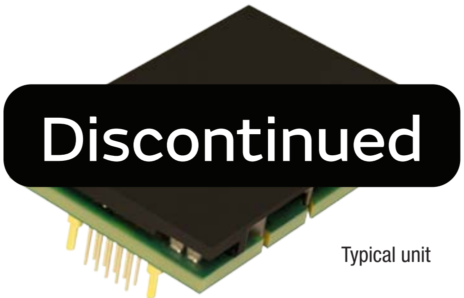
Murata Power Solutions

UDQ Series

420W Fully Regulated, Digitally Controlled, Advanced Bus Converter (ABC)



Typical unit

Output (V)	Current (A)	Input (Vdc)
9	39	36-60
12	35	36-75

FEATURES

- Industry standard five pin Quarter-brick
- Optional digital PMBus interface
- High Efficiency
- Fast dynamic response
- ±1% Vout accuracy
- 2250Vdc input to output isolation voltage (Functional)
- Optional baseplate
- PMBus Rev 1.2 compliant
- Certified to UL/EN/IEC 60950-1, CAN/CSA-C22.2 No. 60950-1, 2nd Edition, safety approvals and EN55022/CISPR22 standards

PRODUCT OVERVIEW

Murata Power Solutions is introducing the first in a series of digitally controlled DC-DC converters that are based on a 32-bit ARM processor. The UDQ series provides a fully regulated, digitally controlled DC output in a ¼-brick format that will support the Advanced Bus Converter (ABC) industry standard footprint for isolated board mounted power modules. The UDQ series supports advances in power conversion technology including a digital interface supporting the PMBus protocol for communications to power modules.

The UDQ is an isolated, regulated, 420W-12Vout quarter brick that supports the TNV input voltage range of 36V–75V with a typical efficiency of 95.5%. The converter also offers high input to output isolation up to 2250 VDC as required for Power over Ethernet (PoE) applications.

The UDQ series is suitable for applications covering MicroTCA, servers and storage applications, networking equipment, telecommunications equipment, Power over Ethernet (PoE), fan trays, wireless networks, wireless pre-amplifiers, and industrial and test equipment, along with other applications requiring a regulated 12V.

Power Management (PMBus Option)

- Configurable soft-start/stop
- Precision delay and ramp-up
- Voltage sequencing and margining
- Voltage/Current/temp monitoring
- Configurable output voltage
- Power good

Applications

- Distributed power architectures
- Intermediate bus voltage applications
- Servers and storage applications
- Network equipment

For full details go to www.murata-ps.com/rohs

ORDERING GUIDE				
Root Model	Input (Volts)	Output (Volts)	Current (Amps)	Power (Watts)
UDQ2100/100	36-60	9	39	351
UDQ2204/001	36-75	12	35	420

The UDQ2100/100 is assembled with components and materials designed to withstand lead-free thermal paste-in-hole process (PIH). Dry pack packaging is also included as shown on page 17.

PART NUMBER EXPLANATION: UDQ0004/001 (UDQn1n2n3n4/n5n6n7)

U = Unipolar

DQ = Digital Quarter brick

PRODUCT NUMBER								
UDQ	n1	n2	n3	n4	/	n5	n6	n7
Mechanical Pin Option	X				/			
Mechanical option		x			/			
Hardware Option			x	x	/			
Configuration file					/	x	x	x

Option Designation	Description
n1	0 = Standard Pin Length 5.33mm (0.210")
	1 = Surfact mount option
	2 = Lead length 3.69mm / Cut (0.145")
	3 = Lead Length 4.57mm / Cut (0.180")
	4 = Lead Length 2.79mm / Cut (0.110")
n2	0 = Open frame
	1 = Baseplate
	2 = Baseplate with GND-pin
n3 n4	00 = 36-60 Vin, 4-9.9 Vout adjusted, with digital interface
	04 = 36-75 Vin, 4-13.2 Vout adjusted, with digital interface
n5 n6 n7	001 = 12 V Standard configuration for 36-75 Vin, n3n4 = 04
	100 = 9V standard configuration for 36-60 Vin, high capacitive load
	xxx = Application Specific Configuration

FUNCTIONAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS	Conditions ②	Minimum	Typical/Nominal	Maximum	Units
Input Voltage, Continuous	Full power operation			80, 65 ①	Vdc
Input Voltage, Transient	Operating or non-operating, 100 mS max. duration			100, 80 ①	Vdc
Isolation Voltage	Input to output, with and without baseplate			2250	Vdc
Input Reverse Polarity	None, install external fuse		None		Vdc
On/Off Remote Control	Power on or off, referred to -Vin	-0.3		18	Vdc
Storage Temperature Range	Vin = Zero (no power)	-55		125	°C
Operating Temperature	See derating curves	-40		85	°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.					
DIGITAL INTERFACE SPECIFICATIONS (PMBus MONITORING)					
Logic Input/Output specs.					
Logic Input low (VIL)	CTRL, SAO, SA1, PG, SCL, SDA			1.1	V
Logic input high (VIH)	CTRL, SAO, SA1, PG, SCL, SDA	2.1			V
Logic output low (VOL)	CTRL, PG, SALERT, SCL, SDA, IoL = 6mA			0.25	V
Logic output high (VOH)	CTRL, PG, SALERT, SCL, SDA, IoH = -6mA	2.7			V
Bus free time T (BUF)	③	1.3			µS
PMBus monitoring accuracy					
VIN_READ	Input Voltage	-2	±0.2	2	%
VOUT_READ	Output Voltage	-1	±0.1	1	%
IOUT_READ	Output Current (50-100% of max Io)	-6	±0.15	6	%
IOUT_READ	Output Current (10% of max Io)	-0.6		0.6	A
TEMP_READ	Temperature	-5	±3.5	5	°C
Fault Protection Specifications					
Input Under Voltage Lockout, UVLV	Factory default		33		V
	Setpoint accuracy	-2		2	%
	Hysteresis (factory default)		2		V
	Hysteresis (Configurable via PMBus of theshold range) ②	0			V
	Delay		300		µS
(Output Voltage) Over/Under Voltage protection, OVP/UVP	VOUT_UV_FAULT_LIMIT (factory default)		0		V
	VOUT_UV_FAULT_LIMIT (Configurable via PMBus,) ②	0		16	V
	VOUT_OV_FAULT_LIMIT (factory default)		15.6		V
	VOUT_OV_FAULT_LIMIT (Configurable via PMBus) ②	Vout		16	V
	Fault response time		200		µS
Over Current Protection, OCP	Setpoint accuracy (Io)	-6		6	%
	IOUT_OC_FAULT_LIMIT (factory default)		41		A
	IOUT_OC_FAULT_LIMIT (Configurable via PMBus) ②	0		100	A
	Fault response time		200		µS
Over Temperature Protection, OTP	OTP_FAULT_LIMIT (factory default)		125		°C
	OTP_FAULT_LIMIT (Configurable via PMBus) ②	-50		125	°C
	OTP hysteresis (factory default)		10		°C
	OTP hysteresis (Configurable via PMBus) ②	0		125	°C
	Fault response time		300		µS

Notes

① For UDQ2100/100 model.
② Typical at TA = +25°C under nominal line voltage and full-load conditions. All models are specified with an external 330µF external input capacitor and 3.5mF || 10µF || 1µF capacitors across their output pins.
③ PMBus timing parameters according to PMBus spec.

FUNCTIONAL SPECIFICATIONS, UDQ2100/100 (9VOUT, 39A, 351W)

INPUT	Conditions ③	Minimum	Typical/Nominal	Maximum	Units
Operating voltage range		36	48	60	Vdc
Recommended External Fuse	Fast blow			20	A
Start-up threshold	Rising input voltage	34	35	36	Vdc
Undervoltage shutdown	Falling input voltage	32	33	34	Vdc
Turn-On/Turn-Off Hysteresis		1	2		Vdc
Input current					
Full Load Conditions	Vin = nominal		7.738	7.89	A
Low Line input current	Vin = minimum		10.484	10.692	A
Inrush Transient	Vin = 48V.		0.015		A2-Sec.
Short Circuit input current			0.05	0.1	A
No Load input current	Iout = minimum, unit=ON		50	150	mA
Shut-Down input currrent(Off, UV, OT)			20	50	mA
Pre-biased startup	External output voltage < Vset		Monotonic		
DYNAMIC CHARACTERISTICS					
Fixed Switching Frequency		133	140	147	KHz
Startup Time	From Vin connection to 90% Vo 10-100% of max Io		24	30	mS
Ramp-up time	From 10-90% of Vo (10-100% of max Io		12	15	mS
Dynamic Load Response	50-75-50% load step to 1% error band		50	100	µSec
Dynamic Load Peak Deviation	same as above		±200		mV
GENERAL and SAFETY					
Efficiency	Vin=48V, half load	94.9	95.9		%
	Vin=48V, full load	93.5	94.5		%
Isolation					
Isolation Voltage	Input to output, with and without baseplate		1500		Vdc
Isolation Voltage, input to baseplate	With baseplate		750		Vdc
Isolation Voltage, output to baseplate	With baseplate		750		Vdc
Insulation Safety Rating			functional		
Isolation Resistance			100		MΩ
Isolation Capacitance			2200		pF
Safety	Certified to UL-60950-1, CSA-C22.2 No.60950-1, IEC/EN60950-1, 2nd edition		Yes		
Calculated MTBF	Per Telcordia SR-332, issue 1, class 3, ground fixed, Tcase=+25°C		TBD		Hours x 10^3

FUNCTIONAL SPECIFICATIONS, UDQ2100/100 (9VOUT, 39A, 351W) (CONT.)

OUTPUT	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Total Output Power		0	351	354.12	W
Voltage					
Setting Accuracy	At 100% load, no trim	8.92	9	9.08	Vdc
Over-Voltage Protection	Magnetic Feedback		11.7	11.8	Vdc
Output Voltage Range	User-adjustable (see operating information)	4		9.9	Vdc
Current					
Output Current Range		0	39	39	A
Minimum Load			No minimum load		
Current Limit Inception	90% of Vnom., after warmup	41	44	47	A
Short Circuit					
Short Circuit Current	Hiccup technique, autorecovery within 1% of Vout		2	3	A
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Continuous		
Short circuit protection method	Hiccup current limiting		Non-latching		
Regulation					
Line Regulation	Vin=min. to max., Vout=nom., full load			±0.133	%
Load Regulation	Iout=min. to max., Vin=nom.			±0.128	%
Ripple and Noise	5 Hz-20 MHz BW, Cout=1μF MLCC paralleled with 10μF		50	110	mV pk-pk
Temperature Coefficient	At all outputs		0.02		% of Vnom./°C
Maximum Output Capacitance		2.2	3.9	6	mF
ENVIRONMENTAL					
Operating Ambient Temperature Range	With derating	-40		85	°C
Storage Temperature	Vin = Zero (no power)	-55		125	°C
Thermal Protection/Shutdown	Measured at hotspot	122	125	128	°C
Electromagnetic Interference	External filter is required				
Conducted, EN55022/CISPR22	External filter necessary		B		Class
RoHS rating			RoHS-6		

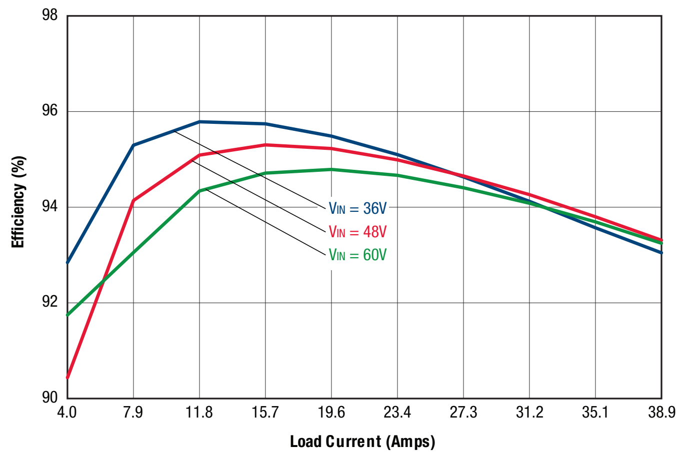
Notes

① Typical at TA = +25°C under nominal line voltage and full-load conditions. All models are specified with an external 300μF external input capacitor and 3.5mF || 10μF || 1μF capacitors across their output pins.

