AVQ400-48S12

400 Watts

Quarter-brick Converter

Total Power: 400 Watts
Input Voltage: 36 to 75 Vdc
# of Outputs: Single

Special Features

- Delivering up to 33A output
- Ultra-high efficiency 93% typ. at full load
- Wide input range: 36V ~ 75V
- Excellent thermal performance
- No minimum load requirement
- RoHS 6 compliant
- Basic isolation
- High power density
- Low output noise
- Improved thermal performance
- Remote output sense
- Input under voltage lockout
- Output over current protection
- Output over voltage protection
- Over temperature protection
- Industry standard quarter-brick pin-out outline
- Open frame or baseplate optional
- Remote control logic optional
- Pin length optional

Safety

IEC/EN/UL/CSA 60950
CE Mark
UL/TUV

Product Descriptions

The AVQ400-48S12 is a single output DC/DC converter with standard quarter-brick outline and Above 93% ultra-high efficiency and excellent thermal performance makes it an ideal choice to used in telecom and datacom applications and can operate under an ambient temperature range of -40 ^{O}C ~ +85 ^{O}C.in configuration. It delivers up to 33A output current with 12V output voltage.

Applications

Telecom/ Datacom

ARTESYN™
EMBEDDED TECHNOLOGIES

Model Numbers

Standard	Output Voltage	Structure	Remote ON/OFF logic	RoHS Status
AVQ400-48S12-6L	12Vdc	No baseplate	Negative	R6
AVQ400-48S12B-6L	12Vdc	Baseplate	Negative	R6
AVQ400-48S12B-4L	12Vdc	Baseplate	Negative	R6
AVQ400-48S12PB-6L	12Vdc	Baseplate	Positive	R6
AVQ400-48S12PB-4L	12Vdc	Baseplate	Positive	R6

Ordering information

AVQ400	-	48	S	12	P	B	-	6	L
①		②	③	④	⑤	⑥		⑦	⑧

①	Model series	AVQ: high efficiency quarter-brick series, 400: output power 400W
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: baseplate; default: no baseplate
⑦	Pin length	6: 3.8mm ± 0.25mm 4:
⑧	RoHS status	L: RoHS, R6

Options

None

Electrical Specifications

Absolute Maximum Ratings

Stress in excess of those listed in the "Absolute Maximum Ratings" may cause permanent damage to the power supply. These are stress ratings only and functional operation of the unit is not implied at these or any other conditions above those given in the operational sections of this TRN. Exposure to any absolute maximum rated condition for extended periods may adversely affect the power supply's reliability.

Table 1. Absolute Maximum Ratings:

Parameter	Model	Symbol	Min	Typ	Max	Unit
Input Voltage						
Operating -Continuous	All	$V_{IN,DC}$	-	-	80	Vdc
Non-operating -100mS	All		-	-	100	Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	396	W
Isolation Voltage[1]						
Input to output	Open frame module		-	-	1500	Vdc
Input to baseplate	Baseplate module		-	-	1500	Vdc
Output to baseplate	Baseplate module		-	-	500	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		-0.7	-	12	Vdc
Humidity (non-condensing)						
Operating	All		-	-	95	%
Non-operating			-	-	95	

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

Input Specifications

Table 2. Input Specifications:

Parameter	Conditions[1]	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, DC	All	$V_{IN,DC}$	36	48	75	Vdc
Turn-on Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,ON}$	-	35	36	Vdc
Turn-off Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,OFF}$	32	34	-	Vdc
Lockout Voltage Hysteresis	$I_O = I_{O,max}$		1	-	3	V
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC} = 36V_{DC}$	$I_{IN,max}$	-	-	13	A
No-load input current	$I_O = 0A$	I_{IN}	-	-	0.2	A
Standby Input current	Remote OFF	I_{IN}	-	0.01	0.1	A
Inrush current transient rating	All		-	-	1	A^2s
Recommended Input Fuse	Fast blow external fuse recommended		-	-	15	A
Input filter component values (C\L)	Internal values		-	8.8\0.68	-	µF\µH
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	100	-	-	uF
Input Reflected Ripple Current	Through 12uH inductor		-	-	150	mA
Operating Efficiency	T_A=25 °C $I_O = I_{O,max}$ $I_O = 50\%I_{O,max}$	η	92.5 94	93 95	- -	% %

Note1 - T_A = 25 °C, airflow rate = 400 LFM, $V_{IN,DC}$ = 48Vdc, nominal V_O unless otherwise noted.

