

## FEATURES

- Input Range of 40-60V, (54V nominal)
- Regulated 12V output
- Continuous Output of 12V @ 71A
- Peak Efficiency of 98%
- Industry Standard 1/4 Brick Package
- Baseplate for Cooling Optimization
- 3+ units can be operated in parallel
- Overcurrent and Overvoltage protection
- PMBus™ 1.2 Interface (optional)
- Black Box Stored Data
- Power-Good Signal
- Remote On/Off Control
- RoHS Compliant



For full details go to  
<https://www.murata-ps.com/rohs>



## SAFETY APPROVALS

- UL 62368-1 3<sup>rd</sup> Edition
- CSA C22.2 No. 62368-1-19
- IEC 62368-1:2018



## PRODUCT OVERVIEW

The MPQ860-12V72-L48NBMC is a 860W, non-isolated, high efficiency, digitally controlled DC-DC board-mount power converter to be offered with a regulated 12Vdc/71A output. PMBus® digital communication capability, supports a comprehensive command list providing capability for the system/host to configure control and monitor status. Robust hardware fault protection from overvoltage, overtemperature and overload conditions is provided and supports operation over a wide temperature range.

The active current sharing capability enables two or more converters to be used in parallel for demanding datacom applications, thus delivering higher power on a single rail and improving redundancy. The MPQ860-12V72-L48NBMC offers a competitive advantage in server, storage, and network applications requiring high power density, efficiency, and reliable DC-DC power conversion.

## ORDERING GUIDE

Part Number <sup>1</sup>	V <sub>IN</sub>	V <sub>OUT</sub>	P <sub>OUT</sub>	L inch(mm)	W inch(mm)	H inch(mm)
MPQ860-12V72-L48NBMC	54Vdc	12Vdc	860W	2.3 (58.4)	1.45 (36.8)	0.57 (14.5)

<sup>1</sup> See the Part Number Structure table on page 2 for more information.

## ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

Parameter	Conditions	Min.	Nom.	Max.	Units
Input Voltage		-0.5	-	65	Vdc
Isolation Voltage	Input to Output	-	-	0	
On/Off Remote Control	Power on, referred to -Vin	-0.3	-	5	
Output Power <sup>2</sup>	Vin=40-60V	-	-	1500	W
Operating Temperature Range <sup>3</sup>		-40	-	85	°C
Storage Temperature Range	Vin=Zero (no power)	-55	-	125	

<sup>1</sup> Absolute maximum are stress ratings. Exposure of devices to greater than any of these conditions might adversely affect long-term reliability.

<sup>2</sup> Output peak power 1500W continuous 500µs.

<sup>3</sup> See thermal consideration section.

## INPUT VOLTAGE CHARACTERISTICS

Parameter	Conditions	Min.	Nom.	Max.	Units
Input Voltage, Operating		40	54	60	Vdc
Start-Up Voltage		36	37	38	
Input Capacitance	Per unit, Nichicon UPM2A271MHD or equivalent	470	-	-	µF
Input Current	Vin @ 40V	-	-	30	A
Inrush Current <sup>1</sup>		-	-	50	% of Iin
Ripple Current <sup>2</sup>		-	1.25	-	mA <sub>RMS</sub> /W

## OUTPUT VOLTAGE CHARACTERISTICS

Parameter	Conditions	Min.	Nom.	Max.	Units
Peak Efficiency	Vin=40V, 50% of Max Pout, Ta=25°C	-	98	-	%
Efficiency	Vin=54V, 50% of Max Pout, Ta=25°C	-	97.3	-	
	Vin=54V, 100% of Max Pout, Ta=25°C	-	97.4	-	
	Vin=48V, 50% of Max Pout, Ta=25°C	-	97.7	-	
	Vin=48V, 100% of Max Pout, Ta=25°C	-	97.6	-	
Switching Frequency			180	-	kHz
Output Voltage Set Point	Vin=54V, Pout=0W, Tc=25°C	12.14	12.2	12.26	Vdc
Output Current		0	-	71	A
Output Power		-	-	860	W
Ripple & Noise	20MHz Bandwidth	-	-	100	mVp-p
Output Capacitance	50% ceramic, 50% Oscon or POSCAP	1500	-	10,000	µF
Load regulation		-	-	30	mV
Line regulation		-	10	35	mV
Output voltage tolerance band	Vin=40-60V, 0-100% of Load	11.7	-	12.4	Vdc