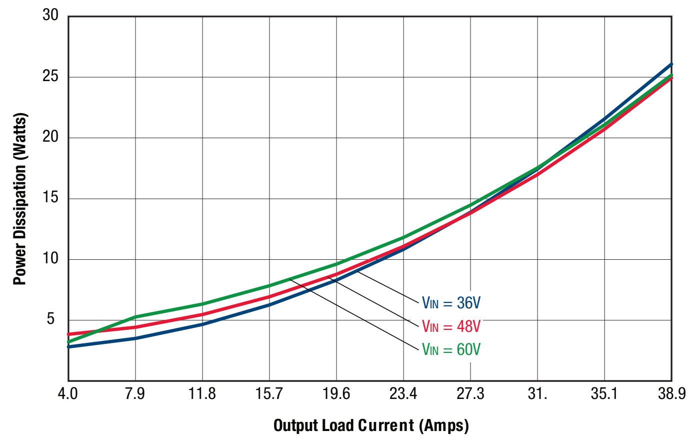
② PMBus timing parameters according to PMBus spec.

PERFORMANCE DATA, UDQ2100/100

Efficiency vs. Line Voltage and Load Current @ +25°C

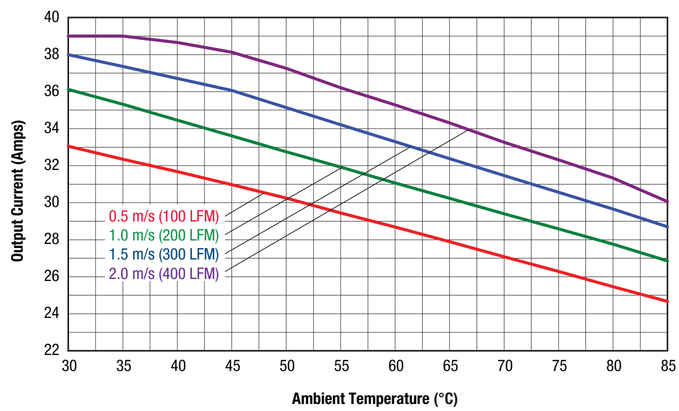


Power Dissipation vs. Load Current @ +25°C



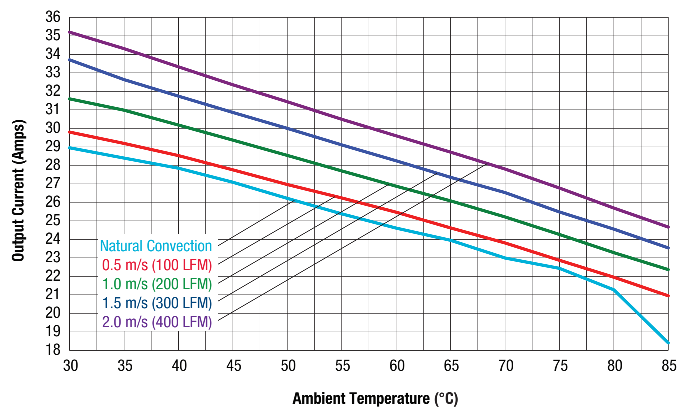
With Baseplate

Maximum Current Temperature Derating at sea level
Vin = 36V (air flow from Pin 1 to Pin 4 on PCB)

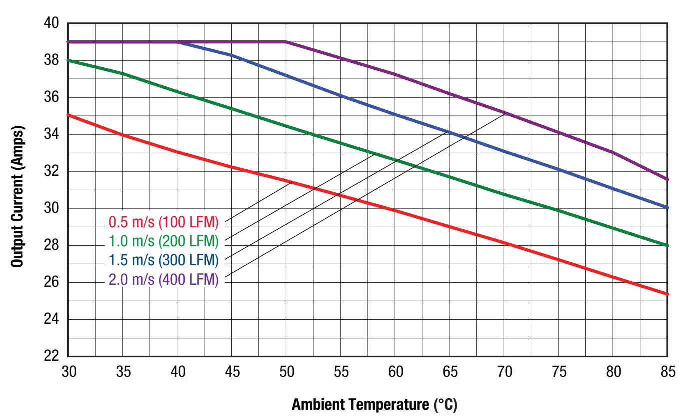


Without Baseplate

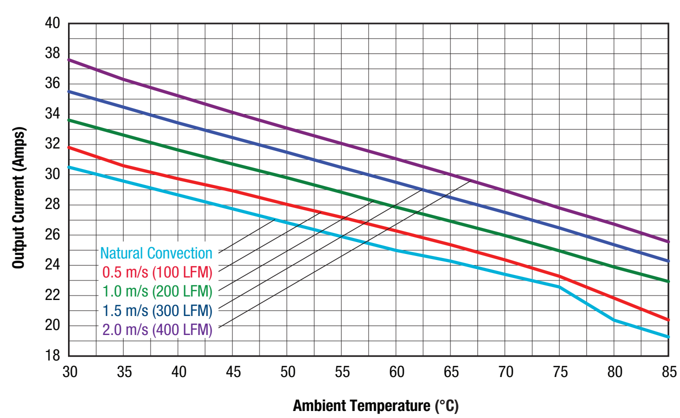
Maximum Current Temperature Derating at sea level
Vin = 36V (air flow from Pin 1 to Pin 4 on PCB)



Maximum Current Temperature Derating at sea level
Vin = 48V (air flow from Pin 1 to Pin 4 on PCB)



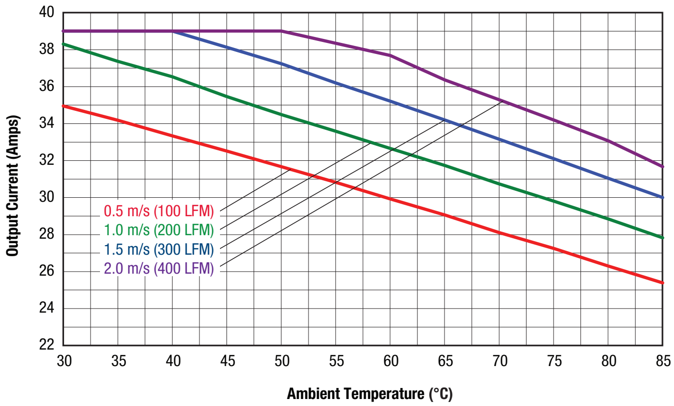
Maximum Current Temperature Derating at sea level
Vin = 48V (air flow from Pin 1 to Pin 4 on PCB)



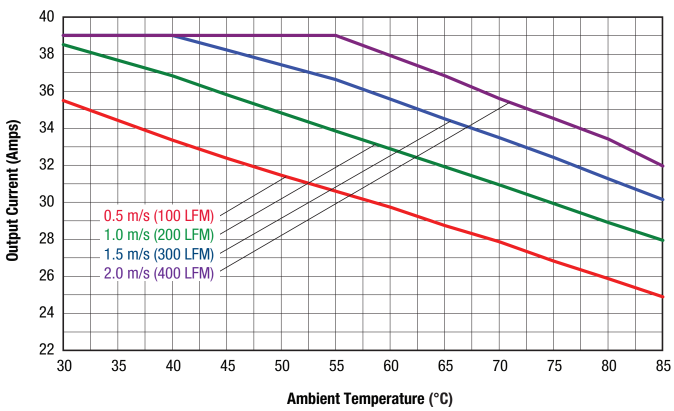
PERFORMANCE DATA, UDQ2100/100

With Baseplate

Maximum Current Temperature Derating at sea level
Vin = 53V (air flow from Pin 1 to Pin 4 on PCB)

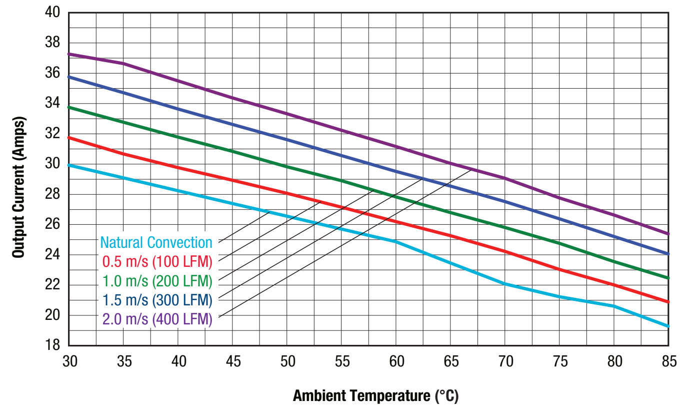


Maximum Current Temperature Derating at sea level
Vin = 60V (air flow from Pin 1 to Pin 4 on PCB)

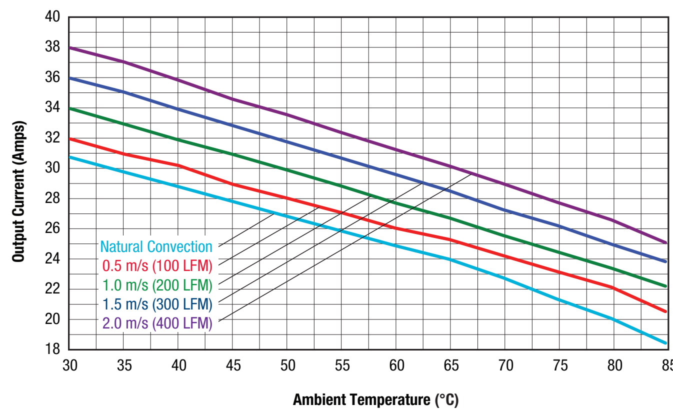


Without Baseplate

Maximum Current Temperature Derating at sea level
Vin = 53V (air flow from Pin 1 to Pin 4 on PCB)

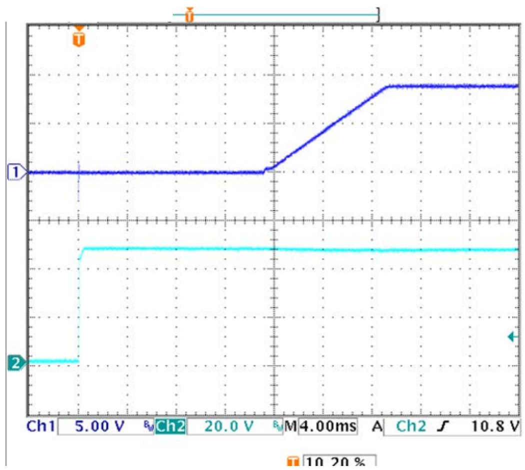


Maximum Current Temperature Derating at sea level
Vin = 60V (air flow from Pin 1 to Pin 4 on PCB)