Output Specifications

Table 3. Output Specifications:

Parameter		Conditions[1]	Symbol	Min	Typ	Max	Unit
Factory Set Voltage		$V_{IN,DC}$ = 48V_{DC} I_O=$I_{O,max}$	V_O	11.80	12	12.20	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
Total output voltage range (Over sample, line, load, temperature & life)		All	V_O	11.8	12	12.2	V
Output Ripple, pk-pk		20MHz bandwidth	V_O	-	-	150	mV_{PK-PK}
Operating Output Current range		All	I_O	0	-	33	A
Output DC current-limit inception[1]			I_O	34.65	-	42.9	A
V_O Load Capacitance[2]		All	C_O	470	1000	10000	uF
V_O Dynamic Response	Peak Deviation Settling Time	50% ~75%~50% slew rate = 0.1A/us	±V_O T_s	- -	- -	600 700	mV uSec
		50% ~75%~50% slew rate = 1A/us	±V_O T_s	- -	- -	1200 700	mV uSec
Turn-on transient	Rise time	I_O = I_{max}	T_{rise}	-	-	100	mS
	Turn-on delay time	I_O = I_{max}	$T_{turn-on}$	-	-	150	mS
	Output voltage overshoot	I_O = 0	%V_O	-	-	5	%
Switching frequency		All	f_{SW}	130	140	150	KHz

Note 1 - Hiccup: auto-restart when over-current condition is removed.

Note 2 - High frequency and low ESR is recommended.

Output Specifications

Table 3. Output Specifications, con't:

Parameter		Conditions[1]	Symbol	Min	Typ	Max	Unit
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
Output over-voltage protection[3]		All	V_O	13	-	16	V
Output over-temperature protection[4]		No baseplate	T	-	125	-	^{O}C
		Baseplate		108	110	114	^{O}C
Over-temperature hysteresis		All	T	-	5	-	^{O}C
MTBF		Telcordia SR-332-2006; 80% load, 300LFM, 40^{O}C Ta		-	1.5	-	10^6 h

Note 3 - Hiccup: auto-restart when over-voltage condition is removed.
Note 4 - Auto recovery.

AVQ400-48S12-6L Performance Curves

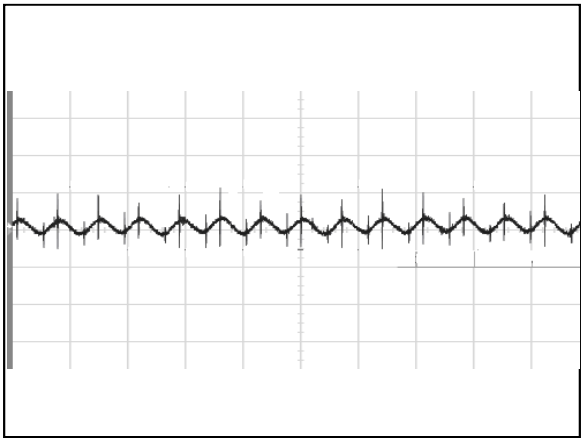


Figure 1: AVQ400-48S12 Input Reflected Ripple Current Waveform (5uS/div, 20mA/div)

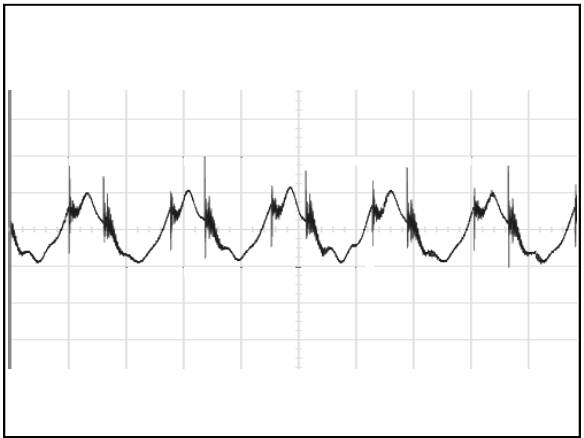


Figure2: AVQ400-48S12 Ripple and Noise Measurement (2uS/div, 16mV/div)

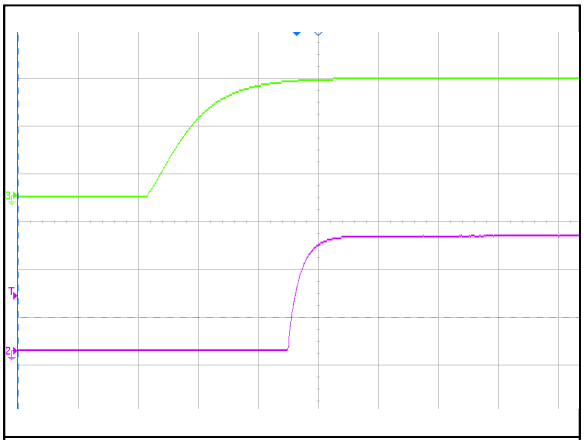


Figure 3: AVQ400-48S12 Output Voltage Startup Characteristic (50mS/div)

