DRQ-12/42-D48 Series

500W Digital Fully Regulated
Intermediate DC-DC Bus Converter

Typical unit

PRODUCT OVERVIEW

The DRQ 500W series provides a fully regulated, digitally controlled DC output in a ¼-brick format that will support the evolving Advanced Bus Converter (ABC) industry standard footprint for isolated board mounted power modules. The DRQ series supports advances in power conversion technology including a digital interface supporting the PMBus protocol for communications to power modules.

The DRQ series offers high output current (up to 43.5 Amps) in an industry standard "quarter brick" package. The DRQ series is an isolated, regulated, 500W-11.5Vout quarter brick that supports the TNV input voltage range of 38V-75V with a typical efficiency of 95.5%.

Advanced automated surface mount assembly and planar magnetics deliver galvanic isolation

rated at 2250 Vdc for functional insulation. Target markets include networking equipment, Power over Ethernet applications, wireless networking equipment, telecommunications equipment, wireless pre-amplifiers, industrial and test equipment, and applications requiring a regulated 11.5V output.

A wealth of self-protection features include input undervoltage lockout and overtemperature shutdown; over current protection using the "hiccup" autorestart technique provides indefinite short-circuit protection, along with output OVP. The DRQ series is certified to safety standards UL/IEC/CSA 60950-1, 2nd edition. It meets RFI/EMI conducted emission compliance to EN55022, CISPR22 with an external filter.

FEATURES

- Fixed DC outputs, 11.5V @43.5A
- Advanced Bus Converter industry standard quarter-brick with digital PMBus™ interface
- Optional five pin version (DOSA compatible pinouts)
- 38 to 75 Volt DC input range (48 VDC nominal)
- Remote ON/Off enable control
- High efficiency (95.5%)
- Stable no-load operation
- Monotonic startup into pre-bias output condition
- Certified to UL 60950-1, CSA-C22.2 No. 60950-1, 2nd edition safety approvals
- Extensive self-protection, OVP, input undervoltage, current limiting and thermal shutdown

APPLICATIONS

- Embedded systems, datacom and telecom installations, wireless base stations
- Disk farms, data centers and cellular repeater sites
- Remote sensor systems, dedicated controllers
- Instrumentation systems, R&D platforms, automated test fixtures
- Data concentrators, voice forwarding and speech processing systems
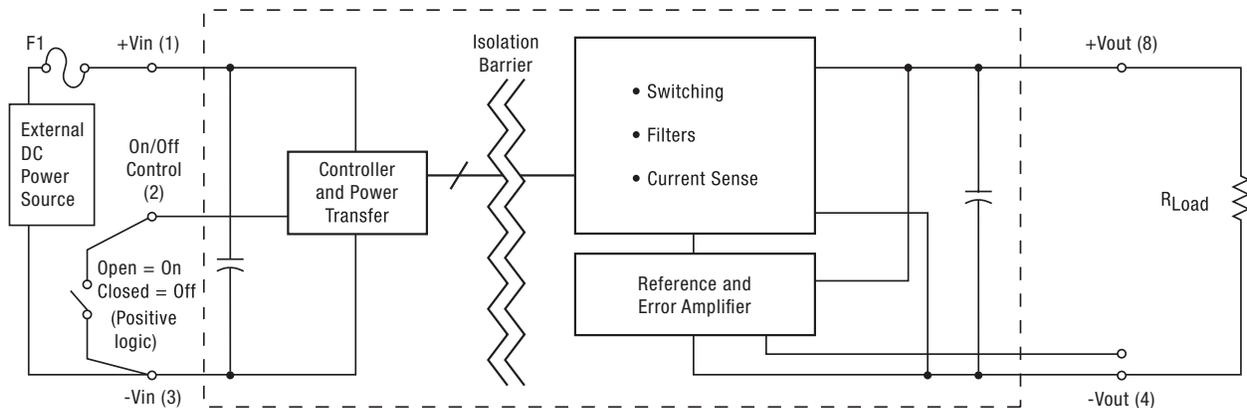

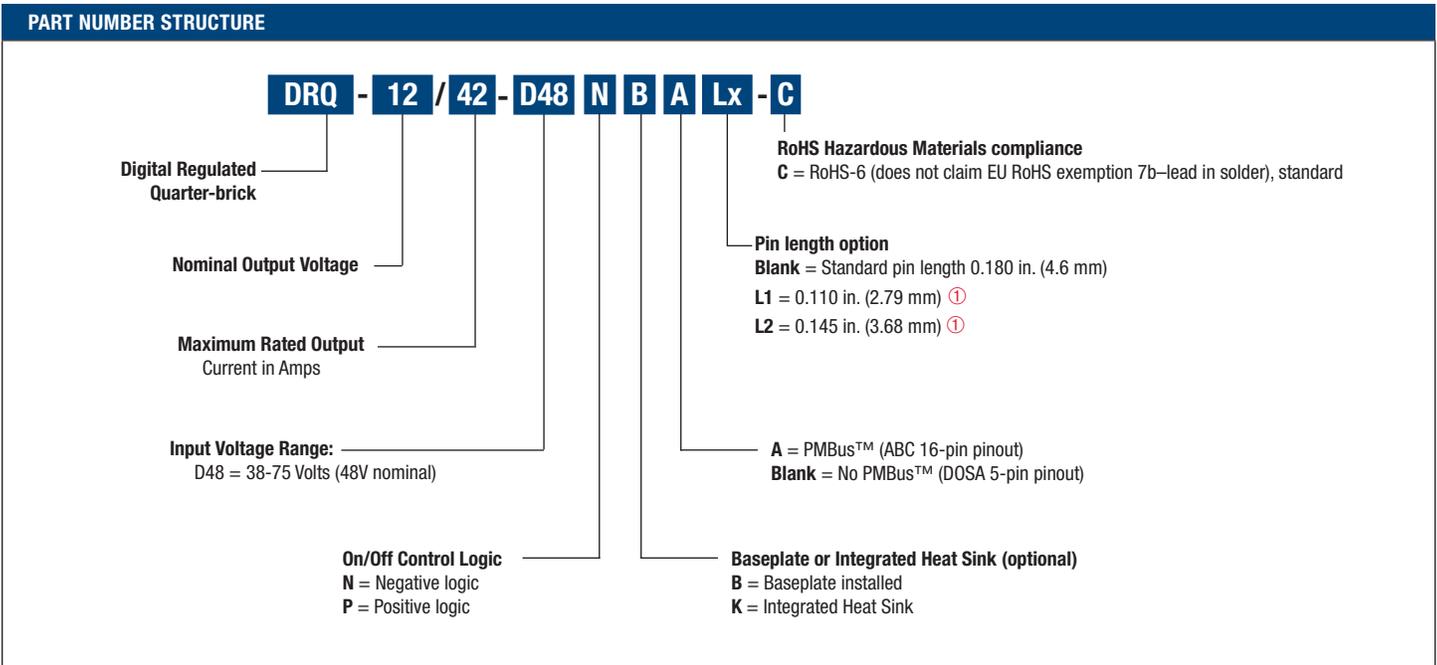Figure 1. Connection Diagram (without digital interface)
Typical topology is shown. Murata Power Solutions recommends an external fuse.

PERFORMANCE SPECIFICATIONS SUMMARY AND ORDERING GUIDE ① ②

Root Model ①	Output						Input				Efficiency	Dimensions with baseplate	
	V_{OUT} (Volts, max.)	I_{OUT} (Amps, max.)	Power (Watts, max.)	R/N (mV pk-pk)		Regulation (mV, max.)		V_{IN} Nom. (Volts)	Range (Volts)	I_{IN} no load (mA)	I_{IN} full load (Amps)	Typ.	(inches)	(mm)
				Typ.	Max.	Line	Load							
DRQ-12/42-D48	11.85	43.5	515.5	80	120	100	100	48	38-75	130	11.39	95.5%	2.3 x 1.45 x 0.52	58.4 x 36.8 x 13.21

① Please refer to the part number structure for additional ordering information and options.

② All specifications are typical at nominal line voltage and full load, +25°C unless otherwise noted. See detailed specifications. Output capacitors are 1 µF || 10 µF. These caps are necessary for our test equipment and may not be needed for your application.

PART NUMBER STRUCTURE

DRQ - **12** / **42** - **D48** **N** **B** **A** **Lx** - **C**

Digital Regulated Quarter-brick

Nominal Output Voltage

Maximum Rated Output
Current in Amps

Input Voltage Range:
D48 = 38-75 Volts (48V nominal)

On/Off Control Logic
N = Negative logic
P = Positive logic

Baseplate or Integrated Heat Sink (optional)
B = Baseplate installed
K = Integrated Heat Sink

A = PMBus™ (ABC 16-pin pinout)
Blank = No PMBus™ (DOSA 5-pin pinout)

Pin length option
Blank = Standard pin length 0.180 in. (4.6 mm)
L1 = 0.110 in. (2.79 mm) ①
L2 = 0.145 in. (3.68 mm) ①

RoHS Hazardous Materials compliance
C = RoHS-6 (does not claim EU RoHS exemption 7b–lead in solder), standard

① Special quantity order is required; samples available with standard pin length only.

② Some model number combinations may not be available. See website or contact your local Murata sales representative.

Complete Model Number Example: **DRQ-12/42-D48NKL1-C**

Negative On/Off logic, Integrated Heat Sink installed, 0.110˝ pin length, RoHS-6 compliance

FUNCTIONAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Input Voltage, Continuous		0		80	Vdc
Input Voltage, Transient	100 mS max. duration			100	Vdc
Isolation Voltage	Input to output			2250	Vdc
On/Off Remote Control	Power on, referred to -Vin	0		13.5	Vdc
Output Power		0		515.5	W
Output Current	Current-limited, no damage, short-circuit protected	0		43.5	A
Storage Temperature Range	Vin = Zero (no power)	-55		125	°C

Absolute maximums are stress ratings. Exposure of devices to greater than any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than those listed in the Performance/Functional Specifications Table is not implied or recommended.

INPUT	Conditions ① ③				
Operating voltage range		38	48	75	Vdc
Recommended External Fuse	Fast blow		25		A
Start-up threshold: (measured @ no load)	Rising input voltage	37	37.5	38	Vdc
Undervoltage shutdown: (measured @ no load)	Falling input voltage	35	35.5	36	Vdc
Internal Filter Type			Pi		
Input current					
Full Load Conditions	Vin = nominal		11.39	11.68	A
Low Line	Vin = minimum		14.55	14.63	A
Inrush Transient			0.15	0.30	A²-Sec.
Short Circuit Input Current			0.05	0.1	A
No Load Input Current	Iout = minimum, unit = ON		130	200	mA
Shut-Down Input Current (Off, UV, OT)			10	20	mA
Reflected (back) ripple current ②	Measured at input with specified filter		40	70	mA, p-p
Pre-biased startup	External output voltage < Vset		Monotonic		

GENERAL and SAFETY					
Efficiency	Vin = 48V, full load		95.5		%
	Vin = min., full load		95.5		%
Isolation					
Isolation Voltage	Input to output			2250	Vdc
Isolation Voltage	Input to baseplate			1500	Vdc
Isolation Voltage	Output to baseplate			1500	Vdc
Insulation Safety Rating			Functional		
Isolation Resistance			10		MΩ
Isolation Capacitance			1500		pF
Safety	Certified to UL-60950-1, CSA-C22.2 No. 60950-1, IEC/60950-1, 2nd edition		Yes		
Calculated MTBF	Per Telcordia SR332, issue 1, class 3, ground fixed, Tambient = +25°C		1.3		Hours x 10⁶

DYNAMIC CHARACTERISTICS					
Switching Frequency	Variable frequency control (default)		175-250		KHz
Vin Start up delay time			25	30	mS
Enable Start up delay time			3	5	mS
Rise time			15	20	mS
Vout Fall Time of Regulated Off: (from 100% to 0%)		18	20	22	mS
Dynamic Load Response	50-75-50% load step, settling time to within 1% of Vout (Cout=1000μF)		200	300	μSec
Dynamic Load Peak Deviation	same as above		±400	±600	mV

FEATURES and OPTIONS					
Remote On/Off Control ④					
"N" suffix:					
Negative Logic, ON state	ON = Ground pin or external voltage	-0.1		0.8	V
Negative Logic, OFF state	OFF = Pin open or external voltage	3.5		13.5	V
Control Current	Open collector/drain			5	mA
"P" suffix:					
Positive Logic, ON state	ON = Pin open or external voltage	3.5		13.5	V
Positive Logic, OFF state	OFF = Ground pin or external voltage	0		0.8	V
Control Current	Open collector/drain			1	mA

Murata Power Solutions

FUNCTIONAL SPECIFICATIONS, (CONT.)

| OUTPUT	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Total Output Power		0	500.25	515.5	W
Voltage					
Nominal Output Voltage	No trim (@ all conditions)	11.16	11.5	11.85	Vdc
Output Voltage	@ Vin=48V, Iout=0, temp=+25°C	11.45		11.55	Vdc
Setting Accuracy	At 50% load, no trim	-2		2	% of Vnom
Overvoltage Protection	Via magnetic feedback	13.8	14.4	15.6	Vdc
Current					
Output Current Range		0		43.5	A
Cold condition	Default, Configurable via PMBUS	52	54	56	
After warm up	Default, Configurable via PMBUS	51	53	55	A
Short Circuit					
Short Circuit Current	Hiccup technique, autorecovery within ±1.25% of Vout		0.4	1	A
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Continuous		
Short circuit protection method	Current limiting				
Regulation ⑤					
Line Regulation	Vin = 38 to 75V, Vout = nom., Iout = nom.		30	100	mV
Load Regulation	Iout = min. to max., Vin = 48V		50	100	mV
Ripple and Noise ⑥	5 Hz- 20 MHz BW		80	120	mV pk-pk
Temperature Coefficient	At all outputs		0.01	0.02	% of Vout./°C
Maximum Capacitive Loading	Low ESR			10000	µF
MECHANICAL (Through Hole Models)					
Outline Dimensions (with heat sink)			2.3 x 1.45 x 1.1		Inches
(Please refer to outline drawing)	LxWxH		58.4 x 36.83 x 27.94		mm
Outline Dimensions (with baseplate)			2.3 x 1.45 x 0.52		
			58.4 x 36.8 x 13.21		
Through Hole Pin Diameter			0.04 & 0.062		Inches
			1.016 & 1.575		mm
Through Hole Pin Material			Copper alloy		
TH Pin Plating Metal and Thickness	Nickel subplate		98.4-299		µ-inches
	Gold overplate		4.7-19.6		µ-inches
ENVIRONMENTAL					
Operating Ambient Temperature Range	See Derating	-40		85	°C
Operating Case Temperature	No derating	-40		110	°C
Storage Temperature	Vin = Zero (no power)	-55		125	°C
Thermal Protection/Shutdown	Measured in center		132		°C
Electromagnetic Interference	External filter is required				
Conducted, EN55022/CISPR22			B		Class
RoHS rating			RoHS-6		

Notes

① Unless otherwise noted, all specifications apply at Vin = nominal, nominal output voltage and full output load. General conditions are near sea level altitude, no base plate installed and natural convection airflow unless otherwise specified. All models are tested and specified with external parallel 1 µF and 10 µF output capacitors (see Technical Notes). All capacitors are low-ESR types wired close to the converter. These capacitors are necessary for our test equipment and may not be needed in the user's application.