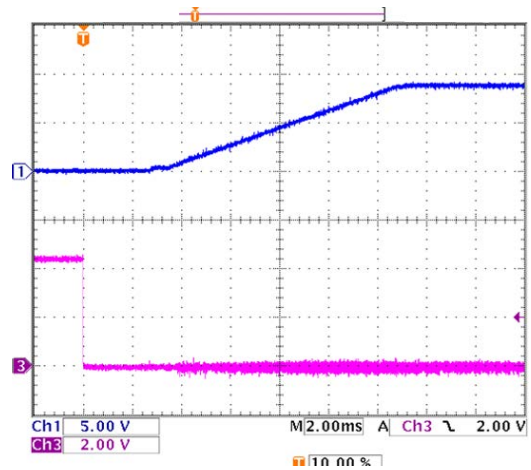


PERFORMANCE DATA, UDQ2100/100

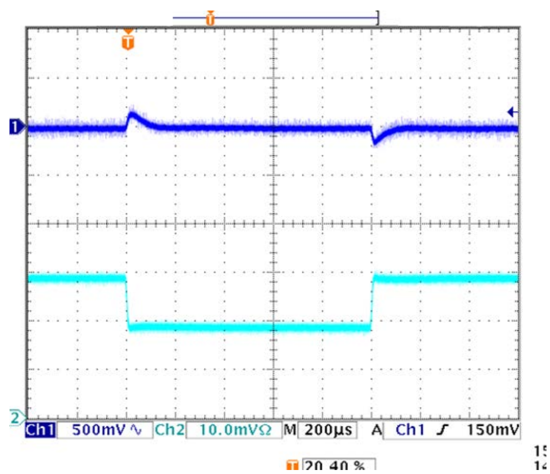
Start-up Delay (Vin = 48V, Vout = nom, Io = 39A, Cload = 6000μf, Ta = +25°C)
Ch1 = Vout, Ch2 = Vin



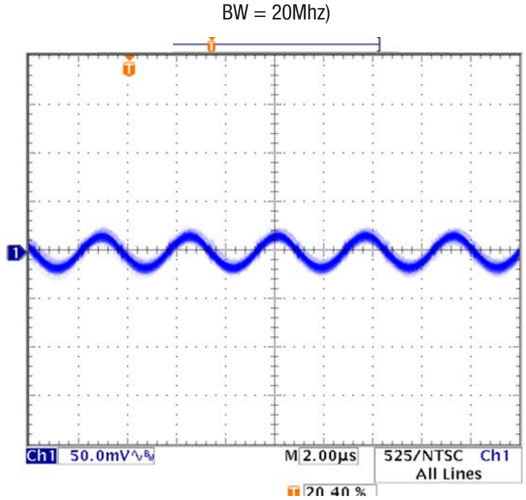
Enable Start-up Delay (Vin = 48V, Vout = nom, Io = 39A, Cload = 6000μf, Ta = +25°C)
Ch1 = Vout, Ch2 = Enable.



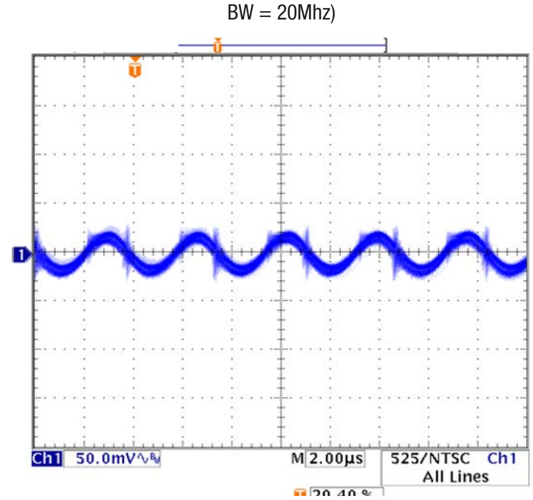
Step load Transient Response (Vin = 48V, Iout = 50-75-50% of Imax, Cload = 6000μf)
Ch1 = Vout, Ch2 = Iout



Output Ripple & Noise (Vin = 48V, Iout = 0A, Cload = 2200μf, Ta = 25°C,
BW = 20Mhz)



Output Ripple & Noise (Vin = 48V, Iout = 39A, Cload = 2200μf, Ta = 25°C,
BW = 20Mhz)



FUNCTIONAL SPECIFICATIONS, UDQ2204/001 (12VOUT, 35A, 420W)

INPUT	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Operating voltage range		36	48	75	Vdc
Recommended External Fuse	Fast blow			20	A
Start-up threshold	Rising input voltage	34	35	36	Vdc
Undervoltage shutdown	Falling input voltage	32	33	34	Vdc
Turn-On/Turn-Off Hysteresis		1	2		Vdc
Input current					
Full Load Conditions	Vin = nominal		9.162	9.259	A
Low Line input current	Vin = minimum		12.281	12.411	A
Inrush Transient	Vin = 48V.		0.015		A2-Sec.
Short Circuit input current			0.05	0.1	A
No Load input current	Iout = minimum, unit=ON		69	150	mA
Shut-Down input currrent(Off, UV, OT)			8.3	15	mA
Pre-biased startup	External output voltage < Vset		Monotonic		
Back Ripple Current			80	100	mA
DYNAMIC CHARACTERISTICS					
Fixed Switching Frequency		133	140	147	KHz
Startup Delay	Vin On to 90% Vout regulated		24	30	mS
Ramp-up time	Remote On to 90% Vout regulated		12	15	mS
Dynamic Load Response	50-75-50% load step to 1% of Vout		200	250	µSec
Dynamic Load Peak Deviation	same as above		±200		mV
GENERAL and SAFETY					
Efficiency	Vin=48V, half load	95.4	96.4		%
	Vin=48V, full load	94.5	95.5		%
Isolation					
Isolation Voltage	Input to output, with and without baseplate		1500		Vdc
Isolation Voltage, input to baseplate	With baseplate		750		Vdc
Isolation Voltage, output to baseplate	With baseplate		750		Vdc
Isolation Resistance			100		MΩ
Isolation Capacitance			2200		pF
Safety	Certified to UL-60950-1, CSA-C22.2 No.60950-1, IEC/EN60950-1, 2nd edition		Yes		
Calculated MTBF	Per Telcordia SR-332, issue 1, class 3, ground fixed, Tcase=+25°C		TBD		Hours x 10^3

FUNCTIONAL SPECIFICATIONS, UDQ2204/001 (12VOUT, 35A, 420W) (CONT.)

OUTPUT	Conditions ①	Minimum	Typical/Nominal	Maximum	Units
Total Output Power		0	420	424.4	W
Voltage					
Setting Accuracy	At 100% load, no trim	11.88	12	12.12	Vdc
Output Voltage tolerance band	0-100% of max Io.	11.76		12.24	
Over-Voltage Protection	Magnetic Feedback		15.6	15.7	Vdc
Output Voltage Range	User-adjustable (see operating information)	4	12	13.2	Vdc
Current					
Output Current Range		0	35	35	A
Minimum Load			No minimum load		
Current Limit Inception	90% of Vnom., after warmup	37	41	44	A
Short Circuit					
Short Circuit Current	Hiccup technique, autorecovery within 1% of Vout		0.2	0.3	A
Short Circuit Duration (remove short for recovery)	Output shorted to ground, no damage		Continuous		
Short circuit protection method	Hiccup current limiting		Non-latching		
Regulation					
Line Regulation	Vin=min. to max., Vout=nom., full load			±0.23	%
Load Regulation	Iout=min. to max., Vin=nom.			±0.166	%
Ripple and Noise	5 Hz-20 MHz BW, Cout=1µF MLCC paralleled with 10µF		60	150	mV pk-pk
Temperature Coefficient	At all outputs		0.02		% of Vnom./°C
Recommended Capacitive Load	Full resistive load, low ESR	0.1	3.5	6	mF
ENVIRONMENTAL					
Operating Ambient Temperature Range	With derating	-40		85	°C
Storage Temperature	Vin = Zero (no power)	-55		125	°C
Thermal Protection/Shutdown	Measured at hotspot	122	125	128	°C
Electromagnetic Interference	External filter is required				
Conducted, EN55022/CISPR22	External filter necessary		B		Class
RoHS rating			RoHS-6		

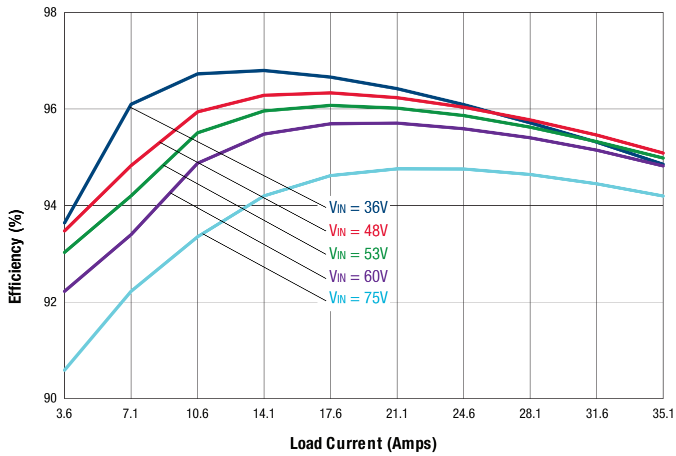
Notes

① Typical at TA = +25°C under nominal line voltage and full-load conditions. All models are specified with an external 330µF external input capacitor and 3.5mF || 10µF || 1µF capacitors across their output pins.

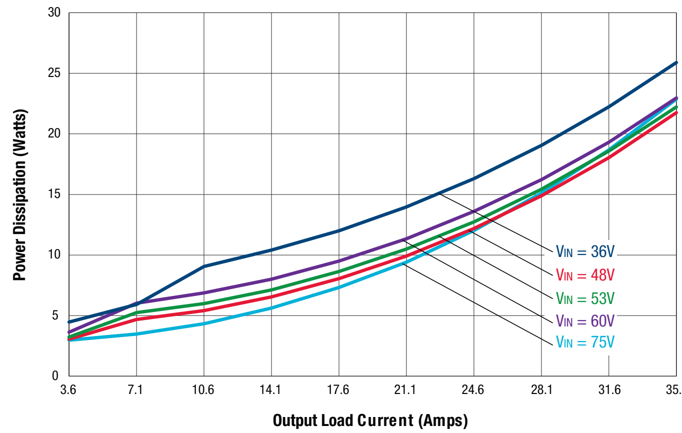
② PMBus timing parameters according to PMBus spec.

