ADO300-48S3V3-6L

198 Watts

Eighth-brick Converter

Total Power: 198 Watts
Input Voltage: 36 to 75 Vdc
# of Outputs: Single

Special Features

- Delivers up to 60A output current
- Ultra-high efficiency 93.7% at half load
- Startup Pre-bias
- Input range: 36V ~ 75V
- Excellent thermal performance
- Power Good (PG) feature
- No minimum load requirement
- RoHS 6 compliant
- Remote control function (negative logic with Secondary Remote On/Off control optional)
- Remote output sense
- Trim from 2.64V to 3.63V
- PMBus Rev.1.2 Compliance
- 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
- Open frame and with baseplate optional
- Pin length option: 3.8mm

Safety

- IEC/EN/UL/CSA 62368
- CE Mark
- UL/TUV
- Materials meet UL94, V-0
- EN55032 Class A with external filter

Product Description

The ADO300-48S3V3-6L is a new generation single output digital control DC/DC converter with standard eighth-brick outline and pin configuration, as well as baseplate and PMBus option. It delivers up to 60A output current with 3.3V output voltage. Above 93.7% ultra-high efficiency and excellent thermal performance make it an ideal choice to supply power in telecom and datacom. It can work under -40^{O}C ~ +85^{O}C with air cooling. PMBus optional interface is also provided for a flexible digital control.

Applications

- Telecom
- Datacom

ARTESYN™
EMBEDDED TECHNOLOGIES

Model Numbers

Standard	Output Voltage	Structure	Remote ON/OFF Logic	RoHS Status	PMBus Interface
ADO300-48S3V3-6L	3.3Vdc	Open frame	Negative	R6	Don't support
ADO300-48S3V3-6LI	3.3Vdc	Open frame	Negative	R6	Support
ADO300-48S3V3B-6L	3.3Vdc	Baseplated	Negative	R6	Don't support
ADO300-48S3V3B-6LI	3.3Vdc	Baseplated	Negative	R6	Support

Ordering information

ADO300	-	48	S	3V3			-	6	L	I
①		②	③	④	⑤	⑥		⑦	⑧	⑨

①	Model series	ADO: high efficiency digital control eighth brick series; 300: output current 60A
②	Input voltage	48: 36V ~ 75V input range, rated input voltage 48V
③	Output number	S: single output
④	Rated output voltage	3V3: 3.3V output
⑤	Remote ON/OFF logic	P: positive logic; None: negative
⑥	Baseplate	B: with baseplate; None: open frame
⑦	Pin length	6: 3.8mm±0.25mm 4: 4.8mm±0.25mm 8: 2.8mm±0.25mm None: 5.8mm±0.25mm
⑧	RoHS status	Y: Rohs, R5; L: RoHS, R6
⑨	PMBus interface	I: available; None: don't support

Options

Positive enable optional

Pin length optional

PMBus 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			-	-	100	Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	198	W
Isolation Voltage[1]						
Input to output	All		-	-	1500	Vdc
Input to metal part	All		-	-	1500	Vdc
Ambient Operating Temperature	All	T_A	-40	-	85	^{O}C
Storage Temperature	All	T_{STG}	-55	-	125	^{O}C
Voltage at Remote ON/OFF Pin	All		-0.3	-	15	Vdc
Logic Pin Voltage (to Sig_Gnd or Vo-), such as Trim/C1, C2, Addr0, Addr1, Clock, Data or SMBAlert	All		-	-	3.6	Vdc
Humidity (non-condensing)						
Operating	All		-	-	95	%
Non-operating	All		-	-	95	%

Note 1 - Basic insulation, pollution degree 2, 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
Input Under Voltage Lockout	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
Input Over Voltage Lockout	Input Over Voltage Protect (Input OVP)		V_{IN}	79	-	87	V
	Input OVP recovery voltage		V_{IN}	78	-	86	V
	Hysteresis			1	-	-	V
Maximum Input Current		$V_{IN,DC}$=36Vdc $I_O=I_{O,max}$	$I_{IN,max}$	-	-	6.5	A
No Load Input Current		I_O =0A	$I_{IN,no\ load}$	-	65	-	mA
Standby Input Current		Remote OFF	$I_{IN,standby}$	-	20	-	mA
Recommended Input Fuse[2]				-	10	-	A
Recommended External Input Capacitance[3]			C_{IN}	220	-	-	μF
Input Reflected Ripple Current[4] (peak-peak)				-	150	-	mApp
Efficiency[5]		$V_{IN,DC}$=48Vdc $I_O=I_{O,max}$ I_O=50%$I_{O,max}$	η	- -	93.0 93.7	- -	% %
Input Filter Component Value(C\L)		Internal values		-	6.9\0.68	-	μF\μH

Note 1 - T_A=25^{O}C, airflow rate=400LFM, $V_{IN,DC}$=48Vdc, nominal output voltage unless otherwise noted.
Note 2 - Fast blow external fuse recommended, see Figure 10.
Note 3 - Low ESR capacitor recommended.
Note 4 - Figure 1,Test condition: through 12μH inductor, see Figure 12.
Note 5 - Figure 9, test condition: T_A=25^{O}C, air velocity: 800LFM.

Output Specifications

Table 3. Output Specifications:

Parameter	Conditions[1]	Symbol	Min	Typ	Max	Unit
Output Voltage Factory Set Point (standard option)	$V_{IN,DC}$=48Vdc, I_O=50%$I_{O,max}$ T_A=25^{O}C	$V_{O,nom}$	3.25	3.3	3.35	Vdc
Output Voltage Line Regulation		$\pm V_O$	-	-	16.5	mV
Output Voltage Load Regulation		$\pm V_O$	-	-	16.5	mV
Output Voltage Temperature Regulation		$\%V_O$	-	-	0.02	%/^{O}C
Output Voltage Ripple and Noise[2] (peak-peak)			-	20	-	mVpp
Operating Output Current Range		I_O	0	-	60	A
Output DC current-limit inception[3]		$\%I_{O,max}$	110	-	150	%
Output Capacitance[4]		C_O	220	-	10000	µF
Output Voltage Trim Range	Via external resistor[5]		2.64	-	3.63	V
	Via PMBus		2.64	-	3.63	V
Output Voltage Remote Sense Range			0	-	0.33	V

Note 1 - T_A=25^{O}C, airflow rate=400LFM, $V_{IN,DC}$=48Vdc, nominal output voltage unless otherwise noted.
Note 2 - Figure 2, test condition:20MHz bandwidth, see Figure 12.
Note 3 - Hiccup: auto-restart when over current condition is removed.
Note 4 - 22µF x 5pcs ceramic parallel OSCON, see Figure 14.
Note 5 - The trim function (via external resistor) is not functional in the area of -/+3% $V_{O,nom}$.

Output Specifications

Table 3. Output Specifications, con't:

Parameter		Condition[1]	Symbol	Min	Typ	Max	Unit
Dynamic Response	Peak Deviation	75%~50%~75%$I_{O,max}$ slew rate=0.1A/μs	$\pm V_O$	-	60[2]	-	mV
	Settling Time		T_s	-	180[2]	-	μs
	Peak Deviation	50%~75%~50%$I_{O,max}$ slew rate=1A/μs	$\pm V_O$	-	220[3]	-	mV
	Settling Time		T_s	-	200[3]	-	μs
Turn-on Transient	Rise Time[4]	$V_{IN,DC}$=48Vdc, I_O=$I_{O,max}$	T_{rise}	-	20	70	ms
	Turn-on Delay Time-1[5]	From $V_{IN,DC}$ reaching Turn-on Voltage	$T_{turn-on}$	-	40	180	ms
	Turn-on Delay Time-2[6]	From ENABLE asserted	$T_{turn-on}$	-	20	70	ms
	Turn-on Overshoot			-	0	165	mV
	Turn-off Undershoot			-	0	165	mV
Switching Frequency			f_{SW}	-	160	-	KHz
Remote ON/OFF control[7]	Off-state Voltage			2.4	-	15	V
	On-state Voltage			-0.3	-	0.8	V
Pre-bias[8]			$\%V_{onom}$	0	-	90	%
Output Over Voltage Protection[9]				3.8	-	5.5	V
Over Temperature Protection[10]		Baseplate module	T	-	115	-	^OC
		Open frame module	T	-	120	-	^OC
Over Temperature Hysteresis			T	5	-	-	^OC
MTBF[11]		Telcordia, SR332 Method 1 Case 3		-	1.5	-	10^6 hrs

Note 1 - T_A=25^{O}C, airflow rate=400 LFM, $V_{IN,DC}$=48Vdc, nominal output voltage unless otherwise noted.
Note 2 - Figure 7, test condition: see Figure 10.
Note 3 - Figure 8, test condition: see Figure 10.
Note 4 - Figure 3, Figure 5, test condition: see Figure 10.
Note 5 - Figure 3, test condition: see Figure 10.
Note 6 - Figure 5, test condition: see Figure 10.
Note 7 - Logic: negative (default), positive available.
Note 8 - Nominal output voltage @0A, 48Vin.
Note 9 - Hiccup: auto-restart when over voltage condition is removed.
Note 10 - Auto recovery. Over Temperature Protect (OTP) test point: see Figure 15.
Note 11 - 300LFM, T_A=40^{O}C, $V_{IN,DC}$=48Vdc, nominal output voltage, I_O=80%$I_{O,max.}$

Digital Interface Specifications

Table 4. Digital Interface Specifications:

Parameter	Condition[1]	Symbol	Min	Typ	Max	Unit
Input High Voltage (Clock,Data,C2,SMBAlert)			2.2	-	3.3	V
Input Low Voltage (Clock,Data,C2,SMBAlert)			0	-	0.8	V
Input High Level Current ((Clock,Data,C2,SMBAlert)			-1	-	1	mA
Output High Voltage (Clock,Data,C2,SMBAlert)	I_O=4mA		2.4	-	-	V
Output Low Voltage (Clock,Data,C2,SMBAlert)	I_O=-4mA		-	-	0.3	V
Output Current Reading Accuracy	30A<I_O≤60A		-8	1.4	8	%
	1A<I_O≤30A		-4	-	4	A
Output Current Reading Resolution				0.19	0.5	A
Output Voltage Reading Accuracy			-2	1	2	%
Output Voltage Reading Resolution			-	0.25	0.5	mV
Input Voltage Reading Accuracy			-4	-	4	%
Input Voltage Reading Resolution			-	0.2	1	V
Temperature Reading Accuracy	T_A>0^{O}C		-5	-	5	^{O}C
Temperature Reading Resolution	T_A>0^{O}C		-	0.25	1	^{O}C

Configurable Control Pins

The module contains two configurable control pins, Trim/C1 and C2, referenced to the module secondary Sig_Gnd. See section Mechanical Outlines for pin locations. The following Table 5 lists the default factory configurations for the functions assigned to these pins. Additional configurations can be accomplished via the PMBus command, what's more, there is a feature description for each function in Table 5.

