ARTESYN ADO550-48S10B-4L SERIES

550 Watts 1/8 Brick Converter

PRODUCT DESCRIPTION

Advanced Energy's Artesyn ADO550-48S10B-4L is a single output digital control, fully regulated control topology DC/DC converter with standard eighth-brick outline and pin configuration. It delivers up to 55A output current with 10.1V output voltage. Above 96.5% ultra-high efficiency and excellent thermal performance makes it an ideal choice to supply power in telecom and datacom. It can work under -20^{O}C ~ +85^{O}C with air cooling.

AT A GLANCE

Total Power

550 Watts

Input Voltage

45 to 56 Vac

# of Outputs

Single

RoHS

SPECIAL FEATURES

- Delivers up to 55A output current
- Ultra-high efficiency 96.5% typ. at 70% load
- Parallel with droop current sharing
- Startup Pre-bias
- Wide input range: 45V to 56V
- Fully regulated output voltage
- Excellent thermal performance
- Power Good (PG) feature
- No minimum load requirement
- RoHS 3.0
- With baseplate
- Remote control function (negative logic option)
- Pin length option: 4.8mm
- Input under voltage lockout
- Input over voltage lockout
- Output over current protection
- Output over voltage protection
- Over temperature protection
- Industry standard eighth-brick pin-out outline

SAFETY

- CE EN60950
- UL94,V-0

TYPICAL APPLICATIONS

- Datacom
- Telecom

MODEL NUMBERS

Standard	Output Voltage	Structure	RoHS Status	PMBus™
ADO550-48S10B-4L	10Vdc	Baseplate	RoHS 3.0	No

Order Information

ADO550	-	48	S	10	B	-	4	L
①		②	③	④	⑤		⑥	⑦

①	Model series	ADO: high efficiency digital control eighth brick series, 550: output power 550W
②	Input voltage	48: 45V ~ 56V input range, rated input voltage 48V
③	Output number	S: single output
④	Rated output voltage	10: 10V output
⑤	Baseplate status	B: with baseplate; default: open frame
⑥	Pin length	-4: 4.8mm
⑦	RoHS status	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	$V_{IN,DC}$	-	-	56	Vdc
Non-operating -100mS	All		-	-	80	Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	500	W
Isolation Voltage[1]						
Input to output	All		-	-	800	Vdc
Ambient Operating Temperature	All	T_A	-20	-	+85	^{O}C
Short-Term Operating Temperature						
96 hours/year	All		-20	-	+90	^{O}C
Storage Temperature	All	T_{STG}	-40	-	+125	^{O}C
Voltage at remote ON/OFF pin	All		-	-	20	Vdc
Humidity (non-condensing)						
Operating	All		-	-	90	%
Non-operating	All		-	-	90	%

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

ELECTRICAL SPECIFICATIONS

Input Specifications

Table 2. Input Specifications:

Parameter		Conditions	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, DC		All	$V_{IN,DC}$	45	48	56	Vdc
Input under-voltage lockout	Turn-on Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,ON}$	41	-	45	Vdc
	Turn-off Voltage Threshold	$I_O = I_{O,max}$	$V_{IN,OFF}$	40	-	42.5	Vdc
	Lockout voltage hysteresis	All		1.5	-	3	Vdc
Input over-voltage lockout	Input OVP	All		60	-	64	Vdc
	Input OVP recovery voltage	All		57	-	63	Vdc
	Hysteresis	All		1	-	3	Vdc
Maximum Input Current		$V_{IN,DC}$ = 45Vdc $I_O = I_{O,max}$	$I_{IN,max}$	-	-	13.5	A
No Load Input Current			I_{IN,no_load}	-	0.11	-	A
Standby Input Current		Remote OFF	$I_{IN,Standby}$	-	0.04	0.2	A
Recommended Input Fuse		Fast blow external fuse recommended		-	-	25	A
Input filter component values (C\L)		Internal values	C_{IN}	-	9.4/0.2	-	µF\µH
Recommended External Input Capacitance		Low ESR capacitor recommended	C_{IN}	220	-	500	uF
Inrush current transient rating [1]		All	$\%I_{IN}$	-	-	50	%
Input Reflected Ripple Current		Through 12uH inductor		-	70	-	mA
Efficiency		T_A=25 °C Airflow = 800LFM $V_{IN} = V_{IN,nom}$ $I_O = 100I_{O,max}$ $I_O = 70\%I_{O,max}$	η	- -	96.2 96.5	- -	%

Note 1 - Inrush Current is defined as the peak current drawn by the unit when unit is enabled after V_{IN} is present. I_{IN} is defined as the steady-state operating current when unit is operating under the same conditions. While V_O is rising, P_O is <25% of Rated Power with a resistive load.