PERFORMANCE DATA, UDQ2204/001

Efficiency vs. Line Voltage and Load Current @ +25°C

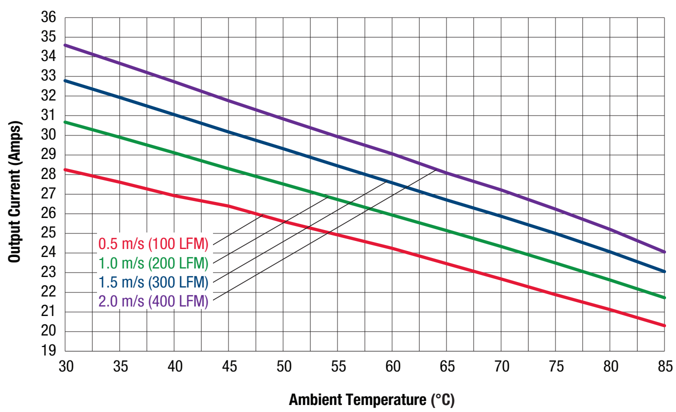


Power Dissipation vs. Load Current @ +25°C

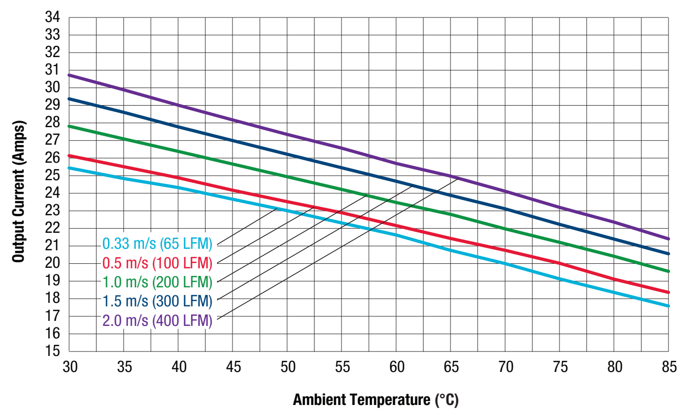


With Baseplate	Without Baseplate

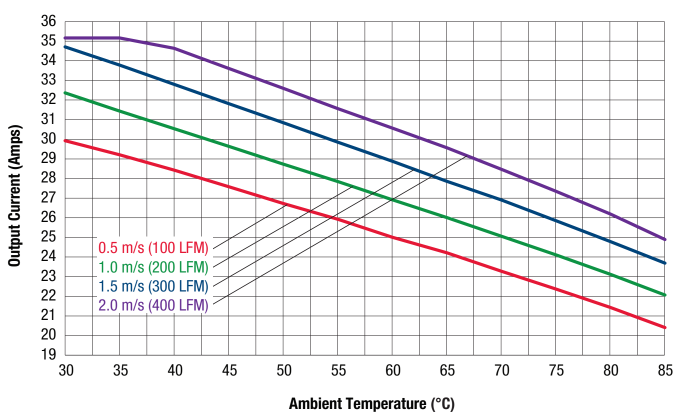
Maximum Current Temperature Derating at sea level
Vin = 36V (air flow from Pin 1 to Pin 4 on PCB)



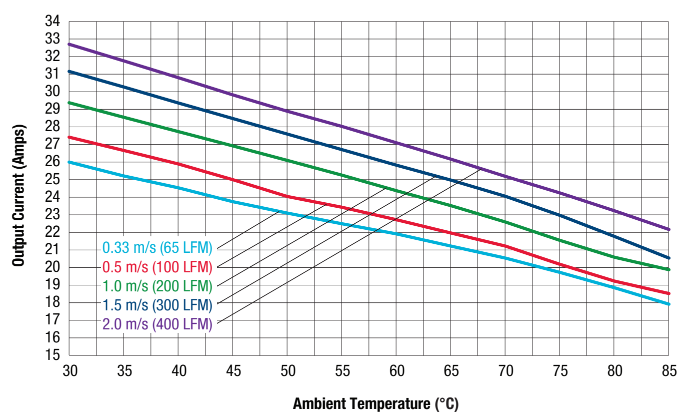
Maximum Current Temperature Derating at sea level
Vin = 36V (air flow from Pin 1 to Pin 4 on PCB)



Maximum Current Temperature Derating at sea level
Vin = 48V (air flow from Pin 1 to Pin 4 on PCB)



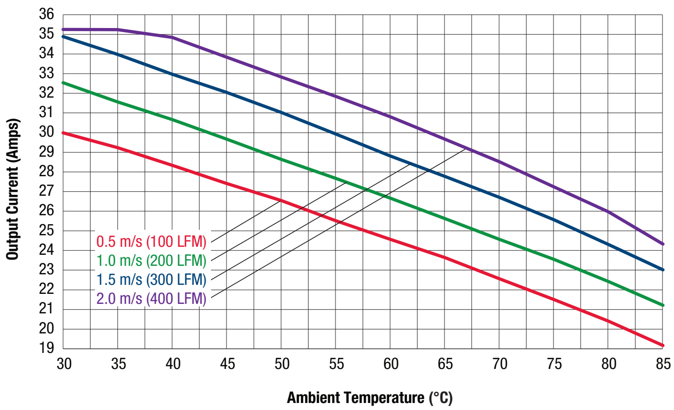
Maximum Current Temperature Derating at sea level
Vin = 48V (air flow from Pin 1 to Pin 4 on PCB)



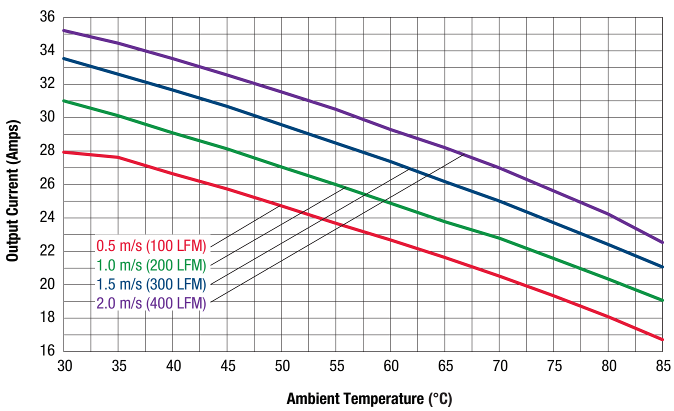
PERFORMANCE DATA, UDQ2204/001

With Baseplate

Maximum Current Temperature Derating at sea level
Vin = 60V (air flow from Pin 1 to Pin 4 on PCB)

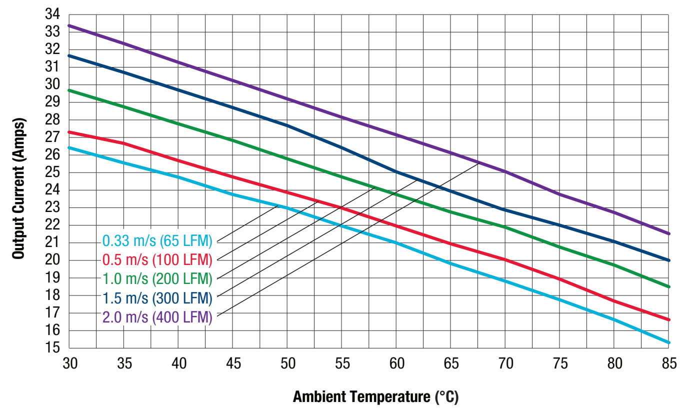


Maximum Current Temperature Derating at sea level
Vin = 75V (air flow from Pin 1 to Pin 4 on PCB)

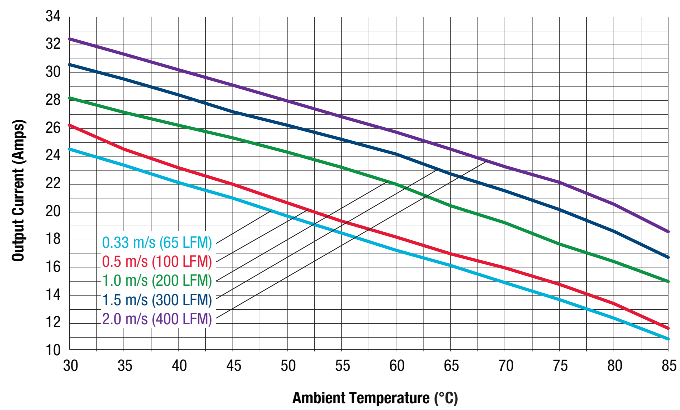


Without Baseplate

Maximum Current Temperature Derating at sea level
Vin = 60V (air flow from Pin 1 to Pin 4 on PCB)

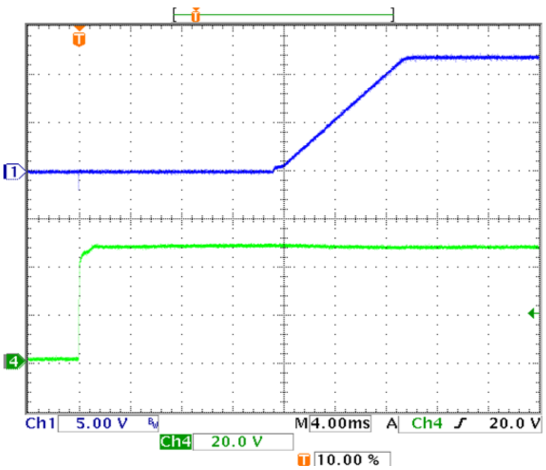


Maximum Current Temperature Derating at sea level
Vin = 75V (air flow from Pin 1 to Pin 4 on PCB)

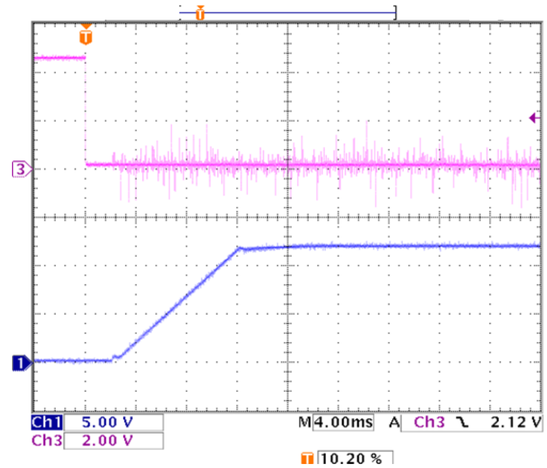


PERFORMANCE DATA, UDQ2204/001

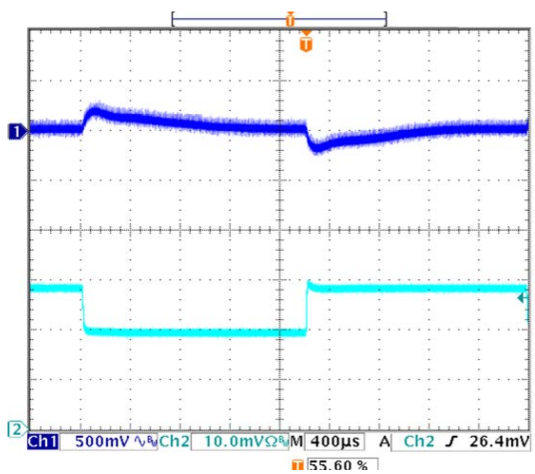
Start-up Delay (Vin=48V, Iout=35A, Co=6000uF, Ta=+25°C) Ch1=Vout, Ch4=Vin.