## RELIABILITY & SAFETY

Parameter	Conditions	Min.	Nom.	Max.	Units
Isolation Voltage	Input to Output Test Voltage	-	-	0	Vdc
	Input to Baseplate Test Voltage	-	-	0	
	Baseplate to Output Test Voltage	-	-	0	
Safety Rating	Non-Isolated	-	-	-	-
Isolation Capacitance		-	-	0	pF
Calculated MTBF	Telcordia SR-332 @ 90°C baseplate temp.	6	-	-	Mhrs

**NOTES: (continued from page 1)**

<sup>1</sup> 1 lin is defined as the steady-state operating current when unit is operating at Vin Max and Pout Max. While Vout is rising, Pout is <=25% of Rated Power with a resistive load.

<sup>2</sup> Measured at input pin with maximum specified Cin and <500uH inductance between voltage source and Cin.

**PART NUMBER STRUCTURE**

Product Family	M	P														MP = Murata Power
Form Factor			Q													Q = Quarter Brick
Output Power				860												860W
Output Voltage					12V											12Vout
Output Current						72										71A
Input Voltage Range							L48									L48 = 40-60Vin
On/Off Control Logic								N								N = Negative Logic (Default)
Mechanical Configuration									B							B = Baseplate
PMBus (option)										M						M = with PMBus interface, Blank = without PMBus interface
RoHS															C	C = RoHS Compliant

**TURN-ON/TURN-OFF CHARACTERISTICS**

Parameter	Conditions	Min.	Nom.	Max.	Units
Turn-On Delay-1	From Vin reaching Turn-On voltage, Vin slew rate is 1V/ms.	35	-	55	ms
Turn-On Delay-2	From Enable asserted	-	-	5	
Restart Delay		-	-	250	
Output Voltage Rise Time		-	-	15	Vdc
Pre-Bias Voltage		0	-	Vout	

**PROTECTION**

Parameter	Conditions	Min.	Nom.	Max.	Units
Vin Undervoltage Shutdown		34	35	36	Vdc
Vin Undervoltage Shutdown Recover		36	37	38	
Vin UVP Hysteresis		1	-	3	
Vin Overvoltage Shutdown		62	64	66	
Vin Overvoltage Shutdown Recover		60	62	64	
Vin OVP Hysteresis		1	-	3	
Vout Overvoltage Shutdown		-	14	-	A
Output Over-Current		-	87 <sup>1</sup>	-	
Short Current Point		-	135 <sup>2</sup>	-	
Current Sharing Accuracy			-	10	%
Over-Temperature (internal temperature sensor)		115	-	130	°C

<sup>1</sup> Module shuts down after a 150ms delay.

<sup>2</sup> Module immediately shuts down after output current trigger short current point.

**Note:** The output over-current threshold can be configured through PMBus. See the PMBus section for details.

**OUTPUT ENABLE (NEGATIVE LOGIC)**

Parameter	Conditions	Min.	Nom.	Max.	Units
Unit OFF: On/Off Pin open or <sup>1, 2, 3</sup>		2.4	-	20	Vdc
Unit ON: On/Off Pin low or <sup>1, 2, 3</sup>		-0.1	-	0.8	
Enable Pin Current (into pin, ext. pull-up to 15V) <sup>1, 2, 3</sup>		-	-	0.5	mA
Enable Pin Current (into pin, ext. pull-up to 10V) <sup>1, 2, 3</sup>		-	-	0.3	

<sup>1</sup> Enable signal is referenced to Vin(-).

<sup>2</sup> Unit disabled via Control Pin, open collector configuration.

<sup>3</sup> The enable logic can be changed via PMBus.

**DYNAMIC CHARACTERISTICS**

Parameter	Conditions	Min.	Nom.	Max.	Units
Dynamic Load Response <sup>1, 2</sup>		-	-	160	μS
Dynamic Load Peak Deviation <sup>1, 2</sup>		-	-	±300	mV
Response to Vin Step <sup>3</sup>		-	-	1.25	Vdc

<sup>1</sup> 25-75-25% load step of Pout Max at 1A/uS, settling time to within 1% of Vout, measurement method.

