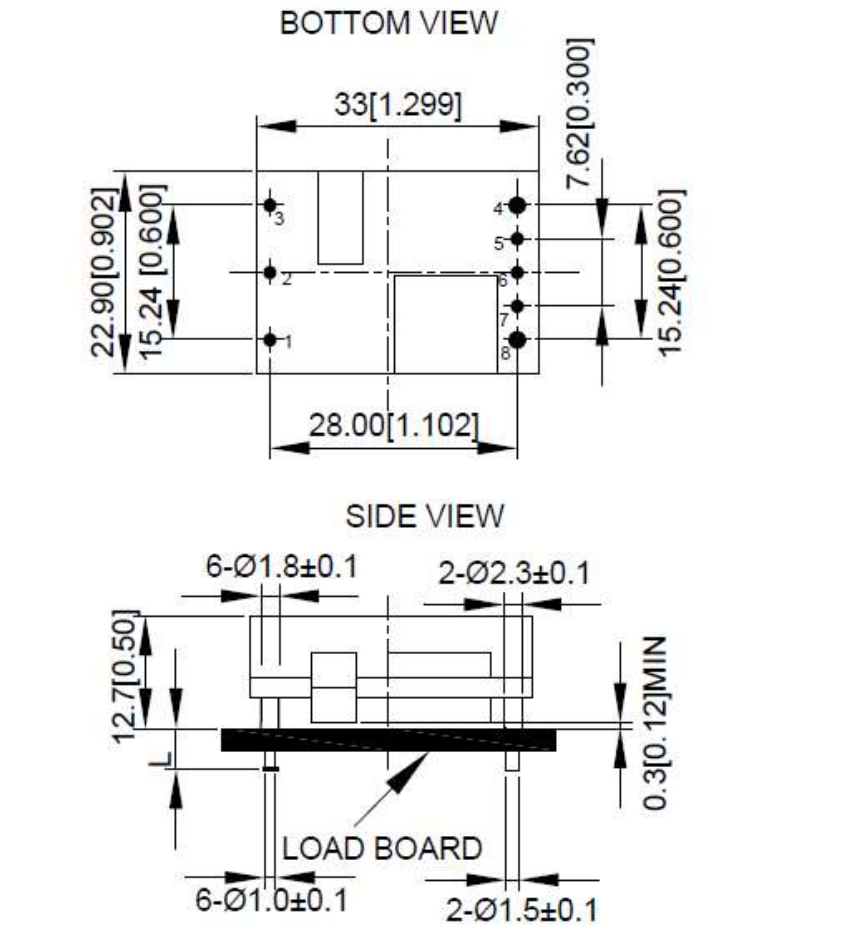
BOTTOM VIEW: pin on upside

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

MECHANICAL SPECIFICATIONS

Mechanical Outlines – Baseplate Module

AVD120-48S12B-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.]

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	S+	Positive remote sense
8	Vo+	Positive output voltage

ENVIRONMENTAL SPECIFICATIONS

Electromagnetic compatibility Characteristics

AVD120-48S12 power supply is designed to meet the following EMC immunity specifications:

Table 4. Environmental Specifications

Document	Description	Criteria
EN55022 DC input port, Class A Limits	Conducted Emission	/
IEC/EN 61000-4-2 Enclosure Port, Level 3	Immunity to Electrostatic Discharge	B
IEC/EN 61000-4-6, DC input port, Level 2	Immunity to Continuous Conducted Interference	A
IEC/EN 61000-4-4 DC input port, Level3	Immunity to Electrical Fast Transient	B
IEC/EN 61000-4-5 DC input port Line to Ground(earth): 600V Line to Line: 600V	Immunity to Surges	B
EN61000-4-29 DC input port	Immunity to Voltage Dips and Short Interruptions and Voltage Variations	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.