Table 5. Configurable Control Pins:

Pin Designation/Function		Configuration
Trim/C1	C2	
On/Off	Power Good	Via PMBus
Trim	Power Good	Factory Default
Trim	On/Off	Via PMBus

Note 1 - T_A=25^{O}C, airflow rate=400LFM, $V_{IN,DC}$=48Vdc, nominal output voltage unless otherwise noted.

Performance Curves

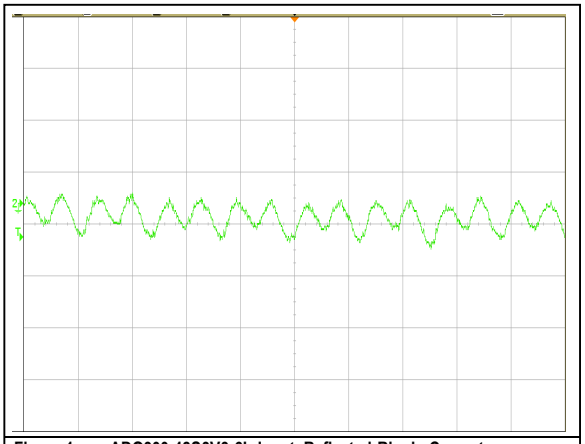


Figure 1. ADO300-48S3V3-6L Input Reflected Ripple Current
see Figure 12 for test configuration
Ch2 : I_{IN} (5µs/div, 10.mA/div)

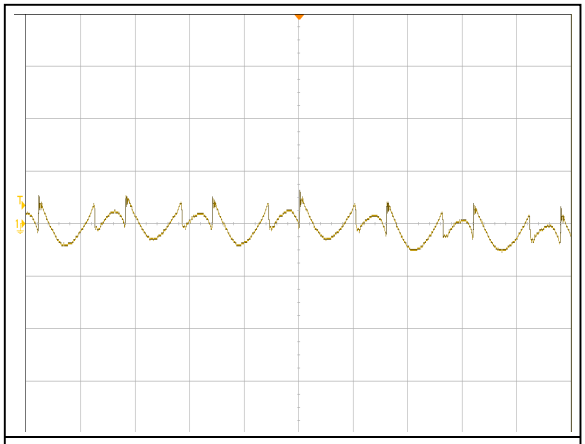


Figure 2. ADO300-48S3V3-6L Output Ripple and Noise
see Figure 12 for test configuration
Ch1 : V_O (2µs/div, 5.0mV/div)

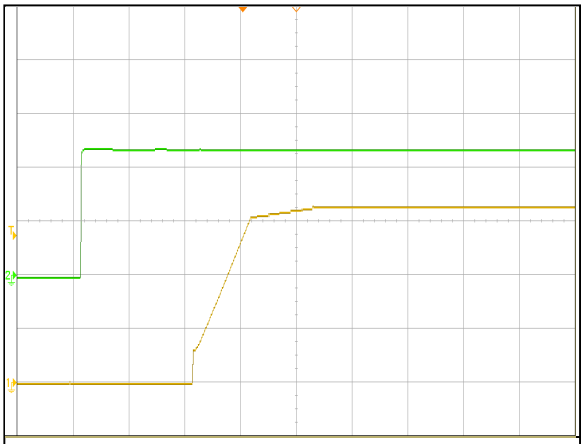


Figure 3. ADO300-48S3V3-6L Start up Characteristic by power on
(20ms/div) see Figure 10 for test configuration
Ch1: V_O (1V/div) Ch2: V_{IN} (20V/div)

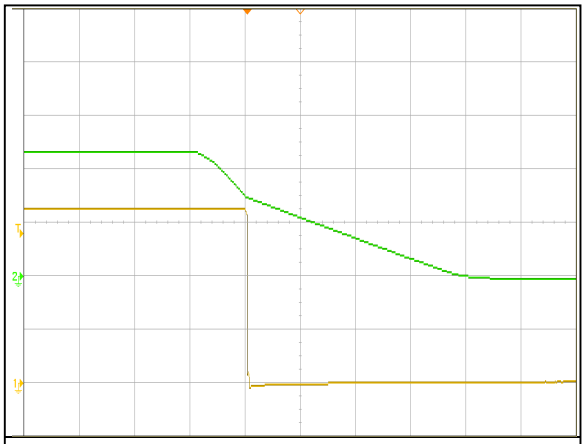


Figure 4. ADO300-48S3V3-6L Shut down Characteristic by power off
(20ms/div) see Figure 10 for test configuration
Ch1: V_O (1V/div) Ch2: V_{IN} (20V/div)

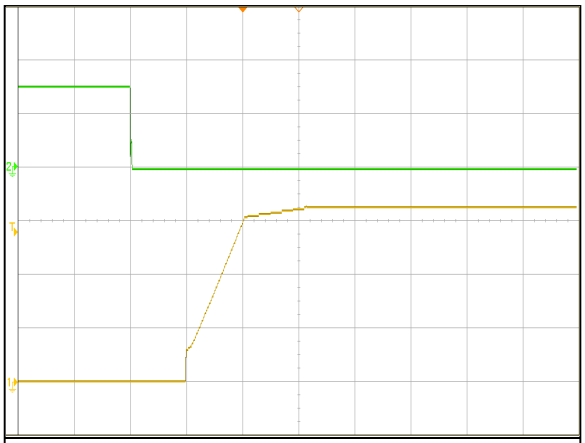


Figure 5. ADO300-48S3V3-6L Remote ON Waveform
(20ms/div) see Figure 11 for test configuration
Ch1: V_O (1V/div) Ch2: Remote ON (2V/div)

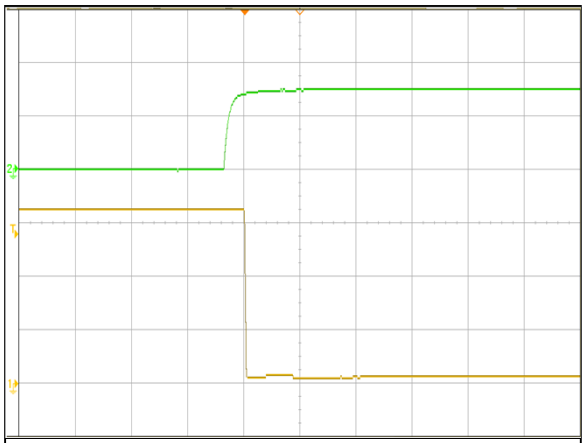


Figure 6. ADO300-48S3V3-6L Remote OFF Waveform
(5ms/div) see Figure 11 for test configuration
Ch1: V_O (1V/div) Ch2: Remote OFF (2V/div)

Performance Curves

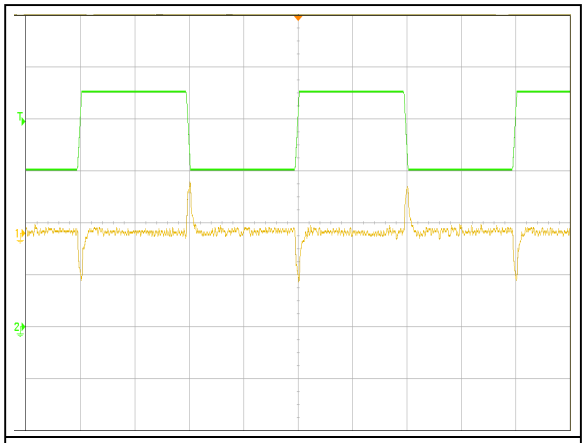


Figure 7. ADO300-48S3V3-6L Transient Response
25% load step (50%~75%~50%) and 0.1A/µs slew rate (2ms/div)
see Figure 10 for test configuration
Ch1: Vo (50mV/div) Ch2: Io (10A/div)

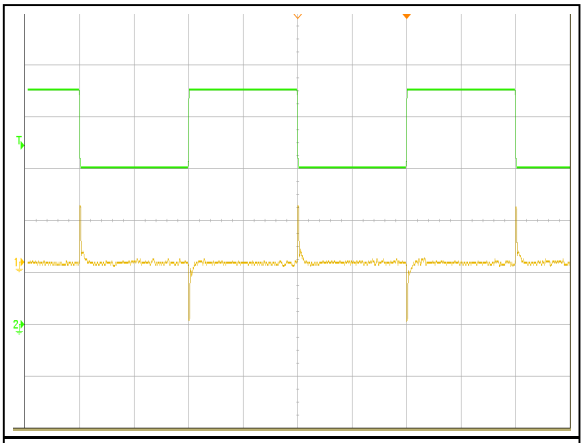


Figure 8. ADO300-48S3V3-6L Transient Response
25% load step (50%~75%~50%) and 1A/µs slew rate (2ms/div)
see Figure 10 for test configuration
Ch1: Vo (100mV/div) Ch2: Io (10A/div)

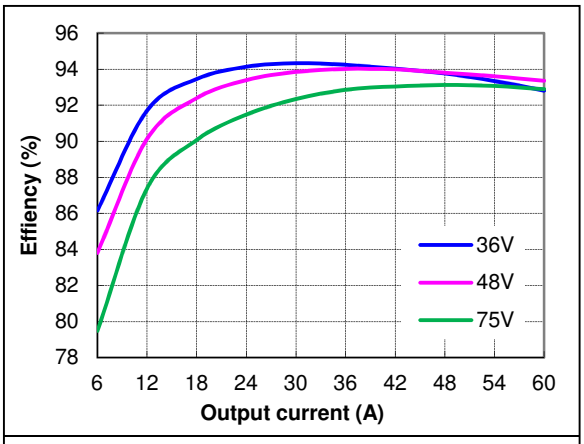
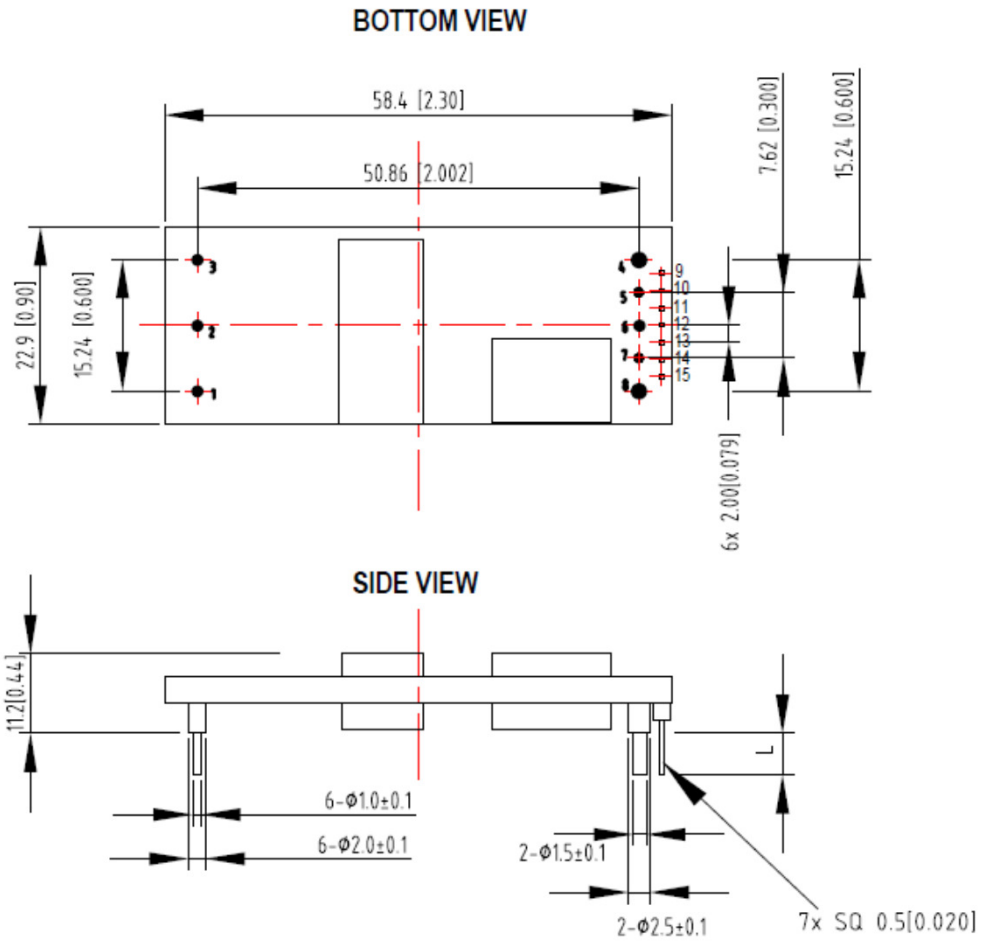