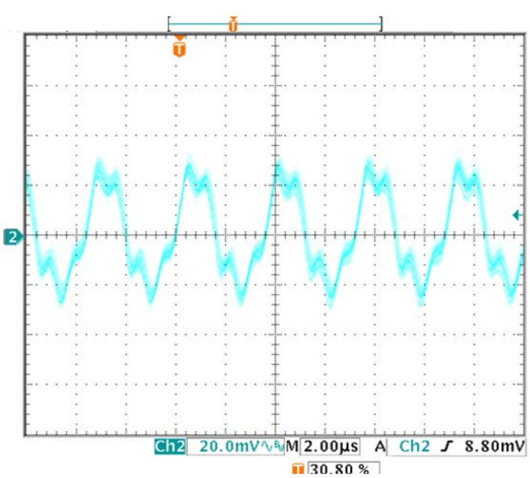
On/Off Enable Start-up. (Vin=48V, Iout=35A, Co=6000uF, Ta=+25°C) Ch1=Vout, Ch3=Enable



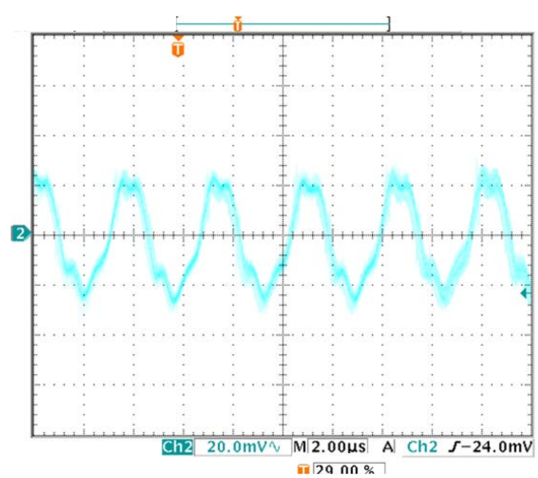
Step Load Transient Response (Vin=48v, Iout=50-75-50% of Imax, Cload=3.5mf)
Ch1=Vout, Ch2=Iout



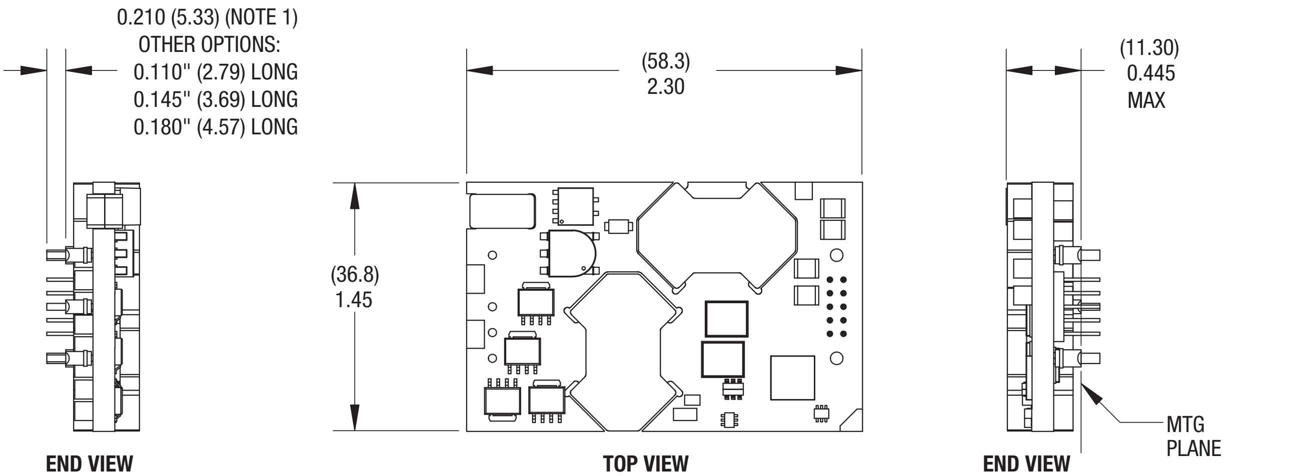
Output Ripple & Noise(Vin=48V, Iout=0A, Cload=100uF, Ta=+25°C, BW=20Mhz)

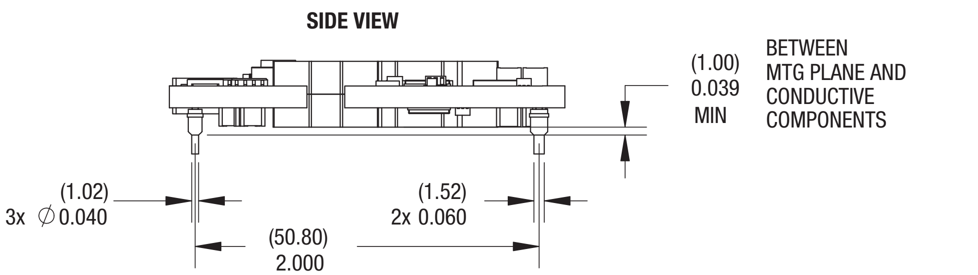


Output Ripple & Noise(Vin=48V, Iout=35A, Cload=100uF, Ta=+25°C, BW=20Mhz)



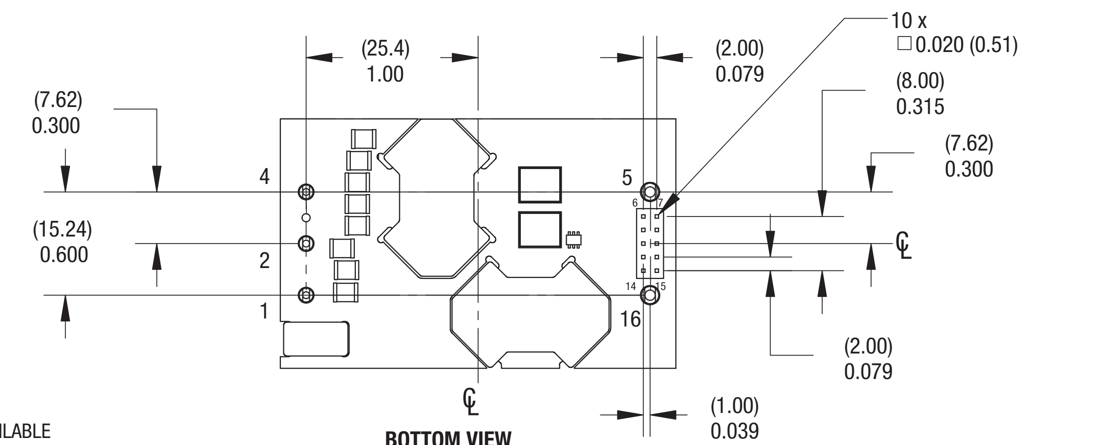
MECHANICAL SPECIFICATIONS (OPEN FRAME)





INPUT/OUTPUT CONNECTIONS	
Pin	**Function**
1	+ Vin
2	Remote On/Off *
3	No Pin
4	- Vin
5	- Vout
6	+ Sense
7	- Sense
8	SA0
9	SA1
10	SCL
11	SDA
12	PG SYNC
13	D GND
14	SALERT
15	CONTROL CS
16	+ Vout

The Remote On/Off can be provided with either positive or negative logic.

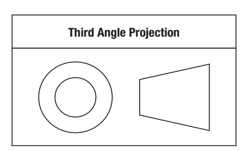


1. ALTERNATE PIN LENGTHS AVAILABLE (CONTACT MURATA-PS FOR INFORMATION)
2. COMPONENTS SHOWN FOR REF ONLY
3. DIMENSIONS ARE IN INCHES (mm)
4. PIN LOCATION DIMENSIONS APPLY AT CIRCUIT BOARD LEVEL

MATERIAL:
∅0.040 PINS: COPPER ALLOY
∅0.060 PINS: COPPER ALLOY

FINISH: (ALL PINS)
GOLD (3-5u") OVER NICKEL (50u" MIN)

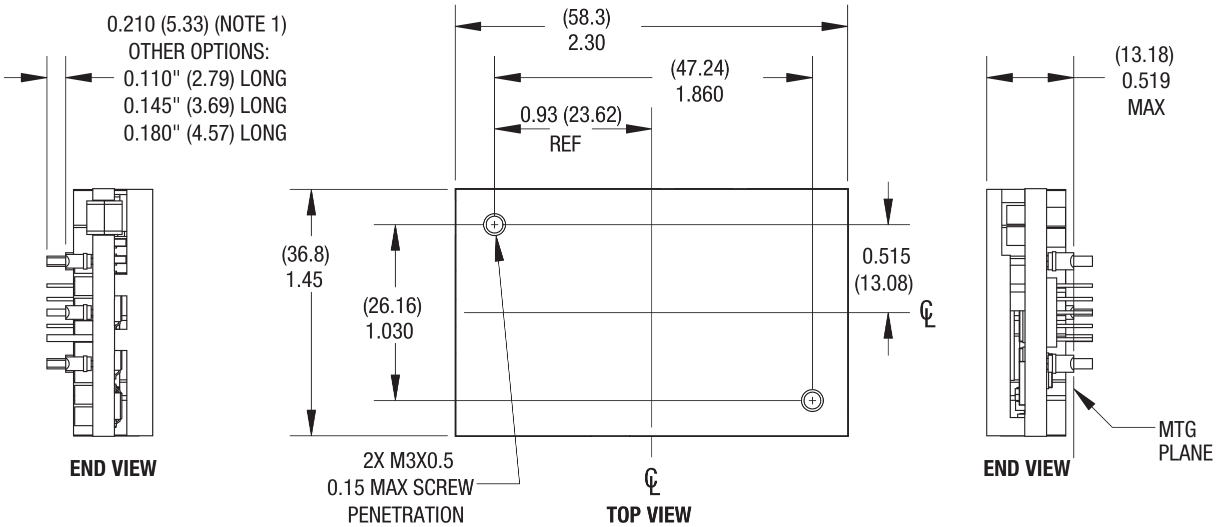
Dimensions are in inches (mm shown for ref. only).

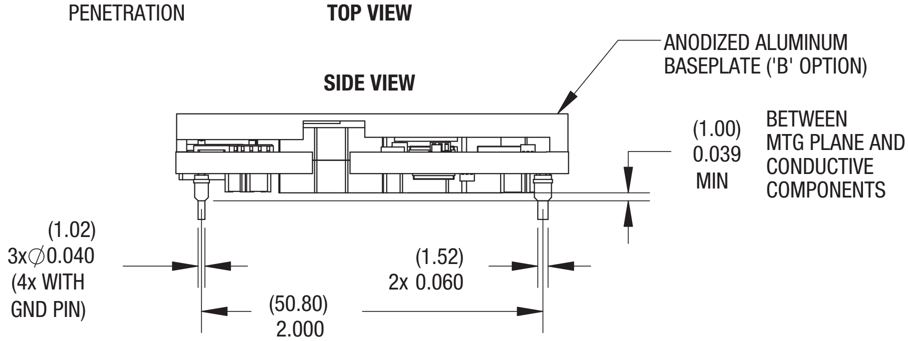


Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2˚

Components are shown for reference only.

