TECHNICAL REFERENCE NOTE

ARTESYN ADQ600B-48S12B-6LK

600 Watts Quarter Brick Converter

PRODUCT DESCRIPTION

Advanced Energy's Artesyn ADQ600B-48S12B-6LK is a single output DC/DC converter with standard quarter brick form factor and pin configuration. It delivers up to 50A output current with 12V output. Ultra-high 95.5% 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 ~ +85 ^{O}C.

AT A GLANCE

Total Power

600 Watts

Input Voltage

36 to 75 Vdc

# of Outputs

Single

RoHS

SPECIAL FEATURES

- Delivering up to 50A output
- Ultra-high efficiency 95.5% typ. at half load
- Wide input range: 36 to 75 Vdc
- Startup Pre-bias: 0%Vout ~ 95%Vout
- Excellent thermal performance
- No minimum load requirement
- RoHS3.0
- Remote control function
- Remote output sense
- Trim
- Input under voltage lockout
- Output over current protection
- Output over voltage protection
- Over temperature protection
- Industry standard quarter brick pin-out outline
- Pin length option: 3.8mm

SAFETY

- IEC/EN/UL/CSA 62368
- UL/TUV
- UL94,V-0
- CE and UKCA Mark

TYPICAL APPLICATIONS

- Telecom
- Datacom

Model Numbers

Standard	Output Voltage	Structure	Remote ON/OFF logic	ROHS
ADQ600B-48S12B-6LK	12Vdc	Baseplate	Negative	RoHS3.0

Order Information

ADQ600B	-	48	S	12	B	-	6	L	K
①		②	③	④	⑤		⑥	⑦	⑧

①	Model series	ADQ: high efficiency quarter brick series, 600: output power 600W
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	Baseplate	B: with baseplate; default: open frame
⑥	Pin length	Omit for 5.8mm±0.25mm 4: 4.8mm±0.25mm 6: 3.80mm±0.25mm 8: 2.80mm±0.25mm
⑦	RoHS status	L: RoHS3.0
⑧	Customer Code	

Options

Pin length optional

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	$P_{O,max}$	-	-	600	W
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	-	18	Vdc
Humidity (non-condensing)						
Operating	All		-	-	95	%
Non-operating	All		-	-	95	%

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	$I_O = I_{O,max}$	$V_{IN,ON}$	-	35	-	Vdc
Turn-off Voltage Threshold	$I_O = I_{O,max}$	VIN,OFF	-	33	-	Vdc
Lockout Voltage Hysteresis	$I_O = I_{O,max}$		-	2	-	Vdc
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC}$ = 36Vdc $I_O = I_{O,max}$	$I_{IN,max}$	-	-	20	A
No-load input current	$V_{IN,DC}$ = 48Vdc		-	0.10	-	A
Standby Input current	Remote OFF		-	0.01	0.1	A
Recommended Input Fuse	Fast blow external fuse recommended		-	-	30	A
Input filter component values (C\L)	Internal values		-	9.4\0.33	-	µF\µH
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	220	-	-	µF
Input Reflected Ripple Current	Through 12uH inductor		-	70	-	mA
Operating Efficiency[2]	T_A=25 °C $I_O = I_{O,max}$ $I_O = 50\% I_{O,max}$	η	- -	94.5 95.5	- -	% %

Note 1 - Ta = 25 °C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.
Note 2 - Refer to figure 9

Electrical Specifications

Output Specifications

Table 3. Output Specifications

Parameter		Conditions[1]	Symbol	Min	Typ	Max	Unit
Factory Set Voltage		$I_O=I_{O,max}$	V_O	11.88	12	12.12	Vdc
Output Voltage Line Regulation		All	V_O	-	20	60	mV
Output Voltage Load Regulation		All	V_O	-	20	60	mV
Output Voltage Temperature Regulation		All	V_O	-	0.002	0.02	%/°C
Output Voltage Trim Range		All	V_O	-33		10	%
Output Ripple, pk-pk		0 to 20MHz bandwidth	V_O	-	100	400[2]	mV_{PK-PK}
Output Current		All	I_O	0	-	50	A
Output DC current-limit inception[3]		All	I_O	55	-	70	A
V_O Load Capacitance[4]		All	C_O	2200		5200	µF
V_O Dynamic Response Peak Deviation Settling Time		50% ~ 75% ~ 50% $I_{O,max}$ 0.1A/µs	$\pm V_O$ Ts	- -	300 300	- -	mV uS
		50% ~ 75% ~ 50% $I_{O,max}$ 1A/µs	$\pm V_O$ Ts	- -	300 300	- -	mV µS
Turn-on transient	Rise time	$I_O=I_{O,max}$	T_{rise}	-	48	100	mS
	Turn-on delay time	$I_O=I_{O,max}$	$T_{turn-on}$	-	65	100	mS
	Output voltage overshoot	I_O = 0	$\%V_O$	-	0	-	%
Isolation Voltage Input to output		1mA for 60s Slew rate of 500V/1s		2250	-	-	Vdc
Switching frequency		All	f_{SW}	-	175	-	KHz
Remote ON/OFF control (negative logic)	Off-state voltage	All		3.5	-	18	Vdc
	On-state voltage	All		-0.3	-	1.2	Vdc

Note 1 - Ta = 25 °C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.
Note 2 - 400mV is for whole range including input voltage, load and temperature.
Note 3 - Hiccup: auto-restart when over-current condition is removed.
Note 4 – the minimal capacitance is 2200uF Al electrolytic and the maximal capacitance is 2200uF Al electrolytic plus 3000uF MLCC or similar type.