EMC test conditions

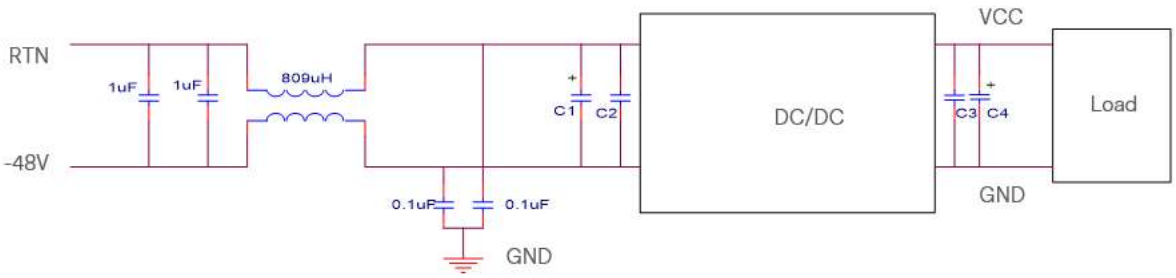


Figure 12 EMC test configuration

C1: 220uF/100V electrolytic capacitor; P/N: UPM2A221MPD (Nichicon) or equivalent caps

C2, C3: 1uF/100V X7R ceramic capacitor, P/N: C3216X7R2A105KT0L0S (TDK) or equivalent caps

C4: 220uF electrolytic capacitor, P/N: UPM1E221MHD (Nichicon) or equivalent caps

Fuse: External fast blow fuse with a rating of 12A. The recommended fuse model is 21612.5P from LITTLEFUSE.

ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The AVD120-48S12 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 AVD120-48S12 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 can be verified by measuring the temperature at the test points as shown in the figure 13. The temperature at these test points should not exceed the maximum values in Table 6.

For a typical application, forced airflow direction is from Vin- to Vin+, Figure 14 shows the derating of output current vs. ambient air temperature at different air velocity.