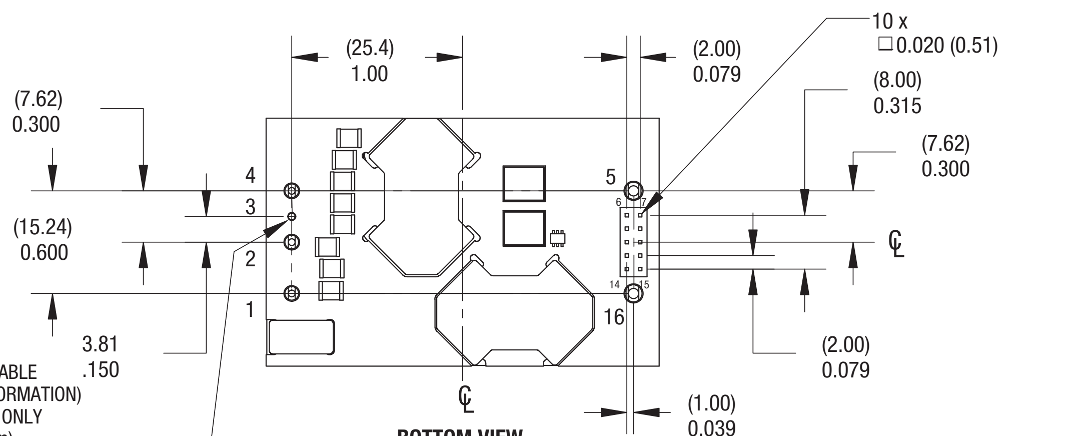
MECHANICAL SPECIFICATIONS (WITH BASEPLATE)





INPUT/OUTPUT CONNECTIONS	
Pin	**Function**
1	+ Vin
2	Remote On/Off *
3	Pin to GND (optional)
4	- Vin
5	- Vout
6	+ Sense
7	- Sense
8	SA0
9	SA1
10	SCL
11	SDA
12	PG SYNC
13	D GND
14	SALERT
15	CONTROL CS
16	+ Vout

The Remote On/Off can be provided with either positive or negative logic.



1. ALTERNATE PIN LENGTHS AVAILABLE (CONTACT MURATA-PS FOR INFORMATION)
2. COMPONENTS SHOWN FOR REF ONLY
3. DIMENSIONS ARE IN INCHES (mm)
4. PIN LOCATION DIMENSIONS APPLY AT CIRCUIT BOARD LEVEL

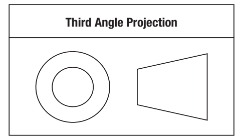
MATERIAL:
∅0.040 PINS: COPPER ALLOY
∅0.060 PINS: COPPER ALLOY

FINISH: (ALL PINS)
GOLD (3-5u") OVER NICKEL (50u" MIN)

OPTIONAL PIN #3 CONNECTS TO BASEPLATE AND IS ELECTRICALLY ISOLATED FROM CONVERTER.

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

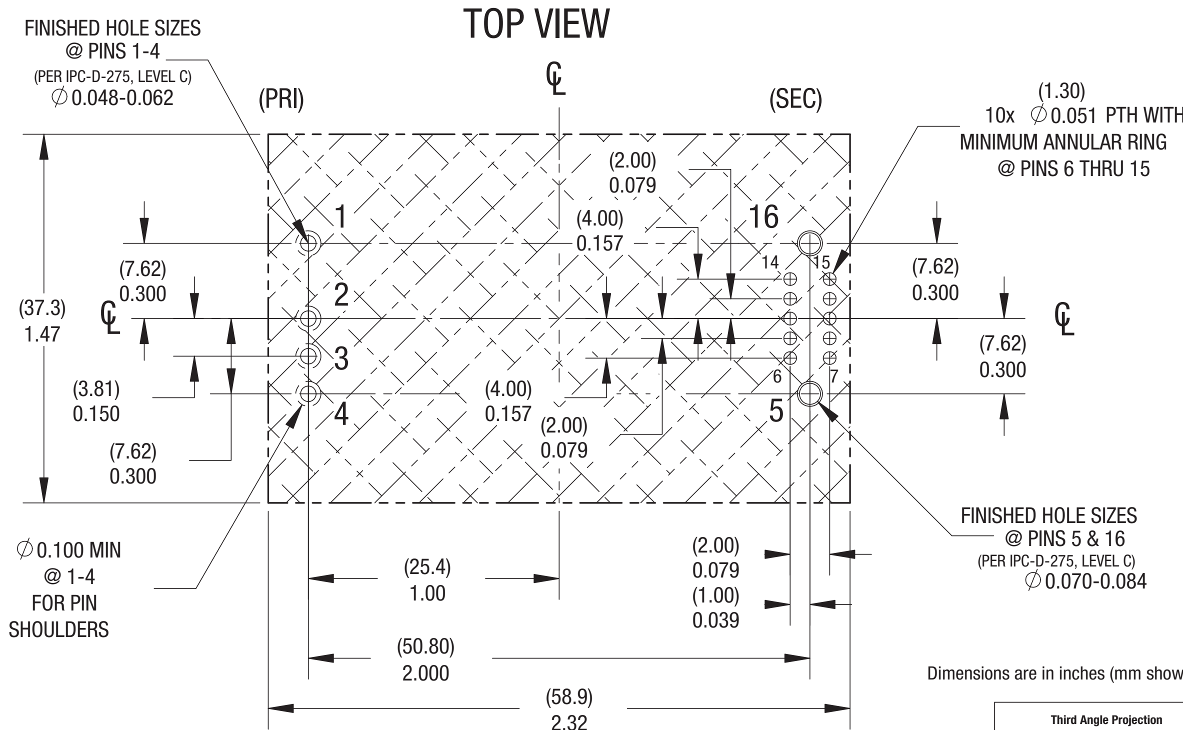
Third Angle Projection



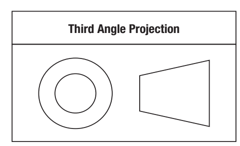
Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2˚

Components are shown for reference only.

RECOMMENDED FOOTPRINT (VIEW THROUGH CONVERTER)



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

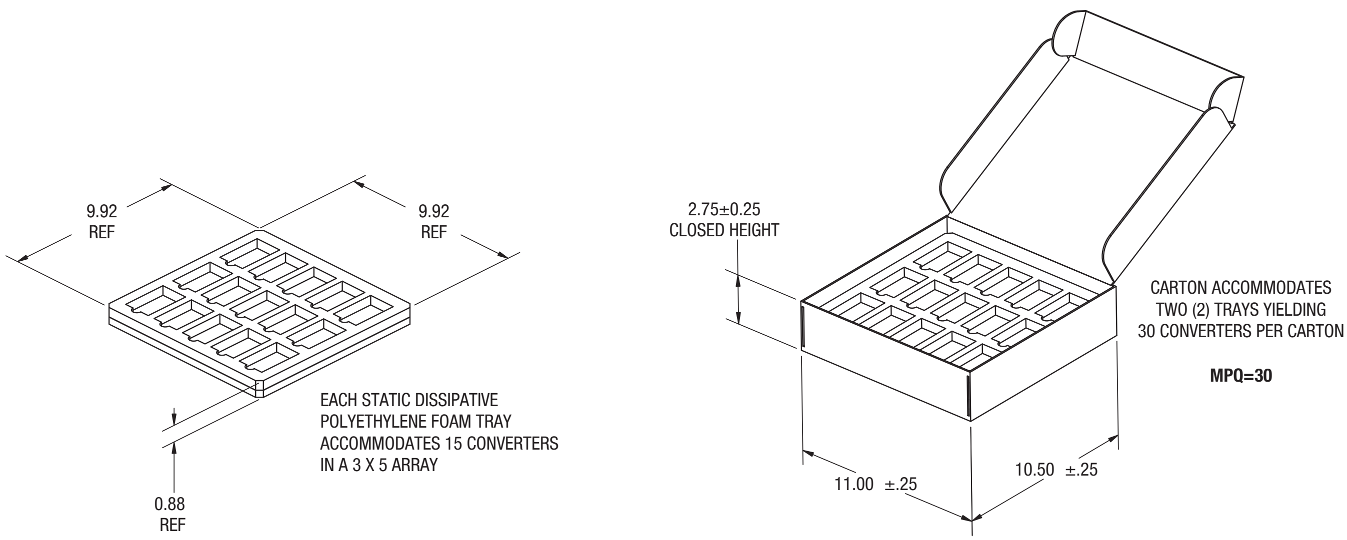


IT IS RECOMMENDED THAT NO PARTS BE PLACED BENEATH CONVERTER (HATCHED AREA). THE STANDOFFS ASSURE MINIMUM CLEARANCE IS MET TO ACHIEVE 2250VDC ISOLATION. OPEN VIAS OR TRACES BENEATH CONVERTER ARE ACCEPTABLE

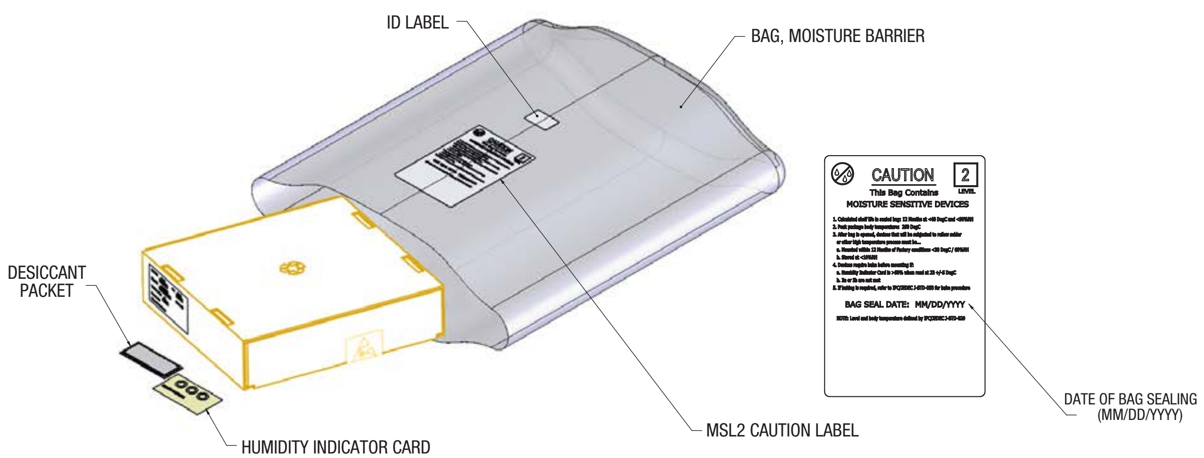
Tolerances (unless otherwise specified):
.XX ± 0.02 (0.5)
.XXX ± 0.010 (0.25)
Angles ± 2˚

Components are shown for reference only.

STANDARD PACKAGING



DRY-PACK PACKAGING



TECHNICAL NOTES

Power Management Overview

This module is prepared with a PMBus interface. 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 protects the load from damage due to unexpected system faults. The SALERT pin alerts the unit if there is a fault in the module. The following product parameters can continuously be monitored by a host: Vin, Vout/current, duty cycle and internal temperature. The module is distributed with a default configuration suitable for a wide range operation in terms of Vin, Vout, and load. The configuration is kept in an internal Non-Volatile Memory (NVM). 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 Murata-PS for design support of special configurations.

Remote On/Off Control

The UDQ series modules are equipped with both Primary (Remote On/Off, Internal pull up resistor) and secondary (CONTROL CS, disabled and floating) 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).

The standard product is provided with 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 +6Vdc 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 +6V 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.

To turn the module On or Off the remote On/Off pin should be left open for a minimum of 150µS. The module can be power up automatically without the need for control signals or a switch; the remote On/Off pin can be wired directly to –Vin or disabled via the 0xE3 command. The logic option for the primary remote On/Off control is configured via 0xE3 command using the PMBus.

CONTROL CS (Secondary On/Off)

The CONTROL CS pin can be configured via the PMBus. The default configuration is disabled and floating. The output can be configured to an internal pull up resistor up to 3.3V using the MFR_MULTI_PIN_CONG (0xF9) PMBus command. The CONTROL CS pin can be left open when not being used. The logic options for the secondary On/Off can be negative or positive logic. The logic for the secondary remote control is configured via ON_OFF_CONFIG (0x02) command using the PMBus command. See also MFR_MULTI_PIN_CONFIG section.