Figure 9. ADO300-48S3V3-6L Efficiency Curves @25°C, V_O=3.3V, 800LFM
Loading: I_O=10% increment to 60A

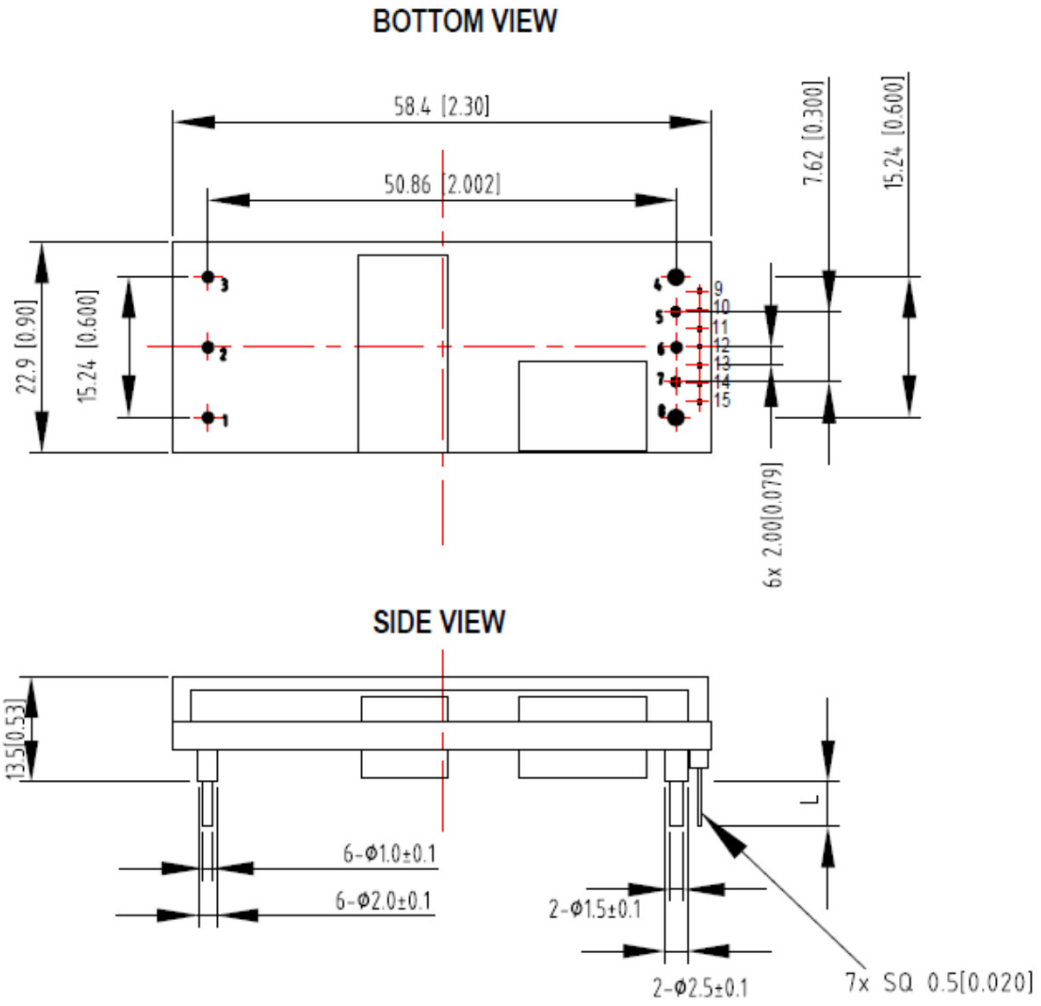
Mechanical Outlines

Open frame module



UNIT: mm (inch)
TOLERANCE: X.X mm±0.5mm [X.XX in.± 0.02in.]
X.XX mm±0.25mm[X.XXX in.±0.01in.]
Note 1: Dimensions within the box are critical dimensions.
Note 2: No pin9~15 for ADO300-48S3V3-6L;
ADO300-48S3V3-6LI with pin9~15.

Module with Baseplate



UNIT: mm (inch)
TOLERANCE: X.X mm±0.5mm [X.XX in.± 0.02in.]
X.XX mm±0.25mm[X.XXX in.±0.01in.]
Note 1: Dimensions within the box are critical dimensions.
Note 2: No pin9~15 for ADO300-48S3V3B-6L;
ADO300-48S3V3B-6LI with pin9~15.

Pin Length option

Device Code Suffix	L (mm)
-4	4.8±0.25
-6	3.8±0.25
-8	2.8±0.25
None	5.8±0.25

Pin Designations

Pin No.	Name	Function	Optional
1	Vin+	Positive input voltage	
2	Remote ON/OFF	Remote control	
3	Vin-	Negative input voltage	
4	Vo-	Negative output voltage	
5	S-	Remote sense negative	Yes
6	Trim/C1	Voltage adjustment or secondary remote ON/OFF	Yes
7	S+	Remote sense positive	Yes
8	Vo+	Positive output voltage	
9	C2	Power Good pin, and this pin also could be configured as secondary on/off control pin	Yes
10	Sig_Gnd	Signal ground	
11	Data	PMBus data line	
12	SMBAlert	PMBus SMBAlert line	
13	Clock	PMBus clock line	
14	Addr1	Addr1 pin sets the high order digit of the address	
15	Addr0	Addr0 pin sets the low order digit of the address	

Electromagnetic Compatibility Specifications

Electromagnetic Compatibility immunity

ADO300-48S3V3-6L power supply is designed to meet the following Electromagnetic Compatibility (EMC) immunity specifications, more details refer to Table 6.

Table 6. EMC immunity Specifications:

Document	Description	Criteria
EN55032, Class A Limits	Conducted and Radiated EMI Limits, DC input port	/
IEC/EN 61000-4-2, Level 3	Electromagnetic Compatibility (EMC) - Testing and measurement techniques: Electrostatic Discharge (ESD) immunity test	B
IEC/EN 61000-4-4, Level3	Electromagnetic Compatibility (EMC) - Testing and measurement techniques: Electrical Fast Transient (EFT). DC input port.	B
IEC/EN 61000-4-5	Electromagnetic Compatibility (EMC) - Testing and measurement techniques: Immunity to Surges (Surges) - 600V common mode and 600V differential mode for DC input port	B
IEC/EN 61000-4-6, Level 2	Electromagnetic Compatibility (EMC) - Testing and measurement techniques: Continuous Conducted Interference. DC input port	A
EN61000-4-29	Electromagnetic Compatibility (EMC) - Testing and measurement techniques: Voltage Dips and Short Interruptions and Voltage Variations (Dips). 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 Filter Configuration

More details refer to section EMC Test Conditions in Application Notes.

Safety Certifications

The ADO300-48S3V3-6L 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 7. Safety Certifications

Document	File #	Description
UL/CSA 62368		US and Canada Requirements
EN62368		European Requirements
IEC62368		International Requirements
CE		CE Marking

Qualification Testing

Table 8. Qualification Certifications

Parameter	Unit (pcs)	Test condition
Halt test	1	-55^{O}C to +120^{O}C, 5^{O}C step, $V_{IN,DC}$=$V_{IN,\ min}$ to $V_{IN,max}$, I_O=$I_{O,min}$ to $I_{O,max}$
Vibration	2	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	2	Type: half sine Acceleration: 30g Duration: 6ms Directions:6 Number of shock: 3times/face
Thermal Shock	3	-55^{O}C to 125^{O}C, temperature 20cycles, >20^{O}C /min
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, 48hrs

Application Notes

Typical Application

This is the typical application of the ADO300-48S3V3-6L power supply, more details refer to Figure 10.

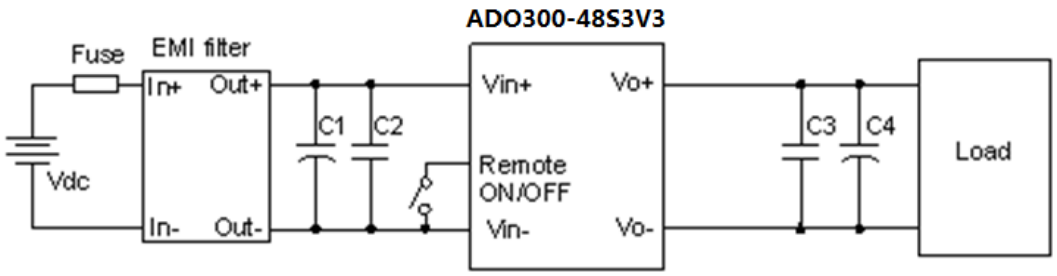


Figure 10. Typical application

Fuse: external fast blow fuse with a rating of 10A/250Vac. The recommended fuse model is 0314010.P from Littelfuse, Inc.
EMI filter: refer to U1 in Figure 14.
C1~C4: see Figure 14.

Remote ON/OFF

Standard negative remote ON/OFF logic is available in ADO300-48S3V3-6L. 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.

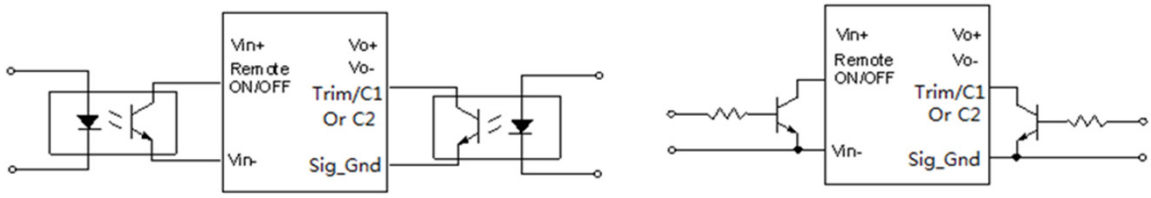
The voltage between pin Remote ON/OFF and pin Vin- must not exceed the range listed in Table 3 to ensure proper operation. The external Remote ON/OFF circuit is highly recommended as shown in Figure 11.

