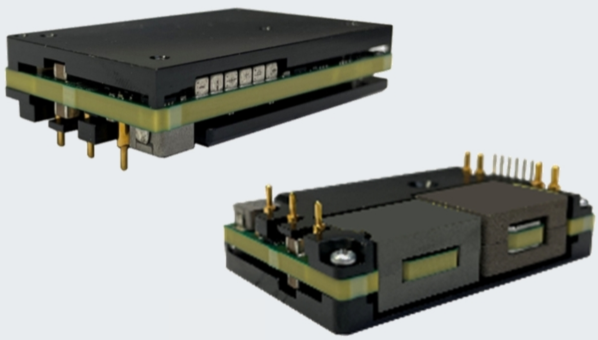
TECHNICAL REFERENCE NOTE

ARTESYN
NDQ1300 Series
1300 W Quarter-brick Converter



PRODUCT DESCRIPTION

Advanced Energy's Artesyn™ NDQ1300 series is a new generation non-isolated single output digital control DC-DC converter with standard quarter-brick outline and pin configuration, as well as PMBus™ option. It delivers up to 1300 W with 12.15 V output voltage. Ultra high peak efficiency of 97.7% and excellent thermal performance makes it an ideal choice for 48 V to 12 V down conversion in high power computing and storage applications. It can produce full power over an operating temperature range of -40°C to +85°C with conduction cooling via the baseplate to a heat sink or other cooling means. A PMBus™ interface is also provided for flexible digital control and monitoring.

SPECIAL FEATURES

- Delivers up to 1300 W
- Ultra-high efficiency 97.7% peak
- Wide input range: 40 to 60 Vdc
- PMBus™ function
- Excellent thermal performance
- Parallel operation
- Remote sense function
- No minimum load requirement
- Fixed switching frequency
- Base-plate for contact cooling
- RoHS 3.0 compliant
- Remote control function (negative logic)
- Input undervoltage lockout
- Input overvoltage lockout
- Output overcurrent protection
- Output overvoltage protection
- Over temperature protection
- Pin length option: 3.8 mm

SAFETY

- IEC/EN/UL/CSA 62368-1
- CE
- UL/TUV
- UL94, V-0

TYPICAL APPLICATIONS

- Telecom
- Datacom
- Computing and storage

WARRANTY

- 2 Years (Consult AE for extended terms)

AT A GLANCE

Total Power

1300 W

Input Voltage

40 to 60 Vdc

# of Outputs

Single

TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION 1 MODEL NUMBERS

Part number	Output Voltage	Structure	Pin Type	RoHS Status	PMBus™
NDQ1300-48S12B-6I	12.15 Vdc	Baseplate	Through hole	RoHS 3.0	Yes
NDQ1300-48S12BP-6IA	12.15 Vdc	Baseplate	Through hole	RoHS 3.0	Yes

Ordering Information

NDQ1300	-	48	S	12		B	-	6	I	A	
①		②	③	④	⑤	⑥		⑦	⑧	⑨	⑩

①	Model series	NDQ: high efficiency non-isolated digital control quarter brick series 1300: output power 1300 W
②	Input voltage	48: 40 to 60 V input range, rated input voltage 50 V
③	Output number	S: single output
④	Rated output voltage	12: 12.15 V output
⑤	Enable polarity	No character = Negative enable, P = Positive enable
⑥	Baseplate status	B: with baseplate
⑦	Pin length	-6: 3.8 mm
⑧	PMBus™ interface	I: present = PMBus pins and PG-pin fitted No character = No PMBus and No PG-pin
⑨	Active current sharing	A: present = active current sharing No character = Droop current sharing with remote sense
⑩	Customization code	-

Options

None

SECTION 2 ELECTRICAL SPECIFICATIONS

2.1 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 Non-operating - 100ms	All	$V_{IN,DC}$	- -	- -	60 80	Vdc Vdc
Maximum Output Power[1]	All	$P_{O,max}$	-	-	1300	W
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		-	-	15	Vdc
Logic Pin Voltage (to SIG_GND or Vo-), such as ADDR, CLK, DATA, SMBALERT	All		-0.3	-	3.6	V
Humidity (non-condensing) Operating Non-operating	All	-	- -	- -	95 95	% %

Note 1 - 1600 W/50 ms peak power. When peak power occurs, the average power with peak power should not exceed 1300 W. High temperature and high di/dt on load step up to peak power, might cause current overshot resulting in OCP fault. Maximum load step slew rate is application dependent and can vary between systems. Application test is required to find maximum load step slew rate.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.2 Input Specifications

Table 2. Input Specifications (Tested with the Application Circuit as Figure 13)

Parameter	Conditions[1]	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, DC	All	$V_{IN,DC}$	40	50	60	Vdc
Turn-on Voltage Threshold	All	$V_{IN,ON}$	35	-	39	Vdc
Turn-off Voltage Threshold	All	$V_{IN,OFF}$	34	-	37	Vdc
Input Under Voltage Lockout Hysteresis	All		1	-	2	Vdc
Input Overvoltage Protection	All		61	65	68	Vdc
Maximum Input Current	$V_{IN,DC}$ = 40 Vdc, $I_O = I_{O,max}$	$I_{IN,max}$	-	-	38	A
No Load Input Current	All	I_{IN,no_load}	-	0.135	-	A
Standby Input Current	Remote OFF	$I_{IN,standby}$	-	0.023	-	A
Recommended Input Fuse	Fast blow external fuse recommended		-	-	50	A
Recommended External Input Capacitance	Low ESR capacitor recommended	C_{IN}	269	-	-	µF
Input Reflected Ripple Current (RMS)[2]	Through 12 uH inductor		-	50	-	mA
Operating Efficiency	$V_{IN,DC}$ = 50 Vdc, T_{PA} = 25°C I_O = 100%$I_{O,max}$ Peak	η	- -	97.0 97.7	- -	% %

Note 1 - T_{PA} = 25°C, Vin = 50 Vdc, nominal Vout unless otherwise noted.
Note 2 - Input Reflected Ripple Current (RMS), tested with the circuit as Figure 13.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.3 Output Specifications

Table 3. Output Specifications (Tested with the Application Circuit as Figure 13)

Parameter		Conditions[1]	Symbol	Min	Typ	Max	Unit
Factory Voltage Set Point		I_O = 0 A I_O = 100%$I_{O,max}$	V_O	12.40 11.90	12.45 12.15	12.50 -	Vdc
Output Voltage Line Regulation			V_O	-	30	-	mV
Output Voltage Load Regulation			V_O	-	300	500	mV
Output Voltage Temperature Regulation		I_O = 0 A	V_O	-	-	0.02	%/^{O}C
Output Voltage Ripple and Noise, pk-pk[2]		20 MHz bandwidth	V_O	-	70	-	mV_{PK-PK}
Output Current			I_O	0	-	107	A
Output DC Current-limit Inception[3]			I_O	115	-	170	A
V_O Load Capacitance		All	C_O	1514	-	20000	µF
Switching Frequency		All	f_{SW}	-	130	-	kHz
V_O Dynamic Response	Peak Deviation Settling Time	50% to 75% to 50% $I_{O,max}$ Slew rate = 0.1 A/µs	$\pm V_O$ T_s	- -	200 300	- -	mV µs
		50% to 75% to 50% $I_{O,max}$ Slew rate = 1 A/µs	$\pm V_O$ T_s	- -	400 300	- -	mV µs
Turn-on Transient	Rise Time	I_O = $I_{O,max}$	T_{rise}	-	25	100	ms
	Turn-on Delay Time	By DC input	$T_{turn-on}$	-	50	200	ms
	Turn-on Delay Time	By Enable	$T_{turn-on}$	-	55	200	ms
	Turn-on Overshoot	All	V_O	-	-	600	mV
	Turn-off Undershoot	All	V_O	-	-	600	mV
Remote ON/OFF Control (Negative logic)	Off-state Voltage	All		2.4	-	15	Vdc
	On-state Voltage	All		-0.3	-	0.8	Vdc
Power good function[4] (Positive logic)	Power-good state	All	Pg	2.4	-	3.6	Vdc
	Power NOT-good state	All	Pg	-0.3	-	0.8	Vdc
Output Overvoltage Protection[5]		All		13.7	-	18.5	Vdc
Output Over-temperature Protection[6]		Baseplate	T	-	116	-	^{O}C
Over-temperature Hysteresis		All		-	10	-	^{O}C
+ Remote Sense		All	V_O	-	-	+0.5	Vdc
- Remote Sense		All	V_O	-	-	-0.25	Vdc