Output Voltage Adjust (Trim) Using PMBus

The output voltage of this module can be reconfigured using the PMBus interface.

Margin Up/Down Controls

These controls allow the output voltage to be momentarily adjusted, either up or down, by a nominal 10%. This provides a suitable method for dynamically testing the operation of the load circuit over its supply margin or range. It can also be used to confirm the function of supply voltage supervisors. The margin up and down levels of the module can be reconfigured using the PMBus interface.

Soft-start Power Up

The default rise time of the ramp up is 10 ms. When starting by applying input voltage the control circuit boot-up time adds an additional 15 ms delay. The soft-start power up of the module can be reconfigured using the PMBus interface. The DLS variants have a pre-configured ramp up time of 25 ms.

Over Voltage Protection (OVP)

The module includes over voltage limiting circuitry for protection of the load. The default OVP limit is 30% 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 re-configured using the PMBus interface.

Over Current Protection (OCP, Current limit)

The module includes current limiting circuitry for protection at continuous overload. The default setting for the product is hicup mode if the maximum output current is exceeded and the output voltage is below 0.3×Vout, set in command IOUT_OC_LV_FAULT_LIMIT (0x48). Above the trip voltage value in command 0x48 the product will continue operate while maintaining the output current at the value set by IOUT_OC_FAULT_LIMIT (0x46). The load distribution should be designed for the maximum output short circuit current specified. Droop Load Share alternates (DLS) will enter hic-up mode, with a trip voltage, 0.04×Vout, set in command IOUT_OC_LV_FAULT_LIMIT (0x48). Above the trip voltage in command (0x48) the product will continue operate while maintaining the output current at the value set by IOUT_OC_FAULT_LIMIT (0x46). The over current protection of the module can be reconfigured using the PMBus interface.

Pre-bias Start-up Capability

The module has a Pre-bias start up functionality and will not sink current during start up if a Pre-bias source is present at the output terminals. If the Pre-bias voltage is lower than the target value set in VOUT_COMMAND (0x21), the module will ramp up to the target value. If the Pre-bias voltage is higher than the target value set in VOUT_COMMAND (0x21), the product will ramp down to the target value and in this case sink current for a limited of time set in the command TOFF_MAX_WARN_LIMIT (0x66).

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

Bit 7:6 **00 = Stand alone** **01 = Slave (N/A)** **10 = DLS** **11 = Master (N/A)**	1	1	1	1	1	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
Bit 5 **Power Good High Z when active**	0	0	0	0	1	1	0	0	0	0	1	1
Bit 4 **Tracking enable (N/A)**	0	0	0	0	0	0	0	0	0	0	0	0
Bit 3 **External reference (N/A)**	0	0	0	0	0	0	0	0	0	0	0	0
Bit 2 **Power Good Enable**	0	0	1	1	1	1	0	0	1	1	1	1
Bit 1 **Reserved**	1	1	1	1	1	1	0	0	0	0	0	0
Bit 0 **Secondary Remote Control Pull up/down resistor enable 1)**	0	1	0	1	0	1	0	1	0	1	0	1
1) When not used with PMBus, the CTRL input can be internally pulled up or down depending on if it is active high or low. When active low it will be pulled up and vice versa			DLS, Power Good Push-pull, PMBus Control (0x86)	DLS, Power Good Push-pull, Sec RC w/ pull up/down (0x87)	DLS, Power Good High Z when active, PMBus Control (0xA6)	DLS, Power Good High Z when active, Sec RC w/ pull up/down (0xA7)	Stand alone, PMBus Control (0x00)	Stand alone, Sec RC w/ pull up/down (0x01)	Stand alone, Power Good Push-pull, PMBus Control (0x04)	Stand alone, Power Good Push-pull, Sec RC w/ pull up/down (0x05)	Stand alone, Power Good High Z when active, PMBus Control (0x24)	Stand alone, Power Good High Z when active, Sec RC w/ pull up/down (0x25)

and no fault condition exists. If specified in section Connections, the product also provides a PG signal output. The Power Good signal is by default configured as active low, Push-pull and can be reconfigured via the PMBus interface. The Power Good output can be configured as Push-pull or "High Z when active" to permit AND'ing of parallel devices. It is not recommended to use Push-pull when paralleling PG-pins, see MFR_MULTI_PIN_CONFIG.

Switching Frequency Adjust Using PMBus

The switching frequency is set to 140 kHz as default but this can be reconfigured via the PMBus interface. The product is optimized at this frequency but can run at lower and higher frequency, (125-150 kHz). The electrical performance can be affected if the switching frequency is changed.

MFR_MULTI_PIN_CONFIG

The MFR_MULTI_PIN_CONFIG (0xF9) command enables or disables different functions inside the product. This command can be configured according to the table for different functions.

The MFR_MULTI_PIN_CONFIG can be reconfigured using the PMBus interface. Default configuration is set to Power Good Push-Pull (0x04) for stand alone variants and DLS Power Good Push-Pull (0x86) for Droop Load Share variants.

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 SALERT line to help alleviate bandwidth limitations related to continuous fault monitoring. The module supports 100 kHz and 400 kHz bus clock frequency only. The PMBus signals, SCL, SDA and SALERT require passive pull-up resistors as stated in the SMBus Specification. Pull-up resistors are required to guarantee the rise time as follows:

$t = R_p C_p \leq \mu s$

where R_p is the pull-up resistor value and C_p is the bus load. The maximum allowed bus load is 400 pF. The pull-up resistor should be tied to an external supply between 2.7 to 5.5 V, which should be present prior to or during power-up. If the proper power supply is not available, voltage dividers may be applied. Note that in this case, the resistance in the equation above corresponds to parallel connection of the resistors forming the voltage divider.

It is recommended to always use PEC (Packet Error Check) when communicating via PMBus. For these products it is a requirement to use PEC when using Send Byte to the device, for example command "RESTORE_DEFAULT_ALL".

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 SALERT 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
- Internal junction temperature
- Switching frequency (Monitors the set value not actual frequency)
- Duty cycle

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.

PMBus Addressing

The following figure and table show recommended resistor values with min and max voltage range for hard-wiring PMBus addresses (series E12, 1% tolerance resistors suggested):

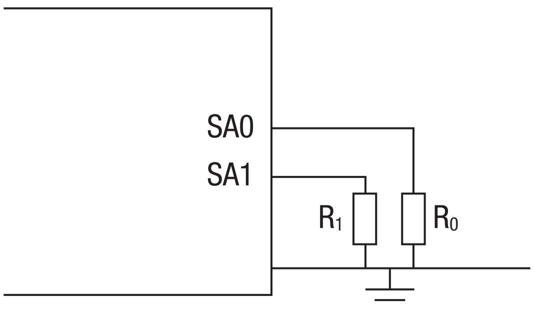


Figure 1. Schematic of Connection of Address Resistors

SA0/SA1 Index	R_{SA0}/R_{SA1} [kΩ]
0	10
1	22
2	33
3	47
4	68
5	100
6	150
7	220

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 0, 11 or 12, PMBus address 127 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.

I²C/SMBus – Timing

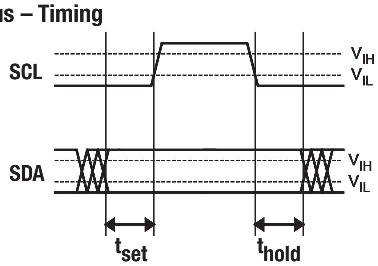


Figure 2. Setup and hold times timing diagram

The setup time, t_{set}, is the time data, SDA, must be stable before the rising edge of the clock signal, SCL. The hold time thold, is the time data, SDA, must be stable after the rising edge of the clock signal, SCL. If these times are violated incorrect data may be captured or meta-stability may occur and the bus communication may fail. When configuring the product, all standard SMBus protocols must be followed, including clock stretching. Additionally, a bus-free time delay between every SMBus transmission (between every stop & start condition) must occur. Refer to the SMBus specification, for SMBus electrical and timing requirements. Note that an additional delay of 5 ms has to be inserted in case of storing the RAM content into the internal non-volatile memory.

PMBus Commands

The products are PMBus compliant. The following table lists 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.

DESIGNATION	CMD	PROT
Standard PMBus Commands		
Control Commands		
OPERATION	01h	No
ON_OFF_CONFIG	02h	No
WRITE_PROTECT	10h	No
Output Commands		
VOUT_MODE	20h	No
VOUT_COMMAND	21h	No
VOUT_TRIM	22h	No
VOUT_CAL_OFFSET	23h	Yes
VOUT_MAX	24h	No
VOUT_MARGIN_HIGH	25h	No
VOUT_MARGIN_LOW	26h	No
VOUT_TRANSITION_RATE	27h	No
VOUT_SCALE_LOOP	29h	Yes
VOUT_SCALE_MONITOR	2Ah	Yes
MAX_DUTY	32h	No
FREQUENCY_SWITCH	33h	No
VIN_ON	35h	No
VIN_OFF	36h	No
IOUT_CAL_GAIN	38h	Yes
IOUT_CAL_OFFSET	39h	Yes
Fault Commands		
VOUT_OV_FAULT_LIMIT	40h	No
VOUT_OV_FAULT_RESPONSE	41h	No
VOUT_OV_WARN_LIMIT	42h	No
VOUT_UV_WARN_LIMIT	43h	No
VOUT_UV_FAULT_LIMIT	44h	No
VOUT_UV_FAULT_RESPONSE	45h	No
IOUT_OC_FAULT_LIMIT	46h	No
IOUT_OC_FAULT_RESPONSE	47h	No
IOUT_OC_LV_FAULT_LIMIT	48h	No
IOUT_OC_WARN_LIMIT	4Ah	No
OT_FAULT_LIMIT	4Fh	No
OT_FAULT_RESPONSE	50h	No
OT_WARN_LIMIT	51h	No
UT_WARN_LIMIT	52h	No
UT_FAULT_LIMIT	53h	No
UT_FAULT_RESPONSE	54h	No
VIN_OV_FAULT_LIMIT	55h	No
VIN_OV_FAULT_RESPONSE	56h	No
VIN_OV_WARN_LIMIT	57h	No
VIN_UV_WARN_LIMIT	58h	No
VIN_UV_FAULT_LIMIT	59h	No
VIN_UV_FAULT_RESPONSE	5Ah	No
POWER_GOOD_ON	5Eh	No
POWER_GOOD_OFF	5Fh	No
Time Setting Commands		
TON_DELAY	60h	No
TON_RISE	61h	No
TON_MAX_FAULT_LIMIT	62h	No
TON_MAX_FAULT_RESPONSE	63h	No
TOFF_DELAY	64h	No
TOFF_FALL	65h	No
TOFF_MAX_WARN_LIMIT	66h	No