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

Secondary Remote On/Off

The module contains an additional secondary remote on/off control, via either the Trim/C1 or C2 pin, reference to the output Sig_Gnd pin. And such pin can be reconfigured as secondary remote on/off pin by the PMBus interface including either negative or positive logic. Negative logic turns the module on during a logic low and off during a logic high. Positive logic turns the module on during a logic high and off during a logic low. The secondary remote on/off can be controlled by an external switch between Trim/C1 or C2 and output Sig_Gnd pin. The switch can be an open collector or open drain, more details refer to Figure 11.

If not using the secondary remote on/off control, the pin may be left N/C.



Isolated remote ON/OFF circuit non-isolated remote ON/OFF circuit

Figure 11. Remote ON/OFF external 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, When using remote sense and trim, the output current should be decreased accordingly so as not to exceed the maximum output power. If the sense compensate function is not necessary, connect S+ to Vo+ and S- to Vo- directly, more details refer to Figure 10.

Power Good

The module provides a Power Good ((PG) ,C2 Pin) feature, to indicate that the output voltage is within the normal output voltage range of the power module. The PG signal will be de-asserted to a low state if any condition such as over temperature, over current, Input Under Voltage Lockout (UVLO), output voltage protect (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.

The Power Good signal, provided on pin C2, is implemented with an open-drain node, pulled up via a 10kΩ resistor to 3.3V internally. For Positive Logic PG (default), the PG signal is high level, when PG is asserted. If not using the Power Good feature, the pin may be left N/C.

Input Ripple & Output Ripple & Noise Test Configuration

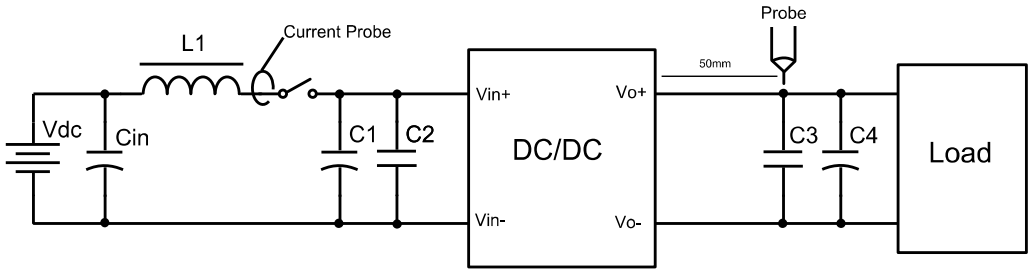


Figure 12. Input ripple & ripple and noise test configuration

Vdc: DC power supply
L1: 12μH
Cin: 220μF/100V typical.
C1~C4: See Figure 14.
Note - Using a coaxial cable with series 50Ω resistor and 0.68uF ceramic capacitor or a ground ring of probe to test output ripple & noise is recommended.

Trim Characteristics

To increase or decrease the output voltage set point, an external resistor is connected 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, more details refer to Figure 13. The following equations determine the external resistance to obtain the trimmed output voltage. When trimming up, the output current should be decreased accordingly so as not to exceed the maximum output power.

Note that the trim function (via external resistor) is not functional in the area of -/+3% $V_{O,nom.}$

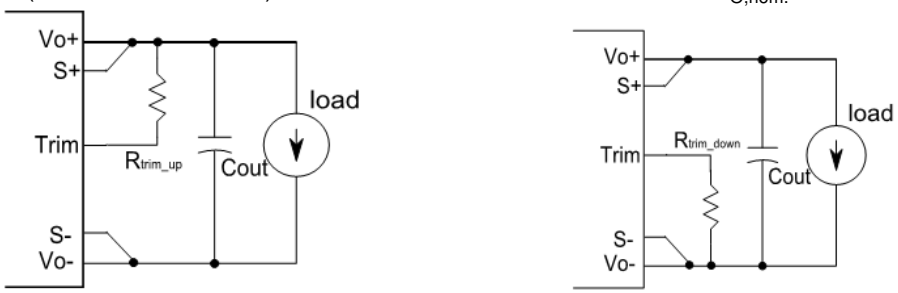


Figure 13. Trim external diagram

$$R_{trim\_up} = \frac{5.11 \times V_{O,nom} \times (100 + \Delta)}{1.225 \times \Delta} - \frac{511}{\Delta} - 10.22(K\Omega)$$

$$R_{trim\_down} = \frac{511}{\Delta} - 10.22(K\Omega)$$

$$\Delta = \left| \frac{100 \times (V_{O,nom} - V_{O,desired})}{V_{O,nom}} \right|$$

Where $V_{O,nom}$:output nominal voltage

$V_{O,desired}$:desired output voltage

For example, to get the desired output voltage 3.63V, so $V_{o,desired}$ equates 3.63.

$$\Delta = \left| \frac{100 \times (V_{O,nom} - V_{O,desired})}{V_{O,nom}} \right| = \left| \frac{100 \times (3.63 - 3.3)}{3.3} \right| = 10$$

$$R_{trim\_up} = \frac{5.11 \times 3.3 \times (100 + \triangle)}{1.225 \times \triangle} - \frac{511}{\triangle} - 10.22 = \frac{5.11 \times 3.3 \times (100 + 10)}{1.225 \times 10} - \frac{511}{10} - 10.22 = 90.10(K\Omega)$$

So, the external resistor is 90.10KΩ. The output voltage can also be trimmed by potential applied at the Trim pin.

$$V_{O,desired} = (V_{trim} + 1.225) \times 4.8571$$

Where

V_{trim} : the voltage of trim pin.

EMC Test Conditions

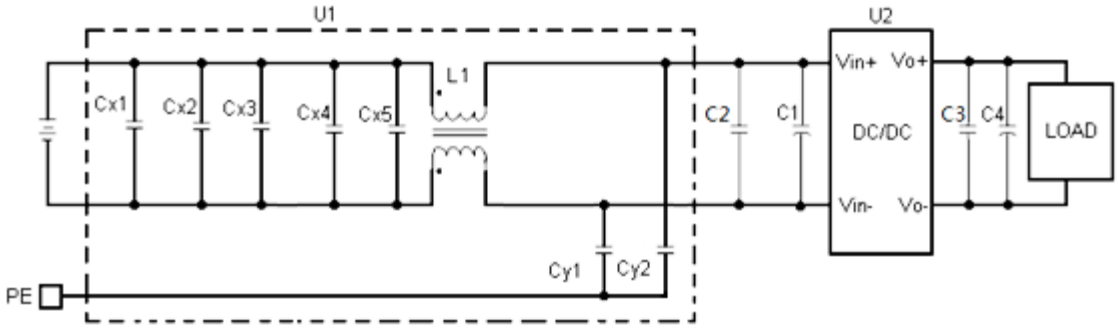


Figure 14. EMC Test Setup

C1: 220μF/100V electrolytic capacitor, P/N: UPM2A221MPD (Nichicon) or equivalent caps
C2: 0.1μF/100V/X7R capacitor
C3: 22μF/10V/X7R x5pcs capacitor
C4: 1000μF/16V electrolytic capacitor, P/N: OSCON or POSCAP
U1: Input EMC filter
U2: Module to test, ADO300-48S3V3-6L
C_{X1}, C_{X2}, C_{X3}, C_{X4}, C_{X5}: 1μF/100V/X7R capacitor
C_{y1}, C_{y2}: 0.1μF/1000V/X7R, Y capacitor
L1: 809μH, common mode inductor

Operating Temperature

The ADO300-48S3V3-6L power supply 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

The converter is designed to operate in different thermal environments and sufficient cooling must be provided. Over Temperature Protect (OTP) test point is shown in figure 15, it is on the left of figure15 that is on the surface of temperature sensor for open frame module, and it is on the right of figure15 that is in the center of baseplate for module with baseplate. Thermal image has been taken by a RF camera at T_A=25^{O}C,$V_{IN,DC}$=48Vdc, I_O=$I_{O,max}$, nominal output voltage, as indicated in figure 16.