② Input (back) ripple current is tested and specified over 5 Hz to 20 MHz bandwidth. Input filtering is Cin = 33 µF/100V, Cbus = 220µF/100V and Lbus = 12 µH.

③ All models are stable and regulate to specification under no load.

④ The Remote On/Off Control is referred to -Vin.

⑤ Regulation specifications describe the output voltage changes as the line voltage or load current is varied from its nominal or midpoint value to either extreme. The load step is ±25% of full load current.

⑥ Output Ripple and Noise is measured with Cout = 1 µF || 10 µF; 20 MHz oscilloscope bandwidth and full resistive load.
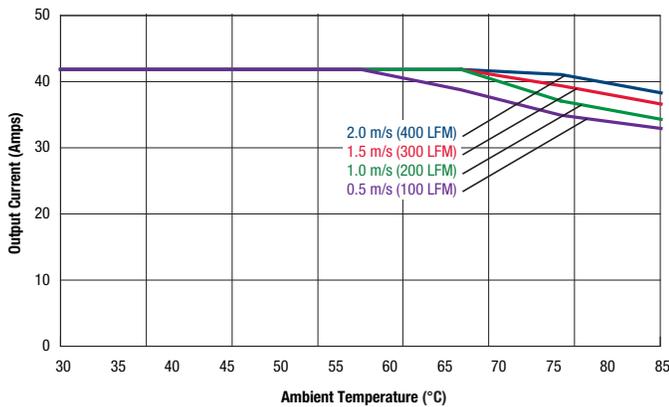
PERFORMANCE DATA

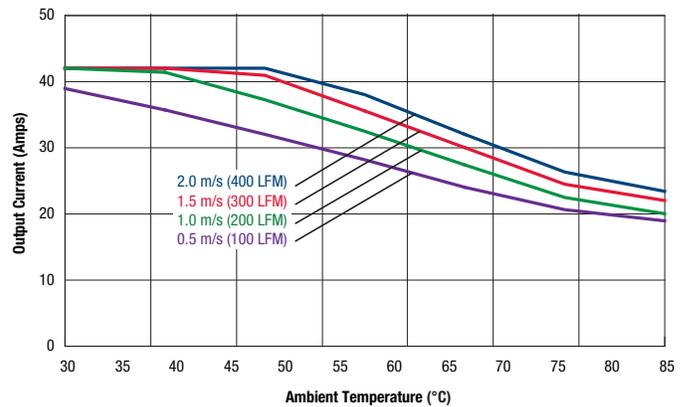Efficiency vs. Line Voltage and Load Current @ +25°C
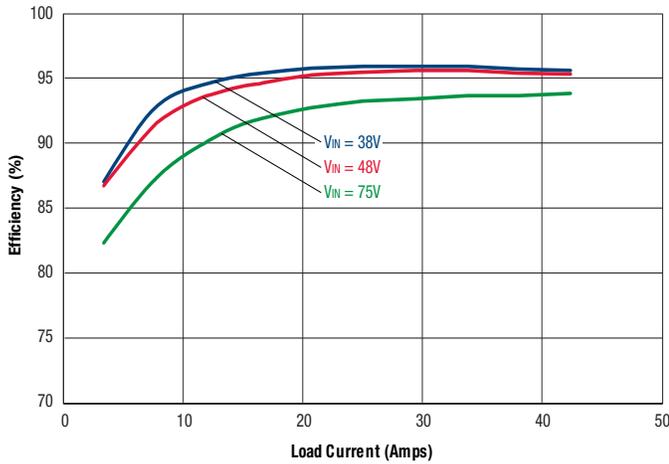
Maximum Current Temperature Derating at sea level
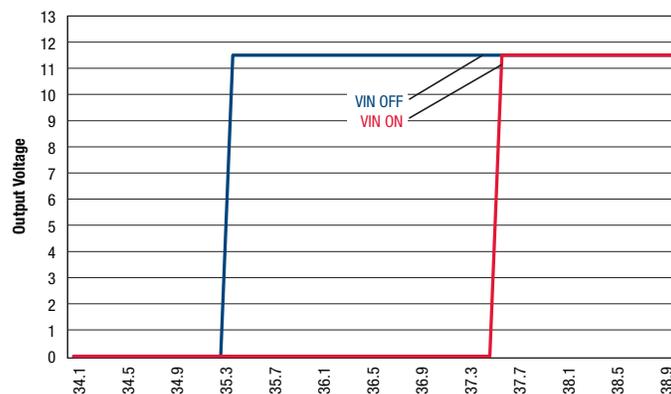(Vin = 40V, airflow from -Vin to +Vin, with heat sink)
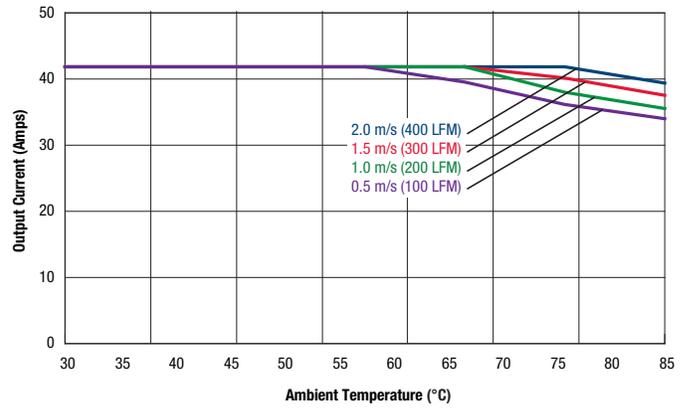
Maximum Current Temperature Derating at sea level
(Vin = 48V, airflow from -Vin to +Vin, with heat sink)

Maximum Current Temperature Derating at sea level
(Vin = 75V, airflow from -Vin to +Vin, with heat sink)
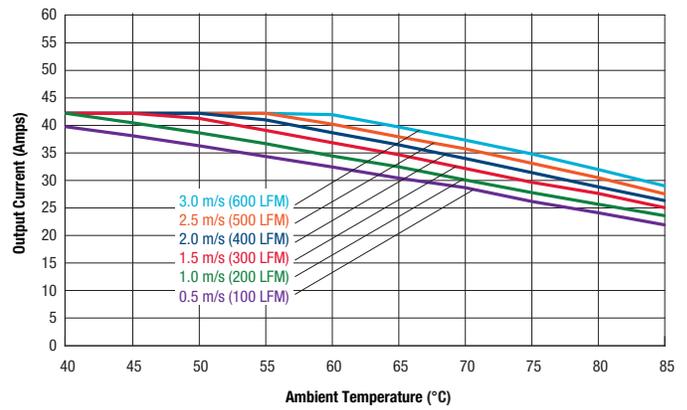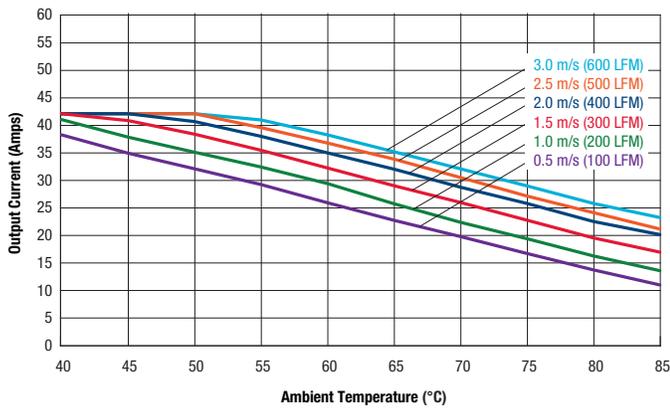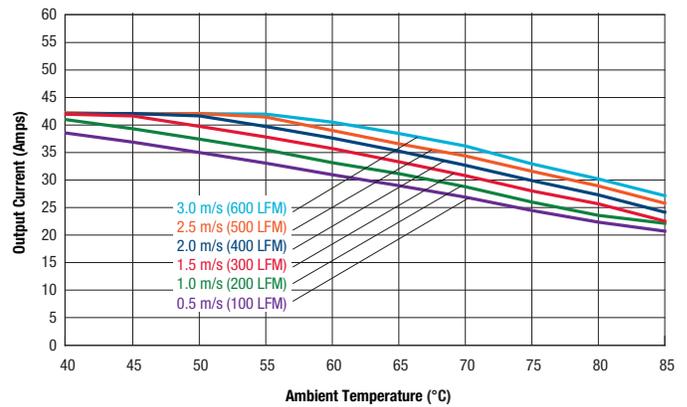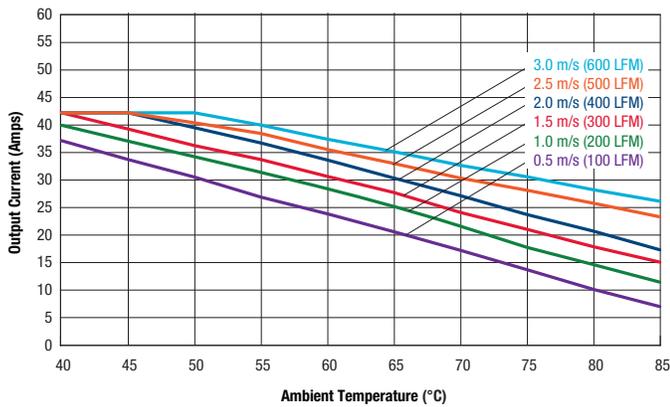

Output vs. Input Voltage @ No Load

PERFORMANCE DATA

Longitudinal	Transverse

Maximum Current Temperature Derating at sea level
(Vin = 38V, airflow from Vin to Vout, with baseplate)

3.0 m/s (600 LFM)
2.5 m/s (500 LFM)
2.0 m/s (400 LFM)
1.5 m/s (300 LFM)
1.0 m/s (200 LFM)
0.5 m/s (100 LFM)

Maximum Current Temperature Derating at sea level
(Vin = 38V, airflow from -Vin to +Vin, with baseplate)

3.0 m/s (600 LFM)
2.5 m/s (500 LFM)
2.0 m/s (400 LFM)
1.5 m/s (300 LFM)
1.0 m/s (200 LFM)
0.5 m/s (100 LFM)

Maximum Current Temperature Derating at sea level
(Vin = 48V, airflow from Vin to Vout, with baseplate)

3.0 m/s (600 LFM)
2.5 m/s (500 LFM)
2.0 m/s (400 LFM)
1.5 m/s (300 LFM)
1.0 m/s (200 LFM)
0.5 m/s (100 LFM)

Maximum Current Temperature Derating at sea level
(Vin = 48V, airflow from -Vin to +Vin, with baseplate)

3.0 m/s (600 LFM)
2.5 m/s (500 LFM)
2.0 m/s (400 LFM)
1.5 m/s (300 LFM)
1.0 m/s (200 LFM)
0.5 m/s (100 LFM)

Maximum Current Temperature Derating at sea level
(Vin = 75V, airflow from Vin to Vout, with baseplate)

3.0 m/s (600 LFM)
2.5 m/s (500 LFM)
2.0 m/s (400 LFM)
1.5 m/s (300 LFM)
1.0 m/s (200 LFM)
0.5 m/s (100 LFM)

Maximum Current Temperature Derating at sea level
(Vin = 75V, airflow from -Vin to +Vin, with baseplate)