Note 1 - T_{PA} = 25 ^{O}C, Vin = 50 Vdc, nominal Vout unless otherwise noted.
Note 2 - Tested with the circuit of Figure 13.
Note 3 - Hiccup: auto-restart when over-current condition is removed.
Note 4 - The power good function will exhibit a logic-High when the unit is operating correctly and a logic-Low when the unit is in fault condition and not supplying power. The power good function is open drain, with external pull-up resistor.
Note 5 - Hiccup: auto-restart when overvoltage condition is removed.
The voltage is sensed through the output pins of the module for output OVP function. In some application (just like connecting remote sense wire to remote location, trimming-up the output voltage and etc.), output OVP level or external output capacitance may need to be adjusted finely to avoid false trigger the output OVP function in transient events
Note 6 - Auto recovery. Temperature protect (OTP) test point is T_{PA} in figure 11.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.4 PMBus™ Signal Interface Characteristics

Table 4. PMBus™ Signal Interface Characteristics[1]

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Input High Voltage (CLK, DATA)			2.1	-	3.6	V
Input Low Voltage (CLK, DATA, PG)			0	-	0.8	V
Input High Level Current (CLK, DATA, PG)			-2.5	-	2.5	mA
Output low voltage (SMBALERT, CLK, DATA)	I_O = 2 mA		-	-	0.4	V
PMBus Operation Frequency[2]			100/400			kHz

2.5 Measurement System Characteristics

Table 5. Measurement System Characteristics

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Output Current Reading Accuracy	$53\%I_{O,max} < I_O < 100\%I_{O,max}$ $0A < I_O \leq 53\%I_{O,max}$		-8 -4.5	- -	8 4.5	% A
Output Current Reading Resolution			-	0.25	-	A
Vo Reading Accuracy			-2	1	2	%
Vo Reading Resolution			-	0.25	-	V
Vin Reading Accuracy			-4	-	4	%
Vin Reading Resolution			-	0.125	-	V
Temperature Reading Accuracy	Temperature above 0^{O}C		-	3	-	^{O}C
Temperature Reading Resolution	Temperature above 0^{O}C		-	1	-	^{O}C

Note 1 - T_{PA} = 25^{O}C, Vin = 50Vdc, nominal Vout unless otherwise noted.
Note 2 - For applications where PMBus frequencies at 400 kHz are required, please contact your Advanced Energy technical support representative.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.6 Performance Curves

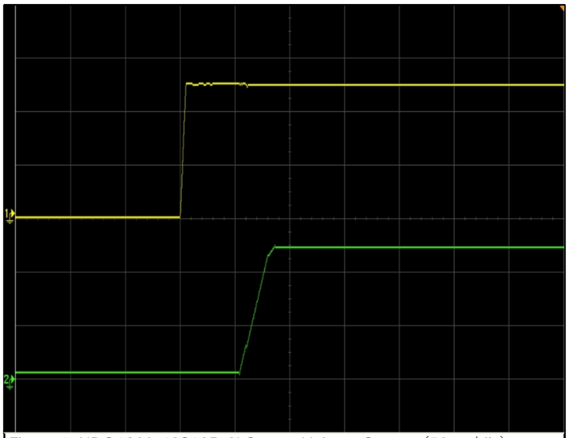


Figure 1: NDQ1300-48S12B-6I Output Voltage Startup (50ms/div)
Vin = 50V Load: Io = 106A
Ch1: Vin (20V/div) Ch2: Vo (5V/div)

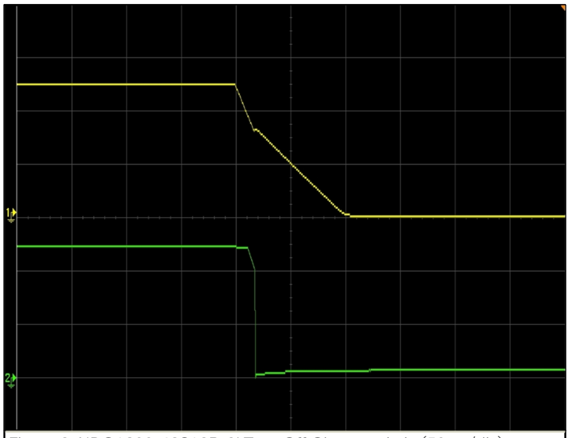


Figure 2: NDQ1300-48S12B-6I Turn Off Characteristic (50ms/div)
Vin = 50V Load: Io = 106A
Ch1: Vin (20V/div) Ch2: Vo (5V/div)

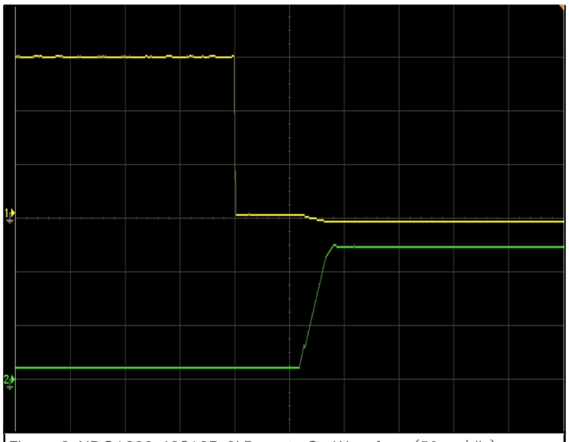


Figure 3: NDQ1300-48S12B-6I Remote On Waveform (50ms/div)
Vin = 50V Load: Io = 106A
Ch 1: Remote On (1V/div) Ch 2: Vo (5V/div)

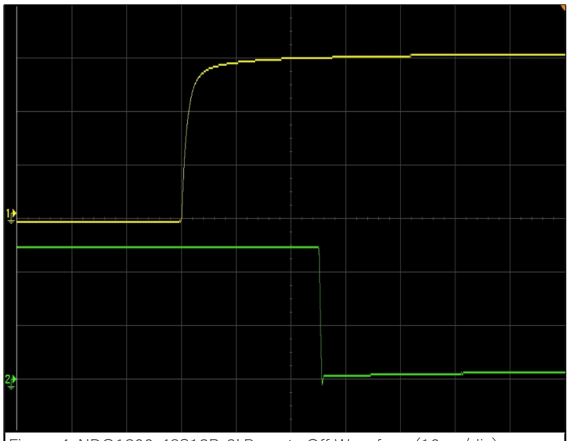


Figure 4: NDQ1300-48S12B-6I Remote Off Waveform (10ms/div)
Vin = 50V Load: Io = 106A
Ch 1: Remote Off (1V/div) Ch 2: Vo (5V/div)

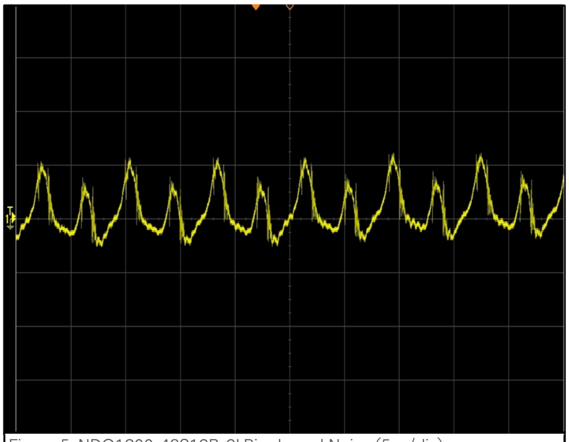


Figure 5: NDQ1300-48S12B-6I Ripple and Noise (5µs/div)
Vin = 50V Load: Io = 106A
Ch 1: Vo (20mV/div)

Figure 6: NDQ1300-48S12B-6I Transient Response (2ms/div)
Vin = 50V Io = 25% load step, 50%~75%~50%, 0.1A/µs slew rate
Ch 1: Vo (100mV/div) Ch 2: Io (25A/div)