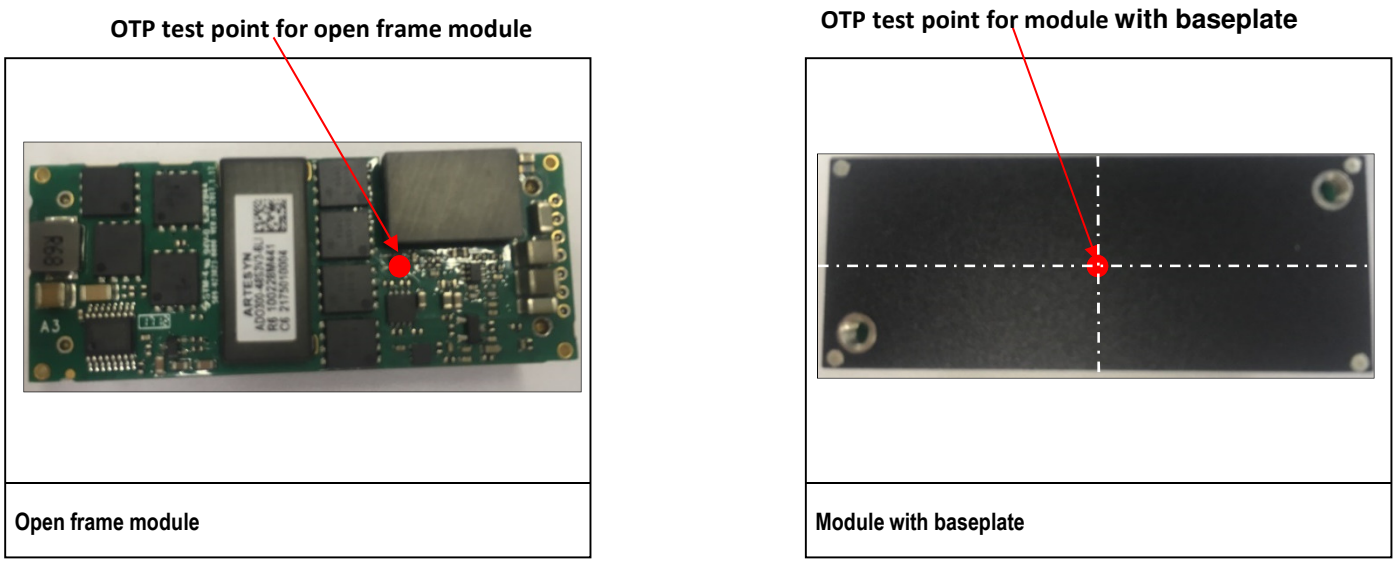


Figure 15. Over Temperature Protect test point

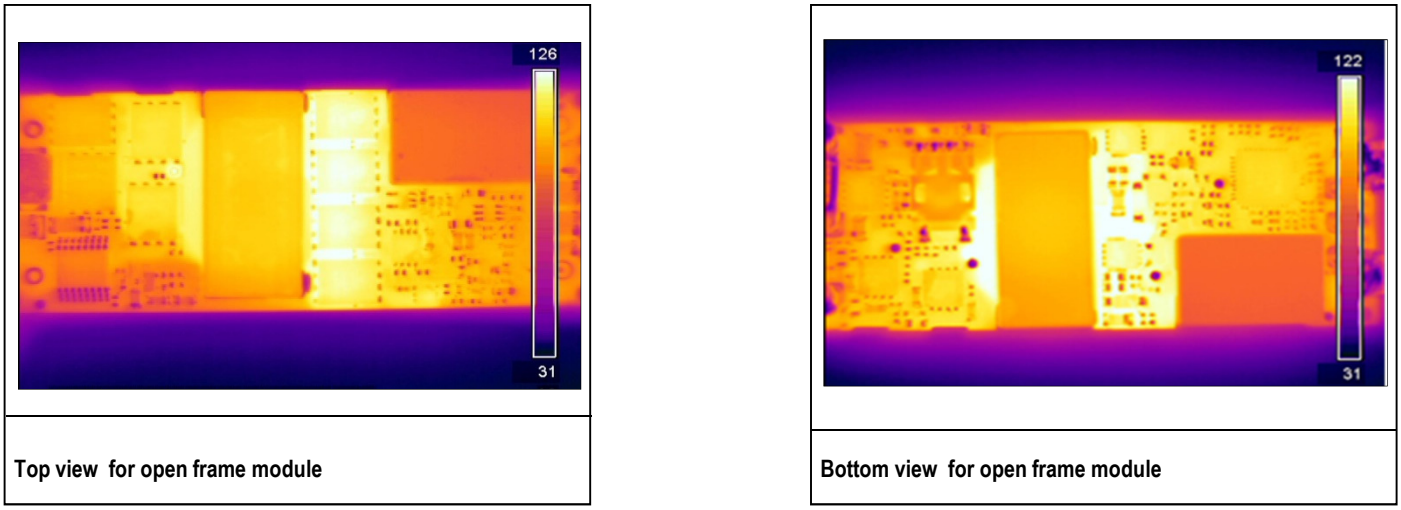
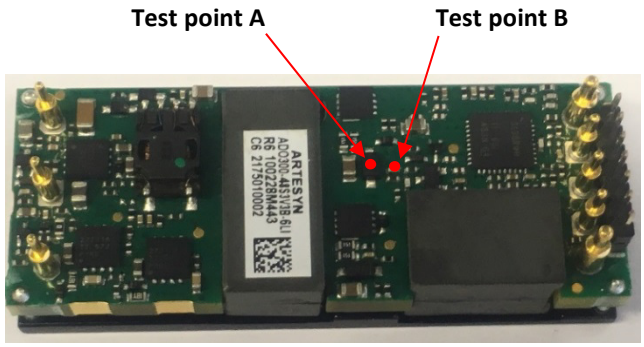


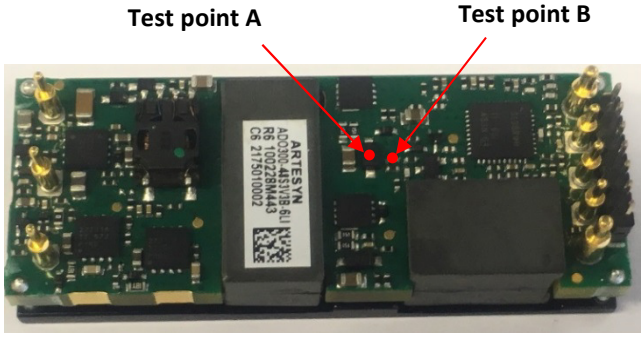
Figure 16. Thermal image, @T_A=25^{O}C, $V_{IN,DC}$=48Vdc, I_O=$I_{O,max}$, nominal output voltage.

Thermal Considerations – for open frame module or with baseplate

In order to operate in different thermal environments, proper cooling can be verified by measuring the temperature at these test points as shown in Figure 17. The number of test points may vary with different thermal design and topology. The temperature above the limit values in Table 9 are not allowed and may cause permanent damage.



Open frame module



Module with baseplate

Figure 17. Temperature test point

Table 9. Temperature limit of the test point

Test Point	Temperature Limit (^{O}C)
Test point A	120
Test point B	115

For a typical application, There is the thermal derating data of output current vs. ambient air temperature at different air velocity @48Vin for open frame module in Figure 18, and does likewise for module with baseplate in Figure 19.

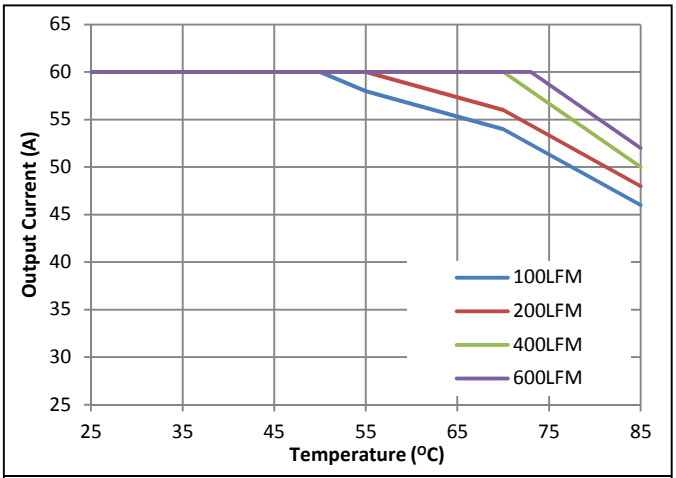


Figure 18. Thermal derating data for open frame module @48V$_{in}$, airflow from V$_{in-}$ to V$_{in+}$

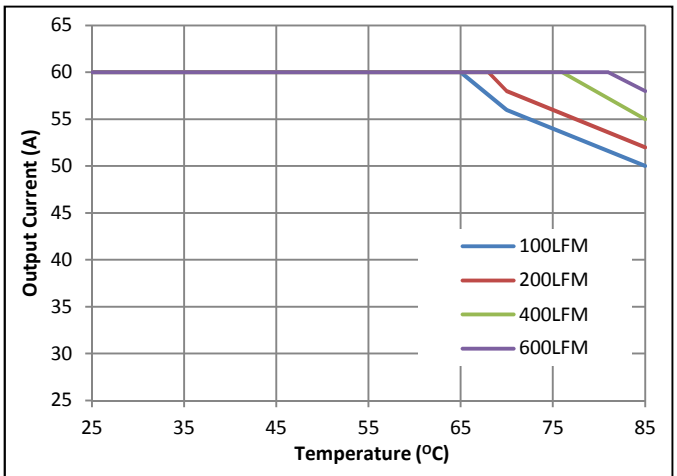


Figure 19. Thermal derating data for module with baseplate @48V$_{in}$, airflow from V$_{in-}$ to V$_{in+}$

Thermal Considerations – for module with baseplate + heatsink

In order to operate in different thermal environments, proper cooling can be verified by measuring the temperature at these test points as shown in Figure 20, The number of test points may vary with different thermal design and topology. The temperature above the limit values in Table 10 are not allowed and may cause permanent damage. For a typical application, there is the thermal derating data of output current vs. ambient air temperature at different air velocity @48Vin for module with baseplate + heatsink in Figure 21.

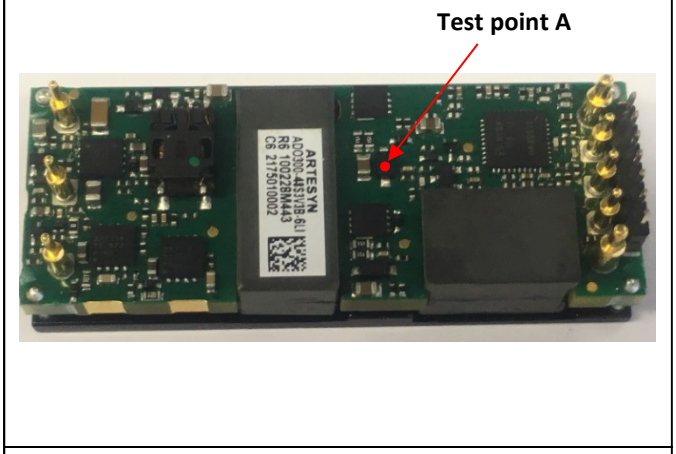


Figure 20. Temperature test point for module with baseplate +heat sink

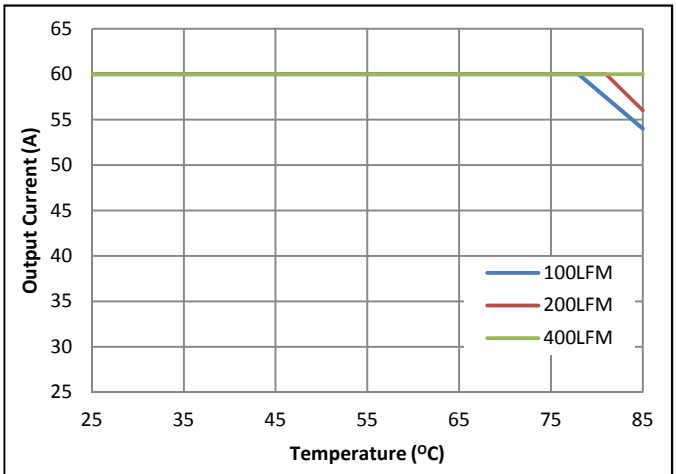


Figure 21. Thermal derating data for module with baseplate +heatsink @48V_{in}, airflow from V_{in-} to V_{in+}

Table 10. Temperature limit of the test point

Test Point	Temperature Limit (°C)
Test point A	120

The heat sink size (L*W*H) is 58.4mm * 22.86mm * 12.7mm, more details refer to Figure 22.

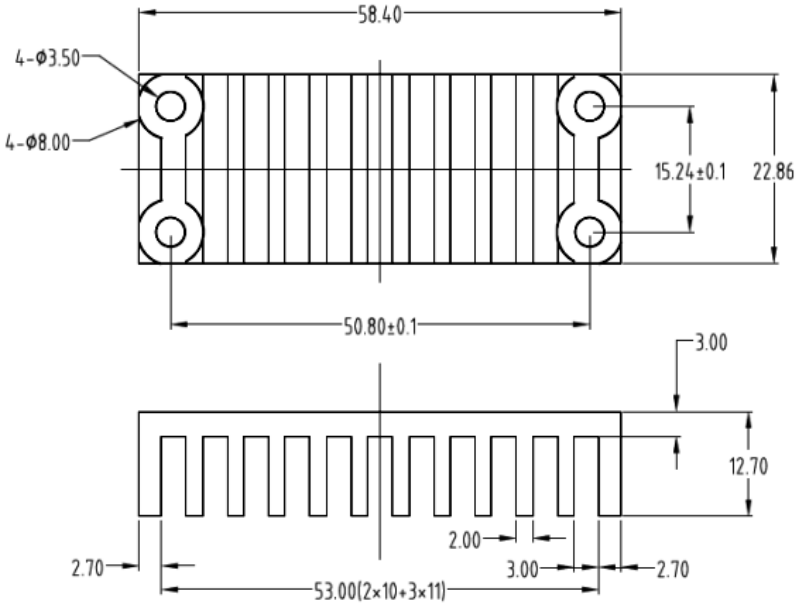


Figure 22. 0.5'' heat sink mechanical diagram

PMBus Communication

PMBus Communication Descriptions

The module has a digital PMBus interface to allow the module to be monitored, controlled and configured by the system. The module supports 4 PMBus signal lines, Data, Clock, SMBAlert (optional), Control (C2 pin, optional), and 2 Address line Addr0 and Addr1. More detail PMBus information can be found in the PMBus Power Management Protocol Specification, Part I and part II, revision 1.2; which is shown in http://pmbus.org . Both 100kHz and 400kHz bus speeds are supported by the module. Connection for the PMBus interface should be following the High Power DC specifications given in section 3.1.3 in the SMBus specification V2.0 or the Low Power DC specifications in section 3.1.2. The complete SMBus specification is shown in http://smbus.org.