3.0 m/s (600 LFM)
2.5 m/s (500 LFM)
2.0 m/s (400 LFM)
1.5 m/s (300 LFM)
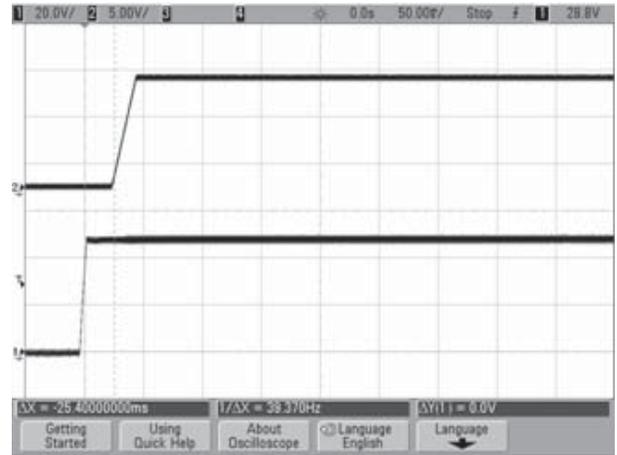1.0 m/s (200 LFM)
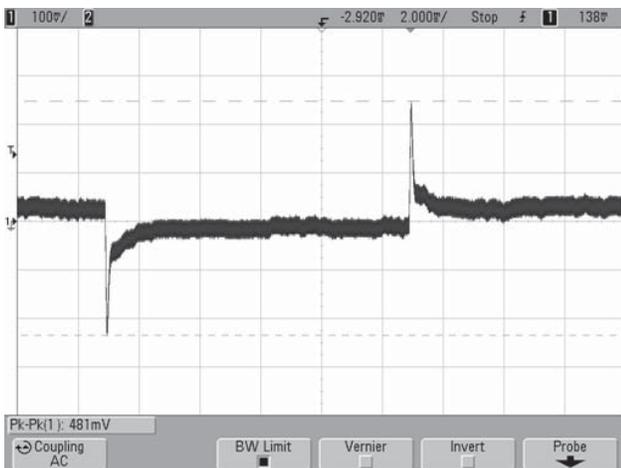0.5 m/s (100 LFM)
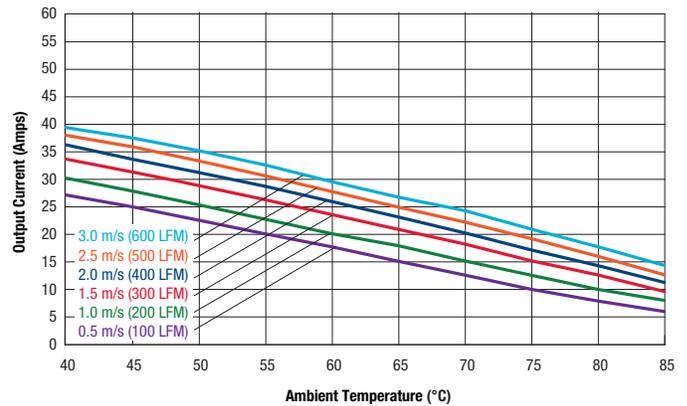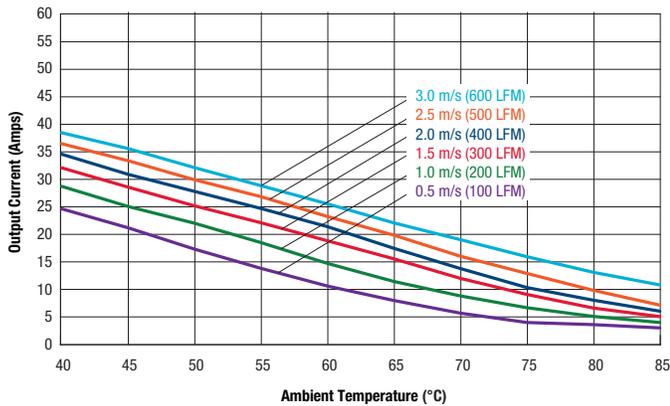
PERFORMANCE DATA

Enable Startup Delay (Vin = 48V, Iout = full load, Cout = 10000µF, Ta = +25°C) Ch2 = Vout, Ch4 = Enable.
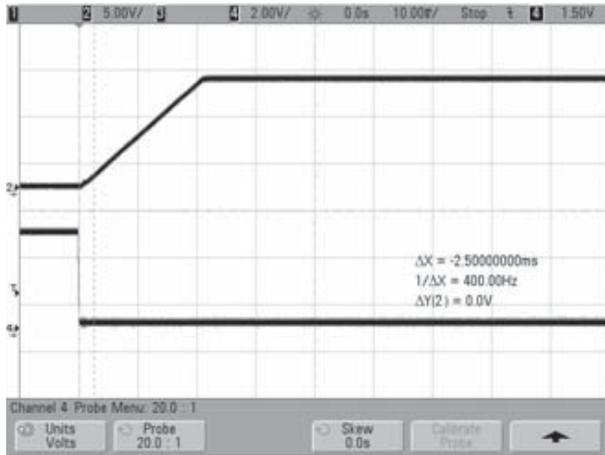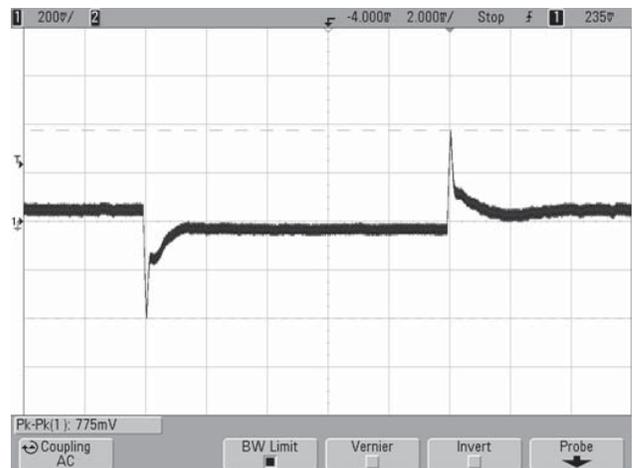

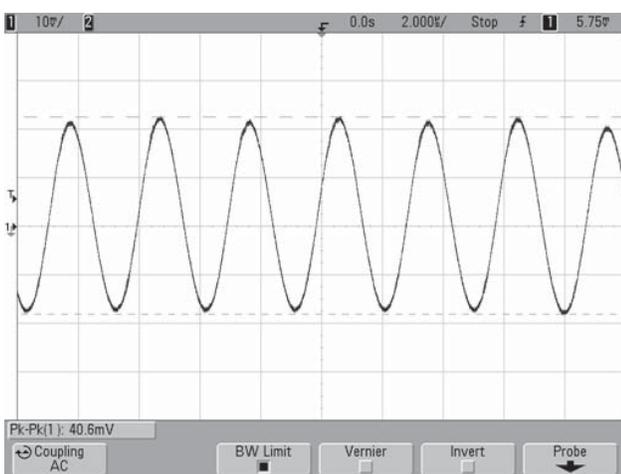Startup Delay (Vin = 48V, Iout = full load, Cout = 10000µF, Ta = +25°C) Ch1 = Vin, Ch2 = Vout.

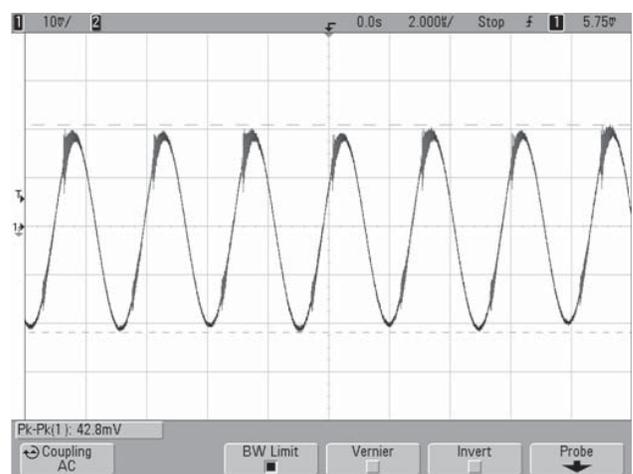Stepload Transient Response (Vin = 48V, Iout = 50-75-50% of Iout, Cload = 1000µF)

Stepload Transient Response (Vin = 48V, Iout = 25-75-25% of Iout, Cload = 1000µF)

Output Ripple & Noise (Vin = 48V, Iout = 0A, Cout = 1µF || 10µF, Ta = +25°C)

Output Ripple & Noise (Vin = 48V, Iout = full load, Cout = 1µF || 10µF, Ta = +25°C)

TECHNICAL NOTES

Power Management Overview

The module includes a wide range of readable and configurable power management features that are easy to implement with a minimum of external components. Furthermore, the module includes protection features that continuously protect the load from damage due to unexpected system faults. The SMBALERT pin alerts the host if there is a fault in the module. The following product parameters can continuously be monitored by a host: Vout, Iout, Vin, Temperature, and Power Good. The module is distributed with a default configuration suitable for a wide range operation in terms of Vin, Vout, and load. All power management functions can be reconfigured using the PMBus interface. The product provides a PMBus digital interface that enables the user to configure many aspects of the device operation as well as monitor the input and output parameters. Please contact our FAE for special configurations.

Soft-start Power Up

The default rise time of the ramp up is 20 ms. When starting by applying input voltage the control circuit boot-up time adds an additional 10 ms delay. The soft-start power up of the module can be reconfigured using the PMBus interface.

Over Voltage Protection (OVP)

The module includes over voltage limiting circuitry for protection of the load. The default OVP limit is 20% above the nominal output voltage. If the output voltage surpasses the OVP limit, the module can respond in different ways. The default response from an over voltage fault is to immediately shut down. The device will continuously check for the presence of the fault condition, and when the fault condition no longer exists the device will be re-enabled. The OVP fault level and fault response can be reconfigured using the PMBus interface.

Over Current Protection (OCP, Current limit)

The module includes current limiting circuitry for protection at continuous over load. The default setting for the product is hicup mode. The current limit could be configured by simply setting the IOUT_OC_FAULT_LIMIT to be greater than the IOUT_OC_WARN_LIMIT. The maximum value that the current limit could be set is 50A.

Power Good

The module provides Power Good (PG) flag in the Status Word register that indicates the output voltage is within a specified tolerance of its target level and no fault condition exists. The Power Good pin default logic is negative and it can be configured by MFR_PGOOD_POLARITY.

Switching Frequency Adjust Using PMBus

By default the switching frequency is set to 175-250 KHz variable frequency control. The product is optimized at this frequency but it can be changed to 175 KHz fixed frequency control. The thermal performance can be affected if the switching frequency is changed when Vin is above 50 Vdc. The following graph shows Frequency vs. Vin.
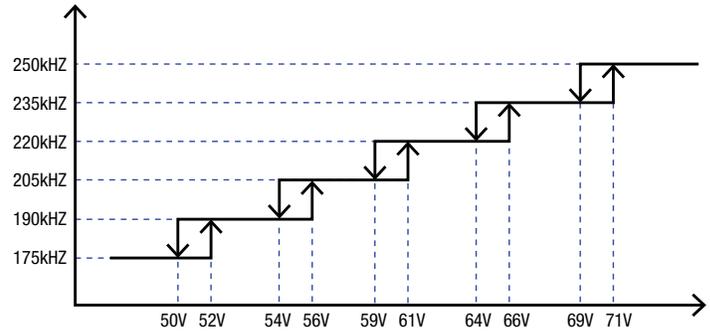

Figure 1. Frequency graph

PMBus Interface

This module offers a PMBus digital interface that enables the user to configure many characteristics of the device operation as well as to monitor the input and output voltages, output current and device temperature. The module can be used with any standard two-wire I2C or SMBus host device. In addition, the module is compatible with PMBus version 1.2 and includes an SMBALERT line to help alleviate bandwidth limitations related to continuous fault monitoring. The module supports 100 kHz and 400 kHz bus clock frequency only.

PMBUS Logic Level	MIN.	NOM.	MAX.	UNITS
Logic high input	2		3.3	V
Logic low input	0		0.8	V
Logic high output	2.4		3.6	V
Logic low output	-0.1		0.4	V

Monitoring via PMBus

A system controller (host device) can monitor a wide variety of parameters through the PMBus interface. The controller can monitor fault conditions by monitoring the SMBALERT pin, which will be asserted when any number of pre-configured fault or warning conditions occur. The system controller can also continuously monitor any number of power conversion parameters including but not limited to the following:
- Input voltage
- Output voltage
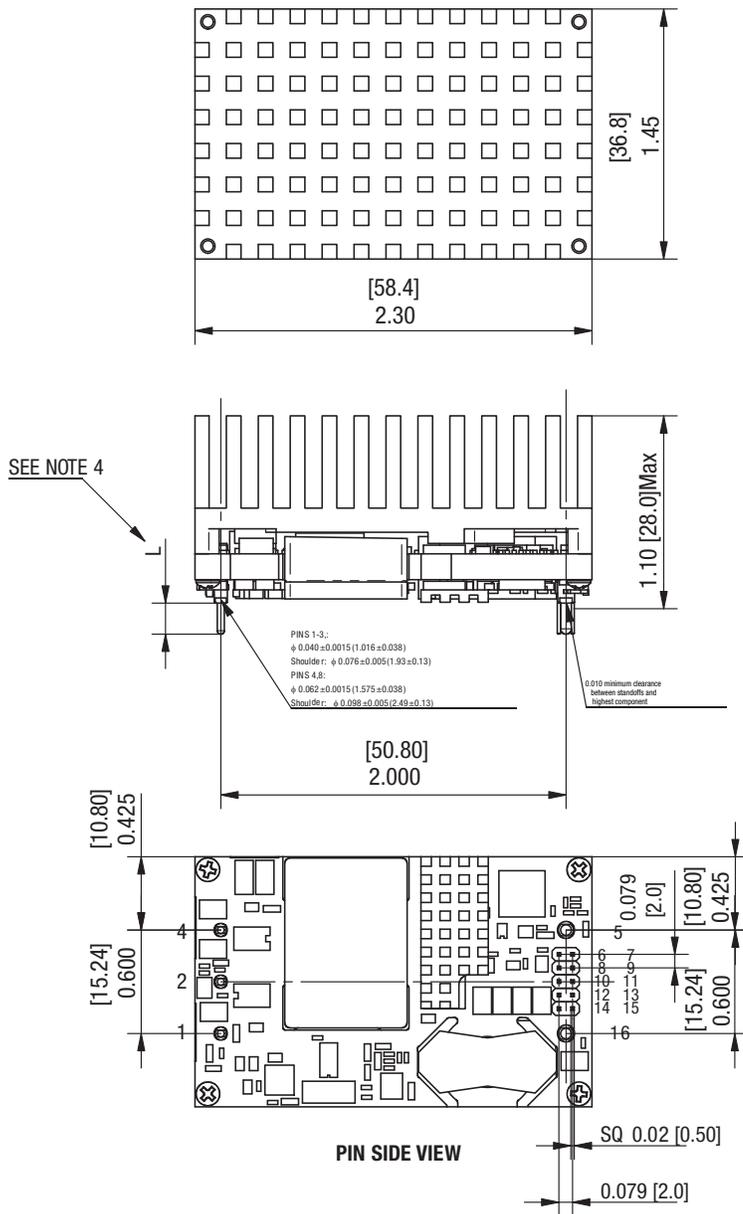- Output current
- Module temperature

Software Tools for Design and Production

For these modules, Murata-PS provides software for configuring and monitoring via the PMBus interface. For more information please contact your local Murata-PS representative.