Ch 2: Vo (5V/div) Ch 3: Vi (20V/div)

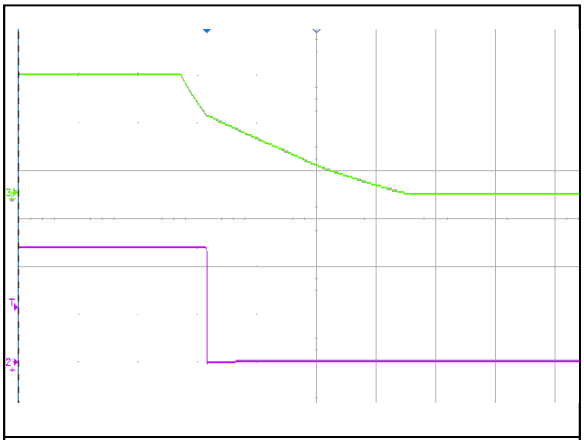


Figure 4: AVQ400-48S12 Turn Off Characteristic (100mS/div)

Ch 2: Vo (5V/div) Ch 3: Vi (20V/div)

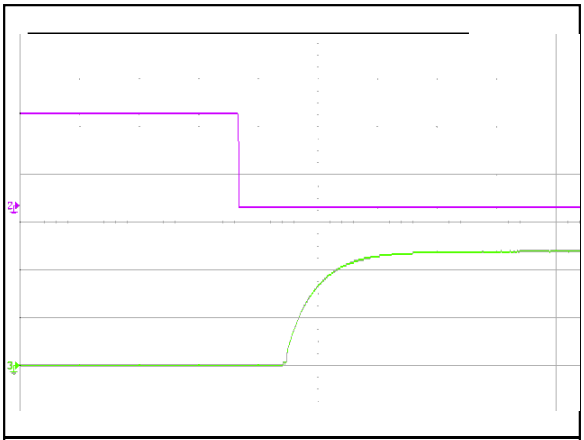


Figure 5: AVQ400-48S12 Remote ON Waveform (20mS/div)

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

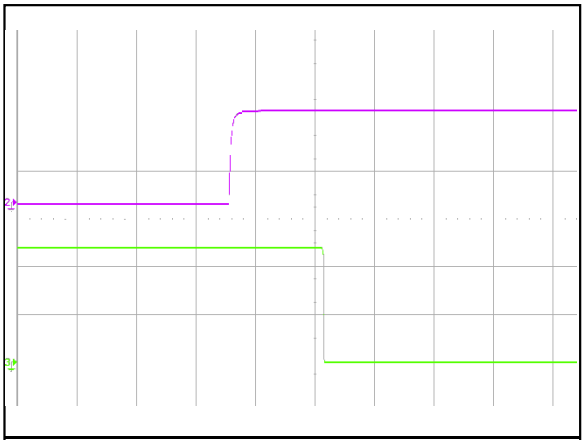


Figure 6: AVQ400-48S12 Remote OFF Waveform (10mS/div)

Ch 3: Vo (5V/div) CH 2: Remote OFF (2V/div)

AVQ400-48S12-6L Performance Curves

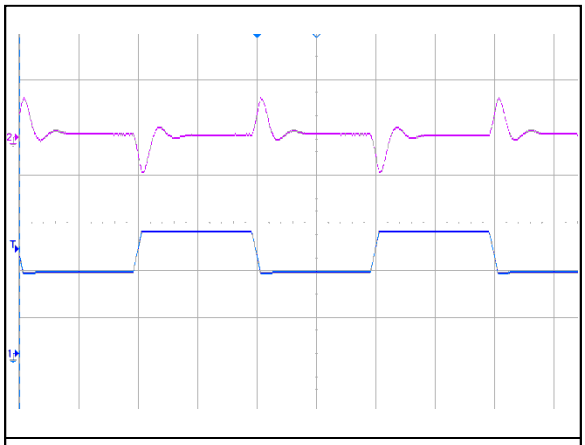


Figure 7: AVQ400-48S12 Transient Response (500uS/div)
50%~75%~50% load change, 0.1A/uS slew rate
Ch 2: Vo (500mV/div) Ch 1: Io (10A/div)

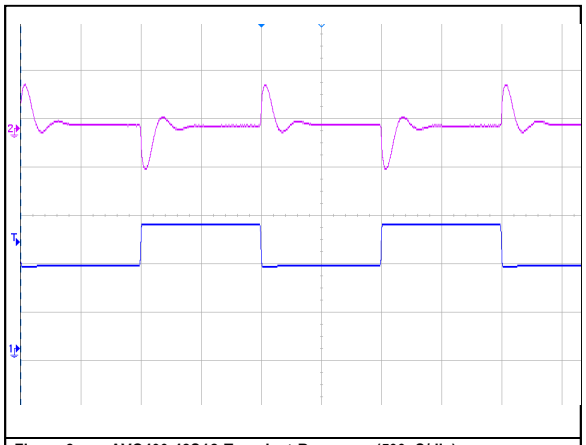


Figure 8: AVQ400-48S12 Transient Response (500uS/div)
50%~75%~50% load change, 1A/uS slew rate
Ch 2: Vo (500mV/div) Ch 1: Io (10A/div)