<sup>2</sup> With a 7500μF output capacitance, 50% ceramic, 50% OSCON or POSCAP.

<sup>3</sup> The occurring max 0.1v/us rate within Vin Operating Range, Pout = 10% - 100% Rated Power, Cout = Cout Max /2.

**POWER-GOOD SIGNAL<sup>1</sup>**

Parameter	Conditions	Min.	Nom.	Max.	Units
Output Voltage Low (trigger limits)		8.5	9.0	9.5	Vdc
Output Voltage Hysteresis		0.2	0.3	-	
High State Voltage		0	-	5.5	
High State Leakage Current (into Pin)		0	-	10	μA
Low State Voltage		0	-	0.8	Vdc
Low State Current (into Pin)		0	-	5	mA
Power Good Signal De-assert Response Time		0	-	3	ms
Power Good Signal Assert Response Time		0	-	3	

<sup>1</sup> The power good logic can be changed via PMBus.

**ENVIRONMENTAL CHARACTERISTICS**

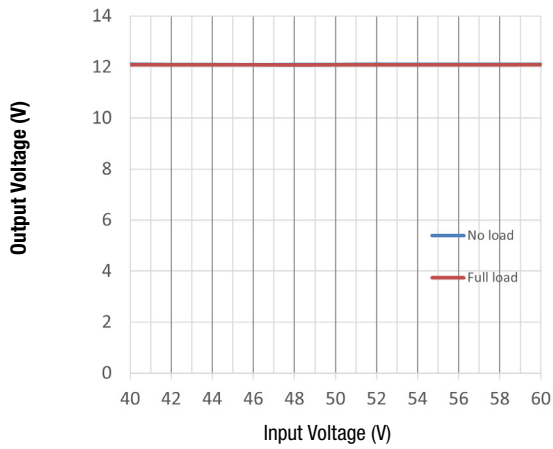
Parameter	Conditions	Min.	Nom.	Max.	Units
Operating Temperature - Ambient		-40	-	85	°C
Storage Temperature		-50	-	125	
Altitude, Operating		-500	-	13,120	feet
Relative Humidity, Operating, Non-Condensing		10	-	90	%
Relative Humidity, Non-Operating, Non-Condensing		10	-	95	
Thermal Protection/Shutdown			120		°C
Electromagnetic Interference Conducted, EN 55032/CISPR 32	With external filter		B		Class

**GENERAL INFORMATION**

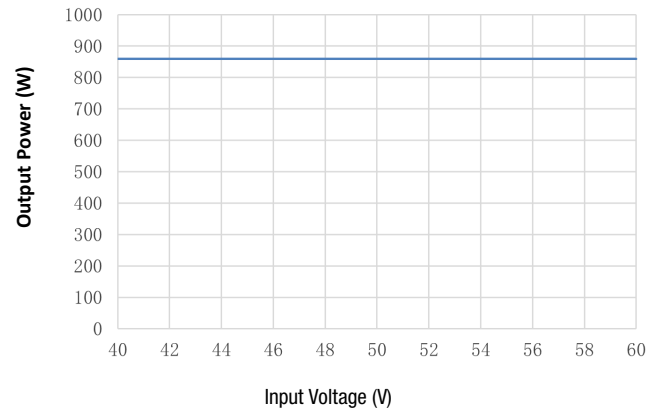
Parameter	Conditions	Min.	Typ.	Max.	Units
Mechanical Dimensions (L x W x H)		2.30 x 1.45 x 0.551			Inches
		58.42 x 36.83 x 14.00			mm
Product Weight (per unit)		2.99			Ounces
		84.8			Grams
Pin Length		0.210			Inches
		5.33			mm
Pin Diameter		0.040/0.060			Inches
		1.0/1.5			mm
Pin Material		Copper with matte tin plating over nickel under plating			
Baseplate Material		Black anodized aluminum			