ELECTRICAL SPECIFICATIONS

Output Specifications

Table 3. Output Specifications

Parameter		Condition[1]	Symbol	Min	Typ	Max	Unit
Factory Set Voltage		$V_{IN,DC}$ = 48V I_O=50%$I_{O,max}$	V_O	10.21	10.26	10.31	Vdc
Total output voltage range		Over sample, line, load, temperature & life	V_O	9.6	10.26	11.2	mV
Output Voltage Line Regulation		$V_{IN,min}$ to $V_{IN,max}$	$\pm V_O$	-	25	70	mV
Load droop Regulation		$I_{O,min}$ to $I_{O,max}$	$\pm V_O$	-	380	500	mV
Output Voltage Temperature Regulation		All	$\%V_O$	-	0.002	0.02	%/^{O}C
Output Ripple and Noise		20MHz bandwidth	V_O	-	-	150	mV_{PK-PK}
Output Current		All	I_O	0	-	55	A
Output DC current-limit inception[1]			I_O	60.5	-	77	A
Output Capacitance[2]		All	C_O	470	-	3470	uF
V_O Dynamic Response	Peak Deviation	25% load change 25%~50%~25% slew rate = 1A/us	$\pm V_O$	- -	330 500	- -	mV uSec
	Settling Time	25% load change 50% ~ 75% ~ 50% slew rate = 1A/us	$\pm V_O$ T_s	- -	330 500	- -	mV uSec
Turn-on transient	Rise time	I_O = I_{max}	T_{rise}	-	-	15	mS
	Turn-on delay	From V_{IN} reaching Turn-On voltage		-	-	30	mS
	Turn-on delay	From Enable asserted		-	4	-	mS
	Overshoot	All	$\pm V_O$	-	-	350	mV
	Undershoot	All	$\pm V_O$	-	-	350	mV

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

Note 2 - Recommended to be used with 22uF *5 PCS Cap + OScon or POSCAP

ELECTRICAL SPECIFICATIONS

Output Specifications Con't

Table 3. Output Specifications, con't:

Parameter		Condition	Symbol	Min	Typ	Max	Unit
Remote ON/OFF control (Negative logic)	Off-state voltage	All		2.4	-	20	V
	On-state voltage			-0.3	-	0.8	V
	Current (out of pin) On			-	-	200	uA
	Current (out of pin) Off			-	-	10	uA
Switching frequency			f_{SW}	-	185	-	KHz
Output over-voltage protection[3]		All	V_O	11.8	-	15	V
Output over-temperature protection[4]		All	T	100	125	130	^{O}C
Parallel unit		All		-	-	2	Units
Current share accuracy		I_O= (0%-160%) $I_{O,max}$		-	-	10	%
Pre-bias		I_O = 0 Vo means full load output voltage at 48V V_{IN}	$\%V_O$	0	-	100	%
Power Good voltage[5]	High state voltage	All		2.4	-	5.5	V
	Low state voltage	All		0	-	0.8	V
Power Good leakage current	High level	All		0	-	10	uA
	Low level	All		0	-	5	mA
Power Good Signal De-assert Response Time[6]		All		0	-	1.0	mS
Calculated MTBF		Airflow = 300LFM T_A =40^{O}C V_{IN}= $V_{IN,nom}$ I_O = 80%$I_{O,max}$ Telcordia,SR332 Method 1 Case3		-	2	-	10^6 h

Note 3 - Hiccup: auto-restart when over-voltage condition is removed.
Note 4 - Auto recovery. See Figure 12 OTP test point.
Note 5 - The Power-Good signal must be a non-latching open-collector output that is Low during normal operation. Power-Good signal is referenced to Vout(-).
Note 6 - Power-Good Signal De-assert Response Time is defined as the duration between the fault occurring and the Power-Good Signal de-asserting.

ELECTRICAL SPECIFICATIONS

ADO550-48S10B-4L-6L Performance Curves

Figure 1: ADO550-48S10B-4L Ripple and Noise Measurement

Ch 4: Vo (5uS/div, 50mV/div)

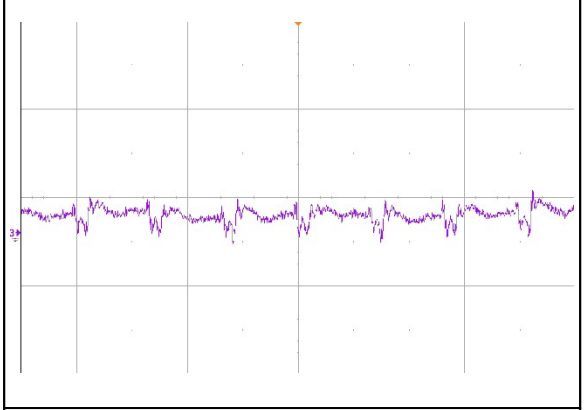


Figure 2: ADO550-48S10B-4L Input reflected ripple current

Ch 3: Io (2uS/div, 50mA/div)