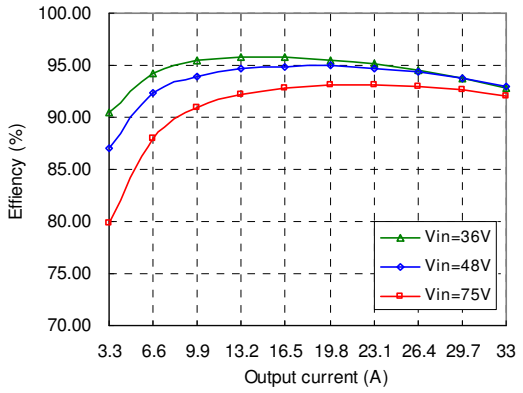


Figure 9: AVQ400-48S12 Efficiency Curves @ 25 ^{O}C, Vo=12V

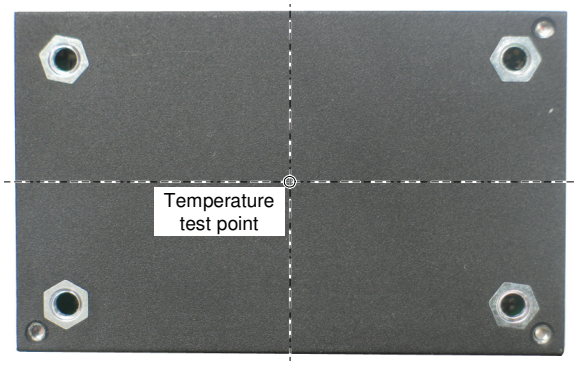
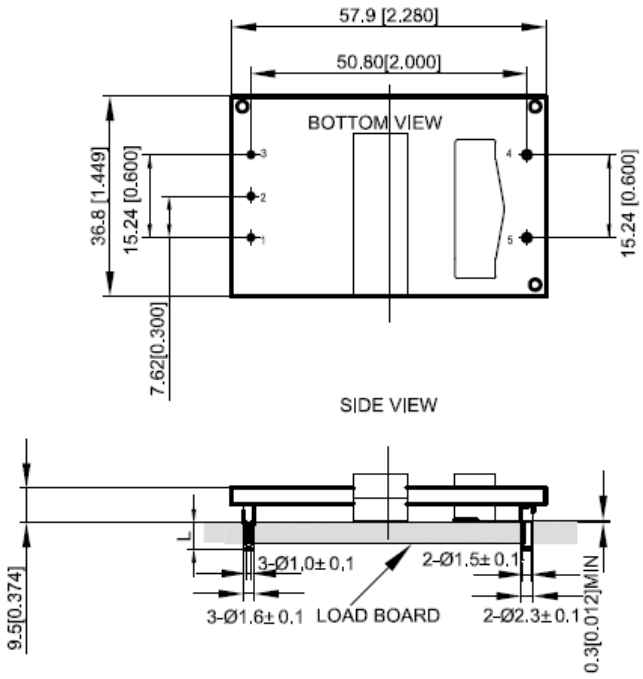