SECTION 2 ELECTRICAL SPECIFICATIONS

2.6 Performance Curves

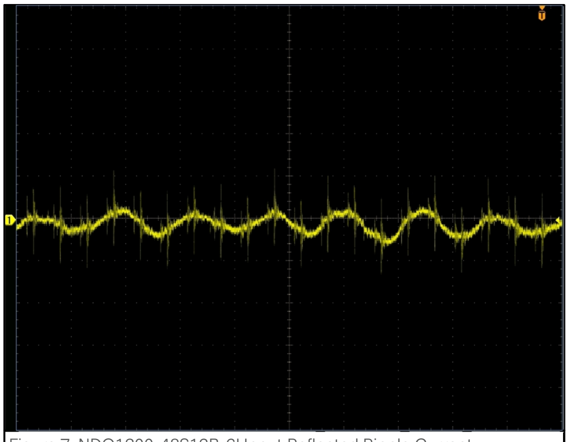


Figure 7: NDQ1300-48S12B-6I Input Reflected Ripple Current
Vin = 50V Load: Io = 106A
Ch 1: Iin (5µs/div, 100mA/div)

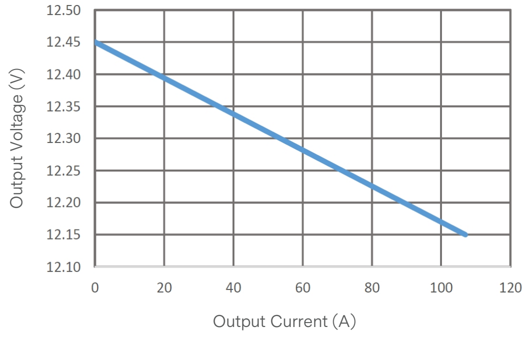


Figure 8: NDQ1300-48S12B-6I Output Voltage vs. Output Current

Vin = 50V T_{PA} = 25°C

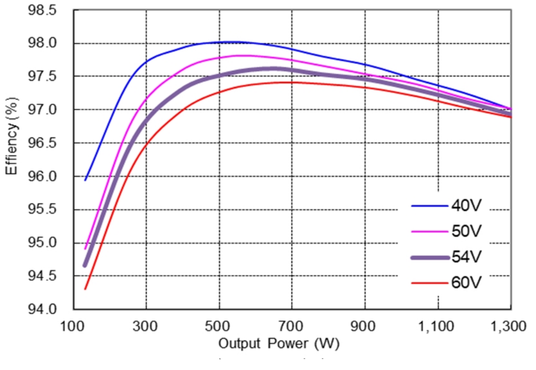


Figure 9: NDQ1300-48S12B-6I Efficiency Curves

Vin = 40 to 60V T_{PA} = 25°C

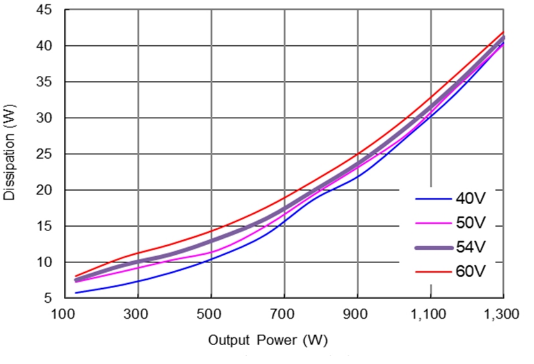
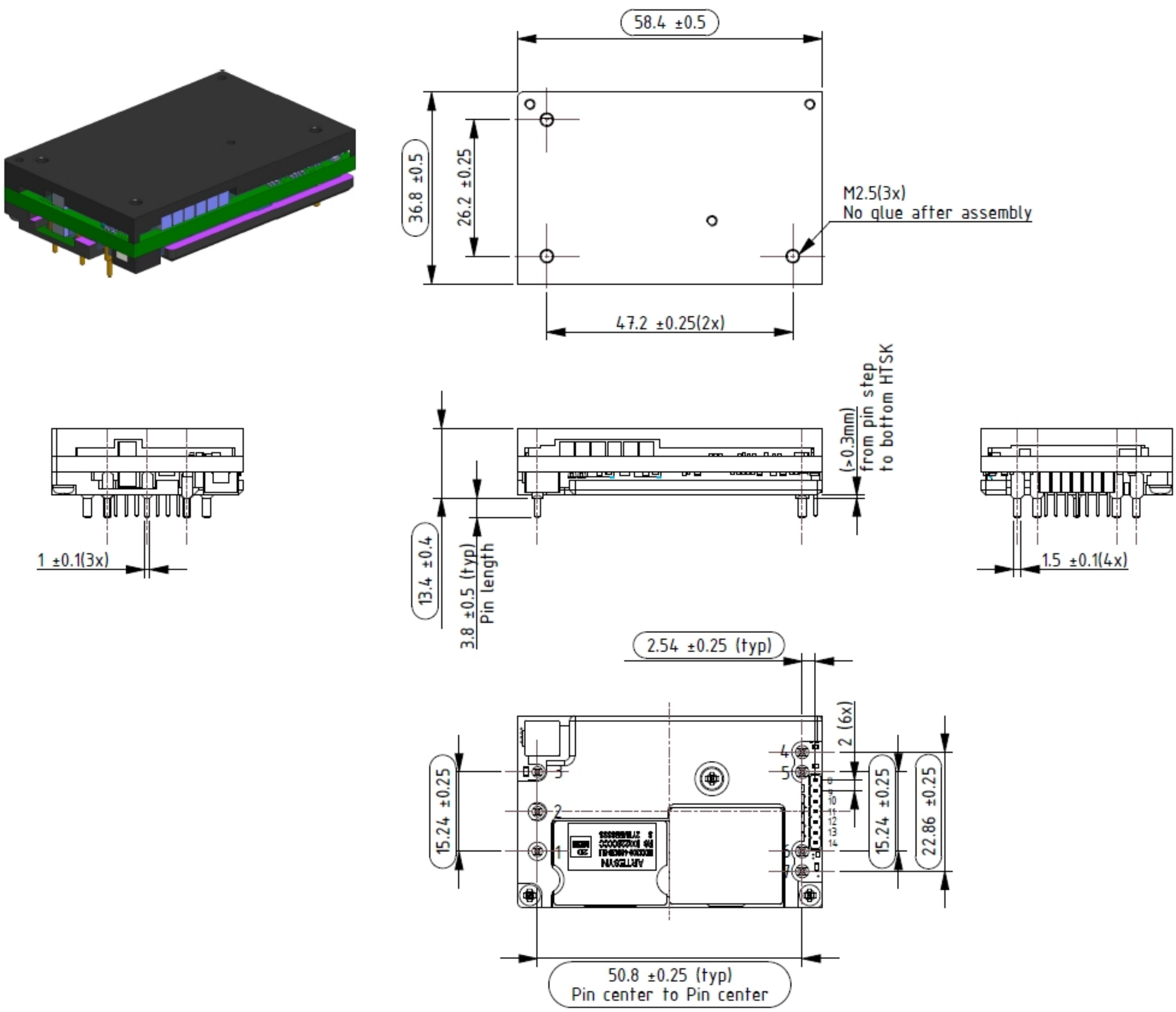


Figure 10: NDQ1300-48S12B-6I Power Loss vs. Output Power

Vin = 40 to 60V T_{PA} = 25°C

SECTION 3 MECHANICAL SPECIFICATIONS

3.1 Mechanical Outlines - Baseplate 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 - NDQ1300-48S12B-6I has pin 8 to 14,
Note 2 - The minimum clearance from customer PCB is 0.2 mm (0.008 inch).
Note 3 - Depth penetration into base plate, of M2.5 screws used at baseplate mounting holes. Do not exceed a depth of 3.0 mm for M2.5 screw in the baseplate screw hole.

SECTION 3 MECHANICAL SPECIFICATIONS

3.2 Pin Length Option

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

3.3 Pin Designations

Pin No	Name	Function	Optional
1	Vin+	Positive input voltage	-
2	CNT	Remote on/off control	-
3	GND	Negative input voltage	-
4	GND	Negative output voltage	-
5	GND	Negative output voltage	-
6	Vo+	Positive output voltage	-
7	Vo+	Positive output voltage	-
8	PG	Power good	Yes
9	-Remote sense/Sig-ground[1]	Negative remote sense/signal ground	Yes
10	DATA	PMBus™ Data	Yes
11	SMBAlert	PMBus™ Alert signal	Yes
12	CLK	PMBus™ Clock	Yes
13	Addr	PMBus™ Address	Yes
14	+Remote sense/Current share[2]	Positive remote sense/current share	Yes

Note 1 - Pin 9 should be -Remote sense for NDQ1300-48S12BP-6I, and Sig-ground for NDQ1300-48S12BP-6IA.
Note 2 - Pin 14 should be +Remote sense of NDQ1300-48S12BP-6I, and current share for NDQ1300-48S12BP-6IA.
Note 3 - The baseplate of the module is connected to GND.