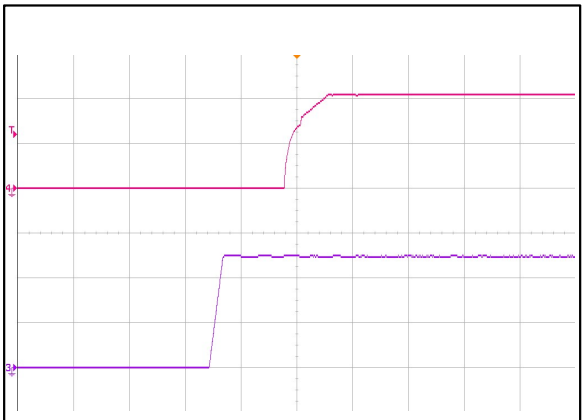


Figure 3: ADO550-48S10B-4L typical start-up from power on
Vin=48V, Vo=10.1V

Ch 3: Vin Ch 4: Vo (20ms/div)

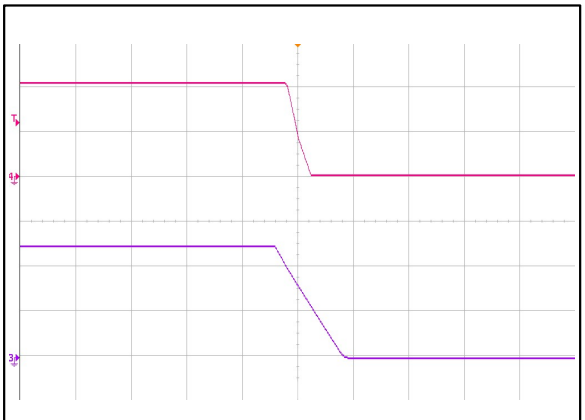


Figure 4: ADO550-48S10B-4L typical shut down from power off
Vin=48V, Vo=10.1V

Ch 3: Vin Ch 4: Vo (100ms/div)

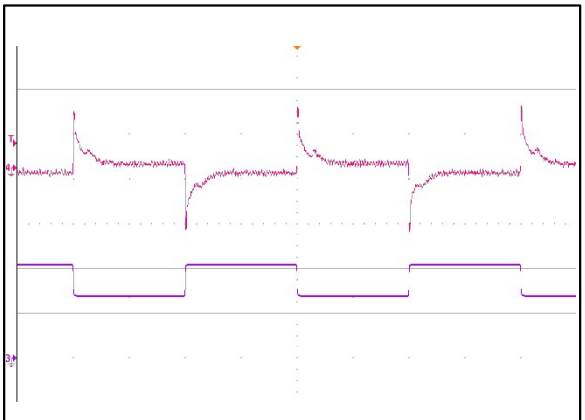


Figure 5: ADO550-48S10B-4L Transient Response
50%-75%-50% load change, 0.1A/uS slew rate, 2mS/div

Ch 3: Io (20A/div) Ch 4: Vo (200mV/div)

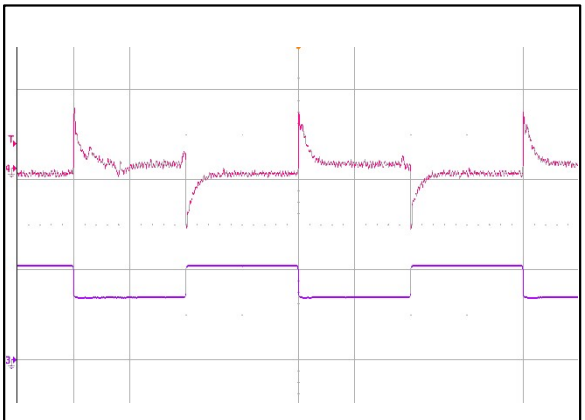


Figure 6: ADO550-48S10B-4L Transient Response
50%-75%-50% load change, 1A/uS slew rate, 2mS/div

Ch 3: Io (20A/div) Ch 4: Vo (200mV/div)

ELECTRICAL SPECIFICATIONS

ADO550-48S10B-4L Performance Curves

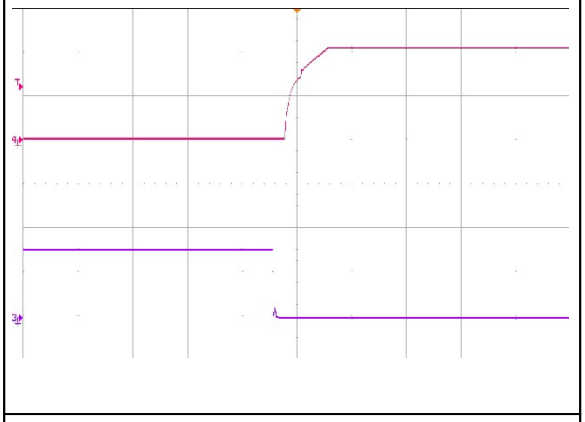


Figure 7: ADO550-48S10B-4L typical start-up by remote ON
Vo=10.1V
Ch 3: Remote ON (2V/div) Ch 4: Vo (200mS/div)