Figure 10 Baseplate model OTP test point

Mechanical Specifications

Mechanical Outlines – No baseplate Module

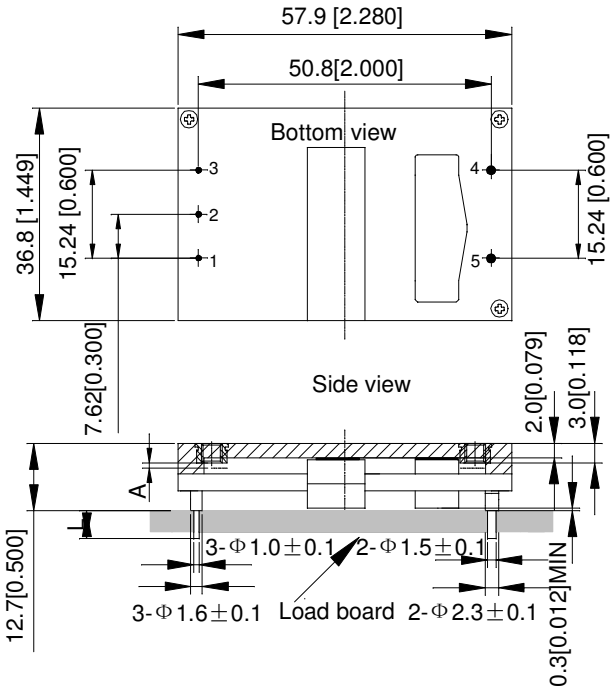


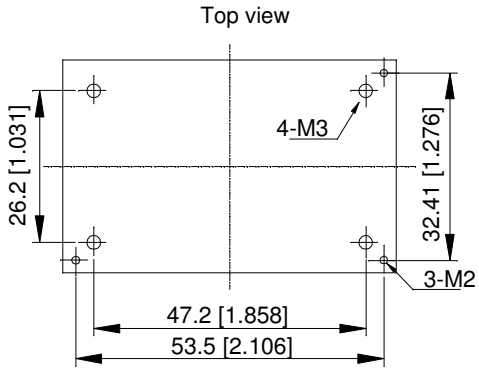
Unit: mm[inch] Bottom view: pin on upside

Tolerance: X.Xmm ± 0.5mm[X.XXin. ±0.02in.]

X.XXmm ± 0.5mm[X.XXXin. ±0.01in.]

Mechanical Outlines – Baseplate Module





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.]

Screws connected customer's heatsink with power module's heatsink protrude nuts

A	1.0mm max

Pin Length Option

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

Pin Designations

Pin No	Name	Function
1	V_{in}+	Positive input voltage
2	CNT	Remote ON/OFF control
3	V_{in}-	Negative input voltage
4	V_o-	Negative output voltage
5	V_o+	Positive output voltage

Environmental Specifications

EMC Immunity

AVQ400-48S12 Series power supply is designed to meet the following EMC immunity specifications:

Document	Description	Criteria
EN55022	Conducted emission, DC Input, Class B limit	/
IEC/EN 61000-4-2, Level 3	ESD, Enclosure port	B
IEC/EN 61000-4-6, Level 2	Conducted disturbances immunity, DC Input	A
IEC/EN 61000-4-4, Level 3	EFT	B
IEC/EN 61000-4-5	Surges, DC Input Line to Ground(earth): 600V, Line to Line: 600V, System reset is no allowed	B
EN61000-4-29	DC voltage dips, short interruption, variation, DC Input	B

Criterion A: Normal performance during and after test.

Criterion B: Temporary output voltage fluctuation ceases after disturbances ceases, and from which the EUT recovers its normal performance automatically. For EFT and surges, low-voltage protection or reset is not allowed. 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 Configuration

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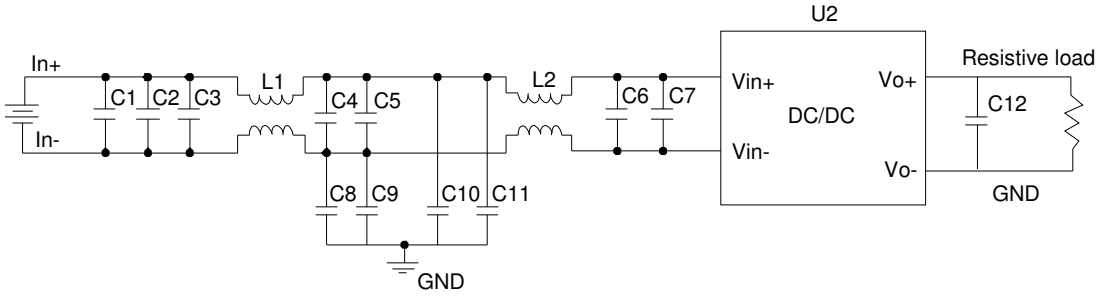


Figure 11 EMC test configuration

U2: Module to test, AVQ400-48S12

C1~C5: SMD ceramic capacitor-100V-1000nF-X7R-1210

C6: SMD ceramic capacitor-100V-100nF-±10%-X7R-1206

L1, L2: Common mode inductor-single phase-473μh-±25%-14A magnetic ring 1mm × 25.4mm × 12.7mm-working temperature range includes module temperature rise. Temperature rises at rated current: 55°C (max.)

C8~C11: High-voltage chip ceramic capacitor. Capacitance: 0.22U/630V/X7R. Size: 2220. Capable of withstanding 1kV voltage

C7: Input electrolytic capacitor, according to the same type as C1 in Figure 16

C8: Output electrolytic capacitor, according to the same type as C3 in Figure 16

Safety Certifications

The AVQ400-48S12 Series 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 4. Safety Certifications for AVQ400-48S12 series power supply system