See http://power.murata.com/datasheet?/data/apnotes/dcan-63.pdf for Application Note AN-63, Digital DC-DC Evaluation Board User Guide.

See http://power.murata.com/datasheet?/data/apnotes/dcan-64.pdf for Application Note AN-64, Murata Power Brick GUI User Guide.

ABC (PMBUS) MECHANICAL SPECIFICATIONS WITH HEAT SINK

[36.8]
1.45

[58.4]
2.30

SEE NOTE 4

1.10 [28.0]Max

PINS 1-3.:
φ 0.040 ±0.0015 (1.016 ±0.038)
Shoulder: φ 0.076 ±0.005 (1.93 ±0.13)
PINS 4,8:
φ 0.062 ±0.0015 (1.575 ±0.038)
Shoulder: φ 0.098 ±0.005 (2.49 ±0.13)

0.010 minimum clearance between standoffs and highest component

[50.80]
2.000

[10.80]
0.425

[15.24]
0.600

0.079
[2.0]

[10.80]
0.425

[15.24]
0.600

PIN SIDE VIEW

SQ 0.02 [0.50]

0.079 [2.0]
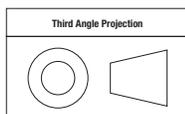
NOTES:
UNLESS OTHERWISE SPECIFIED:
1: ALL DIMENSIONS ARE IN INCHES [MILLIMETERS];
2: ALL TOLERANCES: ×.××in, ±0.02in (×.×mm, ±0.5mm)
×.×××in, ±0.01in (×.××mm, ±0.25mm)
3: COMPONENTS WILL VARY BETWEEN MODELS
4: STANDARD PIN LENGTH: 0.180 Inch
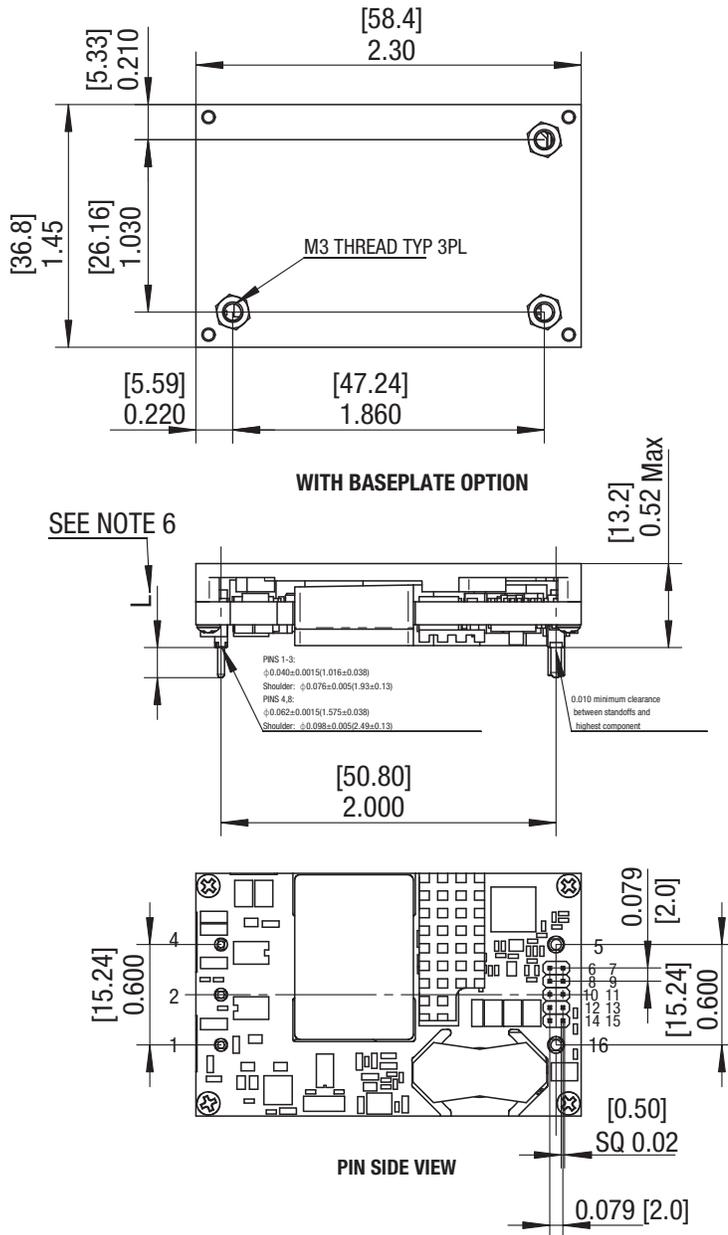FOR PIN LENGTH OPTIONS, SEE PART NUMBER STRUCTURE.
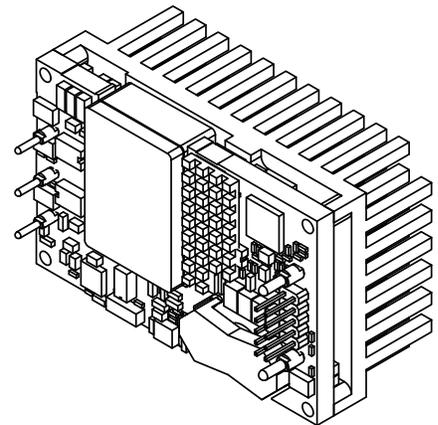
ISOMETRIC VIEW

INPUT/OUTPUT CONNECTIONS		
Pin	Designation	Function
1	+VIN	Positive Input
2	On/Off 1 Control	Primary On/Off Control
3	No Pin	No Pin
4	−VIN	Negative Input
5	−VOUT	Negative Output
6	+S	Positive Remote Sense
7	−S	Negative Remote Sense
8	SA0	Address Pin 0
9	SA1	Address Pin 1
10	SCL	PMBus Clock
11	SDA	PMBus Data
12	PG	Power Good Output
13	DGND	PMBus Ground
14	SMBALERT	PMBus Alert Signal
15	On/Off 2 Control	Secondary On/Off Control
16	+VOUT	Positive Output

Dimensions are in inches (mm) shown for ref. only.

Third Angle Projection

Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2°

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ABC (PMBUS) MECHANICAL SPECIFICATIONS WITH BASEPLATE

[58.4]
2.30

[5.33]
0.210

[36.8]
1.45

[26.16]
1.030

M3 THREAD TYP 3PL

[5.59]
0.220

[47.24]
1.860

WITH BASEPLATE OPTION

SEE NOTE 6

[13.2]
0.52 Max

PINS 1-3:
⌀0.040±0.0015(1.016±0.038)
Shoulder: ⌀0.076±0.005(1.93±0.13)
PINS 4,8:
⌀0.062±0.0015(1.575±0.038)
Shoulder: ⌀0.098±0.005(2.49±0.13)

0.010 minimum clearance
between standoffs and
highest component

[50.80]
2.000

[15.24]
0.600

[15.24]
0.600

0.079
[2.0]

4

5
6   7
8   9
10 11
12 13
14 15

2

1

16

[0.50]
SQ 0.02

PIN SIDE VIEW

0.079 [2.0]

Dimensions are in inches (mm) shown for ref. only.

Third Angle Projection

Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
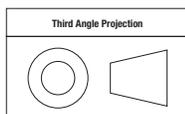.XXX ± 0.010 (0.25)
Angles ± 2°

NOTES:
UNLESS OTHERWISE SPECIFIED:
1: M3 SCREW USED TO BOLT UNIT'S BASEPLATE TO OTHER SURFACES
(SUCH AS HEATSINK) MUST NOT EXCEED 0.11''(2.8mm) DEPTH BELOW
THE SURFACE OF BASEPLATE
2: APPLIED TORQUE PER SCREW SHOULD NOT EXCEED 5.3In-lb (0.6Nm);
3: ALL DIMENSIONS ARE IN INCHES [MILIMETERS];
4: ALL TOLERANCES: ×.××in, ±0.02in (×.×mm, ±0.5mm)
×.×××in, ±0.01in (×.××mm, ±0.25mm)
5: COMPONENTS WILL VARY BETWEEN MODELS
6: STANDARD PIN LENGTH: 0.180 Inch
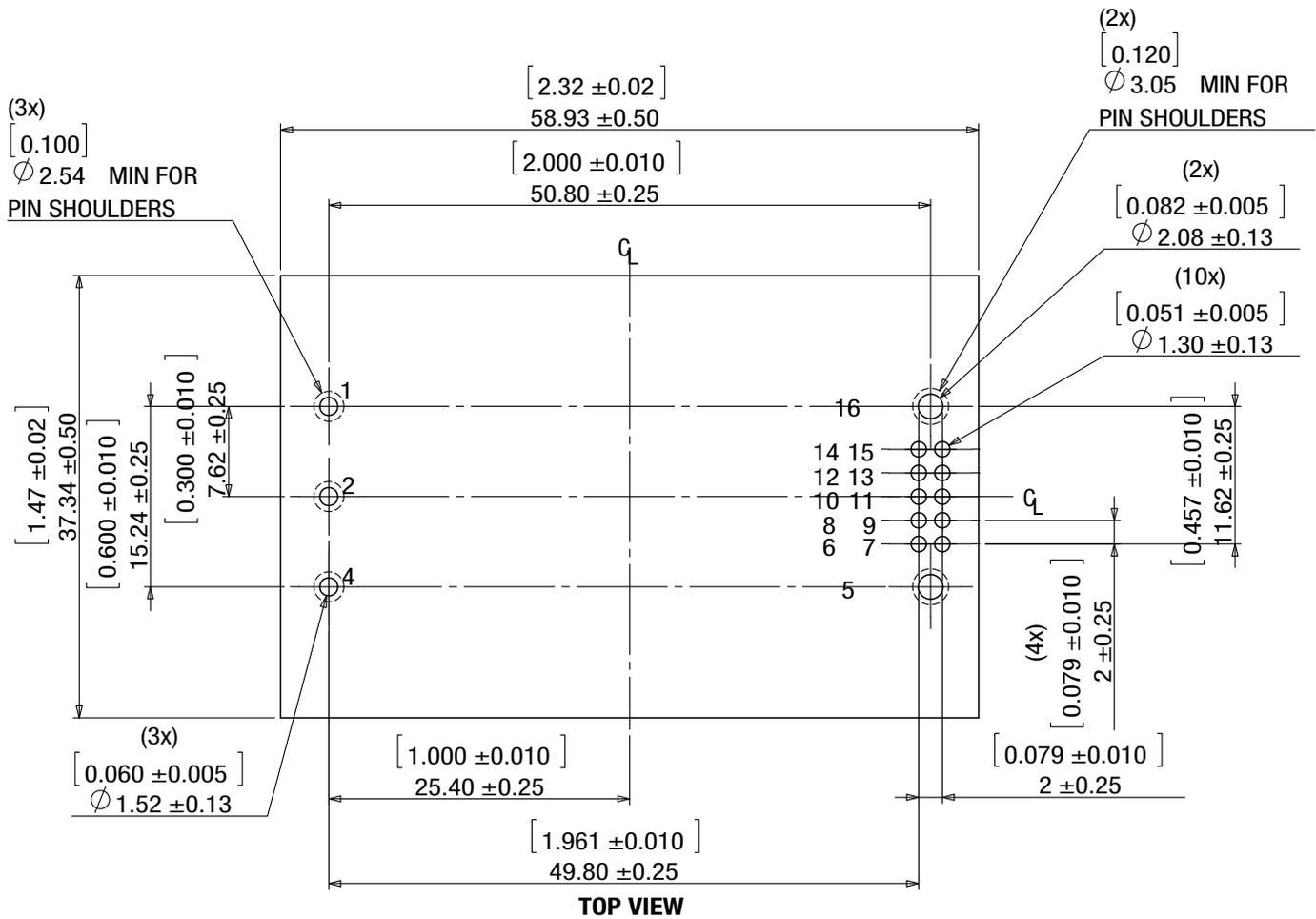FOR PIN LENGTH OPTIONS, SEE PART NUMBER STRUCTURE.