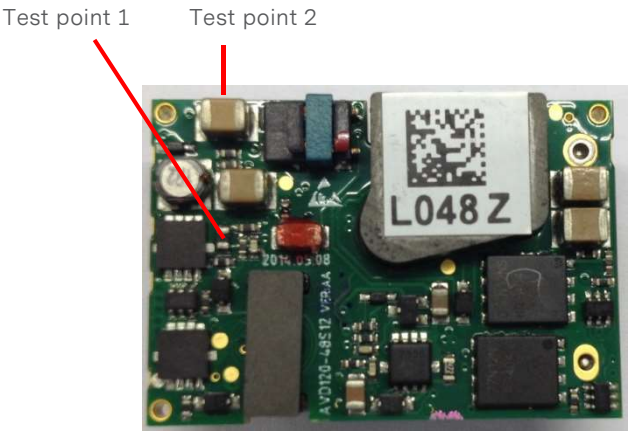


Figure 13 Temperature test point

Table 6. Temperature limit of the test point

Test Point	Temperature limit
Test Point1	119.5 ^{O}C
Test Point2	115 ^{O}C

ENVIRONMENTAL SPECIFICATIONS

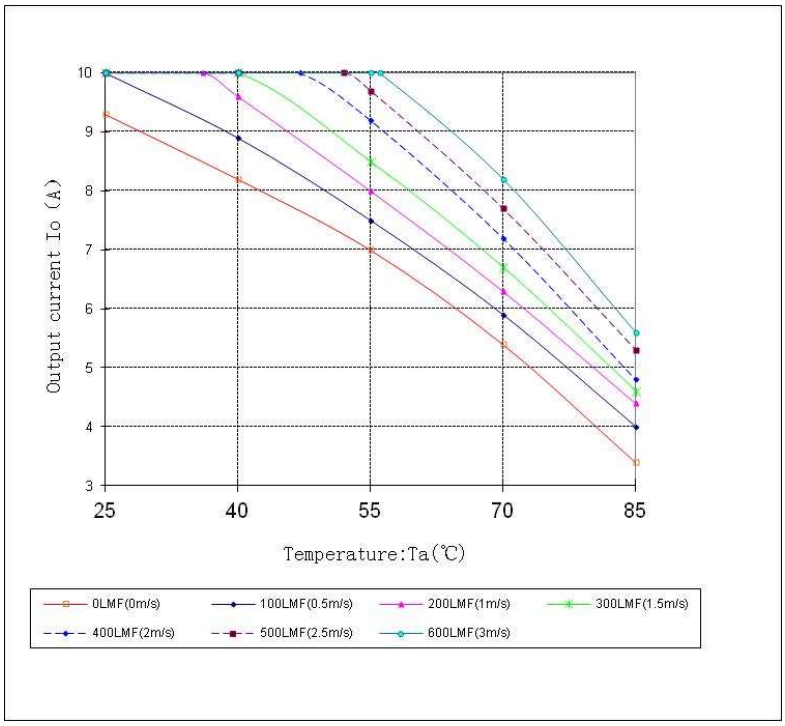


Figure 14 Derating curve

Thermal Considerations – Baseplate 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. The temperature at these points should not exceed the maximum values in Table 7.

For a typical application, forced airflow direction is from Vin- to Vin+, Figure 16 shows the derating of output current vs. ambient air temperature at different air velocity.

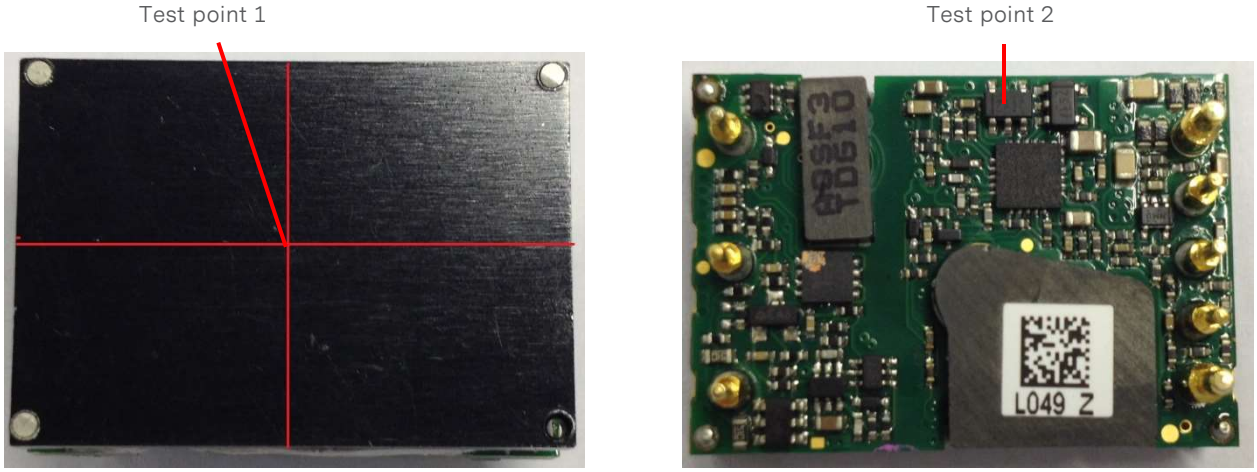


Figure 15 Temperature test point

ENVIRONMENTAL SPECIFICATIONS

Table 7. Temperature limit of the test point	
Test Point	Temperature limit
Test Point1	107.5 °C
Test Point2	110 °C

For a typical application, forced airflow direction is from Vin- to Vin+. Figure 16 shows the derating output current vs. ambient air temperature at different air velocity with a heatsink,