**PERFORMANCE CURVES**

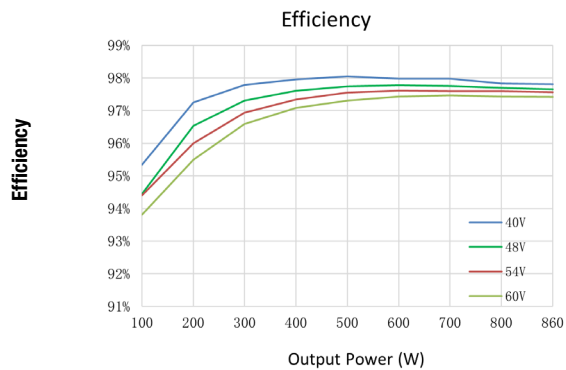
**Output Voltage vs. Input Voltage**



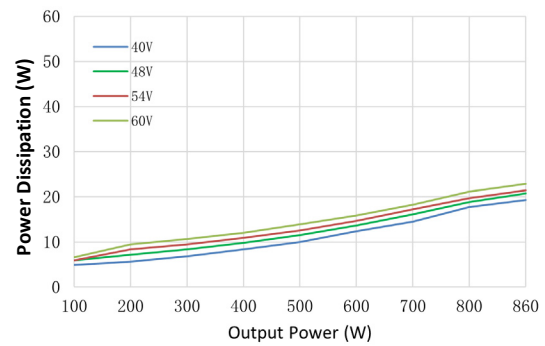
**Output Power vs. Input Voltage**



**Efficiency vs. Output Power**

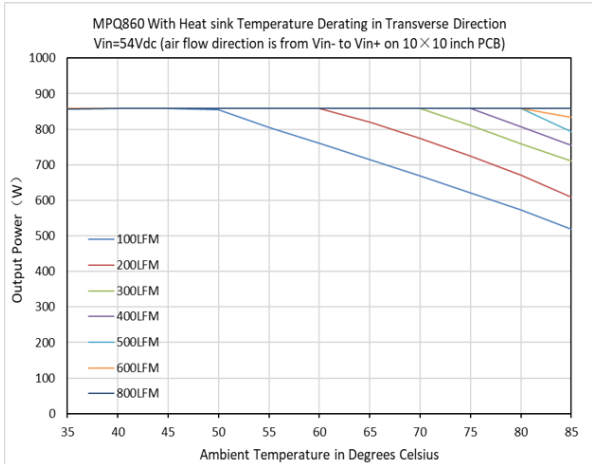


**Power Loss**

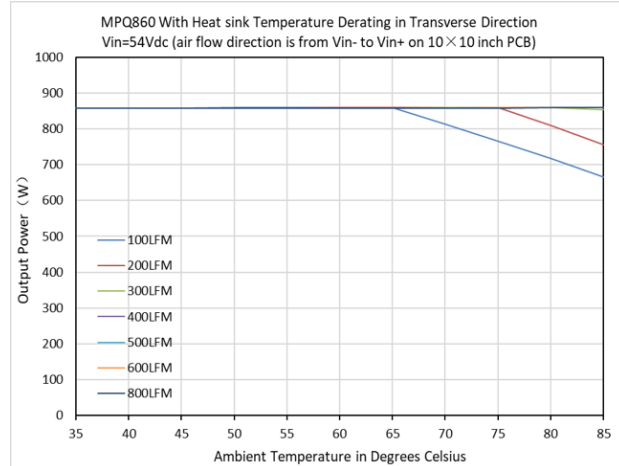


**PERFORMANCE CURVES**

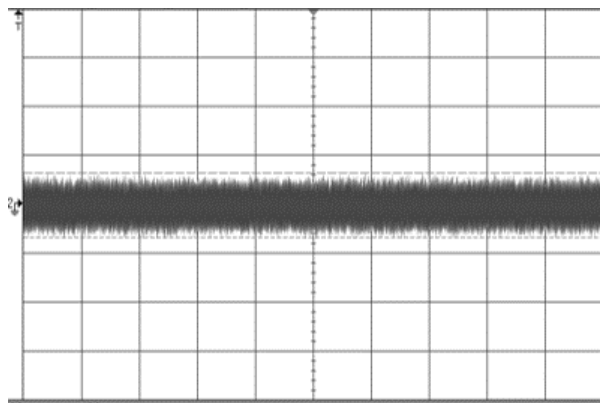
**Output Power Derating 0.5" Heatsink (Vin=54V)**