Electrical Specifications

Output Specifications

Table 3. Output Specifications Con't

Parameter		Conditions	Symbol	Min	Typ	Max	Unit
Remote ON/OFF control (Negative logic)	Off-state voltage	All		3.5	-	18	Vdc
	On-state voltage	All		-0.3	-	1.2	Vdc
Output over-voltage protection[5]		All	V_O	13.8	-	16	Vdc
Pre-bias		All		0	-	95	%
Output over-temperature protection[6]		All		-	100	-	^{O}C
Over-temperature hysteresis		All		5	-	-	^{O}C
+ Sense		All	Vo	-	-	+0.5	Vdc
- Sense		All	Vo	-	-	-0.5	Vdc
MTBF		Telcordia SR-332-2006; 80% load, 300LFM, 40 ^{O}C T_A SR332 Method 1 Case1		-	1.5	-	10^6 h

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

Electrical Specifications

ADQ600B-48S12B-6LK Performance Curves

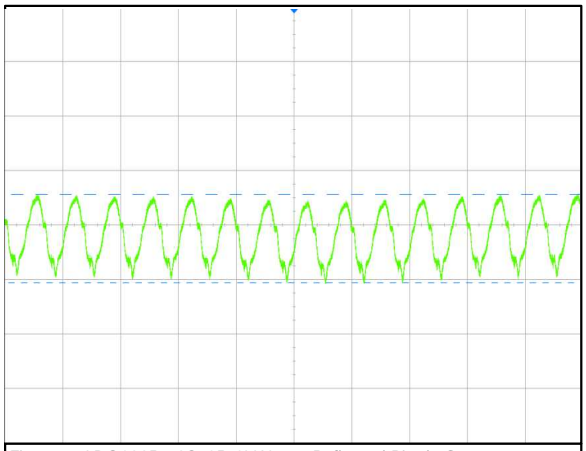


Figure 1: ADQ600B-48S12B-6LK Input Reflected Ripple Current
Vin = 48Vdc Load: Io = 50A
Ch 1: Iin (5uS/div, 50mA/div)

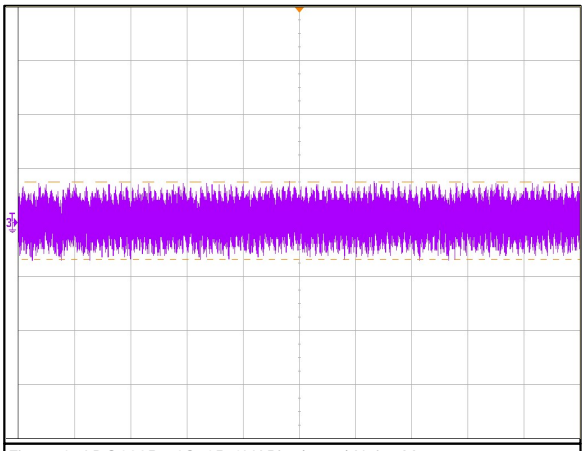


Figure 2: ADQ600B-48S12B-6LK Ripple and Noise Measurement
Vin = 48Vdc Load: Io = 50A
Ch 3: Vo (1ms/div, 50mV/div)

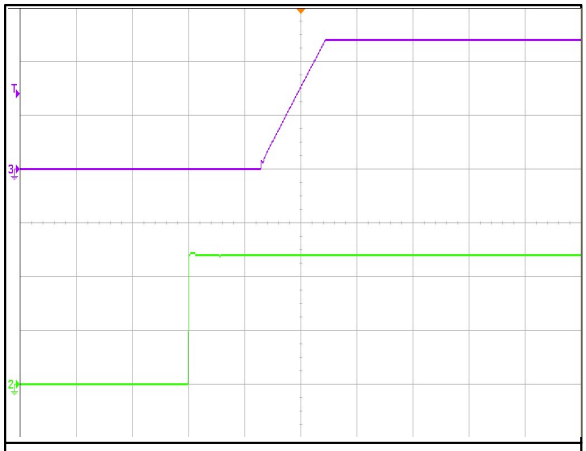


Figure 3: ADQ600B-48S12B-6LK Output Voltage Startup Characteristic
Vin = 48Vdc Load: Io = 50A (50mS/div)
Ch 2: Vi (20V/div) Ch 3: Vo (5V/div)