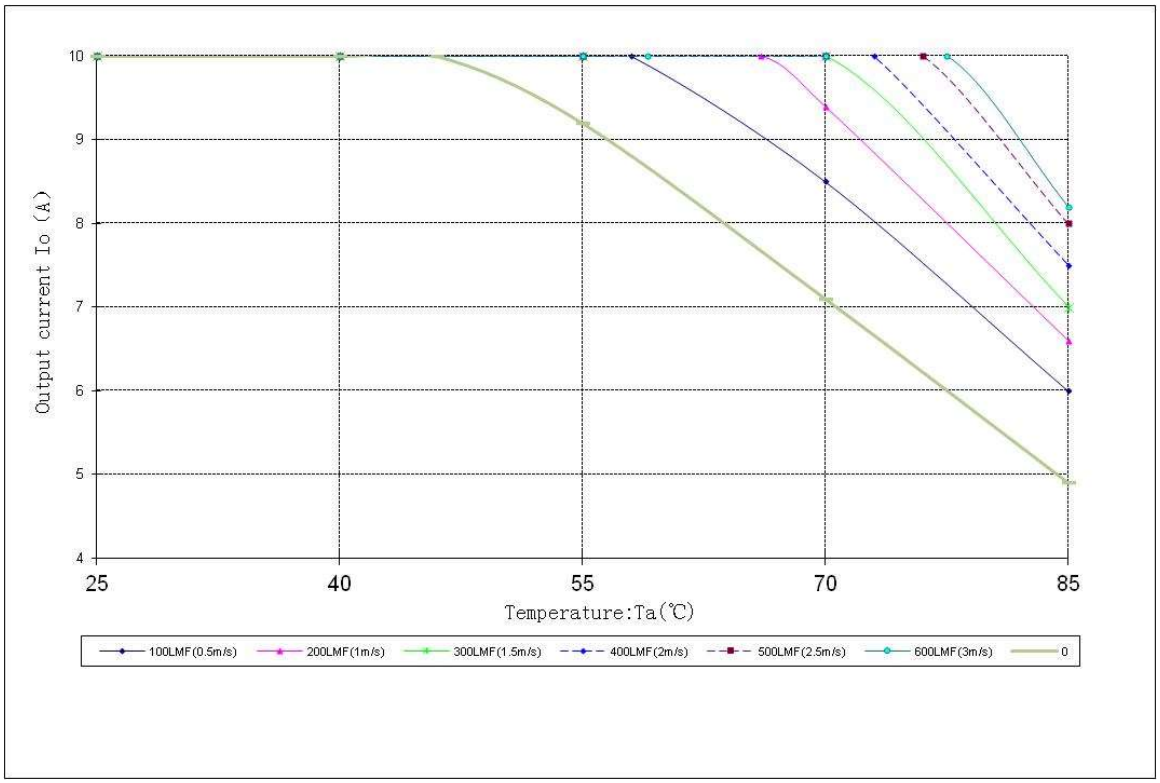


Figure 16 Derating curve

ENVIRONMENTAL SPECIFICATIONS

Qualification Testing

Parameter	Unit (pcs)	Test condition
Halt test	4-5	$T_{a,min}$-30 ^{O}C to $T_{a,max}$+25 ^{O}C, 10 ^{O}C step, V_{in} = min to max, 0 ~ 100% 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	-55 ^{O}C to 125 ^{O}C, unit temperature 20cycles
Thermal Cycling	3	-40 ^{O}C to 85 ^{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 AVD120-48S12 series power supply.

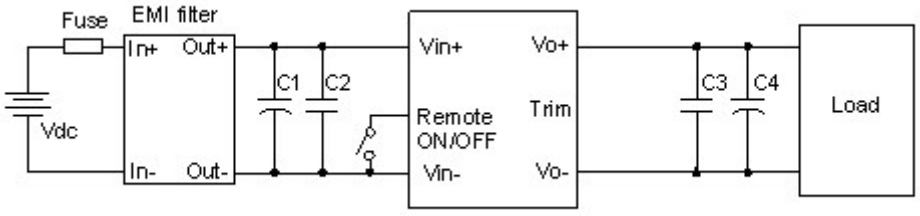


Figure 17 Typical application

C1: 220uF/100V electrolytic capacitor; P/N: UPM2A221MPD (Nichicon) or equivalent caps