**Output Power Derating 1" Heatsink (Vin=54V)**

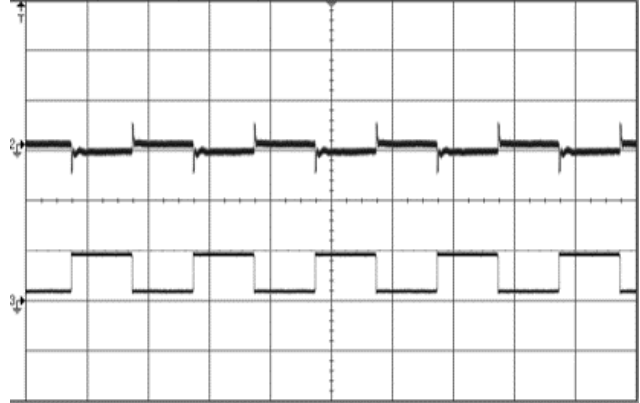


**Ripple & Noise Waveform (Vin = 54V, Iout = 71A)**



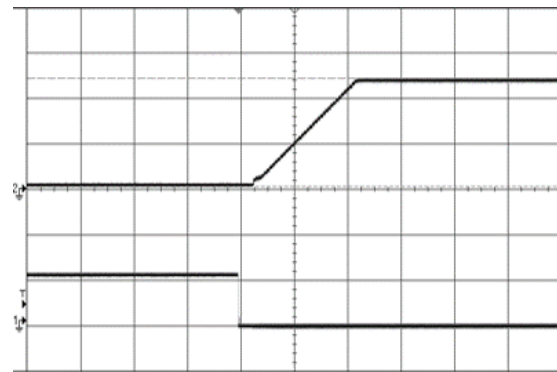
Vout:50mV/div  
Time:20ms/div

**Transient Response (Vin = 54V, 25%-75%-25% Load, 5A/μs)**



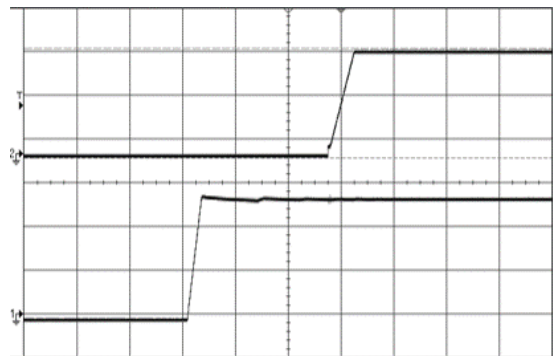
Top Trace:Vout,500mV/div  
Bottom trace:Iout,50A/div  
Time:5ms/div

**Enable Turn On – Negative Logic (Vin = 54V, Iout = 71A)**



Top Trace:Vout,500mV/div  
Bottom trace:Iout,50A/div  
Time:5ms/div

**Vin Turn On (Vin = 54V, Iout = 71A)**



Top Trace:Vout,5V/div  
Bottom trace:Vin,20V/div  
Time:20ms/div

## PMBus Monitoring Accuracy

Parameter	Notes and Conditions	Min.	Typ.	Max.	Units
<b>PMBus General</b>					
PMBus Rev. 1.2; SMBALERT# is supported; PEC is supported; Linear data format is used.					
Bus Speed			100/400		kHz
Logic High Input		2.1		3.3	Vdc
Logic Low Input		0		0.8	Vdc
Logic High Output		2.3			Vdc
Logic Low Output				0.4	Vdc
<b>PMBus Monitoring Accuracy</b>					
VIN_READ		-4		4	%
VOUT_READ		-2		2	%
IOUT_READ	Vin=54V, Io=50% ~ 100% of Io, max;	-5		5	%
	Vin=54V, Io=5% ~ 50% of Io, max;	-1.8		1.8	A
TEMP_READ		-5		5	°C