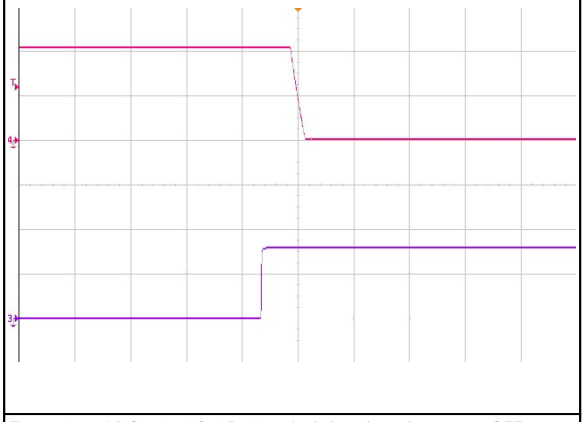


Figure 8: ADO550-48S10B-4L typical shut down by remote OFF
Vo=10.1V
Ch 3: Remote ON (2V/div) Ch 4: Vo (200mS/div)

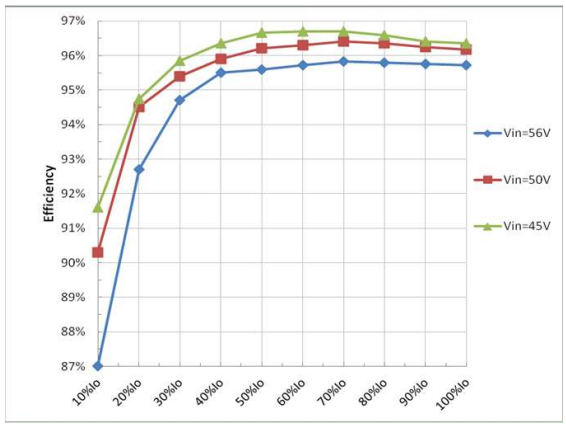


Figure 9: ADO550-48S10B-4L Efficiency Curves @ 25 degC

Loading: Io = 10% increment to 55A

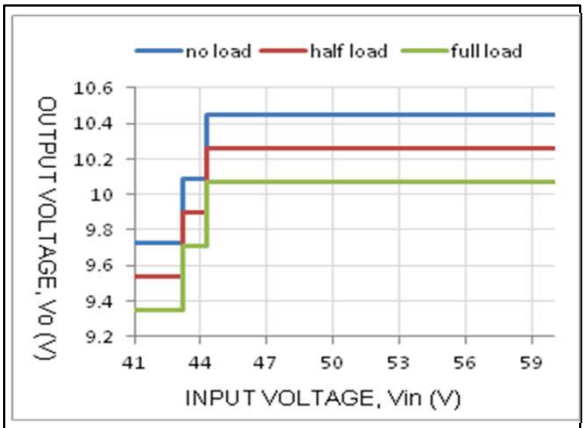


Figure 10: ADO550-48S10B-4L Typical output voltage regulation vs. input Voltage, TA = 25 °C

ELECTRICAL SPECIFICATIONS

Protection Function Specifications

Input Fusing

An external fuse is recommended. To meet international safety requirements, a 250V rated fuse should be used. Recommended rating is 25A for the converter.

Note: The fuse is fast blow type.

Over Voltage Protection (OVP)

The output over-voltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over voltage protection threshold, then the converter will work on hiccup mode. When the over-voltage condition is removed, the converter will automatically restart.

Parameter	Min	Nom	Max	Unit
V_O Output Overvoltage	11.8	/	15.0	V

Over Current Protection (OCP)

When output current exceeds 110 to 140% of rated current, the converter will work on hiccup mode. When the over-current condition is removed, the converter will automatically restart.