INPUT/OUTPUT CONNECTIONS		
Pin	**Designation**	**Function**
1	+VIN	Positive Input
2	On/Off 1 Control	Primary On/Off Control
3	No Pin	No Pin
4	−VIN	Negative Input
5	−VOUT	Negative Output
6	+S	Positive Remote Sense
7	−S	Negative Remote Sense
8	SA0	Address Pin 0
9	SA1	Address Pin 1
10	SCL	PMBus Clock
11	SDA	PMBus Data
12	PG	Power Good Output
13	DGND	PMBus Ground
14	SMBALERT	PMBus Alert Signal
15	On/Off 2 Control	Secondary On/Off Control
16	+VOUT	Positive Output

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TOP VIEW

MECHANICAL SPECIFICATIONS (NO PMBUS) WITH HEAT SINK
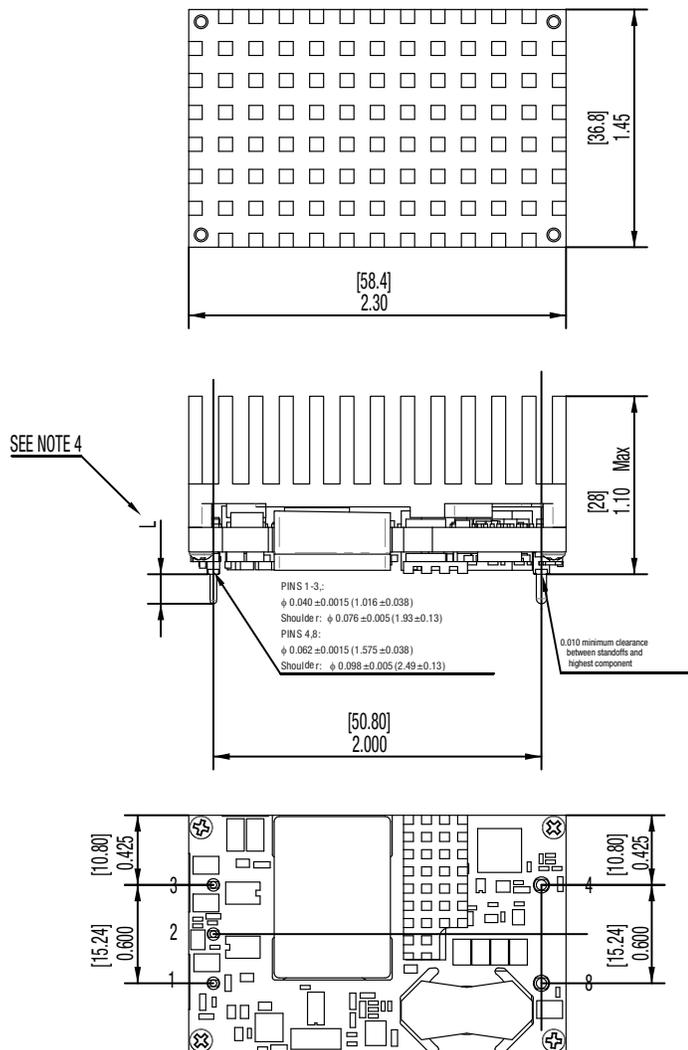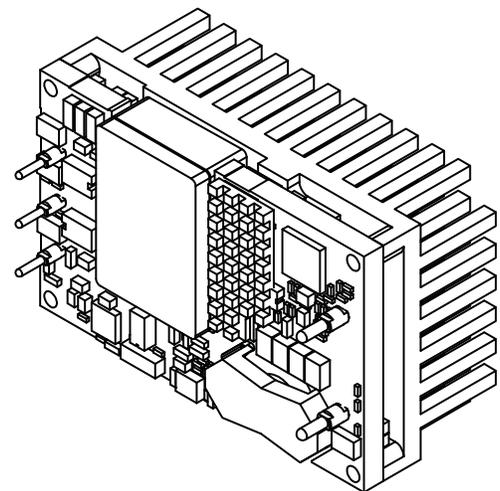
[36.8]
1.45

[58.4]
2.30

SEE NOTE 4

[28] Max
1.10

PINS 1-3,:
ϕ 0.040 ±0.0015 (1.016 ±0.038)
Shoulder: ϕ 0.076 ±0.005 (1.93 ±0.13)
PINS 4,8:
ϕ 0.062 ±0.0015 (1.575 ±0.038)
Shoulder: ϕ 0.098 ±0.005 (2.49 ±0.13)

0.010 minimum clearance
between standoffs and
highest component

[50.80]
2.000

[10.80]
0.425

[15.24]
0.600

[10.80]
0.425

[15.24]
0.600

3 4
2
1 8

PIN SIDE VIEW

NOTES:
UNLESS OTHERWISE SPECIFIED:
1: ALL DIMENSIONS ARE IN INCHES [MILLIMETERS];
2: ALL TOLERANCES: ×.××in, ±0.02in (×.×mm, ±0.5mm)
×.×××in, ±0.01in (×.××mm, ±0.25mm)
3: COMPONENTS WILL VARY BETWEEN MODELS
4: STANDARD PIN LENGTH: 0.180 Inch
FOR PIN LENGTH OPTIONS, SEE PART NUMBER STRUCTURE.
5: DOSA 5 PIN COMPATIBLE

ISOMETRIC VIEW

Dimensions are in inches (mm) shown for ref. only.

Third Angle Projection

Tolerances (unless otherwise specified):
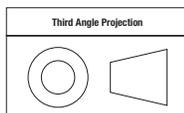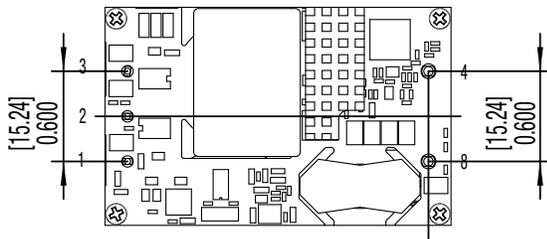.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2°

I/O Connections	
Pin	**Function**
1	+Vin
2	Remote On/Off Control
3	-Vin
4	-Vout
8	+Vout

MECHANICAL SPECIFICATIONS (NO PMBUS) WITH BASEPLATE
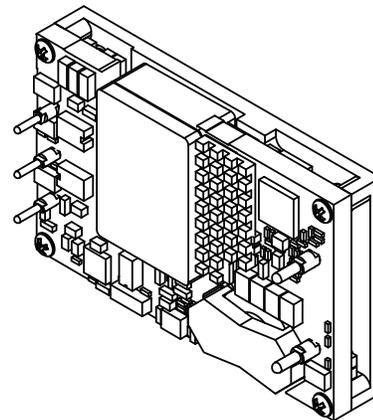
WITH BASEPLATE OPTION

SEE NOTE 6

PINS 1-3:
φ0.040±0.0015(1.016±0.038)
Shoulder: φ0.076±0.005(1.93±0.13)
PINS 4,8:
φ0.062±0.0015(1.575±0.038)
Shoulder: φ0.098±0.005(2.49±0.13)

0.010 minimum clearance between standoffs and highest component

M3 THREAD TYP 3PL

PIN SIDE VIEW

NOTES:
UNLESS OTHERWISE SPECIFIED:
1: M3 SCREW USED TO BOLT UNIT'S BASEPLATE TO OTHER SURFACES (SUCH AS HEATSINK) MUST NOT EXCEED 0.11''(2.8mm) DEPTH BELOW THE SURFACE OF BASEPLATE
2: APPLIED TORQUE PER SCREW SHOULD NOT EXCEED 5.3In-lb (0.6Nm);
3: ALL DIMENSIONS ARE IN INCHES [MILIMETERS];
4: ALL TOLERANCES: ×.××in, ±0.02in (×.×mm, ±0.5mm)
×.×××in, ±0.01in (×.××mm, ±0.25mm)
5: COMPONENTS WILL VARY BETWEEN MODELS
6: STANDARD PIN LENGTH: 0.180 Inch
FOR PIN LENGTH OPTIONS, SEE PART NUMBER STRUCTURE.
7: DOSA 5 PIN COMPATIBLE

ISOMETRIC VIEW

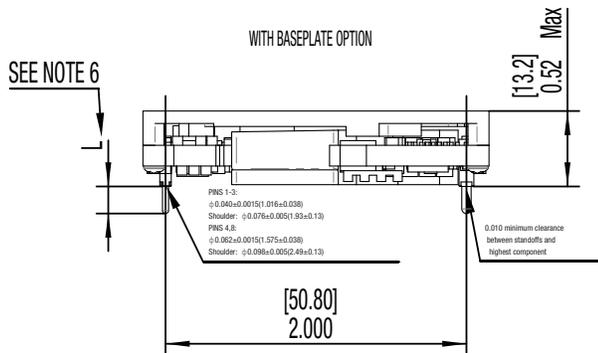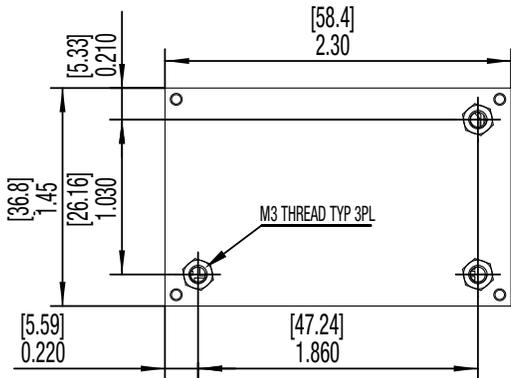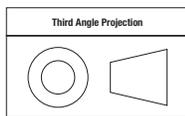Dimensions are in inches (mm) shown for ref. only.

Third Angle Projection

Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2°

I/O Connections	
Pin	**Function**
1	+Vin
2	Remote On/Off Control
3	-Vin
4	-Vout
8	+Vout

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RECOMMENDED FOOTPRINT (NO PMBUS)

TOP VIEW
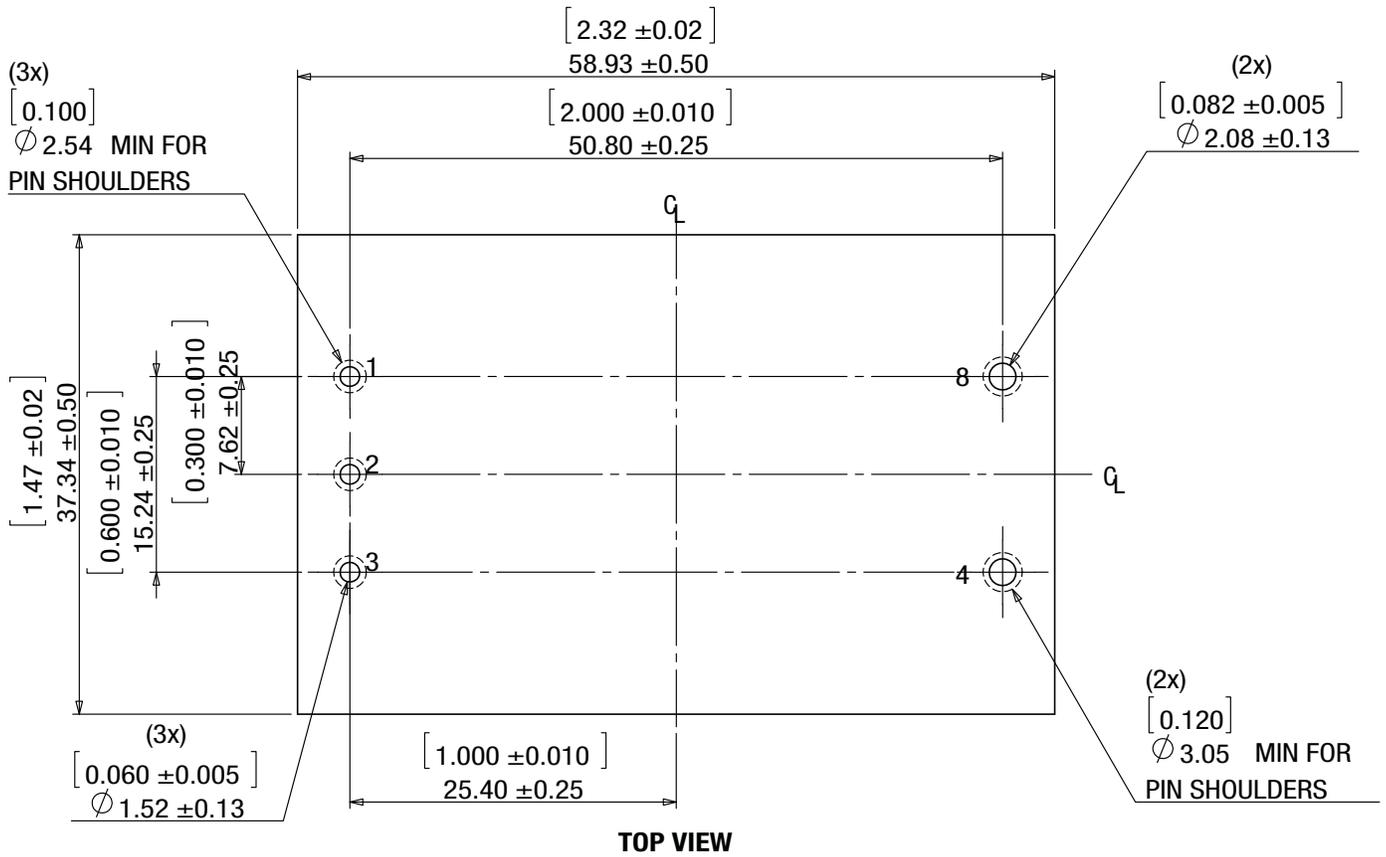
STANDARD PACKAGING

BASEPLATE VERSION

9.92 (251.97) REF

9.92 (251.97) REF

0.88 (22.35) REF

Each static dissipative polyethylene foam tray accommodates 15 converters in a 3 x 5 array.

2.75 (69.85) ±.25 closed height

11.00 (279.4) ±.25

10.50 (266.7) ±.25
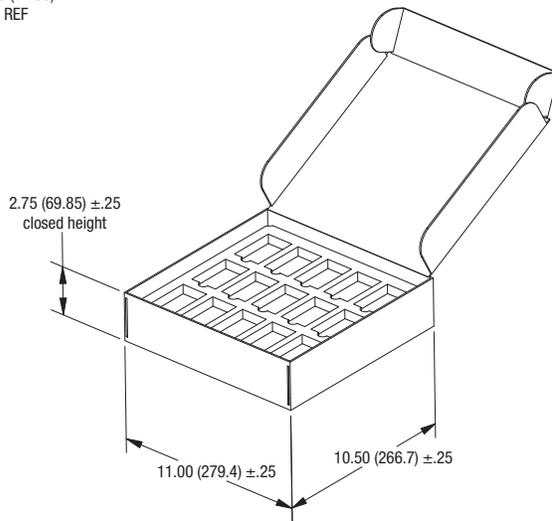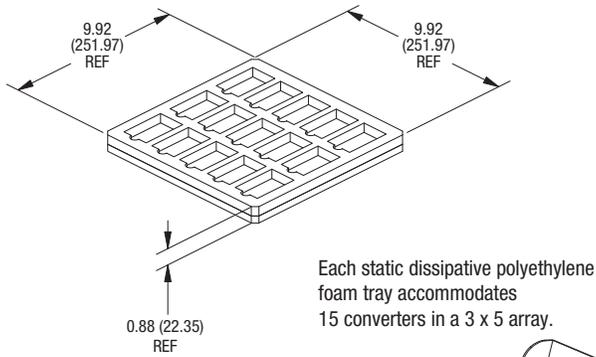
Carton accommodates two (2) trays yielding 30 converters per carton

HEATSINK VERSION
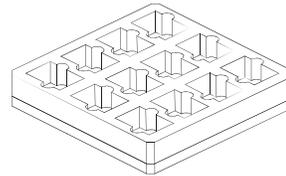
Each static dissipative polyethylene foam tray accommodates 12 converters in a 3 x 4 array.