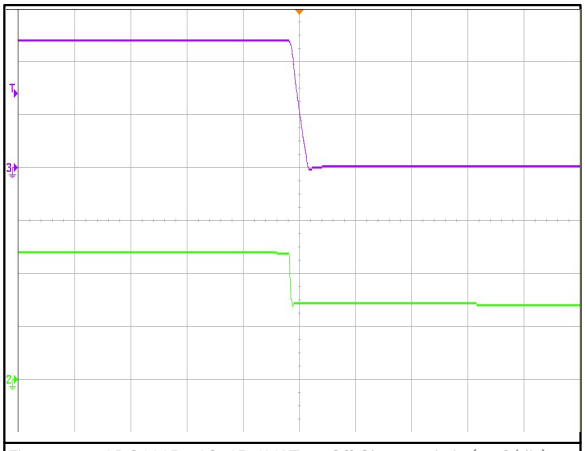


Figure 4: ADQ600B-48S12B-6LK Turn Off Characteristic (5mS/div)
Vin = 48Vdc Load: Io = 50A
Ch 2: Vi (20V/div) Ch 3: Vo (5V/div)

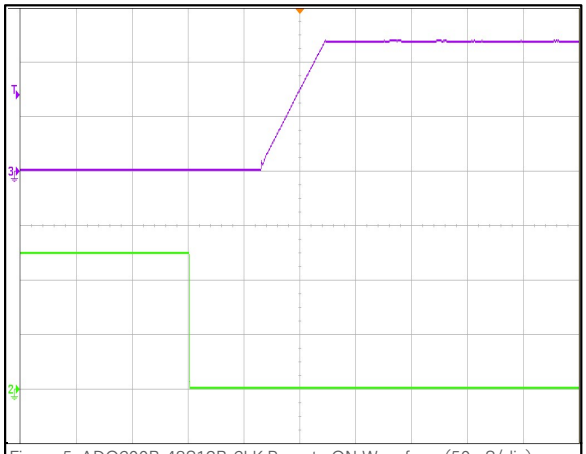


Figure 5: ADQ600B-48S12B-6LK Remote ON Waveform (50mS/div)
Vin = 48Vdc Load: Io =50A
Ch 2: Remote ON (2V/div) Ch 3: Vo (5V/div)

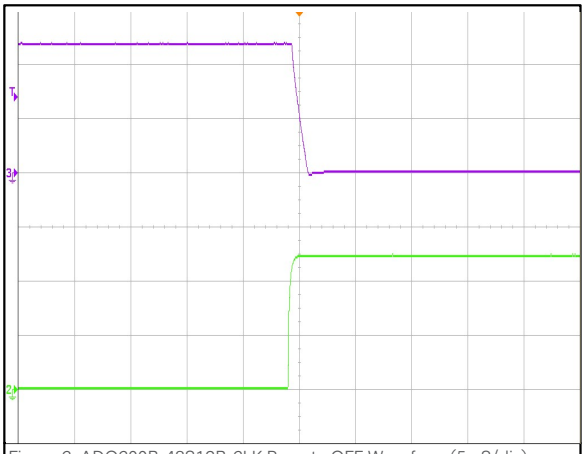


Figure 6: ADQ600B-48S12B-6LK Remote OFF Waveform (5mS/div)
Vin = 48Vdc Load: Io = 50A
Ch 2: Remote OFF (2V/div) CH3: Vo (5V/div)

Electrical Specifications

ADQ600B-48S12B-6LK Performance Curves

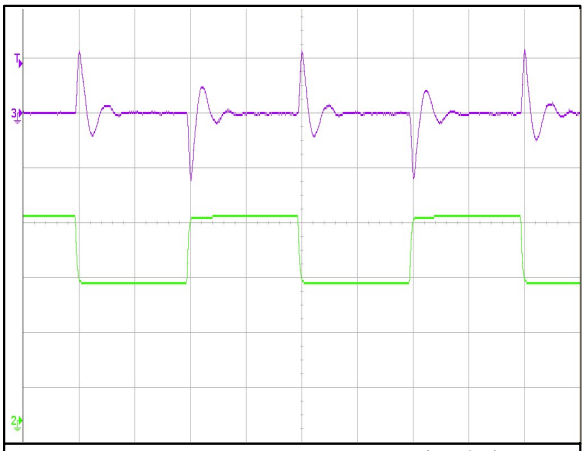


Figure 7: ADQ600B-48S12B-6LK Transient Response (2mS/div)
50%~75%~50% load change, 0.1A/uS slew rate, Vin = 48Vdc
Ch 2: Io (10A/div) Ch 3: Vo (200mV/div)

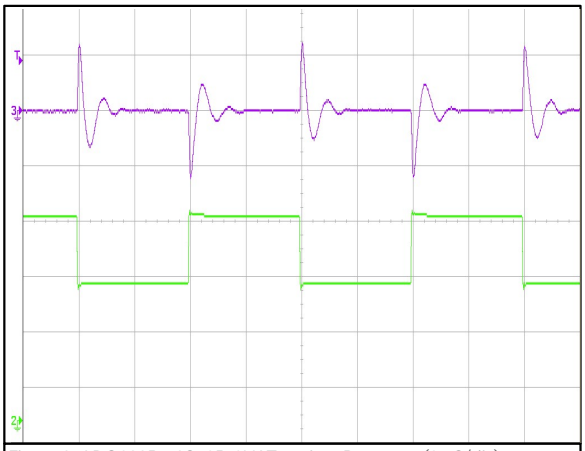


Figure 8: ADQ600B-48S12B-6LK Transient Response (2mS/div)
50%~75%~50% load change, 1A/uS slew rate, Vin = 48Vdc
Ch 2: Io (10A/div) Ch 3: Vo (200mV/div)