Parameter	Min	Nom	Max	Unit
V_O Output Overcurrent	60.5	/	77.0	A

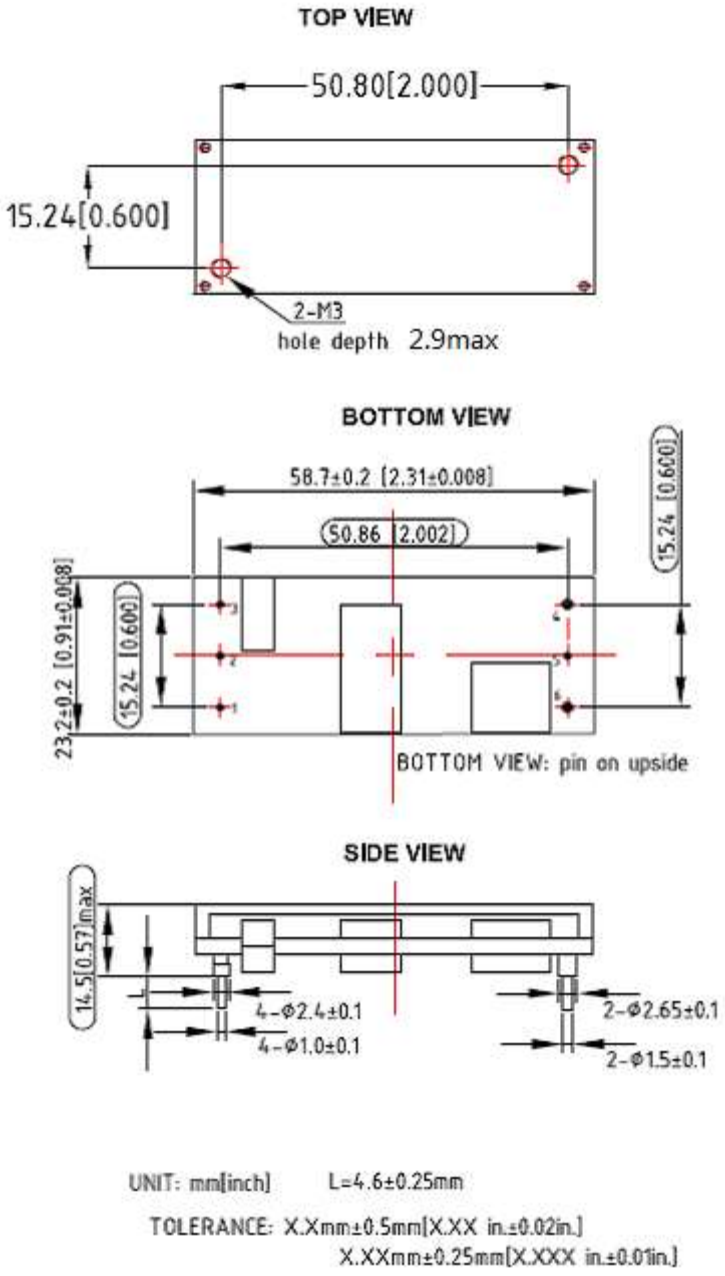
Over Temperature Protection (OTP)

The converter features an over-temperature protection circuit to safeguard against thermal damage. The converter will shutdown when the maximum device reference temperature is exceeded. When the over-temperature condition is removed, the converter will automatically restart.

Parameter	Min	Nom	Max	Unit
V_O Output Over Temperature	100	125	130	^{O}C

MECHANICAL SPECIFICATIONS

Mechanical Outlines



UNIT: mm[inch] L=4.6±0.25mm

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

MECHANICAL SPECIFICATIONS

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	Vin+	Positive input voltage
2	Remote On/Off	Remote control
3	Vin-	Negative input voltage
4	Vo-	Negative output voltage
5	PG	Power Good
6	Vo+	Positive output voltage

ENVIRONMENTAL SPECIFICATIONS

EMC Immunity

ADO550-48S10B-4L series power supply is designed to meet the following EMC immunity specifications.

Table 4. Environmental Specifications

Document	Description	Criteria
EN55022, Class B Limits	Conducted Emission – DC input port	/
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 Line to Ground (earth) and 600V Line to Line 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.

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.

Recommend EMC test Conditions

The EMC test conditions diagram is shown in Figure 15.

ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The ADO550-48S10B-4L 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 ADO550-48S10B-4L power supply system

Document	Description
UL/CSA 60950	US and Canada Requirements
EN60950	European Requirements
IEC60950	International Requirements
TUV	International Requirements
UL94	Materials meet V-0 flammability rating
CE	CE Marking Meets the Low Voltage directives 2006/95/EEC with the Amendment Directive 93/68/EEC which facilitates CE marking in user's end product

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature

The ADO550-48S10B-4L series module will start and operate within stated specifications at an ambient temperature from -20 °C to 85 °C under all load conditions. The storage temperature is -40 °C to 125 °C.

Thermal Considerations - Base plate 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 figure 12. The temperature at this point should not exceed the max values in the table 6. The converter can also operate with a smaller heatsink and sufficient airflow. The heatsink is shown in Figure 13.