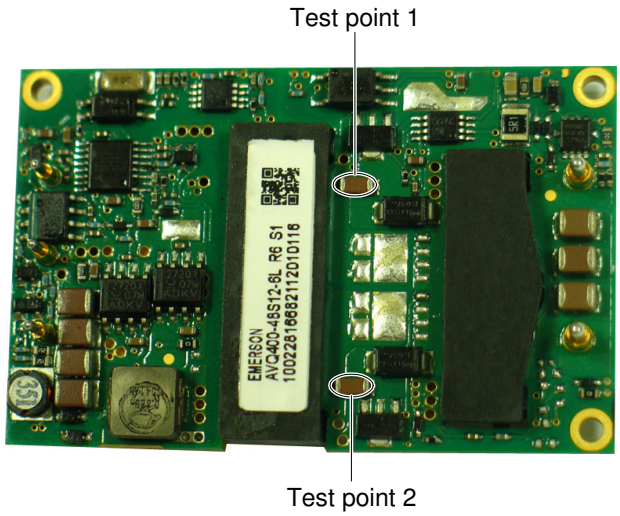
Document	File #	Description
UL60950		US and Canada Requirements
EN60950-1		European Requirements
IEC60950		International Requirements
CE		CE Marking
UL94		V-0 flammability rating

Operating Temperature

The AVQ400-48S12 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 —No baseplate Model

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 these points should not exceed the max values in the Table 5.



Temperature test points on FR-4 board

Figure 12 No baseplate model temperature test point

Table 5 Temperature limit of the test points

Test Point	Temperature limit
Test point 1	118^{O}C
Test point 2	118^{O}C

Thermal Considerations — No Baseplate Model Con't

Figure 13 shows the derating output current vs. ambient air temperature at different air velocity.

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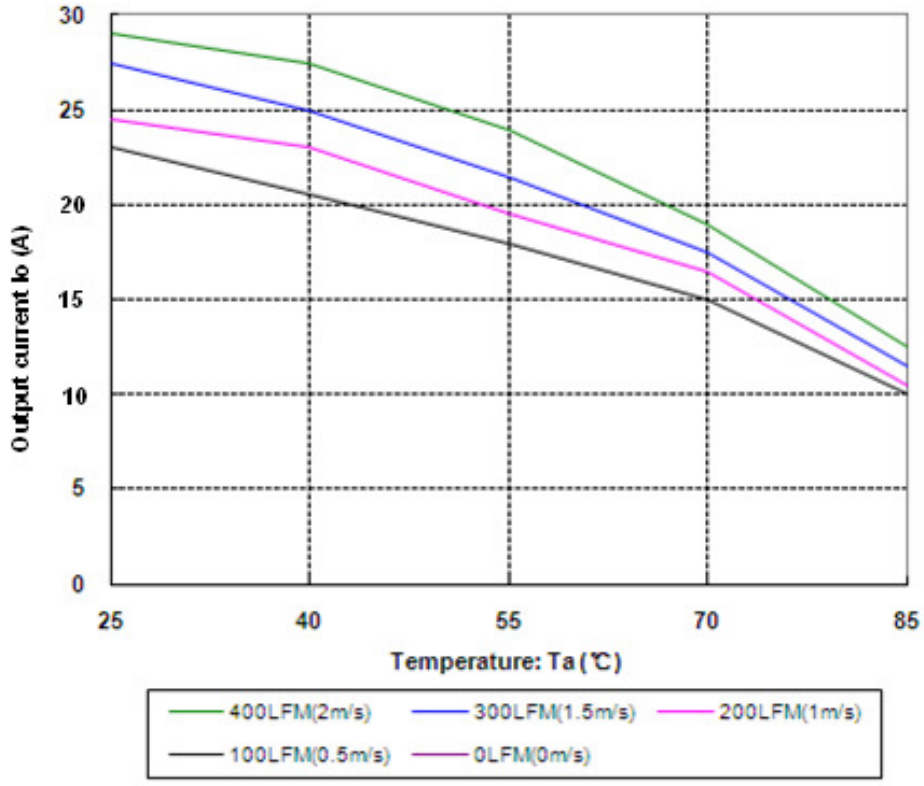

Figure 13 Output power derating, 48V_{in}, air flowing across the converter from pin 1 to pin 3

Thermal Considerations — Baseplate Model

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 14.

The temperature at these points should not exceed the max values in the Table 6.

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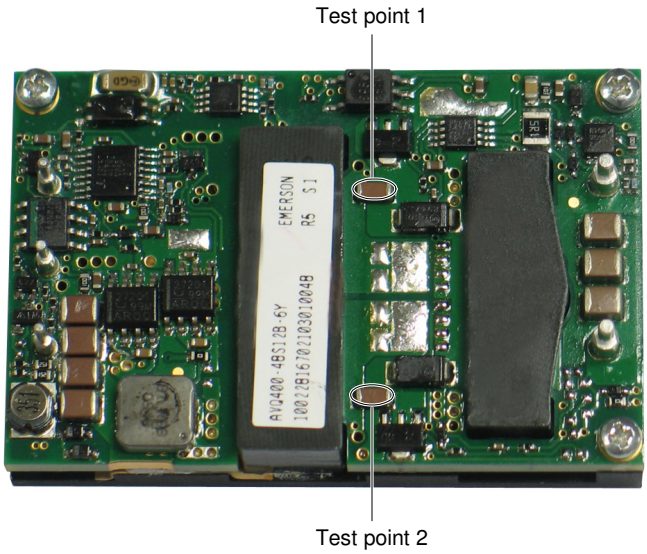