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

4.1 Input Fusing

NDQ1300 series internal fuse is fast blow type. An external fuse is recommended. To meet international safety requirements, recommended rating is 50 A/150 Vdc for the converter.

4.2 EMC Immunity

NDQ1300 series power supply is designed to meet the following EMC immunity specifications.

Table 6. Environmental Specifications

Test Items	Standard	Test Level	Criteria[1]
Conducted Emissions	EN 55032 DC input port	Class B	/
Electro Static Discharge (ESD) Immunity	EN/IEC 61000-4-2	Enclosure port, Level 3	B
Electrical Fast Transients (EFT)/Bursts	EN/IEC 61000-4-4	DC input port, Level 3	B
Surges - Line to Line (DM) and Line to GND (CM)	EN/IEC 61000-4-5	DC input port, 600V DM, 600V CM	B
Conducted Immunity	EN/IEC 61000-4-6	DC input port, Level 2	A
Voltage Dips and Short Interruptions and Voltage Variations	EN61000-4-29	DC input port	B

Note 1: Performance Criteria as defined by EN300386.

Criteria A: The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below specified performance level during intended use of operation.

Criteria B: Output voltage fluctuation or reset is allowed during the test, but recovers to its normal performance automatically after the disturbance ceases.

Criteria C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

Criteria D: Loss of output which is not recoverable, owing to damage to hardware.

4.3 Safety Certifications

The NDQ1300 series power supply is intended for inclusion in other equipment and the installer must ensure that it is in compliance with all the requirements of the end application. This product is only for inclusion by professional installers within other equipment and must not be operated as a stand alone product.

Table 7. Safety Certifications

Standard	Agency	Description
UL/CSA62368-1	UL	US and Canada Requirements
EN 62368	CE	European Requirements
IEC 62368	-	International Requirements
CE	-	CE Marking
UL94	-	Materials meet V-0 flammability rating
TUV	-	International Requirements

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

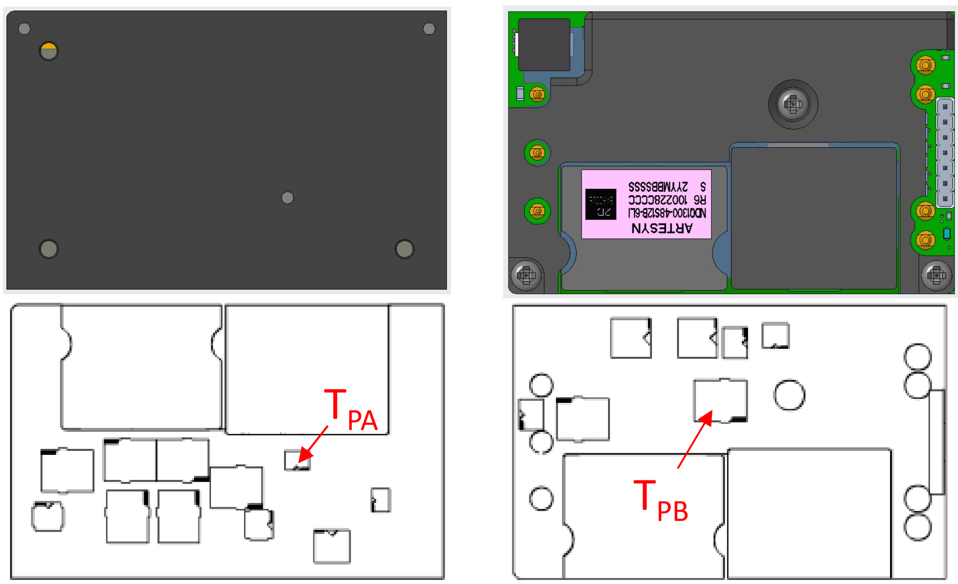
4.4 Operating Temperature

The NDQ1300 series module starts and operates within stated specifications at an ambient temperature from -20°C to 85°C under all load conditions. The storage temperature is -55°C to 125°C.

4.5 Thermal Considerations - Base plate module

NDQ1300 series is designed to operate in different thermal environments and sufficient cooling must be provided. Proper cooling can be verified by measuring the temperature at the test points as shown in the Figure 11. The temperature at these test points should not exceed the maximum values in Table 8.

For a typical application, Figure 12 shows the derating of output current vs. ambient air temperature at different air velocity at 50V input with a 0.7" heat sink. Heat sink needs to be unscrewed in order to attach thermal probe to the component lead.



Top view w/ & w/o heat sink   Bottom view w/ & w/o heat sink

Figure 11 Temperature Test Points

Table 8. Temperature Limit of the Test Points	
Test Point	Temperature Limit (°C)
Test point A (Baseplate middle)	108
Test point B	122

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

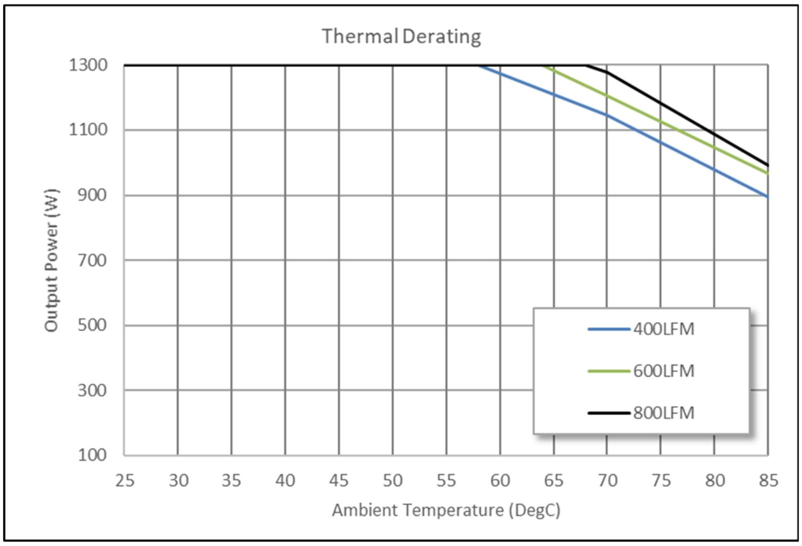


Figure 12 NDQ1300-48S12B-6I with 0.7" heatsink, output power derating at 50Vin, air flowing across the converter from Vin- to Vin+

4.6 Qualification Testing

Table 9. Qualification Testing

Parameter	Unit (pcs)	Test condition
HALT test	2	Operating limit: Ta,min-20°C to Ta,max+25°C, 10°C step, $V_{IN,DC}$ = min to max, 0 to 100% load Vibration limit: > 50 G
Vibration	2	Frequency range: 5 Hz to 20 Hz, 20 Hz to 200 Hz, A.S.D: 1.0 m2/s3, -3 db/oct Axes of vibration: X/Y/Z. Time: 30 min/axis. Non-operational.
Mechanical Shock	2	Type: half sine, Acceleration: 30 g, Duration: 6 ms, Directions: 6 Number of shock: 3 times/face. Non-operational.
Thermal Shock	3	-55°C to 125°C, Temp dwell time: 30 min, Temp change rate: 20°C/min, Unit temperature 20 cycles
Thermal Cycling	3	-40°C to 85°C, temperature change rate: 1°C/min, cycles: 2 cycles
Humidity	3	40°C, 95%RH, 48 h
MTBF		Telcordia, SR332 Method 1 Case 1, 7.2 MHrs typically

SECTION 5 APPLICATION NOTES

5.1 Typical Application

Below is the typical application of the NDQ1300 series power supply.