C2, C3: 1uF/100V X7R ceramic capacitor, P/N: C3216X7R2A105KT0L0S (TDK) or equivalent caps

C4: 220uF electrolytic capacitor, P/N: UPM1E221MHD (Nichicon) or equivalent caps

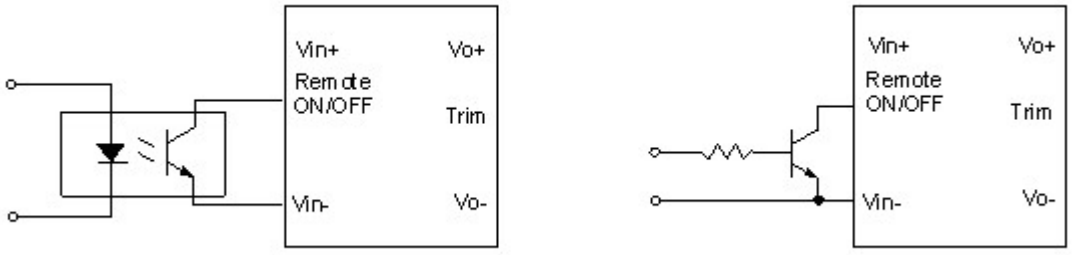
Fuse: External fast blow fuse with a rating of 12A. The recommended fuse model is 21612.5P from LITTLEFUSE.

APPLICATION NOTES

Remote ON/OFF

Negative remote ON/OFF logic is available in AVD120-48S12. 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 “Feature characteristics” to ensure proper operation. The external Remote ON/OFF circuit is highly recommended as shown in figure 19.



Isolated remote ON/OFF circuit

Non-isolated remote ON/OFF circuit

Figure 18 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 5.5V output, the trimming resistor is

$$\Delta = \frac{100 \times (V_{nom} - V_0)}{V_{nom}} = \frac{100 \times (5.5 - 5)}{5} = 10$$

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

When trimming up, the output current should be decreased accordingly so as not to exceed the maximum output power.

Internal side

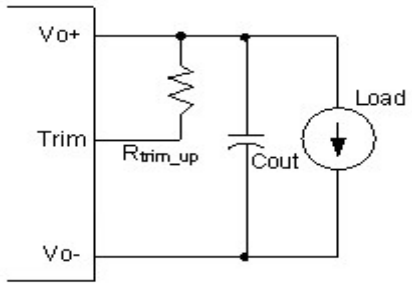


Figure 19 Trim up

Internal side

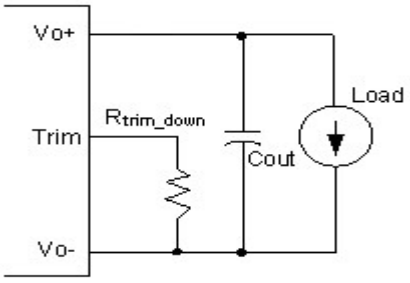


Figure 20 Trim down

APPLICATION NOTES

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

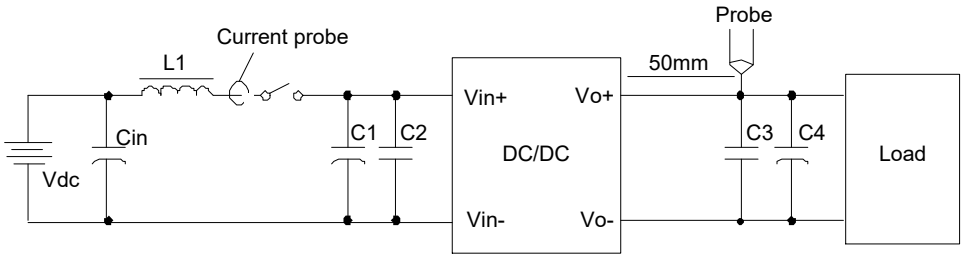


Figure 21 Input ripple & inrush current output ripple & noise test configuration

Vdc: DC power supply

L1: 12uH

Cin: 220uF/100V typical

C1: 220uF/100V electrolytic capacitor; P/N: UPM2A221MPD (Nichicon) or equivalent caps