## PMBus Commands List

CMD	Command Name	SMBus Transaction Type: Writing Data	SMBus Transaction Type: Reading Data	Number Of Data Bytes	Default Value		Data limits	Unit
01h	OPERATION	Write byte	Read Byte	1	0x80			
02h	ON_OFF_CONFIG	Write byte	Read Byte	1	0b000111x1			
03h	CLEAR_FAULTS	Send byte	N/A	0	N/A			
10h	WRITE_PROTECT	Write byte	Read Byte	1	0x00			
11h	STORE_DEFAULT_ALL	Send byte	N/A	0	N/A			
12h	RESTORE_DEFAULT_ALL	Send byte	N/A	0	N/A			
15h	STORE_USER_ALL	Send byte	N/A	0	N/A			
16h	RESTORE_USER_ALL	Send byte	N/A	0	N/A			
19h	CAPABILITY	N/A	Read Byte	1	0b10110000			
1Ah	QUERY	N/A	Block Write-Block Read Process Call	1	N/A			
1Bh	SMBALERT8	N/A	Block Write-Block Read Process Call	2	N/A			
20h	VOUT_MODE	N/A	Read Byte	1	0x1A			
22h	VOUT_TRIM	Write Word	Read Word	2	0x0000	0	-3-2	V
28h	VOUT_DROPP	Write Word	Read Word	2	0x0000	0	0-25	mΩ
35h	VIN_ON	Write Word	Read Word	2	0xE928	37.0	>VIN_OFF	V
36h	VIN_OFF	Write Word	Read Word	2	0xE918	35.0	<VIN_ON	V
40h	VOUT_OV_FAULT_LIMIT	Write Word	Read Word	2	0x03C0	14.00	13.5-15.9	V
41h	VOUT_OV_FAULT_RESPONSE	Write Byte	Read Byte	1	0b10000000			

CMD	Command Name	SMBus Transaction Type: Writing Data	SMBus Transaction Type: Reading Data	Number Of Data Bytes	Default Value		Data limits	Unit
42h	VOUT_OV_WARN_LIMIT	Write Word	Read Word	2	0X0340	13.00	13.00~15.75	V
46h	IOUT_OC_FAULT_LIMIT	Write Word	Read Word	2	0XF218	87.0	0~110	A
47h	IOUT_OC_FAULT_RESPONSE	Write Byte	Read Byte	1	0x93			
4Ah	IOUT_OC_WARN_LIMIT	Write Word	Read Word	2	0xF208	80.0	0~110	A
4Fh	OT_FAULT_LIMIT	Write Word	Read Word	2	0xF230	120	0~150.0	°C
50h	OT_FAULT_RESPONSE	Write Byte	Read Byte	1	0xB8			
51h	OT_WARN_LIMIT	Write Word	Read Word	2	0xF208	110	0~150.0	°C
55h	VIN_OV_FAULT_LIMIT	Write Word	Read Word	2	0xEA00	64.0	40.0~70.0	V
56h	VIN_OV_FAULT_RESPONSE	Write Byte	Read Byte	1	0xB8			
57h	VIN_OV_WARN_LIMIT	Write Word	Read Word	2	0xE9F0	62.0	40.0~70.0	V
58h	VIN_UV_WARN_LIMIT	Write Word	Read Word	2	0xE960	37.0	30.0~70.0	V
59h	VIN_UV_FAULT_LIMIT	Write Word	Read Word	2	0xE950	35.0	30.0~70.0	V
5Ah	VIN_UV_FAULT_RESPONSE	Write Byte	Read Byte	1	0xB8			
5Eh	POWER_GOOD_ON	Write Word	Read Word	2	0x0223	8.8	6.5~10.5	V
5Fh	POWER_GOOD_OFF	Write Word	Read Word	2	0x0110	8.5	6.5~10.5	V
61h	TON_RISE	Write Word	Read Word	2	0x000A	10	0~1024	ms
78h	STATUS_BYTE	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	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	0x22			
99h	MFR_ID	N/A	Block Read	<=22	"Murata Power Solutions"			
9Ah	MFR_MODEL	Block Write*	Block Read	<=28	"MPQ860-12V72-L48#####"			
9Bh	MFR_REVISION	Block Write*	Block Read	<=6	"S00.00"			
9Ch	MFR_LOCATION	Block Write*	Block Read	<=9	"DAS-WUHAN"			
9Dh	MFR_DATE	Block Write*	Block Read	<=10	"08/23/2023"			
9Eh	MFR_SERIAL	Block Write*	Block Read	<=14	"000000001#####"			
A0h	MFR_VIN_MIN	N/A	Read Word	2	0xE900	32.0		V
A1h	MFR_VIN_MAX	N/A	Read Word	2	0xEA00	64.0		V