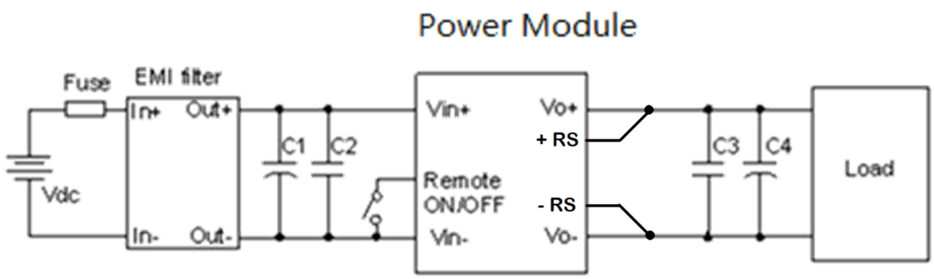


Figure 13 Typical application

C1: 259µF/100V electrolytic capacitor (2*56µF/80V OSCON cap + 100µF/100V Nichicon cap + 47µF/100V Nichicon cap)

C2: 10µF/100V X7R ceramic capacitor

C3: 2PCS 22µF/25V/X7S ceramic capacitor

C4: 4400µF/16V electrolytic capacitor, OSCON or POSCAP

Fuse: External fast blow fuse with a rating of 50A/150Vdc. The recommended fuse model is WM55-50 from Walter Electronic.

EMI Filter: refer to U1 in Figure 15.

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

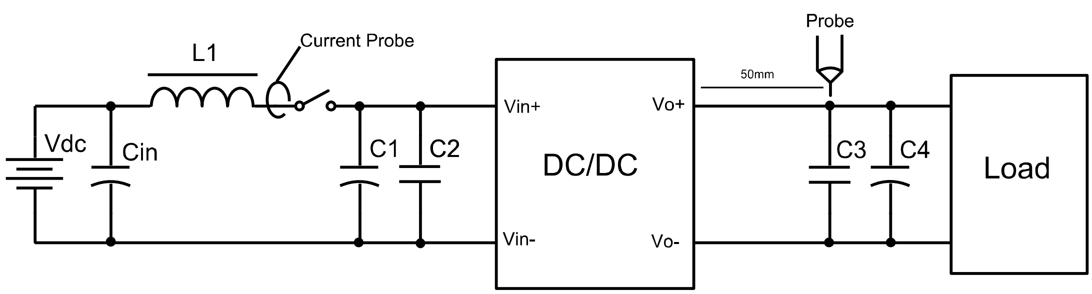


Figure 14 Input ripple & inrush current & output ripple and noise test configuration

Vdc: DC power supply

L1: 12µH

Cin: 220µF/100V typical

C1 to C4: See Figure 13

Note: Using a coaxial cable with a 50 ohm termination resistor and 0.68µF ceramic capacitor in series to test output ripple & noise is recommended.

SECTION 5 APPLICATION NOTES

5.3 EMC Test Conditions

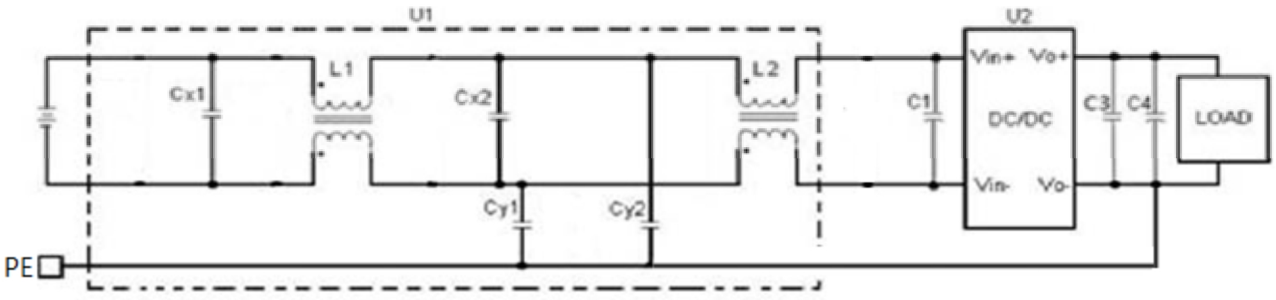


Figure 15 EME test condition

C1: 259µF electrolytic capacitor (2x56µF/80V OSCON cap + 100µF/100V Nichicon cap + 47µF/100V Nichicon cap)

C3: 22uF/25V/X7R *1 PCS capacitor

C4: 1000µF OSCON cap + 470µF OSCON cap

U1: Input EMC filter

U2: Module to test

Cx1: 4*SMD ceramic-100V/4.7µF/X7R capacitor

Cx2: 4*SMD ceramic-100V4.7µF/X7R capacitor

Cy1: 2*SMD ceramic-630V/0.22µF/X7R Y capacitor

Cy2: 2*SMD ceramic-630V/0.22µF/X7R Y capacitor

L1, L2: 650µH, common mode inductor

Fuse: External fast blow fuse with a rating of 50A/150Vdc. The recommended fuse model is WM55-50 from Walter Electronic.

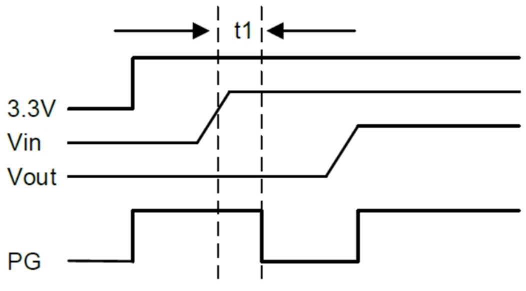
5.4 Power Good Function

The module has a power good function. The power good pin is open drain need external pull-up to high level.

When the unit is operating correctly, supplying power and all parameters are within specification, a logic high voltage will be present on this pin.

When the unit is not operating correctly – either is under a mode of protection (over temperature, over current or overvoltage) that is causing the unit to 'shut-down' and not supply power, or, if the unit has failed, there will be logic low voltage present on this pin. The high level can not exceed 3.6V.

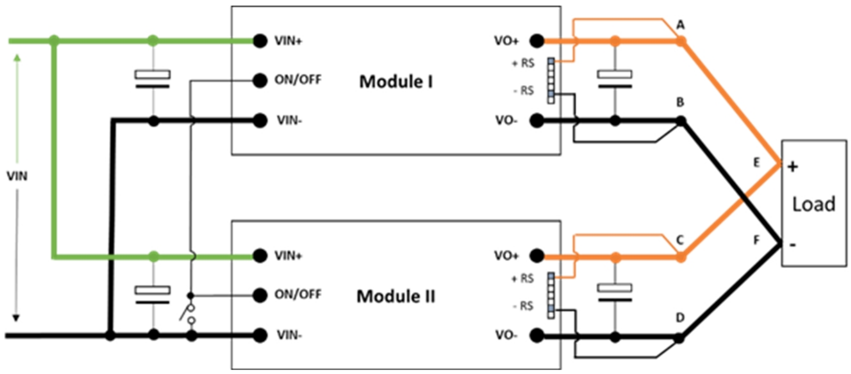
At the beginning of 20ms after Vin is applied to the module, PG maintain high although the Vout doesn't start up. After this 20ms, module internal MCU finish initialization and the PG indicate output voltage correctly, please refer to below picture.



SECTION 5 APPLICATION NOTES

5.5 Current Share Function – Droop Current Sharing

The modules are capable of operating in parallel and realizing current sharing by droop current sharing method. By connecting the Vin pin and the Vo pin of the parallel module together, the current sharing can be realized automatically. Max parallel module number is 3 (Parallel maximum load ≤289A).



If system has no redundancy requirement, the module can be parallel directly for higher power without adding external oring-fet; whereas, If the redundancy function 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 steady current sharing accuracy, below design guideline 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 much as possible.

b) The PCB trace resistance from each converter’s output to the load should be equalized as much as possible.

c) The connection of remote sense is open by default. If remote sense is needed, the remote sense wires +RS and –RS of the parallel modules are prohibited to be connected to a same location. There must be some resistance between the remote sense locations of the parallel modules (AE, CE, BF, and DF in above figure).

d) For accurate current sharing accuracy test, the module should be soldered in order to avoid the unbalance of the touch resistance between the modules to the test board.

3. To ensure the parallel module can start up monotonically without trigging the OCP circuit, below design guideline should be followed:

a) Before all the parallel module finished start up, the total load current should be lower than the rated current of one module.

b) The ON/OFF pin of the converters should be connected together to keep the parallel modules start 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 module start up at the same time.

d) It is recommended to control the turn on sequence. After one module finished turn on, and then turn on other modules.

This can be achieved by modifying other modules’ turn on delay time through PMBUS command. Contact AEI FAE for more detail about the delay time adjustment.