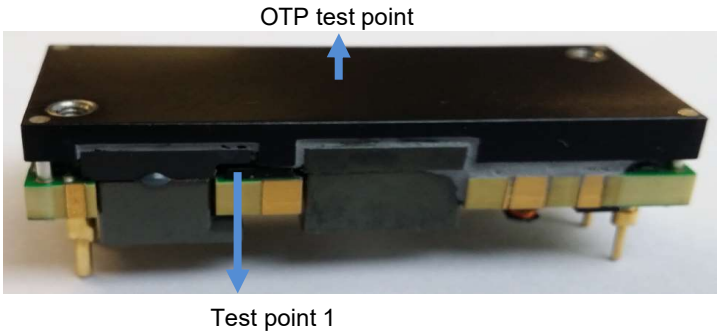


Figure 12 Temperature test point

Table 6. Temperature limit of the test point

Test Point	Temperature Limit (°C)
OTP test point	120
Test point 1	129

ENVIRONMENTAL SPECIFICATIONS

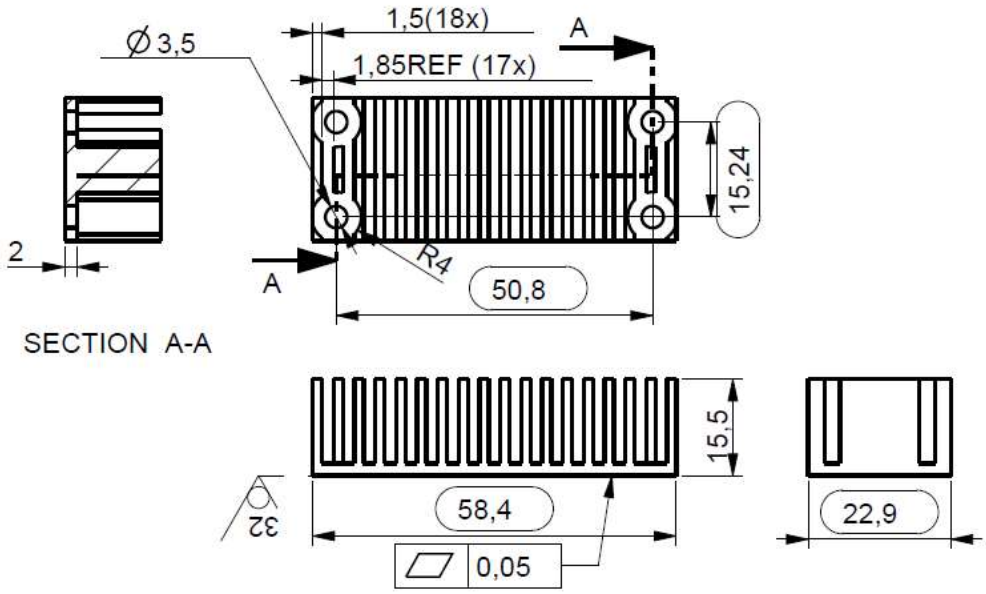


Figure 13 Typical 0.6" Heatsink

For a typical application, figure 14 shows the derating of output current vs. ambient air temperature at different air velocity with a heatsink. The heatsink specification is shown in Figure13. The typical test condition is shown in Figure 14

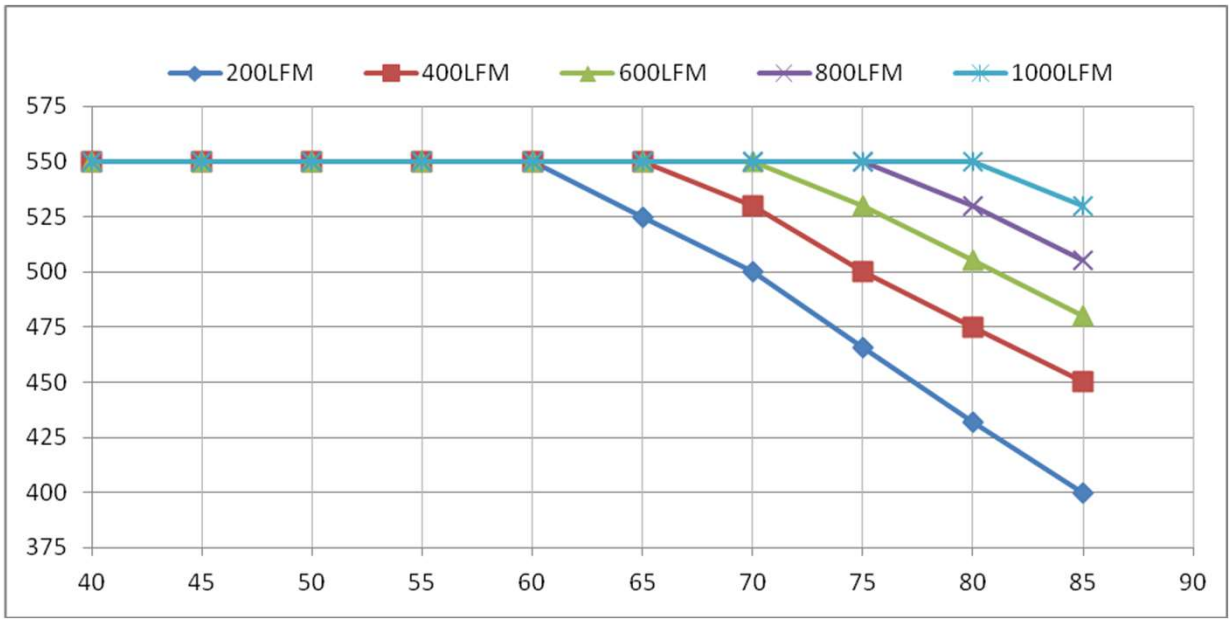


Figure 14 ADO550-48S10B-4L with 0.6" heatsink Output power derating, 50Vin，
air flowing across the converter from Vin- to Vin+

ENVIRONMENTAL SPECIFICATIONS

Parameter	Unit (pcs)	Test condition
Halt test	4-5	$T_{a,min}$-50 ^{O}C to $T_{a,max}$+10 ^{O}C, 5 ^{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/axis
Mechanical Shock	3	30g, 6ms, 3axes, 6directions, 3time/direction
Thermal Shock	3	-40 ^{O}C to 100 ^{O}C, unit temperature 20cycles
Thermal Cycling	3	-20 ^{O}C to 90 ^{O}C, temperature change rate: 1^{O}C/min, cycles: 2cycles
Humidity	3	40 ^{O}C, 90%RH, 48h
Solder Ability	15	IPC J-STD-002C-2007

APPLICATION NOTES

Typical Application

Below is the typical application of the ADO550-48S10B-4L series power supply.