4.25 (108) ±.25 closed height

10.0 (254) ±.25

10.0 (254) ±.25
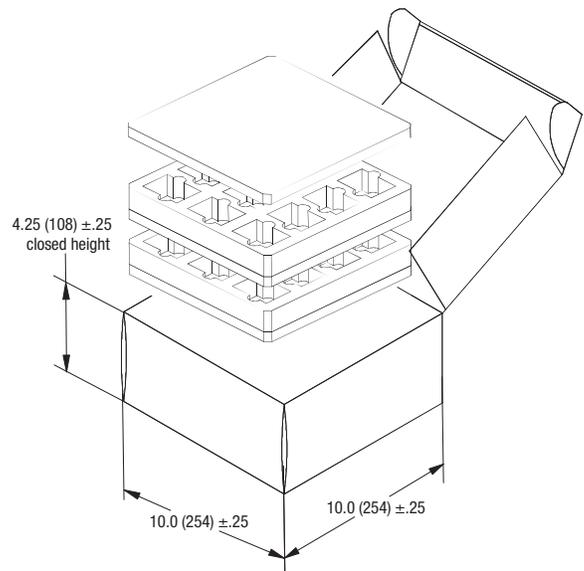
Carton accommodates two (2) trays yielding 24 converters per carton

Dimensions are in inches (mm) shown for ref. only.

Third Angle Projection

Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2°

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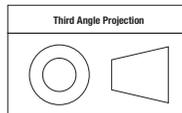
PMBus Addressing

Figure 2 and the accompanying table display the recommended resistor values for hard-wiring PMBus addresses (1% tolerance resistors recommended): The address is set in the form of two octal (0 to 7) digits, with each pin setting one digit. The resistor values for each digit is shown below.

The SA0 and SA1 pins can be configured with a resistor to GND according to the following equation.

PMBus Address = 8 x (SA0value) + (SA1 value)

If the calculated PMBus address is 0d, 11d or 12d, PMBus address 119d is assigned instead. From a system point of view, the user shall also be aware of further limitations of the addresses as stated in the PMBus Specification. It is not recommended to keep the SA0 and SA1 pins left open.

PMBus Commands

The products are designed to be PMBus compliant. The following tables list the implemented PMBus read commands. For more detailed information see "PMBus Power System Management Protocol Specification, Part I – General Requirements, Transport and Electrical Interface" and "PMBus Power System Management Protocol, Part II – Command Language."
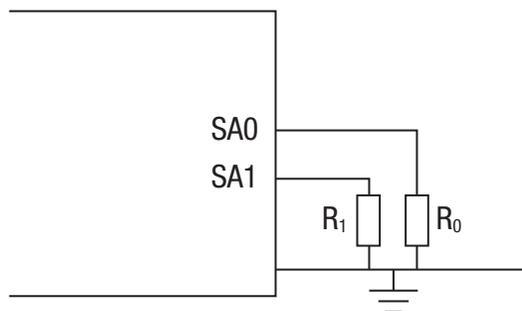

Figure 2. Schematic of Connection of Address Resistors

Digit (SA0, SA1 index)	Resistor Value [kΩ]
0	10
1	22
2	33
3	47
4	68
5	100
6	150
7	220

OVERALL

CMD	Command Name[1]	SMBus Transaction Type: Writing Data	SMBus Transaction Type: Reading Data	Number Of Data Bytes	Default Value	Lower Limit	Upper Limit	Cross Check	Unit
01h	OPERATION[2]	Write Byte	Read Byte	1	0x80				
02h	ON_OFF_CONFIG[3]	Write Byte	Read Byte	1	0x1D				
03h	CLEAR_FAULTS	Send byte	N/A	0	N/A				
10h	WRITE_PROTECT	Write Byte	Read Byte	1	0x00				
11h	STORE_DEFAULT_ALL[4]	Send byte	N/A	0	N/A				
12h	RESTORE_DEFAULT_ALL[4]	Send byte	N/A	0	N/A				
15h	STORE_USER_ALL[4]	Send byte	N/A	0	N/A				
16h	RESTORE_USER_ALL[4]	Send byte	N/A	0	N/A				
19h	CAPABILITY	N/A	Read Byte	1	0xB0				
20h	VOUT_MODE	N/A	Read Byte	1	0x17				
21h	VOUT_COMMAND	Write Word	Read Word	2	11.500	8.100	13.200		V
22h	VOUT_TRIM	Write Word	Read Word	2	0			8.1<=Vout<=13.212	V
25h	VOUT_MARGIN_HIGH	Write Word	Read Word	2	13.199	8.100	13.199	>VOUT_MARGIN_LOW	V
26h	VOUT_MARGIN_LOW	Write Word	Read Word	2	8.100	8.100	13.200	<VOUT_MARGIN_HIGH	V
40h	VOUT_OV_FAULT_LIMIT	Write Word	Read Word	2	14.199	8.100	15.600	>VOUT_OV_WARN_LIMIT	V
41h	VOUT_OV_FAULT_RESPONSE[5]	Write Byte	Read Byte	1	0xB8				
42h	VOUT_OV_WARN_LIMIT	Write Word	Read Word	2	13.500	8.100	15.600	<VOUT_OV_FAULT_LIMIT >VOUT_COMMAND	V
46h	IOUT_OC_FAULT_LIMIT	Write Word	Read Word	2	54.00	0.00	60.00	>IOUT_OC_WARN_LIMIT	A
47h	IOUT_OC_FAULT_RESPONSE[6]	Write Byte	Read Byte	1	0xF8				
4Ah	IOUT_OC_WARN_LIMIT	Write Word	Read Word	2	52.00	0.00	60.00	<IOUT_OC_FAULT_LIMIT	A
4Fh	OT_FAULT_LIMIT	Write Word	Read Word	2	132	30	145	>OT_WARN_LIMIT	°C
50h	OT_FAULT_RESPONSE[5]	Write Byte	Read Byte	1	0xB8				
51h	OT_WARN_LIMIT	Write Word	Read Word	2	115	30	145	<OT_FAULT_LIMIT	°C
58h	VIN_UV_WARN_LIMIT	Write Word	Read Word	2	37.00	32.00	75.00	<VIN_OV_WARN_LIMIT >VIN_UV_FAULT_LIMIT	V
59h	VIN_UV_FAULT_LIMIT	Write Word	Read Word	2	35.50	32.00	75.00	<VIN_UV_WARN_LIMIT	V
5Ah	VIN_UV_FAULT_RESPONSE[7]	Write Byte	Read Byte	1	0xF8				
5Eh	POWER_GOOD_ON	Write Word	Read Word	2	10.799	1.000	13.199	>POWER_GOOD_OFF	V
5Fh	POWER_GOOD_OFF	Write Word	Read Word	2	9.600	1.000	13.199	<POWER_GOOD_ON	V
60h	TON_DELAY	Write Word	Read Word	2	1	1	500		ms
61h	TON_RISE[13]	Write Word	Read Word	2	0	10	100		ms

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OVERALL (CONT.)

CMD	Command Name[1]	SMBus Transaction Type: Writing Data	SMBus Transaction Type: Reading Data	Number Of Data Bytes	Default Value	Lower Limit	Upper Limit	Cross Check	Unit
64h	TOFF_DELAY	Write Word	Read Word	2	0	0	500		ms
65h	TOFF_FALL[13]	Write Word	Read Word	2	0	10	100		ms
78h	STATUS_BYTE	Write Byte	Read Byte	1	N/A				
79h	STATUS_WORD	Write Word	Read Word	2	N/A				
7Ah	STATUS_VOUT	Write Byte	Read Byte	1	N/A				
7Bh	STATUS_IOUT	Write Byte	Read Byte	1	N/A				
7Ch	STATUS_INPUT	Write Byte	Read Byte	1	N/A				
7Dh	STATUS_TEMPERATURE	Write Byte	Read Byte	1	N/A				
7Eh	STATUS_CML	Write Byte	Read Byte	1	N/A				
88h	READ_VIN	N/A	Read Word	2	N/A				V
8Bh	READ_VOUT	N/A	Read Word	2	N/A				V
8Ch	READ_IOUT	N/A	Read Word	2	N/A				A
8Dh	READ_TEMPERATURE_1[8]	N/A	Read Word	2	N/A				°C
8Eh	READ_TEMPERATURE_2[9]	N/A	Read Word*	2	N/A				°C
94h	READ_DUTY_CYCLE	N/A	Read Word	2	N/A				%
95h	READ_FREQUENCY	N/A	Read Word	2	N/A				kHZ
96h	READ_POUT	N/A	Read Word	2	N/A				W
98h	PMBUS_REVISION	N/A	Read Byte	1	0x42				
99h	MFR_ID	N/A	Block Read	22	"Murata Power Solutions"				
9Ah	MFR_MODEL[10]	Block Write*	Block Read	<=20	N/A				
9Bh	MFR_REVISION[10]	Block Write*	Block Read	<=10	N/A				
9Dh	MFR_DATE[10]	Block Write*	Block Read	<=10	N/A				
9Eh	MFR_SERIAL[10]	Block Write*	Block Read	<=10	N/A				
A0h	MFR_VIN_MIN	N/A	Read Word	2	38.00				V
A1h	MFR_VIN_MAX	N/A	Read Word	2	75.00				V
A2h	MFR_IIN_MAX	N/A	Read Word	2	15.5				A
A3h	MFR_PIN_MAX	N/A	Read Word	2	438				W
A4h	MFR_VOUT_MIN	N/A	Read Word	2	8.100				V
A5h	MFR_VOUT_MAX	N/A	Read Word	2	13.199				V
A6h	MFR_IOUT_MAX	N/A	Read Word	2	42.00				A
A7h	MFR_POUT_MAX	N/A	Read Word	2	500				W
A8h	MFR_TAMBIENT_MAX	N/A	Read Word	2	85				°C
A9h	MFR_TAMBIENT_MIN	N/A	Read Word	2	-40				°C
B0h	USER_DATA_00	Block Write	Block Read	<=20	"---"				
B1h	USER_DATA_01	Block Write	Block Read	<=20	"---"				
C0h	MFR_MAX_TEMP_1	N/A	Read Word	2	132				°C
D0h	MFR_VARIABLE_FREQUENCY_DISABLE	Write Byte	Read Byte	1	0x00				
DDh	MFR_PRIMARY_ON_OFF_CONFIG	Write Byte	Read Byte	1	0x04/0x06[11]				
DEh	MFR_PGOOD_POLARITY	Write Byte	Read Byte	1	0x00				
E9h	MFR_VIN_UV_FAULT_HYS	Write Word	Read Word	2	2.00	1.00	20.00		V
EAh	MFR_OT_FAULT_HYS	Write Word	Read Word	2	20	5	50		°C
F6h	MFR_CALIBRATION_STATUS	N/A	Read Byte*	1	0xC7				
F9h	MFR_VIN_SENSE_CALIBRATION	Write byte*	N/A	1	N/A				
FAh	MFR_IOUT_SENSE_CALIBRATION	Write Word*	N/A	2	N/A				
FBh	MFR_VOUT_SET_POINT_CALIBRATION	Write Word*	N/A	2	N/A				
FCh	MFR_SUPERVISOR_PASSWORD	Block Write	N/A	N/A	N/A				

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OVERALL (CONT.)

Notes:

* Only available in supervisor mode (default state is user mode, send password to comand 0xFC to change to supervisor mode)

1. a) Unit restores the entire contents of the non-volatile User Store memory when power up
   b) PEC is supported
   c) Max bus speed: 400kHZ
   d) SMBALERT# is supported
   e) Linear data format used
   f) addressing: If the calculated PMBus address is 0d, 11d or 12d, SA0 or SA1 lefts open, default PMBus address 120d is assigned instead.

2. Not supported items:
   100101XXb Margin Low(Ignore Fault),
   101001XXb On Margin High(Ignore Fault)

3. Restart delay of turned off by OPEATION or CONTROL or primary on/off is 200ms

4. Unit will shutdown 1 second for protection, then recover automaticly

5. Restart delay unit: 500ms, lower limit: 500ms.
   Turn off delay unit: 0ms, lower limit: 0ms
   if bits 7:6=11b, restart delay is 500ms

6. Restart delay unit and Turn off delay unit are same as note 5
   Bits 7:6: 00b,01b,10b are not supported

7. Restart delay unit: 100ms, lower limit: 100ms.
   Turn off delay unit:0ms, lower limit: 0ms
   if bits 7:6=11b, restart delay is 100ms

8. Temperature of baseplate side

9. Temperature of pin side

10. Unit's actual inforamtion

11. Default value of negative logic: 0x04
    Default value of positive logic: 0x06

12. Unit can receive any value for VOUT_TRIM command, but Vout is limited to 8.1~13.2V, if calculated Vout exceeds limit, then equal to limit.