SECTION 5 APPLICATION NOTES

5.6 Current Share Function – Active Current Sharing

Coming soon.

5.7 Remote On/Off

Negative remote On/Off logic is available in NDQ1300-48S12B-6I. The logic is CMOS and TTL compatible.

5.8 Remote Sense

If the load is far from the unit, connect remote sense wire +RS+ and -RS to the terminal of the load respectively to compensate the voltage drop on the transmission line. See Figure 13. If the sense compensate function is not necessary, connect RS+ to Vo+ and RS- to Vo- directly.

SECTION 6 SOLDERING INFORMATION

Generally, as the most common mass soldering method for the solder attachment, wave soldering is used for through-hole power modules and reflow soldering is used for surface-mount ones.

Reflow soldering is not a suggested method for through-hole power modules due to process challenges that can result in reduced module reliability. If you have this kind of application requirement, please contact sales or FAE for further information and recommendations.

Wave Soldering

When wave soldering is used, the temperature on pins is specified to maximum 255^{O}C for maximum 7 s.

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

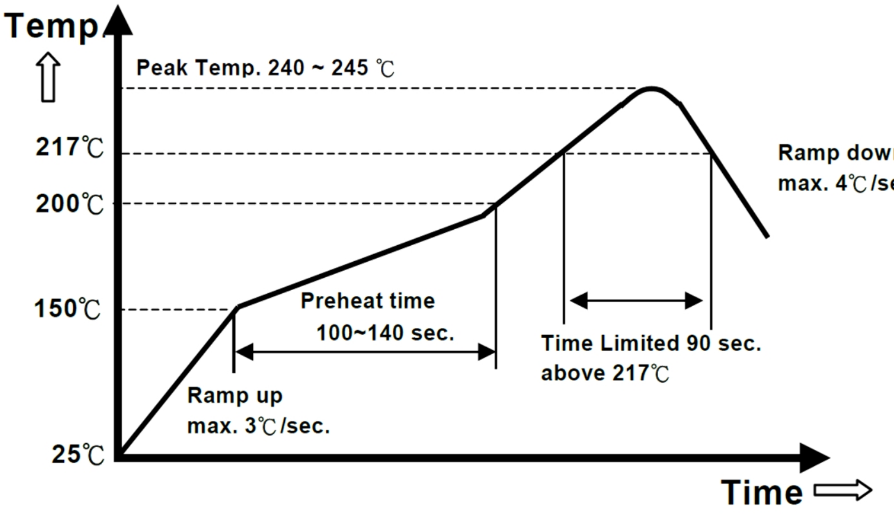
Cleaning of solder joint can be performed with cleaning solvent IPA or simulative.

Reflow Soldering

High temperature and long soldering time will result in IMC layer increasing in thickness and thereby shorten the solder joint lifetime. Therefore the peak temperature over 245^{O}C is not suggested due to the potential reliability risk of components under continuous high-temperature. In the meanwhile, the soldering time of temperature above 217^{O}C should be less than 90 s.

Please refer to following figure for recommended temperature profile parameters.

Shielding cap is requested to mount on DCDC module if with heat-spreader/heat-sink, to prevent the customer side high temperature of reflow to re-melt the DCDC module's internal component's soldering joint.



Note: The temperature is measured on the pins of power module at the solder joint.

SECTION 7 PMBus™ SPECIFICATIONS

7.1 PMBus™ Digital Feature Descriptions

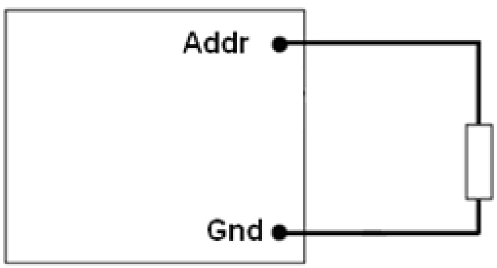
The NDQ1300-48S12B-6LI is equipped with digital PMBus™ interface that allows the module to be configured and to communicate with a system controller. Detailed timing and electrical characteristics of the PMBus™ can be found in the PMB Power Management Protocol Specification, Part 1, revision 1.2, available at http://PMBus.org.

The module supports 100/400 kHz bus timing requirements. The module shall stretch the clock, as long as it does not exceed the maximum clock LO period of 35 ms. It is recommended to always use Packet Error Checking scheme (PEC) byte when communicating via PMBus™.

The module supports a subset of the commands in the PMBus™ 1.2 specification. Most all of the controller parameters can be programmed using the PMBus™ and stored as defaults for later use. All commands that require data input or output use the linear format. The exponent of the data words is fixed at a reasonable value for the command and altering the exponent is not supported. Direct format data input or output is not supported by the module. The supported commands are described in greater detail below. The module contains non-volatile memory that is used to store configuration settings and scale factors. The settings programmed into the device are not automatically saved into this non-volatile memory though. The STORE_DEFAULT_ALL command must be used to commit the current settings to non-volatile memory as device defaults. The settings that are capable of being stored in non-volatile memory are noted in their detailed descriptions.

7.2 PMBus™ Addressing

The module has flexible PMBus™ addressing capability. By connecting different resistors from Addr pin to GND pin, 14 possible addresses can be acquired. The 7-bit PMBus™ address is defined by the value of the resistor as shown in the table below, and ±1% resistor accuracy is acceptable. If there is any resistance exceeding the requested range, address 126 will be returned.



Resistor (kOhm)	PMBus Address
10	96
15	97
21	98
28	99
35.7	100
45.3	101
56.2	102
69.8	103
88.7	104
107	105
130	106
158	107
191	108
232	109

SECTION 7 PMBus™ SPECIFICATIONS

7.3 PMBus™ Supported Adjustment and Measurement

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 34.000 to 40.000V in 0.125V steps. VIN_ON must be 1.5V greater than VIN_OFF.

Both the VIN_ON and VIN_OFF commands use the "Linear" format with two data bytes. The upper five bits [7:3] of the high data byte form the two's complement representation of the exponent, which is fixed at –3 (decimal). 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. The data associated with VIN_ON and VIN_OFF can be stored to non-volatile memory using the STORE_DEFAULT_ALL command. The data associated with VIN_ON and VIN_OFF can be stored to non-volatile memory using the STORE_DEFAULT_ALL command.

Output Voltage Adjustment Using the PMBus™

The 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 -12 (decimal) (read from VOUT_MODE).

VOUT = Mantissa x 2^{-12}

The resolution is 0.244mV . The data associated with VOUT_COMMAND can be stored to non-volatile memory using the STORE_DEFAULT_ALL command.

Range limits (max/min): 13.2/9.6V

Notes

- Trim up @ Vin=44 to 60V,
- When trimmed up, the output power not to exceed 1300W;
- When operated in parallel operation, it is not to recommend to use trim function

(if Trim-function is intended for use when 2 units are in sharing connection – please contact Advanced Energy Technical support for guidance).

Measuring Input Voltage Using the PMBus™

The module can provide input voltage information using the READ_VIN 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, which is fixed at –3 (decimal). 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.

Measuring Input Current Using the PMBusTM

The module can provide input current information using the READ_IIN 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, which is fixed at –2 (decimal). 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.

SECTION 7 PMBus™ SPECIFICATIONS

Measuring Output Voltage Using the PMBus™

The module can provide output voltage information using the READ_VOUT command. The command returns two bytes of data in the linear format, with the 16 bits of the READ_VOUT formatted as an unsigned mantissa, and a fixed exponent of -12 (decimal).

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, which is fixed at –2 (decimal). 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. 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.

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, which is fixed at –2 (decimal). 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 OTP test point (see Figure 11) and is subjected to temperatures higher than the ambient air temperature near the module. The temperature and temperature reading will be highly influenced by module load and airflow conditions.

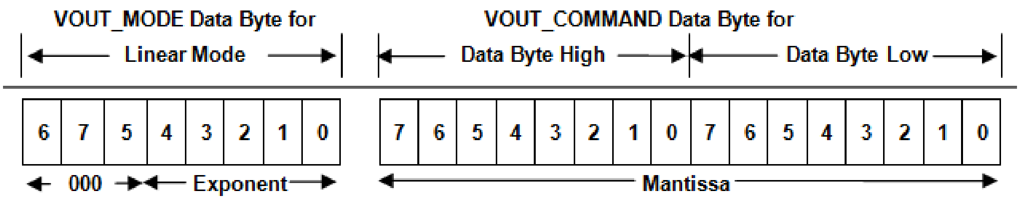
SECTION 7 PMBus™ SPECIFICATIONS

7.4 Black Box

There is a black box function realized by 22 pages of D-flash (20k erase cycles up to 120°C hotspot temp). The first page is used to save the page number where the newest history event is recorded. A further 21 pages with 19 bytes per page, are assigned to record 21 history events. Vin UVLO event is not record in black box. Fault time means the time to Vo turn on.