Figure 14 Baseplate model temperature test point on converter

Table 6 Temperature limit of the test points

Test Point	Temperature limit
Test point 1	118^{O}C
Test point 2	118^{O}C

Thermal Considerations — Baseplate Model Con't

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 velocities with a specified heatsink.

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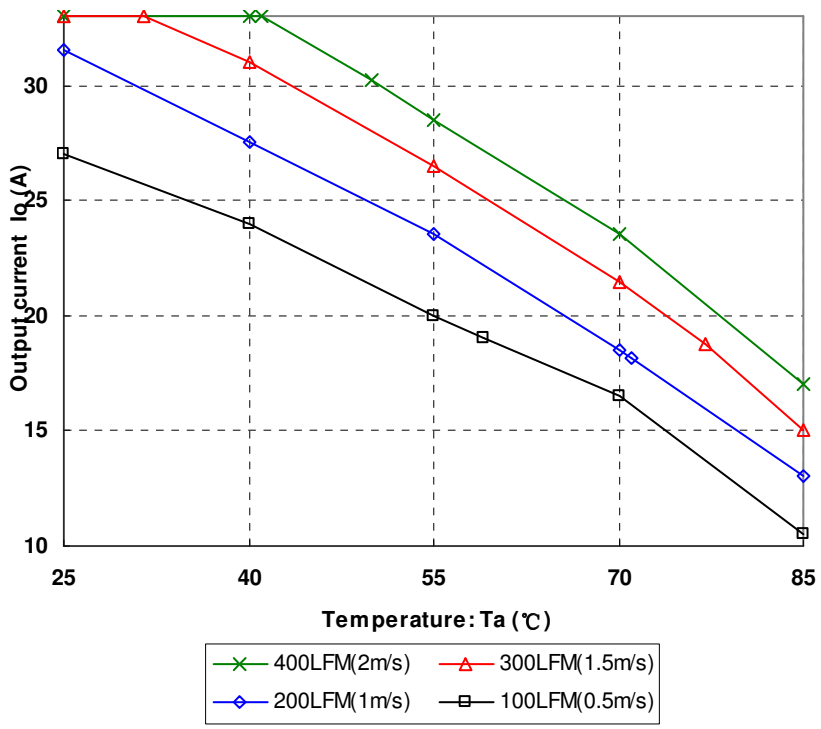

Figure 15 Output power derating, $48V_{IN,DC}$, air flowing across the converter from pin 1 to pin 3

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 AVQ400-48S12 series power supply.

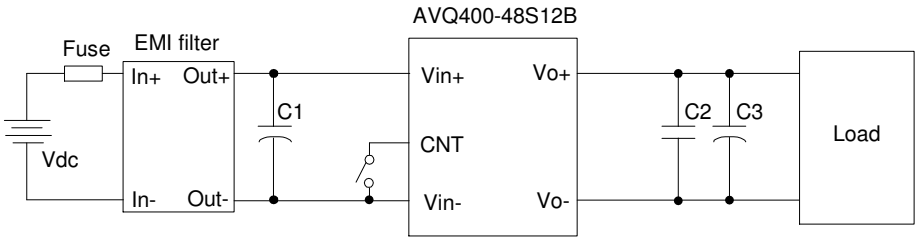

Figure 16 Typical application

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

C2: 1μF/100V X7R ceramic capacitor, P/N: C3225X7R2A105KT0L0U (TDK) or equivalent caps

C3: 1000μF/25V electrolytic capacitor, P/N: UPM1H102MHD (Nichicon) or equivalent caps

Fuse: External fast blow fuse with a rating of 15A. The recommended fuse model is 21612.5P from LITTLEFUSE.

Remote ON/OFF

Either positive or negative remote ON/OFF logic is available in AVQ400-48S12. The logic is CMOS and TTL compatible.

Figure 17 is the detailed internal circuit and reference in AVQ400-48S12-6L.