The module supports the Packet Error Checking (PEC) protocol. It can check the PEC byte provided by the PMBus master, and include a PEC byte in all message responses to the master.

The module contains a data flash used to store configuration settings, which will not be programmed into the device data flash automatically. The STORE_DEFAULT_ALL command must be used to commit the current settings are transfer from RAM to data flash as device defaults.

PMBus Addressing

The module has flexible PMBus addressing capability. When connect different resistor from Addr0 and Addr1 pin to Sig_Gnd pin, 64 possible addresses can be acquired. The address is set in the form of two octal (0 to 7) digits, with each pin setting one digit. The Addr1 pin sets the high order digit and Addr0 sets the low order digit, and then combine together to form the decimal address, and then combine together to form the decimal address as shown in below.

$$Address=16 \times Addr1 + Addr0$$

Corresponded to each octal digit, the requested resistor values are shown in Table 11[1], (1% tolerance resistors are recommended), It is one 510KΩ resistor that the Addr0 and Addr1 pins to Sig_Gnd built in, in order to obtain the resistance value of Table 11[1], you must configure a resistor in parallel with the 510KΩ resistor. More details refer to Figure 23. If the resistor combination is configured as an invalid address (0 through 12, 40, 44, 45, and 55 in decimal), the device address is 88, and if Addr1 pin or Addr0 pin is floating, the device address is 88.

Table 11[1]. Resistance value

Digit	Resistor Value (KΩ)
0	24.9
1	49.9
2	75
3	100
4	124
5	150
6	174
7	200

Note 1- the Addr0 and Addr1 pins to Sig_Gnd built in one 510KΩ resistors

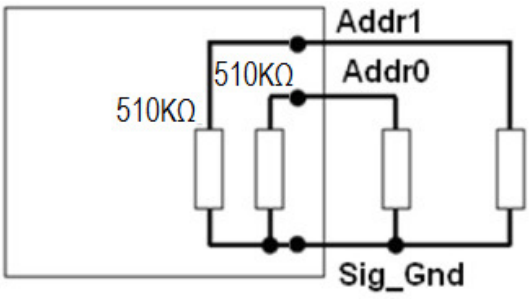
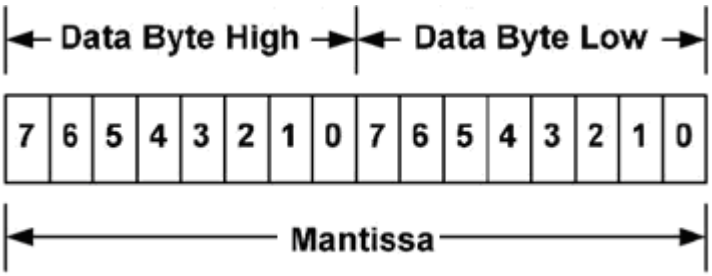


Figure 23. Circuit showing connection of resistors used to set the PMBus address

PMBus Data Format

The module receives and report date in LINEAR format. The Exponent of the data words is fixed at a reasonable value for the command; altering the exponent is not supported. DIRECT format is not supported by the module.

For commands that set or report any voltage thresholds related to the output voltage, the module supports the linear data format consisting of a two byte value with a 16-bit, unsigned mantissa, and a fixed exponent of -9. The format of the two data bytes is shown below:



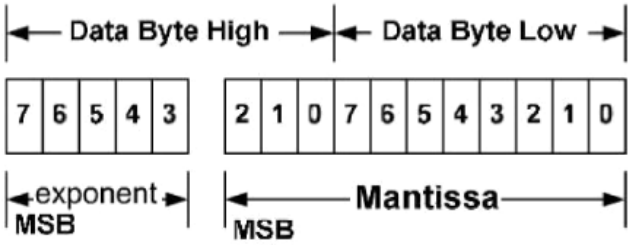
The equation can be written as:

$Vo=Mantissa \times 2^{-9}$

For example, considering set Vo to 3.3V by VOUT_COMMAND, the read/write data can be calculated refer to below process:

1. Mantissa $=Vo/2^{-9}= 3.3/2^{-9}=1689.6$;
2. Converter the calculated Mantissa to hexadecimal 0x699.

For commands that set or report all other thresholds, including input voltages, output current, temperature, time and frequency, the supported linear data format is a two byte value with: an 11 bit, two's complement mantissa , and a 5 bit, two's complement exponent (scaling factor).The format of the two data bytes is shown as in below.



The equation can be written as:

$Value=Mantissa \times 2^{exponent}$

For example, considering set the turn on threshold of input under voltage lockout to 33V by VIN_ON command; the read/write data can be calculated refer to below process:

1. Get the exponent of $V_{IN,ON}$, 0; whose binary is 00000
2. Mantissa $=V_{IN,ON}/2^0=33/2^0=33$;
3. Converter the calculated Mantissa to hexadecimal 21, then converter to binary 00000100001;
4. Combine the exponent and the mantissa, 00000 and 0000000000100001;
5. Converter binary 0000000000100001 to hexadecimal 0021.

The detail exponent and resolution of main parameter is to be decided later.

PMBus Enabled On/Off

The module can also be turned on and off via the PMBus interface. The OPERATION command is used to actually turn the module on and off via the PMBus, while the ON_OFF_CONFIG command configures the combination of analog ON/OFF pin input and PMBus commands needed to turn the module on and off. Bit [7] in the OPERATION command data byte enables the module, with the following functions:

0 : Output is disabled

1 : Output is enabled

This module uses the lower five bits of the ON_OFF_CONFIG data byte to set various ON/OFF options as follows:

Bit Position	4	3	2	1	0
Access	r	r	r	r/w	r
Default Value	1	1	1	0	1

Bit	Value	Action
4	1	Module does not power up until commanded by the analog ON/OFF pin and the OPERATION command as programmed in bits [2:0] of the ON_OFF_CONFIG register.
3	0	Module ignores the ON bit in the OPERATION command
	1	Module responds to the ON bit in the OPERATION command
2	1	Module requires the analog ON/OFF pin to be asserted to start the unit
1	1	Active high (Pull high to start the unit)
	0	Active low (Pull pin low to start the unit)

PMBus Adjustable Input Under voltage Lockout

The module allows adjustment of the input under voltage lockout and hysteresis. The command VIN_ON allows setting the input voltage turn on threshold, while the VIN_OFF command sets the input voltage turn off threshold. For both the VIN_ON and VIN_OFF commands, possible values range from 30.000 to 36.000V in 0.1V steps. VIN_ON must be 1.5V greater than VIN_OFF. The data associated with VIN_ON and VIN_OFF can be stored to non-volatile memory using the STORE_DEFAULT_ALL command.

PMBus Adjustable Soft Start Delay and Rise Time

The soft start delay and rise time can be adjusted in the module via PMBus. The TON_DELAY command sets the delay time in ms, and allows choosing delay times between 20ms and 160ms, with resolution of 0.1ms. The TON_RISE command sets the rise time in ms, and allows choosing soft start times between 10ms and 50ms, with resolution of 0.1ms. When setting TON_RISE, make sure that the charging current for output capacitors can be delivered by the module in addition to any load current to avoid nuisance tripping of the over current protection circuitry during startup. The data associated with TON_RISE and TON_DELAY can be stored to non-volatile memory using the STORE_DEFAULT_ALL command.

Output Voltage Adjustment Using the PMBus

The ADO300-48S3V3-6LI module output voltage set point is adjusted using the VOUT_COMMAND. The output voltage setting uses the Linear data format, with the 16 bits of the VOUT_COMMAND formatted as an unsigned mantissa, and a fixed exponent of -9 (decimal) (read from VOUT_MODE).

$$VOUT = Mantissa \times 2^{-9}$$

The range limits for VOUT_COMMAND are 2.64V to 3.63V, and the resolution is 1.171mV. The data associated with VOUT_COMMAND can be stored to non-volatile memory using the STORE_DEFAULT_ALL command.

Output Voltage Margining Using the PMBus

The ADO300-48S3V3-6LI module can also have its output voltage margined via PMBus commands. The command VOUT_MARGIN_HIGH sets the margin high voltage, while the command VOUT_MARGIN_LOW sets the margin low voltage. Both the VOUT_MARGIN_HIGH and VOUT_MARGIN_LOW commands use the “Linear” mode with the exponent fixed at –9 (decimal). The data associated with VOUT_MARGIN_HIGH and VOUT_MARGIN_LOW can be stored to non-volatile memory using the STORE_DEFAULT_ALL command. The module is commanded to go to the margined high or low voltages using the OPERATION command. Bits [5:2] are used to enable margining as follows:

00XX: Margin Off

0110: Margin Low (Act on Fault)

1010: Margin High (Act on Fault)

Measuring Input Voltage Using the PMBus

The module can provide input voltage information using the READ_VIN command. During module manufacture, offset and gain correction values are written into the non-volatile memory of the module to null errors in the tolerance and A/D conversion of Vin. The command MFR_VIN_READ_CAL_GAIN can be used to read the gain correction - two bytes consisting of an unsigned 16 bit number. The corrected input voltage reading is then given by:

$$Vin(read) = [(Vin(ad) + MFR\_VIN\_READ\_CAL\_OFFSET) \times MFR\_VIN\_READ\_CAL\_GAIN/100]$$

Measuring Output Current Using the PMBus

The module measures output current by using the output filter inductor winding resistance as a current sense element. The module can provide output current information using the READ_IOUT command. The command returns two bytes of data in the linear format. The upper five bits [7:3] of the high data byte form the two’s complement representation of the exponent. The remaining 11 bits are used for two’s complement representation of the mantissa, with the 11th bit fixed at zero since only positive numbers are valid.

During module manufacture, offset and gain correction values are written into the non-volatile memory of the module to null errors in the tolerance and A/D conversion of IOUT. The command MFR_IOUT_CAL_OFFSET can be used to read the offset - two bytes consisting of a five-bit exponent (fixed at -4) and an 11-bit mantissa in two’s complement format. The resolution is 0.19A. The command MFR_IOUT_CAL_GAIN can be used to read the gain correction - two bytes consisting of a unsigned 16 bit number. The resolution of this correction factor 0.000122.