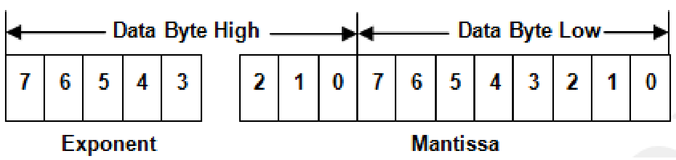
7.5 PMBus™ Data Format

For commands that set or report any voltage thresholds related to output voltage (including VOUT_COMMAND, VOUT_MARGIN, POWER_GOOD and READ_VOUT), the module supports the linear data format consisting of a two byte value with a 16-bit, unsigned mantissa, and a fixed exponent of -12. The format of the two data bytes is shown below:



The value of the number is then given by Value = Mantissa x 2^{-12}

For commands that set or report all other thresholds, including input voltages, output current, temperature, the module supports the linear data format consisting of a two byte value with an 11-bit, two's complement mantissa and a 5-bit, two's complement exponent. The format of the two data bytes is shown below:



The value is of the number is then given by Value = Mantissa x $2^{Exponent}$

7.6 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™, Bit [7] in the OPERATION command data byte enables the module, with the following functions:

0 : Output is disabled

1 : Output is enabled

SECTION 7 PMBus™ SPECIFICATIONS

7.7 Status Commands

The module supports a number of status information commands implemented in PMBus™. However, not all features are supported in these commands. A "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 (Positive logic)	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 Overvoltage	0
4	IOUT Overcurrent	0
3	VIN Undervoltage	0
2	Temperature	0
1	CML (Command)	0
0	X	0

SECTION 7 PMBus™ SPECIFICATIONS

STATUS_VOUT: Returns one byte of information relating to the status of the module's output voltage related faults.

Bit Position	Flag	Default Value
7	VOUT OV Fault	0
6	Output Overvoltage Warning	0
5	X	0
4	X	0
3	X	0
2	X	0
1	X	0
0	X	0

STATUS_IOUT: Returns one byte of information relating to the status of the module's output current related faults.

Bit Position	Flag	Default Value
7	IOUT OC Fault	0
6	X	0
5	IOUT OC Warning	0
4	X	0
3	X	0
2	X	0
1	X	0
0	X	0

STATUS_INPUT: Returns one byte of information relating to the status of the module's input voltage related faults.

Bit Position	Flag	Default Value
7	VIN OV Fault	0
6	Input Overvoltage Warning	0
5	Input Undervoltage Warning	0
4	VIN UV Fault	0
3	X	0
2	X	0
1	X	0
0	X	0

SECTION 7 PMBus™ SPECIFICATIONS

STATUS_TEMPERATURE: Returns one byte of information relating to the status of the module's temperature related faults.

Bit Position	Flag	Default Value
7	OT Fault	0
6	OT Warning	0
5	X	0
4	X	0
3	X	0
2	X	0
1	X	0
0	X	0

All of the warning or fault bits set in the status registers remain set, even if the fault or warning condition is removed or corrected, until one of the following occur:

- The device receives a CLEAR_FAULTS command
- Bias power is removed from the module

SECTION 7 PMBus™ SPECIFICATIONS

7.8 Summary of Supported PMBus™ Commands

This section outlines the PMBus™ command support for this bus converter. 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
- Additional information may be provided in tabular form or other format, if necessary.

OPERATION [0x01]

Command support: On/Off Immediate

Bit Position	Purpose	Bit Value	Meaning
7	Enable/Disable the module	1	Output is enabled
		0	Output is disabled
6	Reserved	-	-
5:4	Vout Command	00	No margin
3:0	Reserved	-	-

CLEAR_FAULTS [0x03]

Command support: All functionality

WRITE PROTECTION [0x10]

Bit Position	Purpose	Bit Value	Meaning
7	Enable/Disable the protection	1	Protection is enabled
		0	Protection is disabled
6:0	Reserved	-	-

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.

SECTION 7 PMBus™ SPECIFICATIONS

VOUT_MODE [0x20]

Command support: Supported. Factory default: 0x14 - Indicates linear mode with exp = -12.

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: 12.45 V

Range limits (max/min): 13.2/9.6

Unit: volt

Note: 1. Trim up at Vin = 44 to 60V

2. When trimmed up, the output power not to exceed 1300W

3. When operated in parallel operation, it is not recommend to use trim function (if trim function is intended for use when 2 units are in sharing connection, please contact Advanced Energy technical support for guidance).

VIN_ON [0x35]

Range limits (max/min): 40/35

Unit: volt

Command support: All functionality

Note: Special interlock checks between VIN_ON and VIN_OFF maintain a hysteresis gap of 1.5V minimum and do not allow the OFF level to be higher than and ON level.

VIN_OFF [0x36]

Range limits (max/min): 39/34

Unit: volt

Command support: All functionality

Note: Special interlock checks between VIN_ON and VIN_OFF maintain a hysteresis gap of 1.5V minimum and do not allow the OFF level to be higher than and ON level.

VOUT_OV_FAULT_LIMIT [0x40]

Range limits (max/min): 16/13.5

Unit: volt

Command support: All functionality

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

SECTION 7 PMBus™ SPECIFICATIONS

VOUT_OV_ WARNING _LIMIT [0x42]

Range limits (max/min): 15/13.5

Units: volt

Command support: All functionality

Note: Value must be the same or less than VOUT_OV_ FAULT _LIMIT value.

IOUT_OC_FAULT_LIMIT [0x46]

Range limits (max/min): 160/120

Unit: amp

Command support: All functionality

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

IOUT_OC_WARN_LIMIT [0x4A]

Range limits (max/min): 140/100

Unit: amp

Command support: Read/write support, functionality complete

Note: Range cross-check-value must be the same or less than IOUT_OC_FAULT_LIMIT value.

OT_FAULT_LIMIT [0x4F]

Range limits (max/min): 140/25

Unit: degC

Command support: All functionality

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

OT_WARN_LIMIT [0x51]

Range limits (max/min): 130/25

Unit: degC

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): 68/61

Unit: volt

Command support: All functionality

SECTION 7 PMBus™ SPECIFICATIONS

STATUS_WORD [0x79]

Command support: full implementation for supported functions

Format	8 bit unsigned (bit field)							
Bit Position	15	14	13	12	11	10	9	8
Access	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset
Function	VOUT	IOUT	INPUT	Reserved	Reserved	Reserved	Reserved	Reserved

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset
Function	Reserved	OUTPUT_OFF	VOUT_OV_FAULT	IOUT_OC_FAULT	VIN_UV_FAULT	TEMP	CML	Reserved

STATUS_VOUT [0x7A]

Command support: VOUT_OV_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	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset
Function	VOUT_OV_FAULT	VOUT_OV_WARN	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

STATUS_IOUT [0x7B]

Command support: IOUT_OC_FAULT and IOUT_OC_WARN supported, all bit reset supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset
Function	IOUT_OC_FAULT	Reserved	IOUT_OC_WARN	Reserved	Reserved	Reserved	Reserved	Reserved

SECTION 7 PMBus™ SPECIFICATIONS

STATUS_INPUT [0x7C]

Command support: VIN_OV_FAULT, VIN_OV_WARN, VIN_UV_WARN and VIN_UV_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	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset
Function	VIN_OV_ FAULT	VIN_OV_ WARN	VIN_UV_ WARN	VIN_UV_ FAULT	Reserved	Reserved	Reserved	Reserved

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	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset
Function	OT_FAULT	OT_WARN	Reserve	Reserve	Reserved	Reserved	Reserved	Reserved

STATUS_CML [0x7E]

Command support: Invalid/Unsupported Command Received, Invalid/Unsupported Data Received and Packet Error Check Failed supported, all bit reset supported

Format	8 bit unsigned (bit field)							
Bit Position	7	6	5	4	3	2	1	0
Access	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset	R/Reset
Function	Invalid/Un supported Command Received	Invalid/Un supported Data Received	Packet Error Check Failed	Reserve	Reserved	Reserved	Reserved	Reserved

READ_VIN [0x88]

Command support: full support

READ_VOUT [0x8B]

Command support: full support

READ_IOUT [0x8C]

Command support: full support

SECTION 7 PMBus™ SPECIFICATIONS

READ_TEMPERATURE_1 [0x8D]

Command support: full support

PMBus_REVISION [0x98]

Command support: full read support

PMBus_CMD_MFR_ID [0x99]

Command support: full read support

PMBus_CMD_MFR_MODEL [0x9A]

Command support: full read support

MFR_FW_REV [0x9B]

Command support: full read support

PMBus_CMD_MFR_LOCATION [0x9C]

Command support: full read/write support

PMBus_CMD_MFR_SERIAL [0x9E]

Command support: full read/write support

CLEAR BLACKBOX[0XB6]

Command support: write support

BLACKBOX_EN [0xDF]

The black box can be set to stop recording once full (21 fault events recorded) or to overwrite the oldest fault event data with the next fault event data once full. The module is shipped with a default setting of Overwrite Disabled.