CMD	Command Name	SMBus Transaction Type: Writing Data	SMBus Transaction Type: Reading Data	Number Of Data Bytes	Default Value		Data limits	Unit
A2h	MFR_IIN_MAX	N/A	Read Word	2	0xF0C3	35.00		A
A3h	MFR_PIN_MAX	N/A	Read Word	2	0x1226	1300		W
A4h	MFR_VOUT_MIN	N/A	Read Word	2	0x028C	10.18		V
A5h	MFR_VOUT_MAX	N/A	Read Word	2	0x0380	14.00		V
A6h	MFR_IOUT_MAX	N/A	Read Word	2	0x2A80	100.0		A
A7h	MFR_POUT_MAX	N/A	Read Word	2	0x11F4	1200		W
A8h	MFR_TAMBIENT_MAX	N/A	Read Word	2	0xF154	85.0		°C
A9h	MFR_TAMBIENT_MIN	N/A	Read Word	2	0xF760	-40.0		°C
Adh	IC_DEVICE_ID	N/A	Block Read	26	"Microchip dsPIC33CK64MP103"			
DAh	MFR_EEPROM_ERASE	Write Word*	Read Word	2	N/A			
DDh	MFR_ON_OFF_CONFIG	Write Byte*	Read Byte	1	N/A			
DEh	MFR_POWER_GOOD_POLARITY	Write Byte	Read Byte	1	0b00000000			
DFh	MFR_BLACK_BOX_CONFIG	Write Byte	Read Byte	1	0b00000011			
E0h	MFR_READ_HISTORY_EVENTS	N/A	Block Read	32	N/A			
E1h	MFR_SET_HISTORY_EVENT_OFFSET	Write Byte	Read Byte	1	N/A			
E8h	MFR_VIN_OV_HYS	Write Word*	Read Word	2	0xE810	2.0	0~10.0	V
E9h	MFR_VIN_UV_HYS	Write Word*	Read Word	2	0xE810	2.0	0~10.0	V
EAh	MFR_TEMPERATURE_OT_HYS	Write Word*	Read Word	2	0xF028	10.0	0~20.0	°C
F6h	MFR_CALIBRATION_STATUS	N/A	Read Byte	1	N/A			
F8h	CAL_READ_VOUT	Block Write*	Block Read	4	N/A			
F9h	CAL_READ_VIN	Block Write*	Block Read	4	N/A			
FAh	CAL_READ_IOUT	Block Write*	Block Read	4	N/A			
FBh	CAL_VOUT_ADJUST	Write Word	Read Word	2	N/A			
FCCh	MFR_SUPERVISOR_PASSWORD	Block Write	N/A	N/A	N/A			

## Notes:

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

- Unit restores the entire contents of the non-volatile User Store memory when powered up.
- PEC is supported.
- Max bus speed: 400kHz.
- Linear data format used.
- Addressing: if PMBus address setting is out of the address table, default PMBus address 64d is assigned instead.



## MFR Commands

01-CFh Refer to PMBUS 1.2 Spec.

### DAh MFR\_EEPROM\_ERASE

Erase the data stored in EEPROM

### DDh MFR\_ON\_OFF\_CONFIG

Set the ON/OFF polarity

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

### DEh MFR\_POWER\_GOOD\_POLARITY

Set the POWER GOOD signal polarity

Bits	Meaning
7:1	RSVD
0	1:Negative logic, output low if Vout rises to specific value 0:Positive logic, output high if Vout rises to specific value

### DFh MFR\_BLACK\_BOX\_CONFIG

Config black box enable/disable and store mode

If overwrite function is disabled, black box only records 7 faults, then it locks and no more faults are recorded. If the overwrite function is enabled, when fault log is full, the new fault overwrites the previous fault, starting from entry 1.