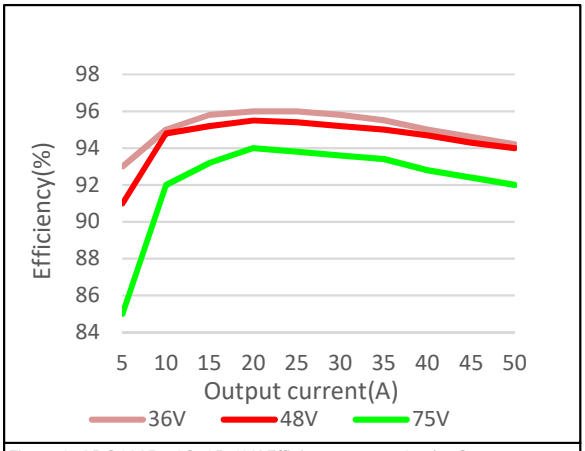


Figure 9: ADQ600B-48S12B-6LK Efficiency curve@25 degC
Loading: Io=5~50A

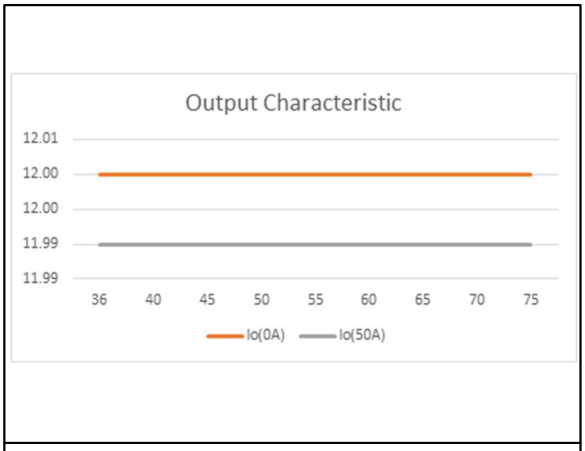


Figure 10: ADQ600B-48S12B-6LK Output Characteristic
Loading: Io=0~50A

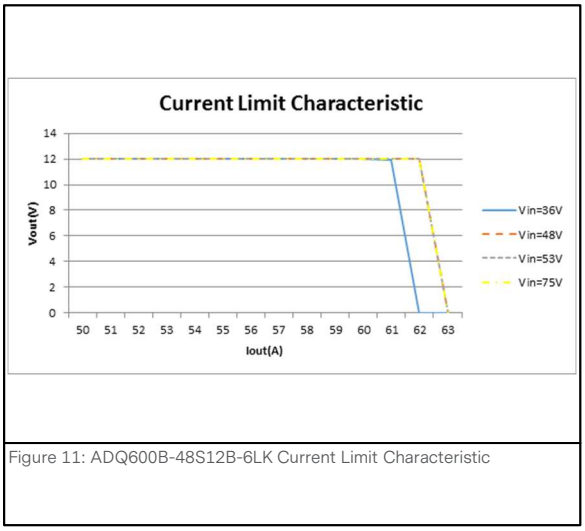
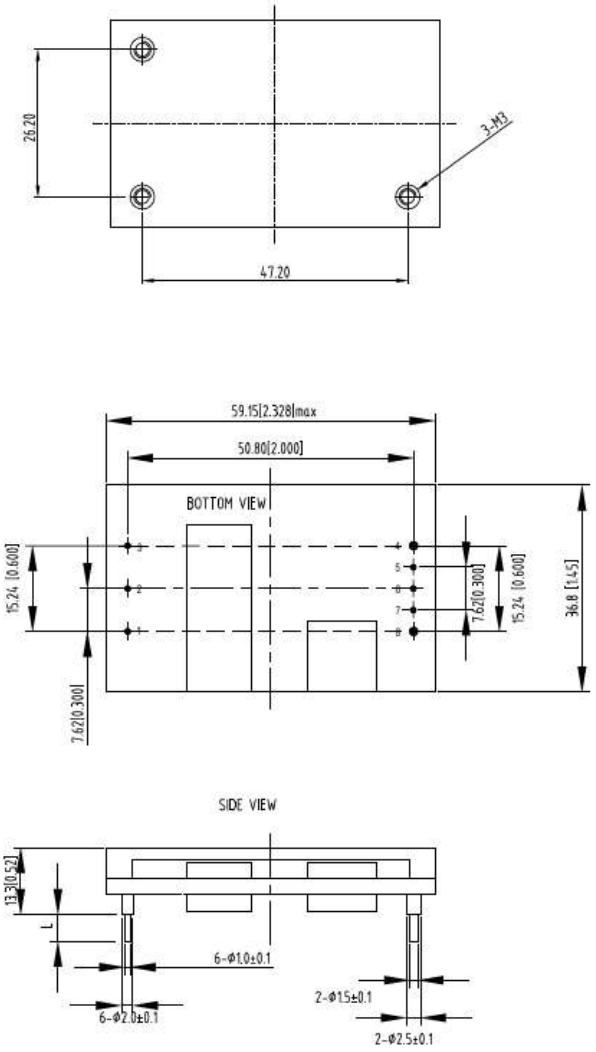


Figure 11: ADQ600B-48S12B-6LK Current Limit Characteristic

Mechanical Specifications

Mechanical Outlines – Baseplate Module



UNIT: mm[inch]

TOLERANCE: X.X mm±0.5 mm[X.XX in. ±0.02 in.]