Bit Position	Purpose	Bit Value	Meaning
7:1	Reserved	-	-
0	Enable/Disable the black box overwrite function	1	Overwrite function is enabled
		0	Overwrite function is disabled

If overwrite function is disabled, black box only record 21 faults, then it will lock and no more faults will be recorded. If overwrite function is enabled, when fault log is full, the new fault will start overwriting previous fault, starting from entry 0.

SECTION 7 PMBus™ SPECIFICATIONS

7.9 History Event Read Section

0xE1 command: Write the Offset Value to Slave to decide which history data for read.

0xE0 command: Read the history data after 0xE1 command.

READ HISTORY EVENT OFFSET (0XE1):

Send command 0XE1 and read one byte, it will return the next event log offset value x.

Start	Device Address & R/W	Command byte(0XE1)	Repeated Start	Device Address & R/W

Event log offset value	PEC	Stop

SET HISTORY EVENT OFFSET [0XE1]

Reading 0xE1 yields the value x of the next history event (to be recorded in the future). To read the last history event (the most recent history event recorded), send write command 0XE1 with offset value of x-1. Then send read command 0XE0 and the last event data will be read back. There are 21 possible values for the offset (0-20), if the number of history events is larger than 20, 0XE1 will be reset from 20 to 0.

Start	Device Address & R/W	Command byte(0XE1)	Offset value	PEC	Stop

READ_HISTORY EVENTS [0xE0]

Start	Device Address & R/W	Command byte(0XE0)	Repeated Start

Device Address & R/W	EVENT#	Status_Word_High_Byte	Status_Word_Low_Byte	Status_Vout
Status_Iout	Status_Input	Status_Temperature	Status_cml	Vin_data_high_byte

Vin_data_low_byte	Vout_data_high_byte	Vout_data_low_byte	Iout_data_high_byte
Iout_data_low_byte	temperature_data_high_byte	temperature_data_low_byte	Fault time_first_byte

Fault time_second_byte	Fault time_third_byte	Fault time_fourth_byte	PEC	Stop

Fault timer: Records the operating time since last fault, up to 256 days. Fault time_first_byte is seconds; Fault time_second_byte is minutes; Fault time_third_byte is hours; Fault time_fourth_byte is days. If no fault occurs after 256 days of operating time the counter will reset and begin a new count.

SECTION 7 PMBus™ SPECIFICATIONS

7.10 NDQ1300-48S12B-6LI Supported PMBus™ Command List

The NDQ1300 series power supply is compliant with the industry standard PMBus™ protocol(Revision 1.2) for monitoring and control of the power supply via the I^2C interface port.

NDQ1300 Series Supported PMBus™ Command list

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
01h	OPERATION	80h	R/W	1	Bit field	Used to turn the unit ON/OFF
02H	ON_OFF_CONFIG	1Dh	R/W	1	Bit field	0x1D (Neg Logic); 0x1F (Pos Logic)
03h	CLEAR_FAULTS	-	Send	1	N/A	Clear any fault bits that have been set
10h	WRITE_PROTECTION	-	R/W	1	-	Set or Clear the bit of Write protection
11h	STORE_DEFAULT_ALL	-	Send	0	N/A	Stores operating parameters to E2prom memory
12h	RESTORE_DEFAULT_ALL	-	Send	0	N/A	Restores operating parameters from E2prom memory
20h	VOUT_MODE	14h	R	1	Mode+exp	To read VOUT data format
21h	VOUT_COMMAND	C733h	R/W	2	VOUT Linear	Set the output voltage
33h	FREQUENCY_SWITCH	-	R	2	-	Reserved
35h	VIN_ON	38	R/W	2	Linear	Set the turn on voltage threshold of vin
36h	VIN_OFF	36	R/W	2	Linear	Set the turn off voltage threshold of vin
40h	VOUT_OV_FAULT_LIMIT	14.7	R/W	2	VOUT Linear	Set the output overvoltage fault threshold
42h	VOUT_OV_FAULT_LIMIT	14	R/W	2	VOUT Linear	Set the output overvoltage warn threshold
46h	IOUT_OC_FAULT_LIMIT	140	R/W	2	Linear	Set the output overcurrent fault threshold
4Ah	IOUT_OC_WARN_LIMIT	130	R/W	2	Linear	Set the output overcurrent warn threshold
4Fh	OT_FAULT_LIMIT	116	R/W	2	Linear	Set the over temperature fault threshold
51h	OT_WARN_LIMIT	107	R/W	2	Linear	Set the over temperature warn threshold
55h	VIN_OV_FAULT_LIMIT	65	R/W	2	Linear	Set the input overvoltage fault threshold
36h	VIN_OFF	-	R/W	2	Linear	Set the turn off voltage threshold of vin
60h	TON_DELAY	-	R/W	2	-	Reserved
79h	STATUS_WORD	-	R	2	Bit field	Returns the information with a summary of the module's fault/warning
7Ah	STATUS_VOUT	-	R	1	Bit field	Returns the information of the module's output voltage related fault/warning
7Bh	STATUS_IOUT	-	R	1	Bit field	Returns the information of the module's output current related fault/warning
7Ch	STATUS_INPUT	-	R	1	Bit field	Returns the information of the module's input overvoltage and undervoltage fault
7Dh	STATUS_TEMPERATURE	-	R	1	Bit field	Returns the information of the module's temperature related fault/warning
7Eh	STATUS_CML	-	R	1	Bit field	Returns the information of the module's communication related faults
88h	READ_VIN	-	R	2	Linear	Returns the input voltage of the module
8Bh	READ_VOUT	-	R	2	VOUT linear	Returns the output voltage of the module

SECTION 7 PMBus™ SPECIFICATIONS

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
8Ch	READ_IOUT	-	R	2	Linear	Returns the output current of the module
8Dh	READ_TEMP1	-	R	2	Linear	Returns the module's temperature sensor temperature
98h	PMBus_REVISION	-	R	1	Bit field	Read the version of the PMBus
99h	PMBus_CMD_MFR_ID	-	R	Variable	Char	Returns the Artesyn
9Ah	PMBus_CMD_MFR_MODEL	-	R	Variable	Char	Returns the name of the module
9Bh	MFR_FW_REV	-	R	Variable	Char	Returns the version of the software
9Ch	MFR_MOD_DATE_LOC_SN	-	R/W	Variable	Char	Returns the production's place of the module
9Eh	PMBus_CMD_MFR_SERIAL	-	R/W	Variable	Char	Returns the serial number of the module
E0h	READ_HISTORY EVENTS	-	BR	Variable	NA	Max 20 events, 20 commands
E1h	SET_HISTORY_EVENT _OFFSET	-	R/W	1	NA	Max 20 events, 20 commands
5Eh	POWER_GOOD_ON	9	R/W	2	VOUT linear	Set POWER GOOD on flip level
5Fh	POWER_GOOD_OFF	8	R/W	2	VOUT linear	Set POWER GOOD off flip level

SECTION 8 RECORD OF REVISION AND CHANGES

Issue	Date	Description	Originators
1.0	03.29.2025	First release	A. Zhang

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than four 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 | TRUST

For international contact information,
visit advancedenergy.com.

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