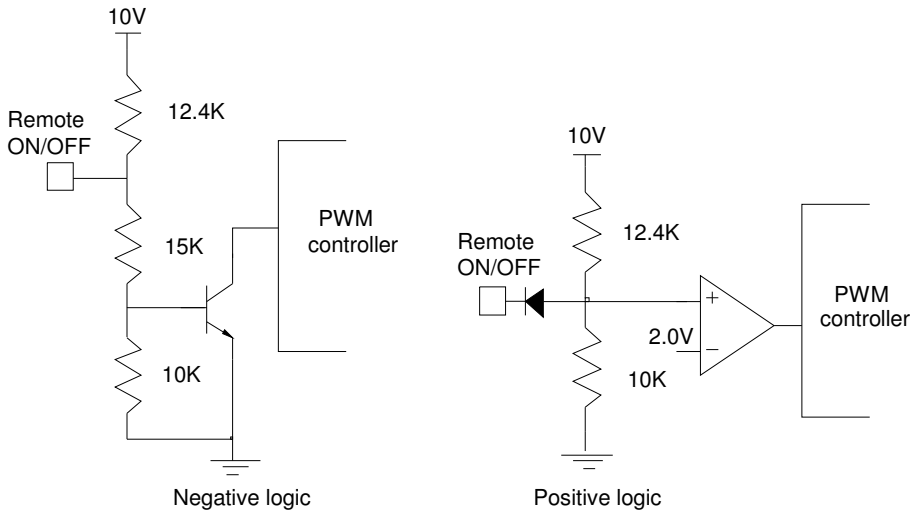

Figure 17 Remote ON/OFF internal diagram

The voltage between pin Remote ON/OFF and pin V_{in}- 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 18.

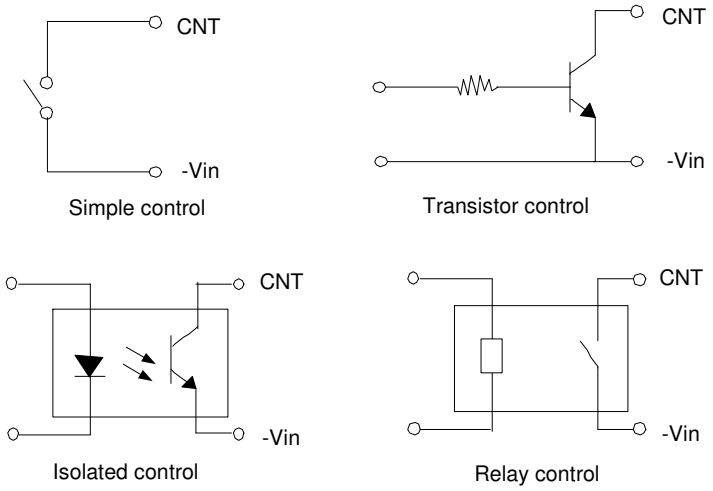

Figure 18 External remote ON/OFF circuit

Input Ripple & Output Ripple & Noise Test Configuration

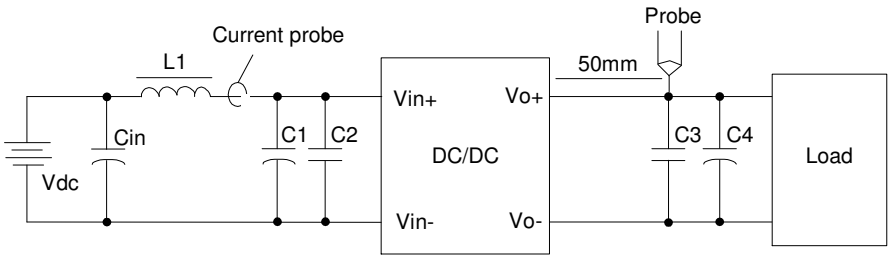

Figure 19 Input ripple & output ripple & noise test configuration

Vdc: DC power supply

L1: 12uH

Cin: 220uF/100V typical

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

C2 ~ C3: 1μF/100V X7R ceramic capacitor; P/N: C3225X7R2A105KT0L0U (TDK) or equivalent caps

C4: 1000μF/25V electrolytic capacitor; P/N: UPM1H102MHD (Nichicon) or equivalent caps

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

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 manual 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 similative.

Assembly

The maximum length of the screw driven into heatsink is 1.0mm.

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Hazardous Substances Announcement (RoHS of China R6)

Parts	Hazardous Substances					
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
AVQ400-48S12	x	x	x	x	x	x

x: Means the content of the hazardous substances in all the average quality materials of the part is within the limits specified in SJ/T-11363-2006

√: Means the content of the hazardous substances in at least one of the average quality materials of the part is outside the limits specified in SJ/T11363-2006

Artesyn Embedded Technologies has been committed to the design and manufacturing of environment-friendly products. It will reduce and eventually eliminate the hazardous substances in the products through unremitting efforts in research. However, limited by the current technical level, the following parts still contain hazardous substances due to the lack of reliable substitute or mature solution:

1. Solders (including high-temperature solder in parts) contain plumbum.
2. Glass of electric parts contains plumbum.
3. Copper alloy of pins contains plumbum

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