X.XX mm±0.25 mm[X.XXX in. ±0.01 in.]

Pin length option

Table 4. 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

Mechanical Specifications

Pin Designations

Pin No	Name	Function
1	V_{IN}+	Positive input voltage
2	Remote ON/OFF	Remote control
3	V_{IN}-	Negative input voltage
4	V_O-	Negative output voltage
5	-Sense	Remote sense negative
6	trim	Voltage adjustment
7	+Sense	Remote sense positive
8	V_O+	Positive output voltage

Mechanical Specifications

Weight

The ADQ600B-48S12B-6LK weight is 80.3g.maximum.(65.7g.minmum)

Environmental Specifications

EMC Immunity

ADQ600B-48S12B-6LK power supply is designed to meet the following EMC immunity specifications:

Table 4. Environmental Specifications:

Document	Description	Criteria
EN55032, Class B Limits	Conducted EMI Limits	B
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 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 Figure20.

Environmental Specifications

Safety Certifications

The ADQ600B-48S12B-6LK 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 6. Safety Certifications for ADQ600B-48S12B-6LK series power supply system

Standard	Agency	Description
UL/CSA 62368	UL+CUL	US and Canada Requirements
EN62368	TUV-SUD	European Requirements
IEC62368	UL	International Requirements
CE	TUV-SUD	CE Marking
TUV	CE	Germany Requirements
UL94,V-0		flammability rating
UKCA Mark		UK Requirements

Environmental Specifications

Operating Temperature

The ADQ600B-48S12B-6LK 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

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 figure 12. The temperature at this point should not exceed the max values in the table 7.

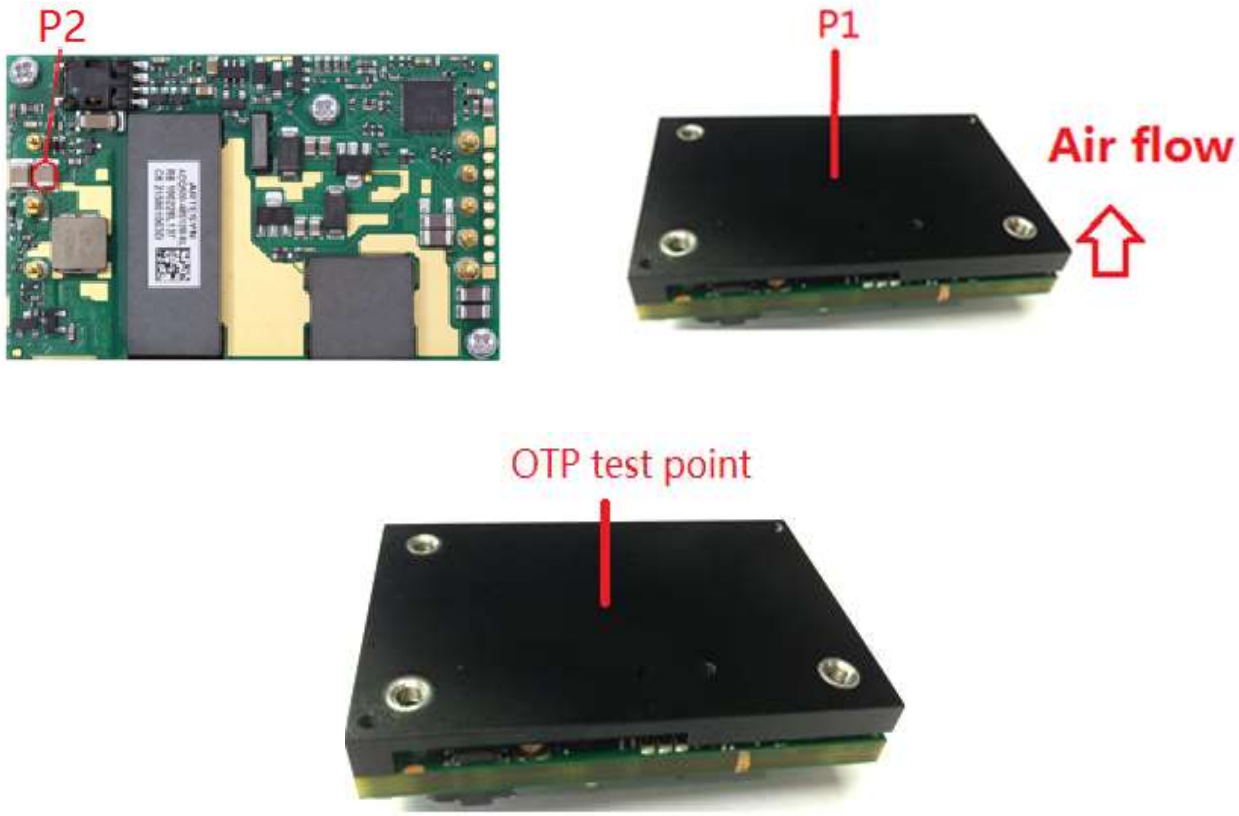


Figure 12 Thermal test points(TOP)