C2, C3: 1uF/100V X7R ceramic capacitor, P/N: C3216X7R2A105KT0L0S (TDK) or equivalent caps

C4: 220uF electrolytic capacitor, P/N: UPM1E221MHD (Nichicon) or equivalent caps

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

Package Information

Package type

moisture sensitivity level 3, moisture barrier bags.

Minimal package QTY

192 pcs.

Package disassembly

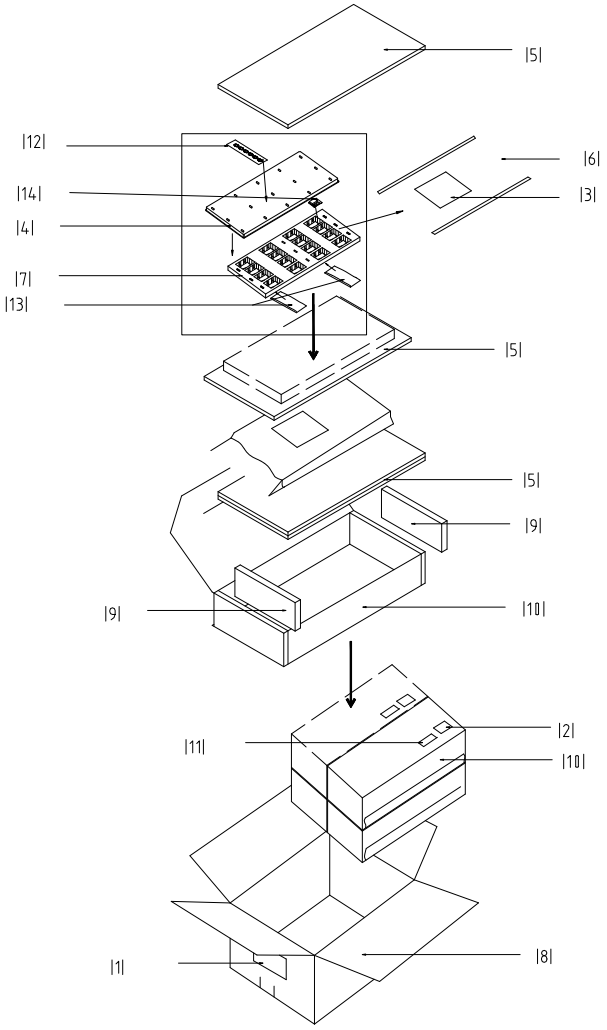


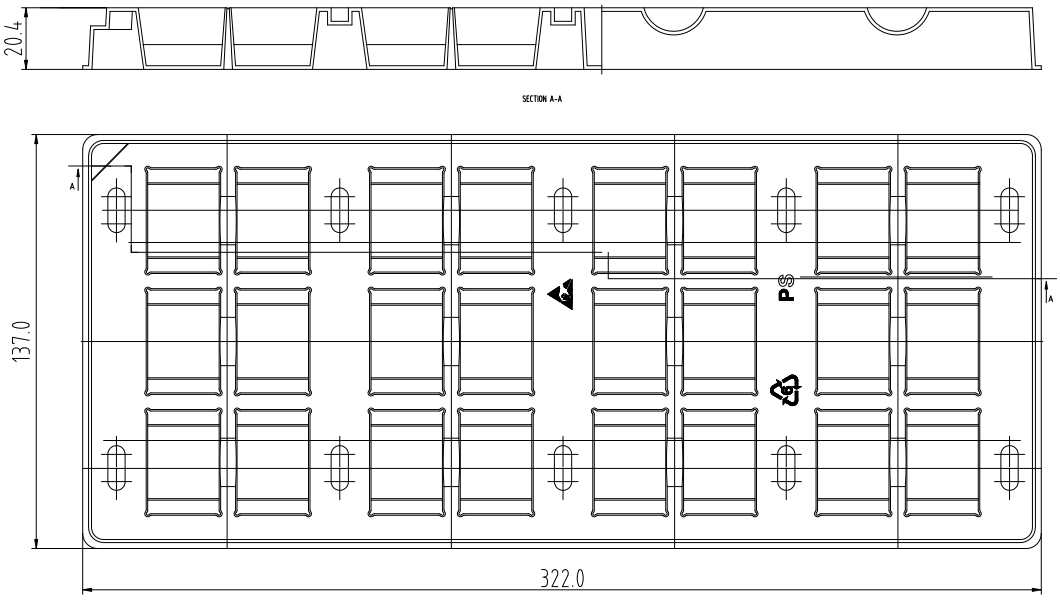
Figure 22 Package disassembly

APPLICATION NOTES

Package Information

Table 8. Assemblies description	
No.	Description
1	Shipping label
2	Moisture proof 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	AVD120-48S12-6L AVD120-48S12B-6L

When wave soldering is used, the temperature on pins is specified to maximum 260 °C for maximum 7s.

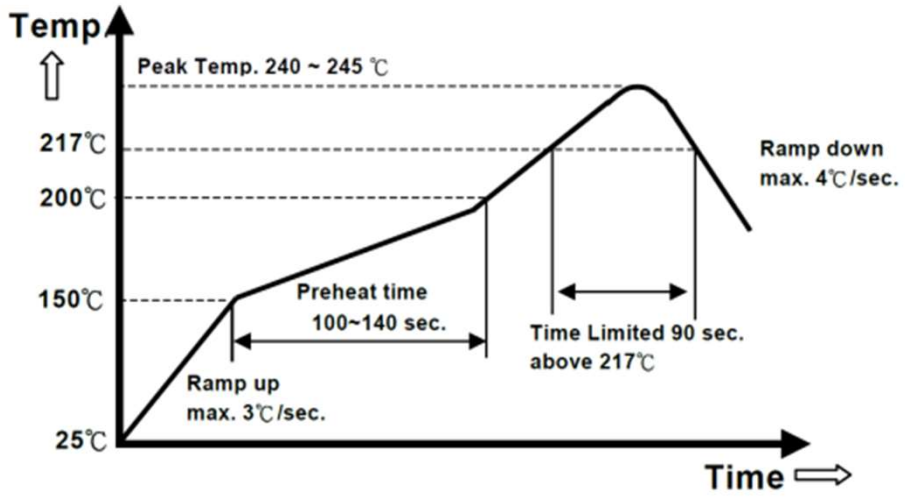
When soldering by hand, the iron temperature should be maintained at 300 °C ~ 380 °C and applied to the converter pins for less than 10s. Longer exposure can cause internal damage to the converter.

Cleaning of solder joint can be performed with cleaning solvent IPA or similative.

The below products are intended for standard reflow soldering.

	Product Requirement	Product Name
R6	Reflow soldering	AVD120-48S12-6L AVD120-48S12TL

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	12.04.2014	First Issue	E. Wang
1.1	03.13.2015	Update the picture on the Page 16	E. Wang
1.2	12.01.2015	Update the C4 capacitor part number on Page 13, 19 & 22; Update AVD100 to AVD120 on Page 15	E. Wang
1.3	10.18.2016	Update mechanical drawing on Page 9, 10.	E.Wang
1.4	03.16.2016	Update Switching frequency	K. Wang
1.5	11.19.2018	Update mechanical drawing	K. Wang
1.6	12.05.2019	Update reflow description	E.Wang
1.7	02.24.2020	Update RoHS status	C.Liu
1.8	05.06.2021	Update the 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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AVD120-48S12 - Rev.05.06.21_#1.8