13. Value of 0 is acceptable, which is the same as lower limit to unit.

MURATA-PS defined commands (01-CFh Refer to PMBus 1.2 SPEC)

D0h: MFR_VARIABLE_FREQUENCY_DISABLE			
Bits	**Purpose**	**Value**	**Meaning**
7:1		0000000	Reserved
0	Variable frequency control	0	Turn on variable frequency control
		1	Turn off variable frequency control

DDh: MFR_PRIMARY_ON_OFF_CONFIG			
Bits	**Purpose**	**Value**	**Meaning**
7:3		00000	Reserved
2	Controls how the unit responds to the CONTROL pin	0	Unit ignores the primary ON/OFF pin
		1	Unit requires the primary ON/OFF pin to be asserted to start the unit
1	Polarity of primary ON/OFF logic	0	Active low (Pull pin low to start the unit)
		1	Active high (Pull high or open to start the unit)
0		0	Reserved

DEh: MFR_ PGOOD_POLARITY			
Bits	**Purpose**	**Value**	**Meaning**
7:1		0000000	Reserved
0	Power good polarity of pin 12	0	Negative logic, output low if Vout rises to specific value
		1	Positive logic, output high if Vout rises to specific value

E9h: MFR_VIN_UV_FAULT_HYS
Hysteresis of VIN_UV_FAULT recover, Linear data format

EAh: MFR_OT_FAULT_HYS
Hysteresis of OT_FAULT recover, Linear data format

F6h: MFR_CALIBRATION_STATUS
Refer to calibration procedure file

F9h: MFR_VIN_SENSE_CALIBRATION
Refer to calibration procedure file

FAh: MFR_IOUT_SENSE_CALIBRATION
Refer to calibration procedure file

FBh: MFR_VOUT_SET_POINT_CALIBRATION
Refer to calibration procedure file

FCh: MFR_SUPERVISOR_PASSWORD
Set unit to supervisor mode or ROM mode, Refer to password table

STATUS WORD AND BYTE (GREEN = SUPPORTED)

STATUS_VOUT
- 7 VOUT_OV_FAULT
- 6 VOUT_OV_WARNING
- 5 VOUT_UV_WARNING
- 4 VOUT_UV_FAULT
- 3 VOUT_MAX Warning
- 2 TON_MAX_FAULT
- 1 TOFF_MAX_WARNING
- 0 VOUT Tracking Error

STATUS_IOUT
- 7 IOUT_OC_FAULT
- 6 IOUT_OC_LV_FAULT
- 5 IOUT_OC_WARNING
- 4 IOUT_UC_FAULT
- 2 In Power Limiting Mode
- 1 POUT_OP_FAULT
- 0 POUT_OP_WARNING

STATUS_TEMPERATURE
- 7 OT_FAULT
- 6 OT_WARNING
- 5 UT_WARNING
- 4 UT_FAULT
- 3 Reserved
- 2 Reserved
- 1 Reserved
- 0 Reserved

STATUS_CML
- 7 Invalid/Unsupported Command
- 6 Invalid/Unsupported Data
- 5 Packet Error Check Failed
- 4 Memory Fault Detected
- 3 Processor Fault Detected
- 2 Reserved
- 1 Other Communication Fault
- 0 Other Memory Or Logic Fault

STATUS_WORD
- 7 VOUT
- 6 IOUT/POUT
- 5 INPUT
- 4 MFR_SPECIFIC
- 3 POWER_GOOD#
- 2 FANS
- 1 OTHER
- 0 UNKNOWN
- 7 BUSY
- 6 OFF
- 5 VOUT_OV_FAULT
- 4 IOUT_OC_FAULT
- 3 VIN_UV_FAULT
- 2 TEMPERATURE
- 1 CML
- 0 NONE OF THE ABOVE

STATUS_OTHER
- 7 Reserved
- 6 Reserved
- 5 Input A Fuse/Breaker Fault
- 4 Input B Fuse/Breaker Fault
- 3 Input A OR-ing Device Fault
- 2 Input B OR-ing Device Fault
- 1 Output OR-ing Device Fault
- 0 Reserved

STATUS_INPUT
- 7 VIN_OV_FAULT
- 6 VIN_OV_WARNING
- 5 VIN_UV_WARNING
- 4 VIN_UV_FAULT
- 2 IIN_OC_FAULT
- 1 IIN_OC_WARNING
- 0 PIN_OP_WARNING

STATUS_MFR_SPECIFIC
- Manufacturer Defined
- Manufacturer Defined
- Manufacturer Defined
- Manufacturer Defined
- Manufacturer Defined
- Manufacturer Defined
- Manufacturer Defined
- Manufacturer Defined

STATUS_FANS_1_2
- 7 Fan 1 Fault
- 6 Fan 2 Fault
- 5 Fan 1 Warning
- 4 Fan 2 Warning
- 3 Fan 1 Speed Override
- 2 Fan 2 Speed Override
- 1 Air Flow Fault
- 0 Air Flow Warning

STATUS_FANS_3_4
- 7 Fan 3 Fault
- 6 Fan 4 Fault
- 5 Fan 3 Warning
- 4 Fan 4 Warning
- 3 Fan 3 Speed Override
- 2 Fan 4 Speed Override
- 1 Reserved
- 0 Reserved

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TECHNICAL NOTES (CONT.)

Thermal Shutdown

Extended operation at excessive temperature will initiate overtemperature shutdown triggered by a temperature sensor outside the PWM controller. This operates similarly to overcurrent and short circuit mode. The inception point of the overtemperature condition depends on the average power delivered, the ambient temperature and the extent of forced cooling airflow. Thermal shutdown uses only the hiccup mode (autorestart) and PMBus configurable hysteresis.

Start Up Considerations

When power is first applied to the DC-DC converter, there is some risk of start up difficulties if you do not have both low AC and DC impedance and adequate regulation of the input source. Make sure that your source supply does not allow the instantaneous input voltage to go below the minimum voltage at all times.

Use a moderate size capacitor very close to the input terminals. You may need two or more parallel capacitors. A larger electrolytic or ceramic cap supplies the surge current and a smaller parallel low-ESR ceramic cap gives low AC impedance.

Remember that the input current is carried both by the wiring and the ground plane return. Make sure the ground plane uses adequate thickness copper. Run additional bus wire if necessary.

Input Fusing

Certain applications and/or safety agencies may require fuses at the inputs of power conversion components. Fuses should also be used when there is the possibility of sustained input voltage reversal which is not current-limited. For greatest safety, we recommend a fast blow fuse installed in the ungrounded input supply line.

Input Under-Voltage Shutdown and Start-Up Threshold

Converters will not begin to regulate properly until the rising input voltage exceeds and remains at the Start-Up Threshold Voltage (see Specifications). Once operating, converters will not turn off until the input voltage drops below the Under-Voltage Shutdown Limit. Subsequent restart will not occur until the input voltage rises again above the Start-Up Threshold. This built-in hysteresis prevents any unstable on/off operation at a single input voltage. The over/under-voltage fault level and fault response and hysterisis can be configured via the PMBus interface.

Start-Up Time

Start-Up Time (see Specifications) is the time interval between the point when the rising input voltage crosses the Start-Up Threshold and the output voltage enters and remains within its specified accuracy band.

These converters include a soft start circuit to control Vout ramp time, thereby limiting the input inrush current.

The On/Off Remote Control interval from On command to Vout (final ±5%) assumes that the converter already has its input voltage stabilized above the Start-Up Threshold before the On command. The interval is measured from the On command until the output enters and remains within its specified accuracy band.

Recommended Input Filtering

The user must assure that the input source has low AC impedance to provide dynamic stability and that the input supply has little or no inductive content, including long distributed wiring to a remote power supply. The converter will operate with no additional external capacitance if these conditions are met.

For best performance, we recommend installing a low-ESR capacitor immediately adjacent to the converter's input terminals. The capacitor should be a ceramic type such as the Murata GRM32 series or a polymer type. More input bulk capacitance may be added in parallel (either electrolytic or tantalum) if needed.

Recommended Output Filtering

The converter will achieve its rated output ripple and noise with no additional external capacitor. However, the user may install more external output capacitance to reduce the ripple even further or for improved dynamic response. Again, use low-ESR ceramic (Murata GRM32 series) or polymer capacitors. Mount these close to the converter. Measure the output ripple under your load conditions.

Use only as much capacitance as required to achieve your ripple and noise objectives. Excessive capacitance can make step load recovery sluggish or possibly introduce instability. Do not exceed the maximum rated output capacitance listed in the specifications.

Input Ripple Current and Output Noise

All models in this converter series are tested and specified for input reflected ripple current and output noise using designated external input/output components, circuits and layout as shown in the figures below. The Cbus and Lbus components simulate a typical DC voltage bus.
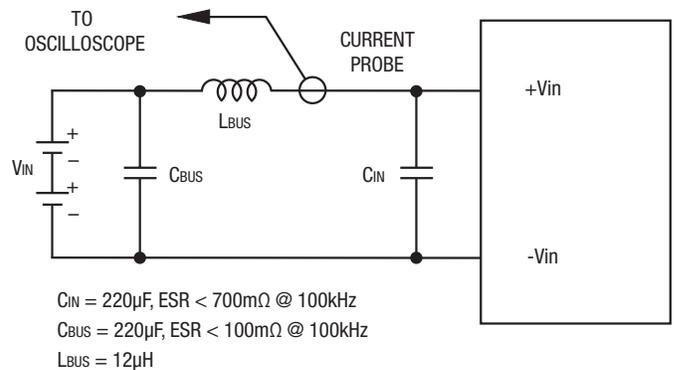

C_{IN} = 220µF, ESR < 700mΩ @ 100kHz
C_{BUS} = 220µF, ESR < 100mΩ @ 100kHz
L_{BUS} = 12µH

Figure 3. Measuring Input Ripple Current

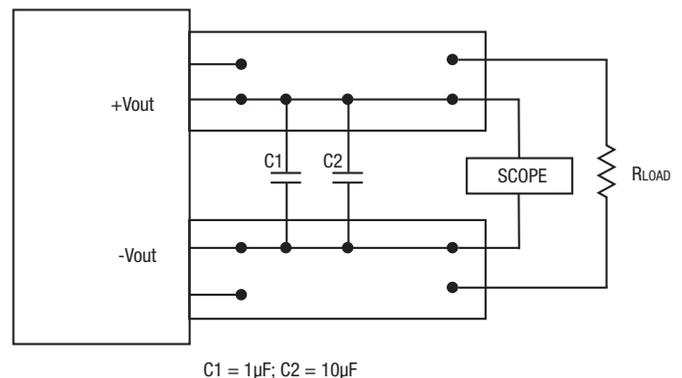C1 = 1µF; C2 = 10µF
LOAD 2-3 INCHES (51-76mm) FROM MODULE
Figure 4. Measuring Output Ripple and Noise (PARD)

Minimum Output Loading Requirements

All models regulate within specification and are stable under no load to full load conditions.

Thermal Shutdown (OTP, UTP)

To prevent many over temperature problems and damage, these converters include thermal shutdown circuitry. If environmental conditions cause the temperature of the DC-DCs to rise above the Operating Temperature Range up to the shutdown temperature, an on-board electronic temperature sensor will power down the unit. When the temperature decreases below the turn-on threshold set in the command recover temp is (OT_FAULT_LIMIT-MFR_OT_ FAULT_HYS), the hysteresis is defined in general electrical specification section. The OTP and hysteresis of the module can be reconfigured using the PMBus. The OTP and UTP fault limit and fault response can be configured via the PMBus.

CAUTION: If you operate too close to the thermal limits, the converter may shut down suddenly without warning. Be sure to thoroughly test your application to avoid unplanned thermal shutdown.

Temperature Derating Curves

The graphs in this data sheet illustrate typical operation under a variety of conditions. The Derating curves show the maximum continuous ambient air temperature and decreasing maximum output current which is acceptable under increasing forced airflow measured in Linear Feet per Minute ("LFM"). Note that these are AVERAGE measurements. The converter will accept brief increases in current or reduced airflow as long as the average is not exceeded.

Note that the temperatures are of the ambient airflow, not the converter itself which is obviously running at higher temperature than the outside air. Also note that "natural convection" is defined as very flow rates which are not using fan-forced airflow. Depending on the application, "natural convection" is usually about 30-65 LFM but is not equal to still air (0 LFM).

Murata Power Solutions makes Characterization measurements in a closed cycle wind tunnel with calibrated airflow. We use both thermocouples and an infrared camera system to observe thermal performance. As a practical matter, it is quite difficult to insert an anemometer to precisely measure airflow in most applications. Sometimes it is possible to estimate the effective airflow if you thoroughly understand the enclosure geometry, entry/exit orifice areas and the fan flowrate specifications.

CAUTION: If you exceed these Derating guidelines, the converter may have an unplanned Over Temperature shut down. Also, these graphs are all collected near Sea Level altitude. Be sure to reduce the derating for higher altitude.

Output Short Circuit Condition

The short circuit condition is an extension of the "Current Limiting" condition. When the monitored peak current signal reaches a certain range, the PWM controller's outputs are shut off thereby turning the converter "off." This is followed by an extended time out period. This period can vary depending on other conditions such as the input voltage level. Following this time out period, the PWM controller will attempt to re-start the converter by initiating a "normal start cycle" which includes softstart. If the "fault condition" persists, another "hiccup" cycle is initiated. This "cycle" can and will continue indefinitely until such time as the "fault condition" is removed, at which time the converter will resume "normal operation." Operating in the "hiccup" mode during a fault condition is advantageous in that average input and output power levels are held low preventing excessive internal increases in temperature.

Remote On/Off Control

The DRQ series modules are equipped with both primary (On/Off 1, enabled, pull up internal) and secondary (On/Off 2, disabled, pull up internal) control pins for increased system flexibility. Both are configurable via PMBus. The On/Off pins are TTL open-collector and/or CMOS open-drain compatible. (See general specifications for threshold voltage levels. See also MFR_PRIMARY_ON_OFF_ CONFIG section.)

Negative-logic models are on (enabled) when the On/Off is grounded or brought to within a low voltage (see specifications) with respect to –Vin. The device is off (disabled) when the On/Off is left open or is pulled high to +13.5Vdc with respect to –Vin. The On/Off function allows the module to be turned on/off by an external device switch.

Positive-logic models are enabled when the On/Off pin is left open or is pulled high to +13.5V with respect to –Vin. Positive-logic devices are disabled when the On/Off is grounded or brought to within a low voltage (see specifications) with respect to –Vin. For voltage levels for On/Off 2 signal see functional specifications.