Table 7. Temperature limit of the test point	
Test Point	Temperature limit
P1	100 ^{O}C
P2	115 ^{O}C

Environmental Specifications

The typical test condition is shown in Figure 13.
For a typical application, figure 14 shows the derating of output current vs. ambient air temperature at different air velocity @48V input.

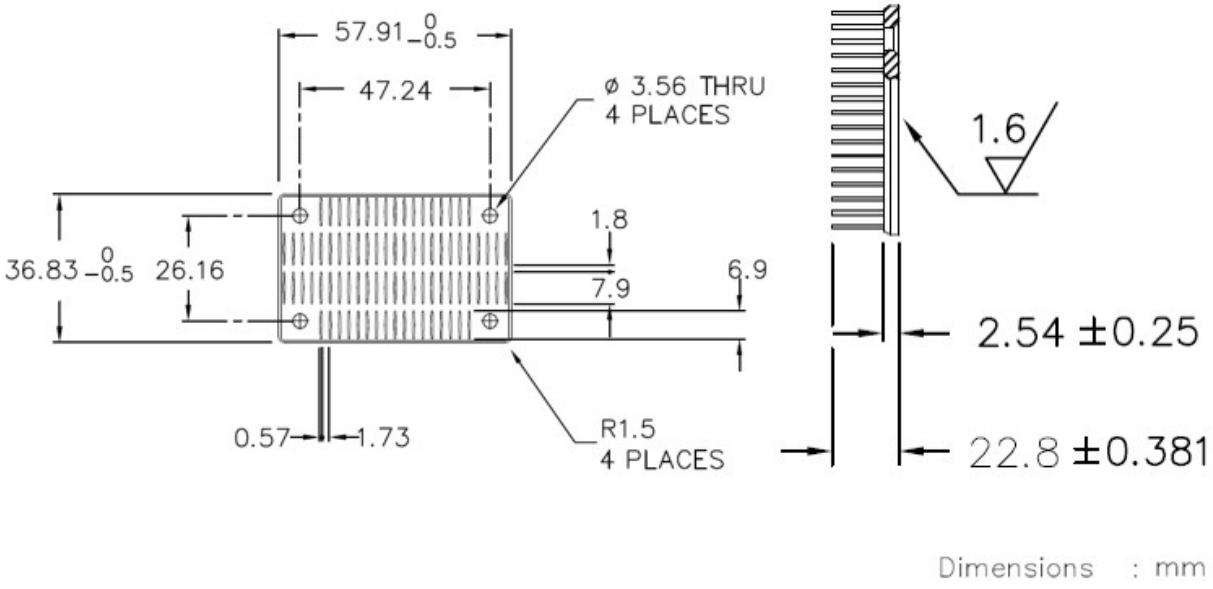


Figure 13 Typical test condition, heatsink

Environmental Specifications

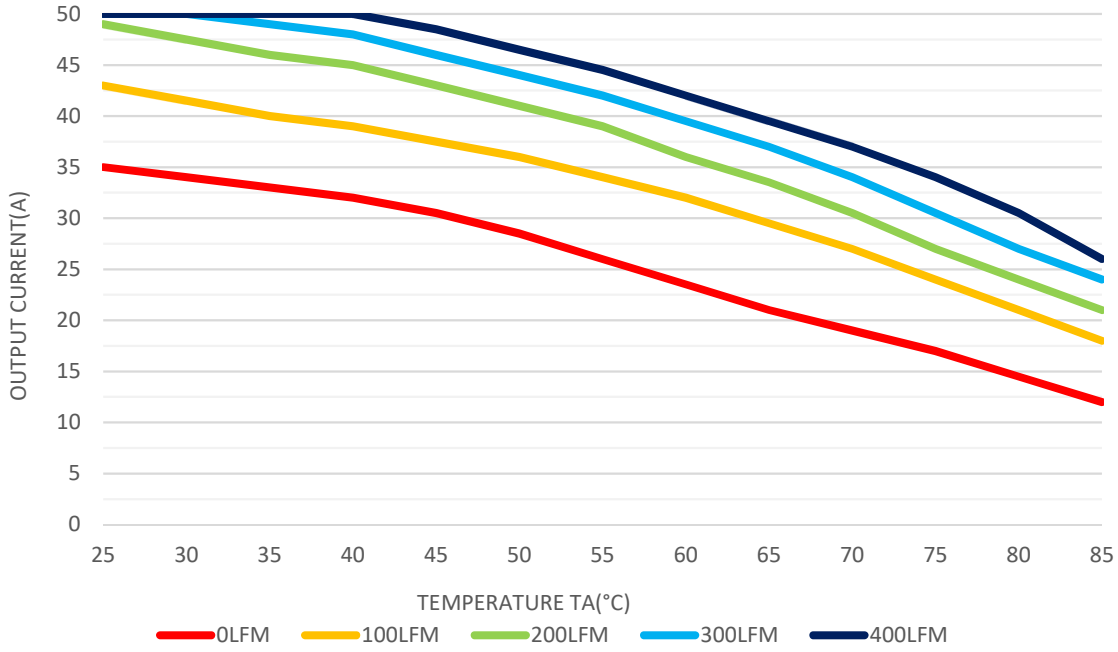


Figure 14 Output power derating, 48Vin, air flowing across the converter from V_{IN} - to V_{IN} +

Environmental Specifications

Qualification Testing

Table 8. Qualification testing		
Parameter	**Unit (pcs)**	**Test condition**
Halt test	3-4	$T_{a,min}$ -30 °C to $T_{a,max}$+20 °C, 5 °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. Non operational
Mechanical Shock	3	Half sine, Acceleration: 30g, 6ms, 3 axes, 6 directions, 3 time/direction. Non operational
Thermal Shock	3	-55 °C to 125 °C, Temp Dwell Time: 30min, Temp change rate: 20 °C/min, unit temperature 20 cycles. Non operational
Thermal Cycling	3	-40 °C to 85 °C, temperature change rate: 1°C/min, cycles: 2cycles
Humidity	3	40 °C, 95%RH, 48h
Solder Ability	15	IPC J-STD-002C-2007

Application Notes

Typical Application

Below is the typical application of the ADQ600B-48S12B-6LK series power supply.

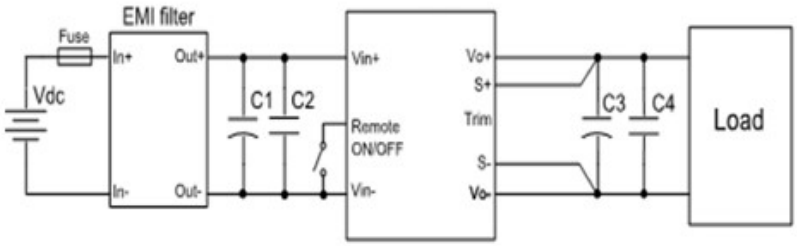


Figure 15 Typical application

C1: 220μF/100V electrolytic capacitor, P/N: UPM2A221MPD (Nichicon) or equivalent caps
C2: 1μF/100V X7R ceramic capacitor, P/N: C3225X7R2A105KT0L0U (TDK) or equivalent caps
C3: 2200uF Al electrolytic
C4: 22uF/16V X7R ceramic capacitor *137(about 3000uF),P/N: C3225X7R1C226KT000N (TDK) or equivalent caps type