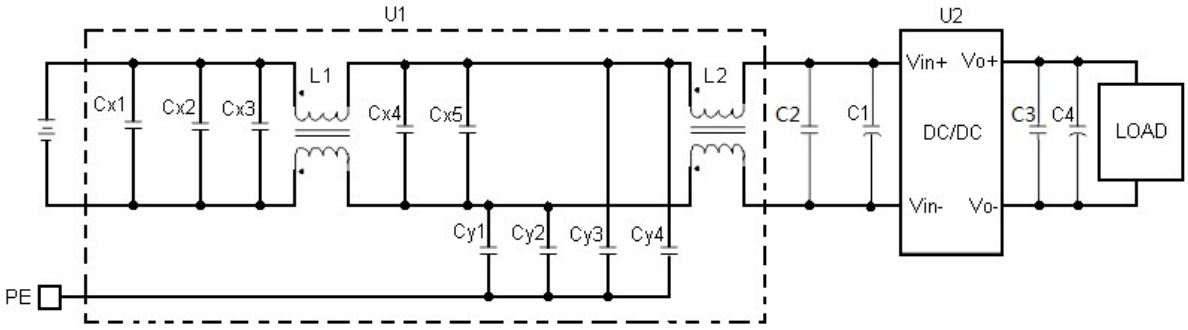


Figure 15 Typical application

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

C2: 1μF/100V/X7R capacitor

C3: 22uF/16V/X7S *5 PCS capacitor

C4: 1000μF/25V electrolytic capacitor, P/N: OScon or POSCAP

U1: Input EMC filter

U2: Module to test, ADO550-48S10B-4L

CX1, CX2, CX3, CX4, CX5: 1μF/100V/X7R capacitor

Cy1, Cy2, Cy3, Cy4: 0.88μF/630V/X7R, Y capacitor

L1, L2: 473μH, common mode inductor

Fuse: External fast blow fuse with a rating of 25A/250Vac. The recommended fuse model is 0314025.P from Karwin Tech limited.

APPLICATION NOTES

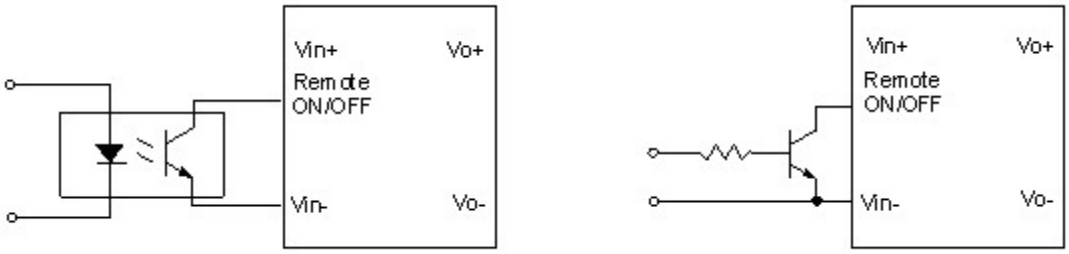
Remote ON/OFF

Negative remote ON/OFF logic is available in ADO550-48S10B-4L. The logic is CMOS and TTL compatible.

Remote ON/OFF (ENABLE) can be controlled by an external switch between the on/off terminal and the Vin(-) terminal. The switch can be an open collector or open drain.

The voltage between pin Remote ON/OFF and pin Vin- must not exceed the range listed in table “Output Specifications” to ensure proper operation. The external Remote ON/OFF circuit is highly recommended as shown in figure 16.

For the negative logic, if the remote ON/OFF (ENABLE) feature is not used, please maintain the ENABLE pin to Vin(-).



Isolated remote ON/OFF circuit

Non-isolated remote ON/OFF circuit

Figure 16 External Remote ON/OFF circuit

APPLICATION NOTES

Parallel and Droop Current Sharing

The modules are capable of operating in parallel, and realizing current sharing by droop current sharing method. There is about 400mV output voltage droop from 0A to full output Load, and there is no current sharing pin. By connecting the Vin pin and the Vo pin of the parallel module together, the current sharing can be realized automatically.