The READ_IOUT command provides module average output current information. This command only supports positive current sourced from the module. If the converter is sinking current a reading of 0 is provided.

$$Iout(read) = [(Iout(ad) - \text{MFR\_IOUT\_CAL\_OFFSET }] \times 1000 \,/\, \text{MFR\_IOUT\_CAL\_GAIN}$$

Note that the current reading provided by the module is measured in the room temperature.

Measuring the Temperature using the PMBus

The module can provide temperature information using the READ_TEMPERATURE_1 command. The command returns two bytes of data in the linear format. The upper five bits [7:3] of the high data byte form the two's complement representation of the exponent. The remaining 11 bits are used for two's complement representation of the mantissa.

Note that the module's temperature sensor is located close to the module hot spot TH1 (see Thermal Considerations).and is subjected to temperatures higher than the ambient air temperature near the module. The temperature reading will be highly influenced by module load and airflow conditions.

Reading the Status of the Module using the PMBus

The module supports a number of status information commands implemented in PMBus. However, not all features are supported in these commands. An X in the FLAG cell indicates the bit is not supported.

STATUS_WORD: Returns two bytes of information with a summary of the module's fault/warning conditions.

High Byte:

Bit Position	Flag	Default Value
15	VOUT fault	0
14	IOUT fault or warning	0
13	Input Voltage fault	0
12	X	0
11	POWER_GOOD# (is negated)	0
10	X	0
9	X	0
8	X	0

Low Byte:

Bit Position	Flag	Default Value
7	X	0
6	OFF	0
5	VOUT Over voltage	0
4	IOUT Over current	0
3	VIN Under voltage	0
2	Temperature	0
1	CML(Comm. Memory Fault)	0
0	X	0

Summary of Supported PMBus Commands

This section outlines the PMBus command support for the ADO300-48S3V3 modules (PMbus version). Each supported command is outlined in order of increasing command codes with a quick reference table of all supported commands included at the end of the section. Each command will have the following basic information.

Command Name [Code]

Command support

Data format

Factory default

Additional information may be provided in tabular form or other format, if necessary.

OPERATION [0x01]

Command support: On/Off Immediate and Margins (Act on Fault). Soft off with sequencing not supported and Margins (Ignore Fault) not supported. Therefore bits 6, 3, 2, 1 and 0 set as read only at factory defaults.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/w	r	r/w	r/w	r	r	r	r
Function	ON/OFF		Vout Command		N/A		N/A	
Default Value	1	0	0	0	1	0	0	0

ON_OFF_CONFIG [0x02]

Command support: Bit 1 polarity will be set based upon module code [0=Negative on/off logic, 1=positive on/off logic to allow customer system to know hardware on/off logic.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r/w	r
Function	(reserved)			Bit4 pu	Bit3 cmd	Bit2 cpr	Bit1 pol	Bit0 cpa
Default Value	0	0	0	1	1	1	0	1

CLEAR_FAULTS [0x03]

Command support: All functionality.

STORE_DEFAULT_ALL[0x11]

Command support: All functionality – Stores operating parameters to E^2prom memory.

RESTORE_DEFAULT_ALL[0x12]

Command support: All functionality – Restores operating parameters from E^2prom memory.

VOUT_MODE[0x20]

Command support: Supported. Factory default: 0x14 – indicates linear mode with exp = -9.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r
Function	Mode(linear)			2's complement exponent				
Default Value	0	0	0	1	0	1	0	0

VOUT_COMMAND [0x21]

Data format: 16 bit unsigned mantissa (implied exponent per VOUT_MODE)

Factory default: 3.300V ($3.300 / 2^{-9} \rightarrow 1690 = 0x69A$)

Range limits (max/min): 3.630V/2.640V

Units: volt

Command support: Supported, except when Trim function is selected via MFR_C1_C2_ARA_CONFIG [0xE0].

VOUT_MARGIN_HIGH [0x25]

Range limits (max/min): 3.63/2.640

Units: volt

Command support: read/write support, full functionality except "Ignore faults".
Note: Range cross-check - value must be greater than VOUT_MARGIN_LOW value.

VOUT_MARGIN_LOW [0x26]

Range limits (max/min): 3.630/2.640

Units: volt

Command support: read/write support, full functionality except "Ignore faults".
Note: Range cross-check - value must be less than VOUT_MARGIN_HIGH value.

VIN_ON [0x35]

Range limits (max/min): 36/31

Units: volt

Command support: All functionality
Note: Special interlock checks between VIN_ON and VIN_OFF maintain a hysteresis gap of 1V minimum and do not allow the OFF level to be higher than and ON level

VIN_OFF [0x36]

Range limits (max/min): 35/30

Units: volt

Command support: All functionality

Note: Special interlock checks between VIN_ON and VIN_OFF maintain a hysteresis gap of 1V minimum and do not allow the OFF level to be higher than and ON level

VOUT_OV_FAULT_LIMIT [0x40]

Range limits (max/min): 5.3/3.3 (See note 2)

Units: volt

Command support: All functionality

Note1: Range cross- check – value must be greater than VOUT_COMMAND value.

Note2: The maximum OV Fault Limit equals the output set point plus 2V, up to 5.3V. This is an automatic module protection feature that will override a user-set fault limit if the user limit is set too high.

VOUT_OV_FAULT_RESPONSE [0x41]

Command support:

Response settings (bits RSP0:1) – only a setting of 10, unit shuts down and responds according to the retry settings below, is supported.

Retry settings (bits RS0:2) – only settings of 000 (unit does not attempt to restart on fault) and 111 unit continuously restarts (normal startup) while fault is present until commanded off, bias power is removed or another fault condition causes the unit to shutdown.

Delay time setting (bits 0-2) – only DT0:2 = 0 (no delay) supported.

Default Settings: The default settings for the VOUT_OV_FAULT_RESPONSE command are;

The unit shuts down in response to a VOUT over voltage condition.

The unit will continuously restart (normal startup) while the VOUT over voltage condition is present until it is commanded off, bias power is removed or another fault condition causes the unit to shutdown.

The shutdown delay is set to 0 delay cycles.

Format	**8 bit unsigned (bit field)**							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r/w	r/w	r/w	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default Value	1	0	1	1	1	0	0	0

IOUT_OC_FAULT_LIMIT [0x46]

Range limits (max/min): 90/66

Units: amp

Command support: All functionality

Note: Range cross-check – value must be greater than IOUT_OC_WARN_LIMIT value.

IOUT_OC_FAULT_RESPONSE [0x47]

Command support:

Response settings (bits RSP0:1) – only settings of 11, unit shuts down and responds according to the retry settings below, is supported.

Retry settings (bits RS0:2) – only settings of 000 (unit does not attempt to restart on fault) and 111 unit continuously restarts (normal startup) while fault is present until commanded off, bias power is removed or another fault condition causes the unit to shut down.

Delay time setting (bits 0-2) – only DT0:2 = 0 (no delay) supported.

Default Settings: The default settings for the IOUT_OC_FAULT_RESPONSE command are;

The unit shuts down in response to an IOUT over current condition.

The unit will continuously restart (normal startup) while the IOUT over current condition is present until it is commanded off, bias power is removed or another fault condition causes the unit to shut down.

The shutdown delay is set to 0 delay cycles.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r/w	r/w	r/w	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default Value	1	1	1	1	1	0	0	0

IOUT_OC_WARN_LIMIT [0x4A]

Range limits (max/min): 90/66

Units: amp

Command support: read/write support, functionality complete
Note: Range cross-check – value must be less than IOUT_OC_FAULT_LIMIT value.

OT_FAULT_LIMIT [0x4F]

Range limits (max/min): 135/90

Units: degrees C.

Command support: All functionality
Note: Range cross-check – value must be greater than OT_WARN_LIMIT value.

OT_FAULT_RESPONSE [0x50]

Command support:

Response settings (bits RSP0:1) – only setting of 10, unit shuts down and responds according to the retry settings below.

Retry settings (bits RS0:2) – only settings of 000 (unit does not attempt to restart on fault) and 111 unit continuously restarts (normal startup) while fault is present until commanded off, bias power is removed or another fault condition causes the unit to shutdown.

- Delay time setting (bits 0-2) – only DT0:2 = 0 (no delay) supported.

Default Settings: The default settings for the OT_FAULT_RESPONSE command are;

The unit shuts down in response to an over-temperature condition.

The unit will continuously restart (normal startup) while the over-temperature condition is present until it is commanded off, bias power is removed or another fault condition causes the unit to shut down.

The shutdown delay is set to 0 delay cycles.

Format	**8 bit unsigned (bit field)**							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r/w	r/w	r/w	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default Value	1	0	1	1	1	0	0	0

OT_WARN_LIMIT [0x51]

Range limits (max/min): 135/90

Units: degrees C.

Command support: All functionality
Note: Range cross-check – value must be less than OT_FAULT_LIMIT value.

VIN_OV_FAULT_LIMIT [0x55]

Range limits (max/min): 87/79

Units: volt

Command support: All functionality

VIN_OV_FAULT_RESPONSE [0x56]

Default Settings: The default settings for the VIN_OV_FAULT_RESPONSE command are;

The unit shuts down in response to a VIN over voltage condition.

The unit will continuously prepares to restart (normal startup) while the VIN over voltage condition is present until it is commanded off, bias power is removed, the VIN over voltage condition is removed, or another fault condition causes the unit to shut down.

The shutdown delay is set to 0 delay cycles.

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r/w	r/w	r/w	r	r	r
Function	RSP[1]	RSP[0]	RS[2]	RS[1]	RS[0]	DT[2]	DT[1]	DT[0]
Default Value	1	1	0	0	0	0	0	0

POWER_GOOD_ON [0x5E]

Range limits (max/min): 3.63/1.50

Units: volt

Command support: full support
Note: Range cross-check – value must be greater than POWER_GOOD_OFF value by 0.8V.

POWER_GOOD_OFF [0x5F]

Range limits (max/min): 3.63/1.50

Units: volt

Command support: full support
Note: Range cross-check – value must be less than POWER_GOOD_ON value by 0.8V.