DESIGNATION	CMD	PROT
Status Commands (Read Only)		
CLEAR_FAULTS	03h	No
STATUS_BYTES	78h	No
STATUS_WORD	79h	No
STATUS_VOUT	7Ah	No
STATUS_IOUT	7Bh	No
STATUS_INPUT	7Ch	No
STATUS_TEMPERATURE	7Dh	No
STATUS_CML	7Eh	No
STATUS_OTHER	7Fh	No
Monitior Commands (Read Only)		
READ_VIN	88h	No
READ_VOUT	8Bh	No
READ_IOUT	8Ch	No
READ_TEMPERATURE_1	8Dh	No
READ_TEMPERATURE_2	8Eh	No
READ_DUTY_CYCLE	94h	No
Designation	Cmd	Prot
READ_FREQUENCY	95h	No
Configuration and Control Commands		
USER_DATA_00	B0h	No
Identification Commands (Read Only)		
PMBUS_REVISION	98h	No
MFR_ID	99h	Yes
MFR_MODEL	9Ah	Yes
MFR_REVISION	9Bh	Yes
MFR_LOCATION	9Ch	Yes
MFR_DATE	9Dh	Yes
MFR_SERIAL	9Eh	Yes
Supervisory Commands		
STORE_DEFAULT_ALL	11h	Yes
RESTORE_DEFAULT_ALL	12h	No
STORE_USER_ALL	15h	No
RESTORE_USER_ALL	16h	No
CAPABILITY	19h	No
Product Specific Commands		
MFR_POWER_GOOD_POLARITY	D0h	No
MFR_VIN_SCALE_MONITOR	D3h	Yes
MFR_SELECT_TEMP_SENSOR	DCh	No
MFR_VIN_OFFSET	DDh	Yes
MFR_VOUT_OFFSET_MONITOR	DEh	Yes
MFR_TEMP_OFFSET_INT	E1h	No
MFR_REMOTE_TEMP_CAL	E2h	No
MFR_REMOTE_CTRL	E3h	No
MFR_DEAD_BAND_DELAY	E5h	Yes
MFR_TEMP_COEFF	E7h	Yes
MFR_DEBUG_BUFF	F0h	No
MFR_SETUP_PASSWORD	F1h	No
MFR_DISABLE_SECURITY_ONCE	F2h	No
MFR_DEAD_BAND_IOUT_THRESHOLD	F3h	Yes
MFR_SECURITY_BIT_MASK	F4h	Yes
MFR_PRIMARY_TURN	F5h	Yes
MFR_SECONDARY_TURN	F6h	Yes
MFR_ILIM_SOFTSTART	F8h	No
MFR_MULTI_PIN_CONFIG	F9h	No
MFR_DEAD_BAND_VIN_THRESHOLD	FAh	Yes
MFR_DEAD_BAND_VIN_IOUT_HYS	FBh	Yes
MFR_RESTART	FEh	No

Notes:
CMD is short for Command.
PROT is short for commands that are protected with security mask.

Thermal Shutdown

Extended operation at excessive temperature will initiate overtemperature shutdown triggered by a temperature sensor inside 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).

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

Under normal start-up conditions, 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 can be configured via the PMBus interface.

Start-Up Time

Assuming that the output current is set at the rated maximum, the Vin to Vout Start-Up Time (see Specifications) is the time interval between the point when the rising input voltage crosses the Start-Up Threshold and the fully loaded output voltage enters and remains within its specified accuracy band. Actual measured times will vary with input source impedance, external input capacitance, input voltage slew rate and final value of the input voltage as it appears at the converter.

These converters include a soft start circuit to moderate the duty cycle of its PWM controller at power up, 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. The specification assumes that the output is fully loaded at maximum rated current. Similar conditions apply to the On to Vout regulated specification such as external load capacitance and soft start circuitry.

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. Make sure that the input terminals do not go below the undervoltage shutdown voltage at all times. More input bulk capacitance may be added in parallel (either electrolytic or tantalum) if needed.

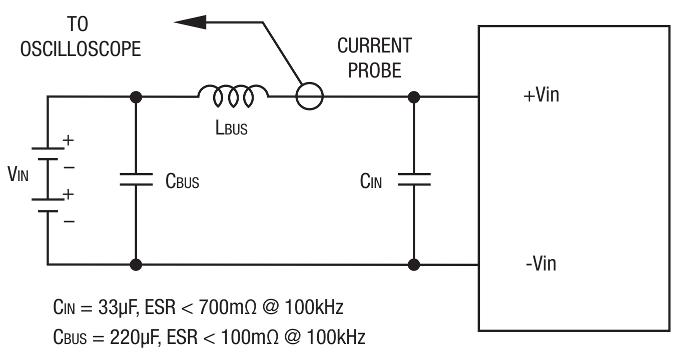
Recommended Output Filtering

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.



CIN = 33μF, ESR < 700mΩ @ 100kHz
CBUS = 220μF, ESR < 100mΩ @ 100kHz
LBUS = 12μH

Figure 3. Measuring Input Ripple Current

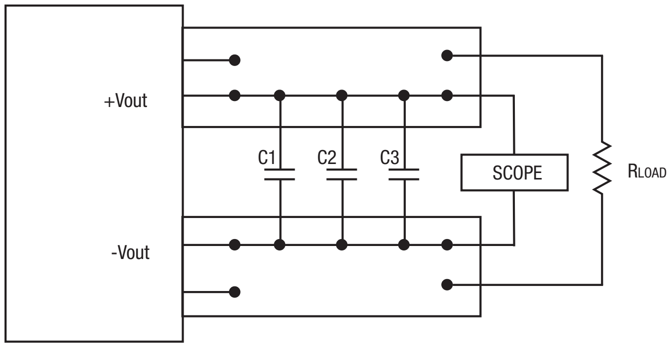
Minimum Output Loading Requirements

All models regulate within specification and are stable under no load to full load conditions. Operation under no load might however slightly increase output ripple and noise.

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/DC's 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 OT_WARM_LIMIT (0X51), the hysteresis is defined in general electrical specification section. The OTP and hysteresis of the module can be re-configured using the PMBus interface. The module has also an under temperature protection. The OTP and UTP fault limit and fault response can be configured via the PMBus. Note: using the fault response "continue without interruption" may cause permanent damage to the module. There is a small amount of hysteresis to prevent rapid on/off cycling.

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.



C1 = 3.5mF; C2 = 1μF; C3 = 10μF
LOAD 2-3 INCHES (51-76mm) FROM MODULE

Figure 4. Measuring Output Ripple and Noise (PARD)

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 Fusing

The converter is extensively protected against current, voltage and temperature extremes. However your output application circuit may need additional protection. In the extremely unlikely event of output circuit failure, excessive voltage could be applied to your circuit. Consider using an appropriate fuse in series with the output.

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.

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.

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.

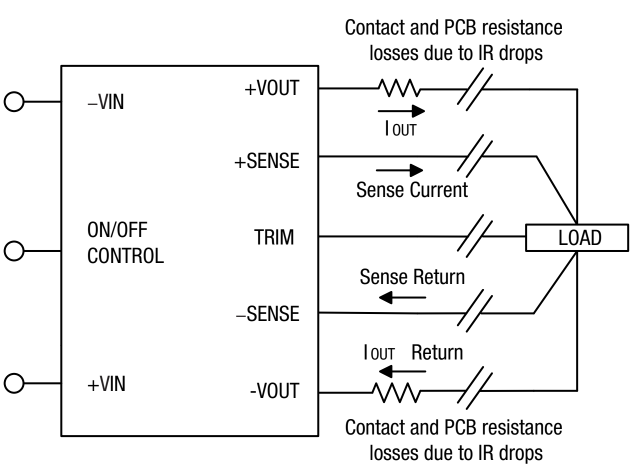


Figure 5. Remote Sense Circuit Configuration

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)

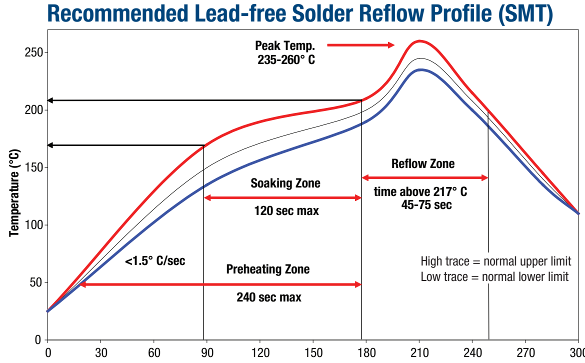
Soldering Guidelines

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

Reflow Solder Operations for surface-mount products (SMT)	
For Sn/Ag/Cu based solders:	
Preheat Temperature	Less than 1 °C. per second
Time over Liquidus	45 to 75 seconds
Maximum Peak Temperature	260 °C.
Cooling Rate	Less than 3 °C. per second
For Sn/Pb based solders:	
Preheat Temperature	Less than 1 °C. per second
Time over Liquidus	60 to 75 seconds
Maximum Peak Temperature	235 °C.
Cooling Rate	Less than 3 °C. per second

Recommended Lead-free Solder Reflow Profile (SMT)



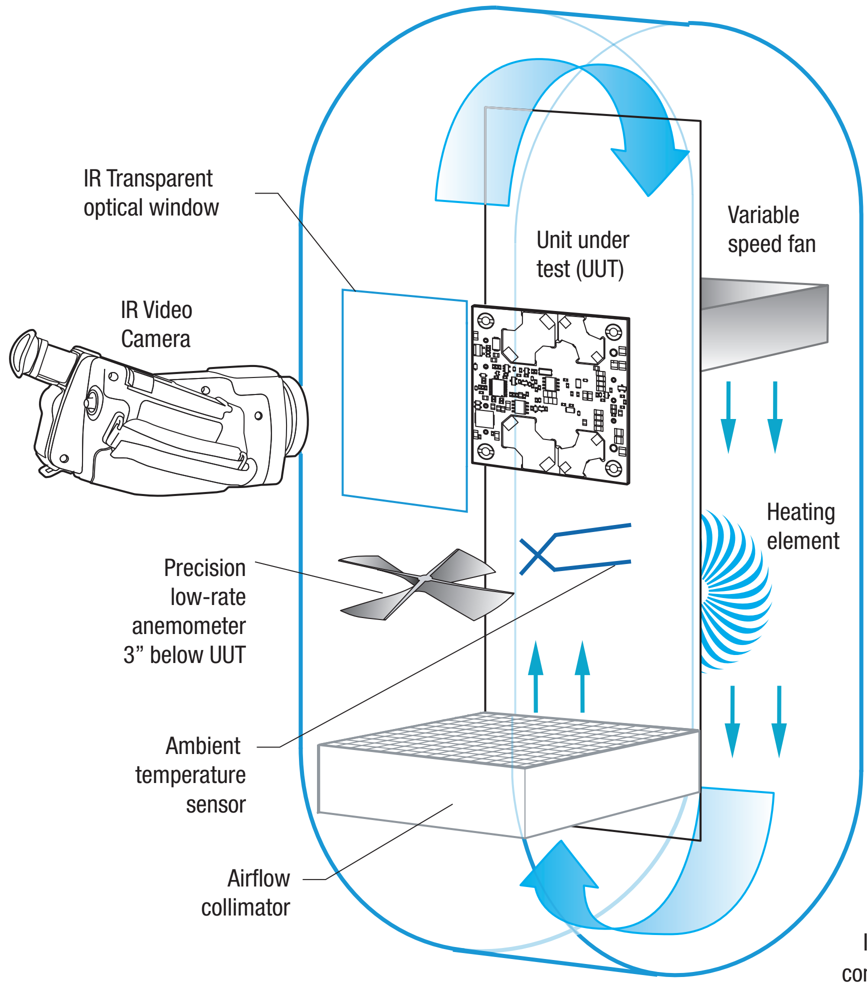


Figure 6. Vertical Wind Tunnel

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.