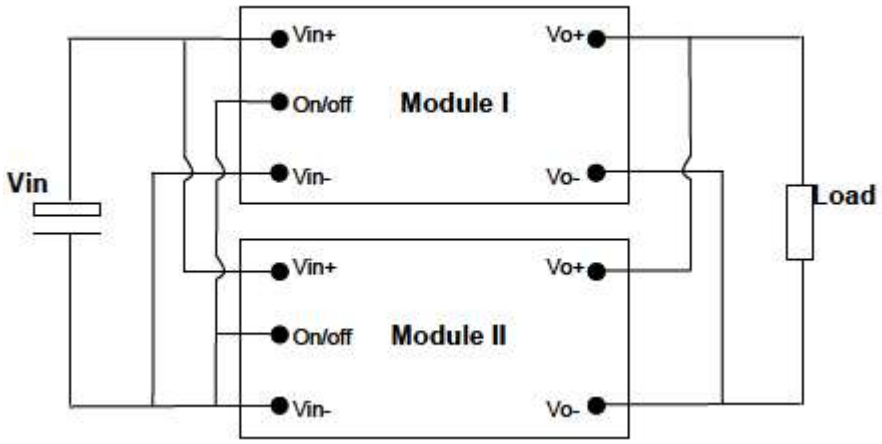


Figure 17 Parallel and droop current sharing configuration for no redundancy requirement system

If system has no redundancy requirement, the module can be connected in parallel directly for higher power delivery without adding external oring-fet; whereas, if redundancy is required, the external oring-fet should be added.

For a normal parallel operation the following precautions must be observed:

1. The current sharing accuracy equation is:
X% = | Io – (Itotal / N) | / Irated, Where,
Io is the output current of per module;
Itotal is the total load current;
N is parallel module numbers;
Irated is the rated full load current of per module.

2. To ensure a better current sharing accuracy, the design guidelines below should be followed:
a) The inputs of the converters must be connected to the same voltage source; and the PCB trace resistance from Input voltage source to Vin+ and Vin- of each converter should be equalized as closely as possible.
b) The PCB trace resistance from each converter's output to the load should be equalized as closely as possible.
c) For accurate current sharing accuracy test, the module should be soldered into the host PCB in order to avoid any unbalance of the contact resistance between the modules and the host board.

3. To ensure the parallel module can start up monotonically without trigging the OCP circuit, the design guidelines should be followed:
a) Before the parallel modules have finished their start up and PG signal is asserted, the total load current should be lower than the rated current of 1 module.
b) The ON/OFF pin of the converters should be connected together to keep the parallel modules starting up at the same time.
c) The under voltage lockout point will slightly vary from unit to unit. The dv/dt of the rising edge of the input source voltage must be greater than 1V/ms to ensure that the parallel modules start up at the same time.

4. If fault tolerance is desired in parallel applications, output ORing devices should be used to prevent a failure of either module from collapsing the load bus.

APPLICATION NOTES

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

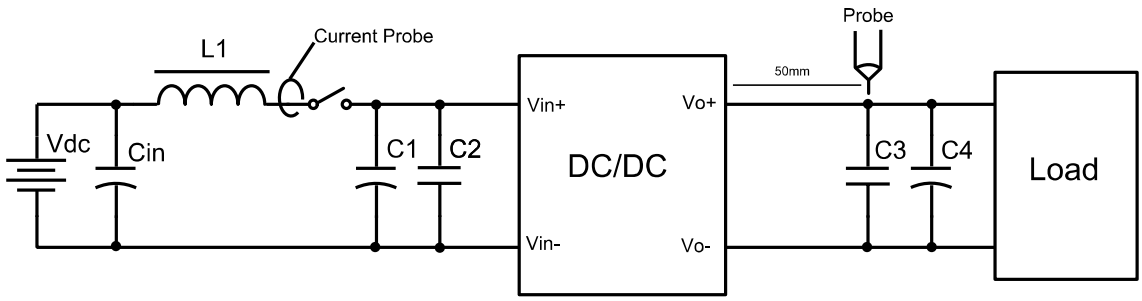


Figure 18 Input ripple & inrush current output ripple & noise test configuration

Vdc: DC power supply

L1: 12μH

Cin: 220μF/100V electrolytic capacitor

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

C2: 1μF/100V/X7R capacitor

C3: 22uF/16V/X7S *5 PCS capacitor

C4: 1000μF/25V electrolytic capacitor, P/N: OScon or POSCAP

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.

APPLICATION NOTES

Power Good, PG

The module provides a Power Good (PG Pin) feature, to indicate that the output voltage is within the normal output voltage range of the power module. The PG signal will be changed to a logic -high state if any condition such as over temperature, over current, UVLO, OVP, startup with diode emulation mode or loss of regulation occurs that would result in the output voltage going below the normal voltage range value.

Before the parallel module's have finished their start up and PG signal asserts, the total load current should be lower than the rated current of 1 module.

If the user is not using the Power Good feature, the pin may be left as not connected.

SOLDERING INFORMATION

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	01.28.2016	First Issue	A. Zhang
1.1	04.13.2016	Change the photo at first page	K. Wang
1.2	02.25.2020	Update the RoHS information	A. 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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