Fuse: External fast blow fuse with a rating of 30A/250Vac. The recommended fuse model is 0314030 MRP from Karwin Tech limited.
EMI filter: Refer to figure 20

Remote ON/OFF

Negative remote ON/OFF logic is available in ADQ600B-48S12B-6LK. The logic is CMOS and TTL compatible. Below is the detailed internal circuit and reference in ADQ600B-48S12B-6LK.

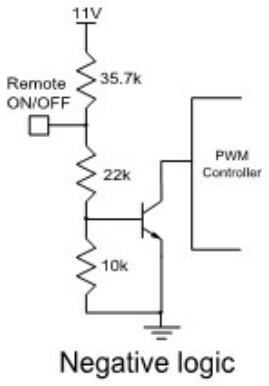


Figure 16 Remote ON/OFF internal diagram

Remote Sense

If the load is far from the unit, connect S+ and S- to the terminal of the load respectively to compensate the voltage drop on the transmission line. See Figure 15. If the sense compensate function is not necessary, connect S+ to Vo+ and S- to Vo- directly.

Application Notes

Trim Characteristics

To increase or decrease the output voltage set point, connect an external resistor between the TRIM pin and either the Vo+ or Vo-. The TRIM pin should be left open if this feature is not used. Below Trim equation is only adapt to the module without droop current sharing option code; For the module with droop current sharing option code, please contact Artesyn's technical support team. Connecting an external resistor between Trim pin and Vo- pin will decrease the output voltage. While connection it between Trim and Vo+ will increase the output voltage. The following equations determine the external resistance to obtain the trimmed output voltage.

$$R_{adj-down} = \frac{511}{\Delta} - 10.22(K\Omega)$$

$$R_{adj-up} = \frac{5.11 \times V_{nom} \times (100 + \Delta)}{1.225 \times \Delta} - \frac{511}{\Delta} - 10.22(K\Omega)$$

Δ : Output e rate against nominal output voltage.

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

V_{norm} : Nominal output voltage.