The restart delay for this module to turn On/Off by the On/Off control pin is 100ms.

On/Off 1 can be configured by PMBus command MFR_PRIMARY_ON_OFF_ CONFIG (DDh); default configuration is not ignored; required On/Off 1 control pin to be asserted to start the unit.

On/Off 2 can be configured by PMBUS command ON_OFF_CONFIG (02h); default configuration is ignored; treat it as always ON.

DRQ's On/Off status is dependent on On/Off 1 control, On/Off 2 control, and OPERATION (PMBus command) status; all three must be ON to turn DRQ on; if one of them is OFF, unit will be turned off.

On/Off 1 or 2 Control status				
	Not ignored		**Ignored**	
On/Off 1 or 2 pin	P LOGIC	N LOGIC	P LOGIC	N LOGIC
OPEN	ON	OFF	ON	ON
PULL HIGH	ON	OFF	ON	ON
PULL LOW	OFF	ON	ON	ON

Output Capacitive Load

These converters do not require external capacitance added to achieve rated specifications. Users should only consider adding capacitance to reduce switching noise and/or to handle spike current load steps. Install only enough capacitance to achieve noise objectives. Excess external capacitance may cause degraded transient response and possible oscillation or instability.

Remote Sense Input

Use the Sense inputs with caution. Sense is normally connected **at the load**. Sense inputs compensate for output voltage inaccuracy delivered at the load. This is done by correcting IR voltage drops along the output wiring and the current carrying capacity of PC board etch. This output drop (the difference between Sense and Vout when measured at the converter) should not exceed 0.5V. Consider using heavier wire if this drop is excessive. Sense inputs also improve the stability of the converter and load system by optimizing the control loop phase margin.

Note: The Sense input and power Vout lines are internally connected through low value resistors to their respective polarities so that the converter can operate without external connection to the Sense. Nevertheless, if the Sense function is not used for remote regulation, the user should connect +Sense to +Vout and –Sense to –Vout at the converter pins.

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The remote Sense lines carry very little current. They are also capacitively coupled to the output lines and therefore are in the feedback control loop to regulate and stabilize the output. As such, they are not low impedance inputs and must be treated with care in PC board layouts. Sense lines on the PCB should run adjacent to DC signals, preferably Ground. In cables and discrete wiring, use twisted pair, shielded tubing or similar techniques.

Any long, distributed wiring and/or significant inductance introduced into the Sense control loop can adversely affect overall system stability. If in doubt, test your applications by observing the converter's output transient response during step loads. There should not be any appreciable ringing or oscillation. You may also adjust the output trim slightly to compensate for voltage loss in any external filter elements. Do not exceed maximum power ratings.

Please observe Sense inputs tolerance to avoid improper operation:

[Vout(+) −Vout(-)] − [Sense(+) −Sense(-)] ≤ 10% of Vout

Output overvoltage protection is monitored at the output voltage pin, not the Sense pin. Therefore excessive voltage differences between Vout and Sense together with trim adjustment of the output can cause the overvoltage protection circuit to activate and shut down the output.

Power derating of the converter is based on the combination of maximum output current and the highest output voltage. Therefore the designer must ensure:

(Vout at pins) x (Iout) ≤ (Max. rated output power)

Figure 5. Remote Sense Circuit Configuration

Soldering Guidelines

Murata Power Solutions recommends the specifications below when installing these converters. These specifications vary depending on the solder type. Exceeding these specifications may cause damage to the product. Be cautious when there is high atmospheric humidity. We strongly recommend a mild pre-bake (100° C. for 30 minutes). Your production environment may differ; therefore please thoroughly review these guidelines with your process engineers.

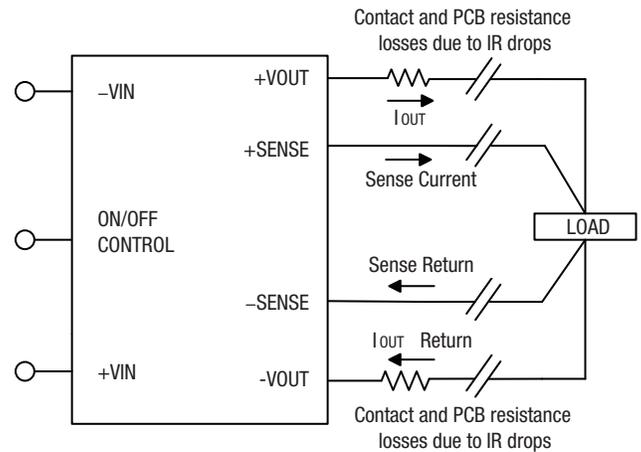| Wave Solder Operations for through-hole mounted products (THMT)	
For Sn/Ag/Cu based solders:	
Maximum Preheat Temperature	115° C.
Maximum Pot Temperature	270° C.
Maximum Solder Dwell Time	7 seconds
For Sn/Pb based solders:	
Maximum Preheat Temperature	105° C.
Maximum Pot Temperature	250° C.
Maximum Solder Dwell Time	6 seconds

Emissions Performance

Murata Power Solutions measures its products for conducted emissions against the EN 55022 and CISPR 22 standards. Passive resistance loads are employed and the output is set to the maximum voltage. If you set up your own emissions testing, make sure the output load is rated at continuous power while doing the tests.

The recommended external input and output capacitors (if required) are included. Please refer to the fundamental switching frequency. All of this information is listed in the Product Specifications. An external discrete filter is installed and the circuit diagram is shown below.
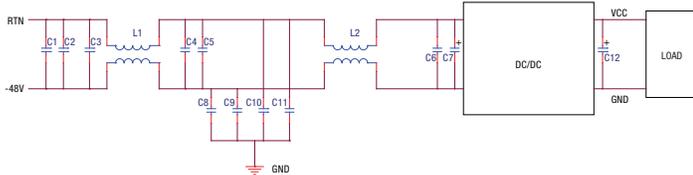

Figure 6. Conducted Emissions Test Circuit

[1] Conducted Emissions Parts List

| Reference	Part Number	Description	Vendor
C1, C2, C3, C4, C5	GRM32ER72A105KA01L	SMD CERAMIC-100V-1000nF-X7R-1210	Murata
C6	GRM319R72A104KA01D	SMD CERAMIC100V-100nF-±10%-X7R-1206	Murata
L1, L2	PG0060T	COMMON MODE-473uH-±25%-14A	Pulse
C8, C9, C10, C11	GRM55DR72J224KW01L	SMD CERAMIC630V-0.22uF-±10%-X7R-2220	Murata
C7	UHE2A221MHD	Aluminum100V-220Uf-±10%-long lead	Nichicon
C12	NA		

[2] Conducted Emissions Test Equipment Used

Hewlett Packard HP8594L Spectrum Analyzer – S/N 3827A00153
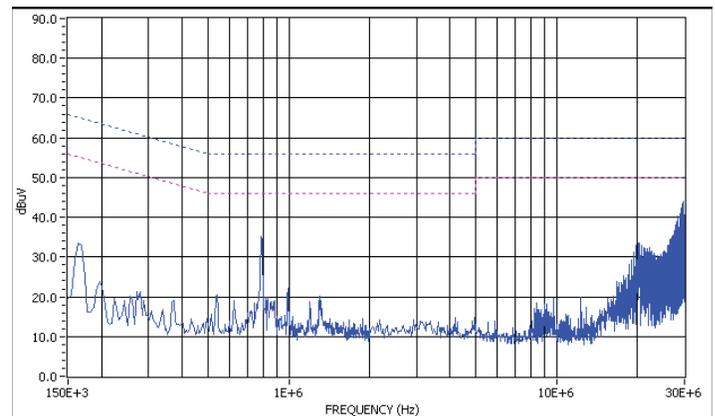2Line V-networks LS1-15V 50Ω/50Uh Line Impedance Stabilization Network
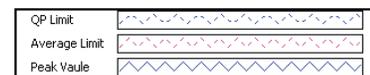
[3] Conducted Emissions Test Results
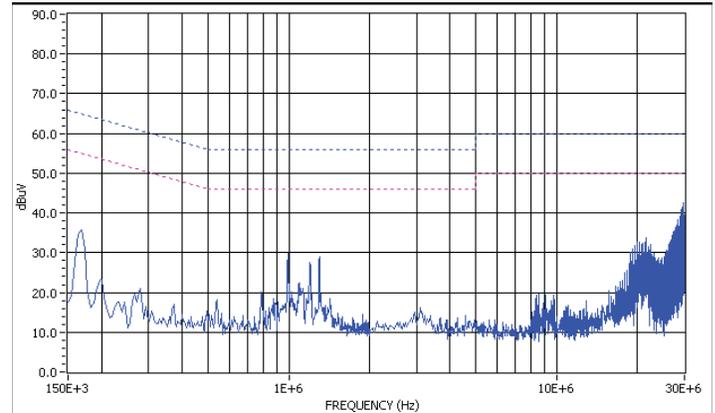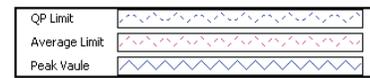
Graph 1. Conducted emissions performance, Positive Line, CISPR 22, Class B, full load

Graph 2. Conducted emissions performance, Negative Line, CISPR 22, Class B, full load

[4] Layout Recommendations

Most applications can use the filtering which is already installed inside the converter or with the addition of the recommended external capacitors. For greater emissions suppression, consider additional filter components and/or shielding. Emissions performance will depend on the user's PC board layout, the chassis shielding environment and choice of external components. Please refer to Application Note GEAN-02 for further discussion.

Since many factors affect both the amplitude and spectra of emissions, we recommend using an engineer who is experienced at emissions suppression.
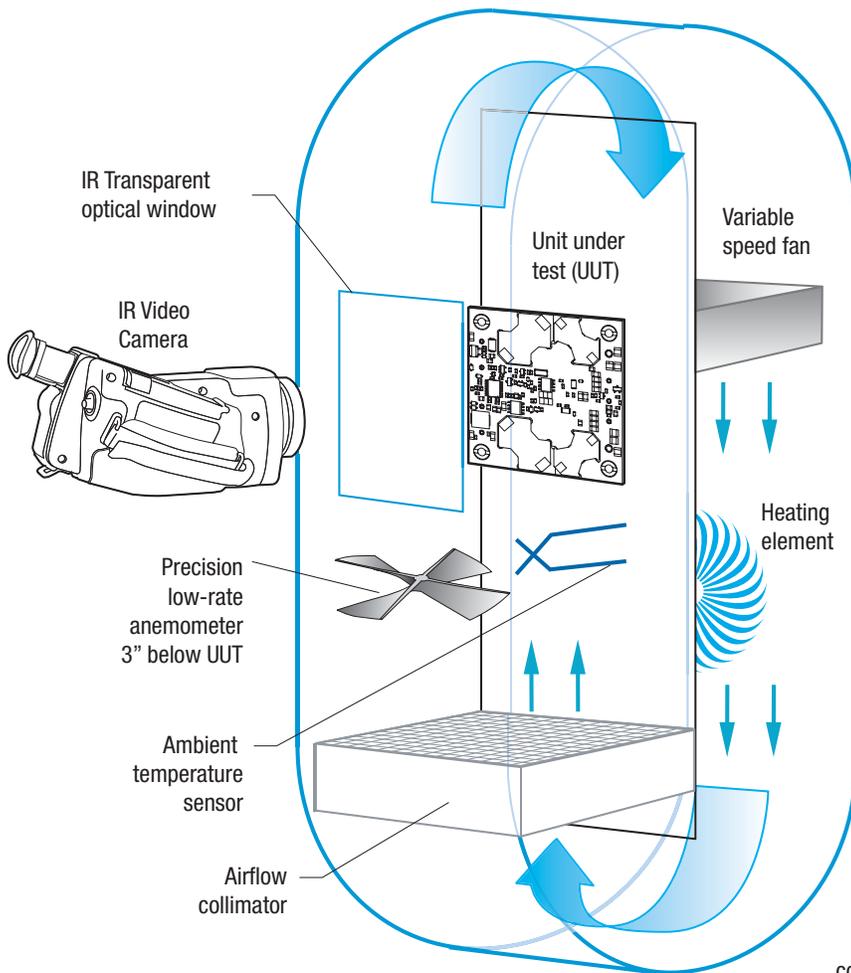
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Vertical Wind Tunnel

Murata Power Solutions employs a computer controlled custom-designed closed loop vertical wind tunnel, infrared video camera system, and test instrumentation for accurate airflow and heat dissipation analysis of power products. The system includes a precision low flow-rate anemometer, variable speed fan, power supply input and load controls, temperature gauges, and adjustable heating element.

The IR camera monitors the thermal performance of the Unit Under Test (UUT) under static steady-state conditions. A special optical port is used which is transparent to infrared wavelengths.

Both through-hole and surface mount converters are soldered down to a 10" x 10" host carrier board for realistic heat absorption and spreading. Both longitudinal and transverse airflow studies are possible by rotation of this carrier board since there are often significant differences in the heat dissipation in the two airflow directions. The combination of adjustable airflow, adjustable ambient heat, and adjustable Input/Output currents and voltages mean that a very wide range of measurement conditions can be studied.

The collimator reduces the amount of turbulence adjacent to the UUT by minimizing airflow turbulence. Such turbulence influences the effective heat transfer characteristics and gives false readings. Excess turbulence removes more heat from some surfaces and less heat from others, possibly causing uneven overheating.

Both sides of the UUT are studied since there are different thermal gradients on each side. The adjustable heating element and fan, built-in temperature gauges, and no-contact IR camera mean that power supplies are tested in real-world conditions.

IR Transparent optical window

IR Video Camera

Unit under test (UUT)

Variable speed fan

Precision low-rate anemometer 3" below UUT

Heating element

Ambient temperature sensor

Airflow collimator

Figure 7. Vertical Wind Tunnel

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