STATUS_WORD [0x79]

Command support: full implementation for supported functions (note: Fans, MFR_SPECIFIC, Unknown not supported)

Format	8 bit unsigned (bit field)							
Bit Position	15	14	13	12	11	10	9	8
Access	r	r	r	r	r	r	r	r
Function	VOUT	I/POUT	INPUT	MFR_SPEC	#PWR_GOOD	FAN[1]	OTHER[1]	UNKNOWN[1]

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r
Function	BUSY[1]	OUTPUT_OFF	VOUT_OV_FAULT	IOUT_OC_FAULT	VIN_UV_FAULT	TEMP	CML	NONE OF ABOVE[1]

Note1: Not supported

STATUS_VOUT [0x7A]

Command support: VOUT_OV_FAULT support, all bit reset supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/reset[1]	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset
Function	VOUT_OV_FAULT	VOUT_OV_WARN[1]	VOUT_UV_WARN[1]	VOUT_UV_FAULT[1]	VOUT_MAX_WARN[1]	TON_MAX_FAULT[1]	TOFF_MAX_WARN[1]	VOUT_TRACKING ERROR[1]

STATUS_IOUT [0x7B]

Command support: IOUT_OC_FAULT support, all bit reset supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/reset[1]	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset
Function	IOUT_OC_FAULT	IOUT_OC_LV_FAULT[1]	IOUT_OC_WARN	IOUT_UC_FAULT[1]	Current Share Fault[1]	In Power Limiting Mode[1]	POUT_OP_FAULT[1]	POUT_OP_WARN[1]

STATUS_INPUT [0x7C]

Command support: VIN_OV_FAULT support, all bit reset supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/reset[1]	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset
Function	VIN_OV_FAULT	VIN_OV_WARN[1]	VIN_UV_WARN[1]	VIN_UV_FAULT	Unit Off(low input voltage)	IIN_OC_FAULT[1]	IIN_OC_WARN[1]	PIN_OP_WARN[1]

STATUS_TEMPERATURE [0x7D]

Command support: OT_WARN, OT_FAULT supported, all bit reset supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r/reset[1]	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset	r/reset
Function	OT_FAULT	OT_WARN	UT_WARN[1]	UT_FAULT[1]	reserved	reserved	reserved	reserved

Note1: Not supported

READ_VIN [0x88]

Command support: full support

READ_VOUT [0x8B]

Command support: full support

READ_IOUT [0x8C]

Command support: full support

READ_TEMPERATURE_1 [0x8D]

Range cross-check - value must be greater than VOUT_MARGIN_LOW value.

Command support: full support

MFR_IOUT_CAL_GAIN [0xD6]

Command support: support for IOU gain calibration (factor in flash), lockout per MFR_DEVICE_TYPE

MFR_IOUT_CAL_OFFSET [0xD7]

Command support: support for IOU offset calibration (factor in flash), lockout per MFR_DEVICE_TYPE

MFR_VOUT_READ_CAL_GAIN [0XD1]

Command support: support for VOUT gain calibration (factor in flash), lockout per MFR_DEVICE_TYPE

MFR_VIN_READ_CAL_GAIN [0xDD]

Factory default:194

Range limits (max/min): 210/180

Command support: support for VIN gain calibration (factor in flash), lockout per MFR_DEVICE_TYPE

MFR_VIN_READ_CAL_OFFSET [0xDE]

Range limits (max/min): 200/0

Units: N/A

Command support: support for VIN offset calibration (factor in flash), lockout per MFR_DEVICE_TYPE

MFR_FW_REV [0x9B]

Range limits (max/min): 0 - 0xff (0.00 – 15.15)

Units: N/A

Command support: full read support

MFR_C1_C2_ARA_CONFIG [0xE0]

Command Code

Command support: Full support.

Command	MFR_C1_C2_ARA_CONFIG							
Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r/w	r/w	r/w	r/w	r/w
Function	Reserved			ARA	Assignment Table			
Default Value	0	0	0	0	0	0	0	0

Assignment Table:

Bit	Description	Value	Meaning
7:5	Reserved	000	Reserved
4	ARA	0	ARA not functional, module remains at resistor programmed address when SMBLAERT is asserted
		1	ARA functional, module responds to ARA only, when SMBLAERT is asserted
3:0	PIN Configuration	0000	T/C1 pin: ON/OFF (Secondary) C2 pin: POWER_GOOD
		0001	T/C1 pin: TRIM C2 pin: POWER_GOOD
		0010	T/C1 pin: TRIM C2 pin: ON/OFF (Secondary)

MFR_ C2_LOGIC [0xE1]

Command Code

Command support: full support (bits 0 and 1) as follows:

Command	MFR_C2_ARA_LOGIC							
Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r/w	r/w
Function	Reserved						On/Off(primary & secondary) combination	logic
Default Value	0	0	0	0	0	0	0	0

Bit	Description	Value	Meaning
7:2	Reserved	000000	Reserved
1	ON/OFF Configuration	0	Secondary side on/off pin state, when mapped to either T/C1 or C2, is ignored
		1	AND – Primary and Secondary side on/off
0	Secondary Side ON/OFF Logic	0	Negative Logic (Low Enable: Input < 0.8V wrt Vout(-)
		1	Positive Logic (High Enable: Input > 2.2V wrt Vout(-)

MFR_PGOOD_POLARITY [0xE6]

Command support: full support (bit 0) as follows:

Bit 0:

0 = Negative PGOOD logic (module PGOOD asserted when pin is LO, PGOOD de-asserted when pin is HI)

1 = Positive PGOOD logic (module PGOOD de-asserted when pin is LO, PGOOD asserted when pin is HI)

Command	MFR_PGOOD_POLARITY							
Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	r	r	r	r	r	r	r	r/w
Function	Reserved							logic
Default Value	0	0	0	0	0	0	0	1

MFR_MODULE_DATE_LOC_SN [0xF0]

Command support: read/write support for 12 byte block, lockout per MFR_DEVICE_TYPE

PMBus Command List

The main PMBus commands described in the PMBus 1.2 specification are supported by the module. Partial PMBus commands are fully supported; Partial PMBus commands have difference with the definition in PMBus 1.2 specification. The details about all the supported PMBus commands are to be decided later.

PMBus CMD	CMD Code	Data Bytes	Data Format	Data Units	Transfer Type	Default Value
OPERATION	0x01	1	Bit field	N/A	R/W byte	0x80
ON_OFF_CONFIG	0x02	1	Bit field	N/A	R/W byte	0x1D (Negative Logic) 0x1F (Positive Logic)
CLEAR_FAULTS	0x03	0	N/A	N/A	Send byte	None
STORE_DEFAULT_ALL	0x11	0	N/A	N/A	Send byte	none
RESTORE_DEFAULT_ALL	0x12	0	N/A	N/A	Send byte	none
VOUT_MODE	0x20	1	mode + exp	N/A	Send byte	0x17
VOUT_COMMAND	0x21	2	VOUT linear	V	R/W word	3.3000
VOUT_MARGIN_HIGH	0x25	2	VOUT linear	V	R/W word	3.6300
VOUT_MARGIN_LOW	0x26	2	VOUT linear	V	R/W word	2.6400
VIN_ON	0x35	2	VIN linear	V	R/W word	34.000
VIN_OFF	0x36	2	VIN linear	V	R/W word	32.000
VOUT_OV_FAULT_LIMIT	0x40	2	VOUT linear	V	R/W word	4.000
VOUT_OV_FAULT_RESPONSE	0x41	1	Bit field	N/A	R/W byte	0xB8
IOUT_OC_FAULT_LIMIT	0x46	2	IOUT linear	A	R/W word	72.000
IOUT_OC_FAULT_RESPONSE	0x47	1	Bit field	N/A	R/W byte	0xF8
IOUT_OC_WARN_LIMIT	0x4A	2	IOUT linear	A	R/W word	68.000
OT_FAULT_LIMIT	0x4F	2	TEMP linear	^{O}C	R/W word	120
OT_FAULT_RESPONSE	0x50	1	Bit field	N/A	R/W byte	0xB8
OT_WARN_LIMIT	0x51	2	TEMP linear	^{O}C	R/W word	100
VIN_OV_FAULT_LIMIT	0x55	2	VIN linear	V	R/W word	84
VIN_OV_FAULT_RESPONSE	0x56	1	Bit field	N/A	R/W byte	0xC0
POWER_GOOD_ON	0x5E	2	VOUT linear	V	R/W word	2.640
POWER_GOOD_OFF	0x5F	2	VOUT linear	V	R/W word	1.600
TON_DELAY	0x60	2	Time linear	ms	R/W word	40
TON_RISE	0x61	2	Time linear	ms	R/W word	20
STATUS_WORD	0x79	2	Bit field	N/A	Read word	N/A
STATUS_VOUT	0x7A	1	Bit field	N/A	Read byte	N/A
STATUS_IOUT	0x7B	1	Bit field	N/A	Read byte	N/A
STATUS_INPUT	0x7C	1	Bit field	N/A	Read byte	N/A
STATUS_TEMPERATURE	0x7D	1	Bit field	N/A	Read byte	N/A
READ_VIN	0x88	2	VIN linear	V	Read word	N/A
READ_VOUT	0x8B	2	VOUT linear	V	Read word	N/A
READ_IOUT	0x8C	2	IOUT linear	A	Read word	N/A
READ_TEMP1	0x8D	2	TEMP linear	^{O}C	Read word	N/A
PMBus_REVISION	0x98	1	Bit Field	N/A	Read byte	1.2
MFR_FW_REV	0x9B	1	8 bit unsigned	N/A	R/W word	AA
MFR_VIN_READ_CAL_GAIN	0xDD	2	U 16 bit	N/A	R/W word	MS
MFR_VIN_READ_CAL_OFF	0XDE	2	U 16 bit	N/A	R/W word	MS
MFR_C1_C2_ARA_CONFIG	0xE0	1	Bit field	N/A	R/W byte	0x01
MFR_ C2_LOGIC	0xE1	1	Bit field	N/A	R/W byte	0x01
MFR_PGOOD _POLARITY	0xE6	1	Bit field	N/A	R/W byte	0x01
MFR_MOD_DATE_LOC_SN	0xF0	12	8 bit char	N/A	R/W block	China. SZ
MFR_VOUT_READ_CAL_GAIN	0xD1	2	U 16 bit	N/A	R/W word	TBD
MFR_IOUT_CAL_GAIN	0xD6	2	U 16 bit	N/A	R/W word	MS
MFR_IOUT_CAL_OFFSET	0xD7	2	U 16 bit	N/A	R/W word	MS
MS=Module specific						

Application Notes

Soldering

The product ADO300-48S3V3-6L and ADO300-48S3V3-6LI are intended for standard manual or wave soldering or reflow soldering.

The product ADO300-48S3V3B-6L and ADO300-48S3V3B-6LI are 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 manual soldering is used, 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.

When reflow soldering is used, device must be qualified for Pb-Free reflow soldering process without any electrical or mechanical property degradation. The Pb-Free process parameters are as follows:

- Max. sustain temperature:
- 245^{O}C (J-STD-020C Table 4-2: Packaging Thickness≥2.5mm/ Volume > 2000mm^{3}),
- Peak temperature over 245^{O}C is not suggested due to the potential reliability risk of components under continuous high-temperature.
- Min. sustain duration above 217^{O}C : 90s
- Min. sustain duration above 180^{O}C : 150s
- Max. heat up rate: 3^{O}C /s
- Max. cool down rate: 4^{O}C /s
- In compliance with JEDEC J-STD-020C spec for 2 times reflow requirement.

The device module will comply with J-STD-020 Rev. C (Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices) for both Pb-free solder profiles and MSL classification procedures.

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

Hazardous Substances Announcement (RoHS of China)

Parts	Hazardous Substances					
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
ADO300-48S3V3-6L	x	x	x	x	x	x
ADO300-48S3V3-6LI	x	x	x	x	x	x
ADO300-48S3V3B-6L	x	x	x	x	x	x
ADO300-48S3V3B-6LI	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

Record of Revision and Changes

Issue	Date	Description	Originators
1.0	12.13.2017	First Issue	William Feng

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