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

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

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

$$R_{adj-up} = \frac{5.11 \times 12 \times (100 + 10)}{1.225 \times 10} - \frac{511}{10} - 10.22 = 489.3(K\Omega)$$

$$V_O = (V_{trim} + 1.225) \times 1.347$$

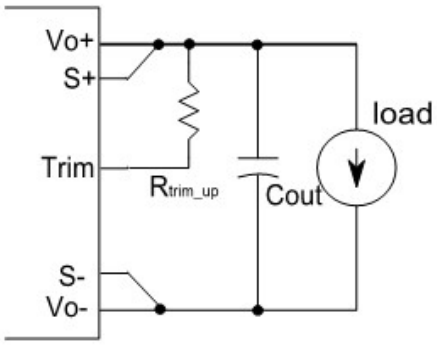


Figure 17 Trim up

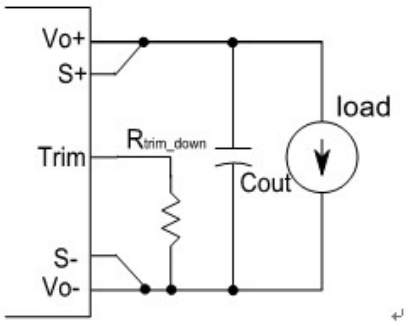


Figure 18 Trim down

Where is the potential applied at the Trim pin, and Vo is the desired output voltage. When trimming up, the output current should be decreased accordingly so as not to exceed the maximum output power.

Application Notes

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

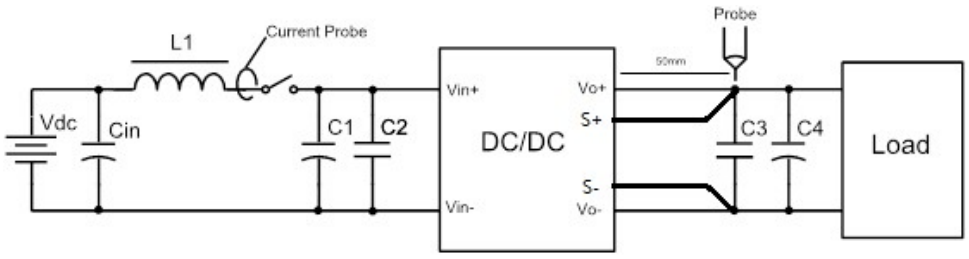


Figure 19 Input ripple & inrush current output ripple & noise test configuration

Vdc: DC power supply

L1: 12μH

Cin: 220μF/100V typical

C1 ~ C4: See Figure 15

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

EMC test conditions

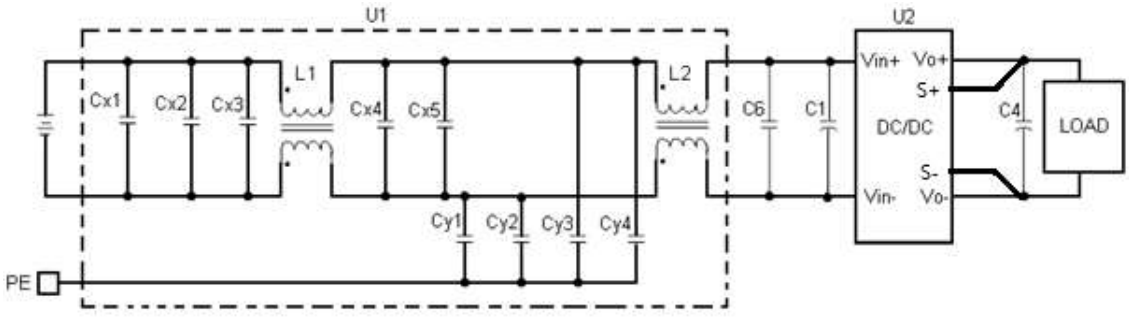


Figure 20 EMC test configuration

U1: Input EMC filter
U2: Module to test, ADQ600B-48S12B-6LK
C_{X1} :1000nF/100V/X7R capacitor*2
C_{X2} :1000nF/100V/X7R capacitor
C_{X4}:1000nF/100V/X7R capacitor*3
C_{X3},C_{X5}: 2200nF/100V/X7S capacitor
C_{y1}, C_{y2}, C_{y3}, C_{y4}: 0.47μF/630V/X7T, Y capacitor*2
L1, L2: 473μH, common mode inductor
C6: 1000nF/100V/X7R capacitor
C1: 220μF/100V electrolytic capacitor
C4: See Figure 15

Application Notes

Soldering

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 255 ^{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 similative.

Record of Revision and Changes

Issue	Date	Description	Originators
1.0	04.20.2020	First Issue	H. Fang/ K. Wang
1.1	06.30.2020	Add two curves at page 8	K. Wang
1.2	02.04.2020	New Template	J. Zhang
1.3	05.20.2022	Add UKCA Mark	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.

PRECISION | POWER | PERFORMANCE

For international contact information,
visit advancedenergy.com.

powersale@aei.com (Sales Support)
productsupport.ep@aei.com (Technical Support)
+1 888 412 7832

ADQ600B-48S12B-6LK - Rev.05.20.22_#1.3