Bits	Meaning
7:2	RSVD
1	Overwrite function; 1: Enable 0: Disable
0	Black box function; 1: Enable 0: Disable

**E0h MFR\_READ\_HISTORY\_EVENTS**

Read the black box stored data.

Bytes	Meaning	Bytes	Meaning
0	Event Number	16	Power On Timer Byte0
1	Status Word High Byte	17	Power On Timer Byte1
2	Status Word Low Byte	18	Power On Timer Byte2
3	Status Vout	19	Power On Timer Byte3
4	Status Iout	20	RSVD
5	Status Input	21	RSVD
6	Status Temperature	22	RSVD
7	Status CML	23	RSVD
8	READ_VIN High Byte	24	RSVD
9	READ_VIN Low Byte	25	RSVD
10	READ_VOUT High Byte	26	RSVD
11	READ_VOUT Low Byte	27	RSVD
12	READ_IOUT High Byte	28	RSVD
13	READ_IOUT Low Byte	29	RSVD
14	READ_TEMPERATURE High Byte	30	RSVD
15	READ_TEMPERATURE Low Byte	31	RSVD

**E1h MFR\_SET\_HISTORY\_EVENT\_OFFSET**

Set and Read the event offset, if you read back is x, you have to write x - 1.

**E8h MFR\_VIN\_OV\_FAULT\_HYS**

 Hysteresis of VIN\_OV\_FAULT  
recover, linear data format

**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

**F8h CAL\_READ\_VOUT**

Refer to calibration procedure file

**F9h CAL\_READ\_VIN**

Refer to calibration procedure file

**FAh CAL\_READ\_IOUT**

Refer to calibration procedure file

**FBh CAL\_VOUT\_ADJUST**

Refer to calibration procedure file

**FCb 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
3 Current Share 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
2 CML

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
5 VIN_UV_FAULT
2 IIN_OC_FAULT
1 IIN_OC_WARNING
0 PIN_OP_WARNING

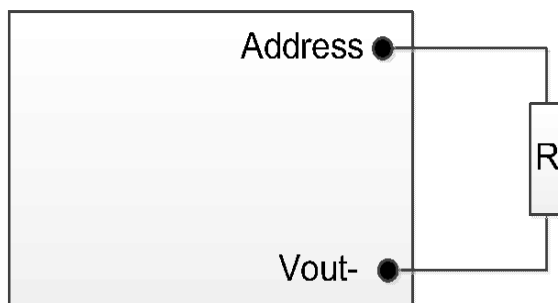
STATUS_MFR_SPECIFIC
Manufacturer Defined
Manufacturer Defined
Manufacturer Defined
Manufacturer Defined
Manufacturer Defined
Manufacturer Defined
Manufacturer Defined
Manufacturer Defined

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

## PMBus Address List

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



PMBus address is selected by applying an external resistor from the Address to Vout (-) as defined in the following table.

PMBus Address	Resistor Value (Kohm)
96	10
97	15
98	21
99	28
100	35.7
101	45.3
102	56.2
103	69.8
104	88.7
105	107
106	130
107	158
108	191
109	232
+/-1% resistor accuracy is acceptable.	

If PMBus address setting from the address table, default PMBus address 64d is assigned instead.

**PIN DEFINITION/DETAILS**

**Input/Output Pinout Table**

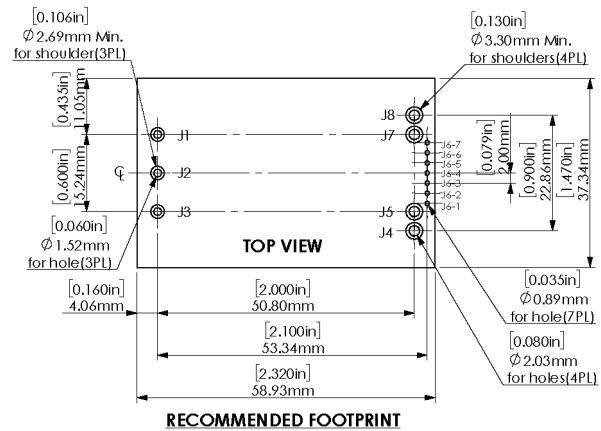
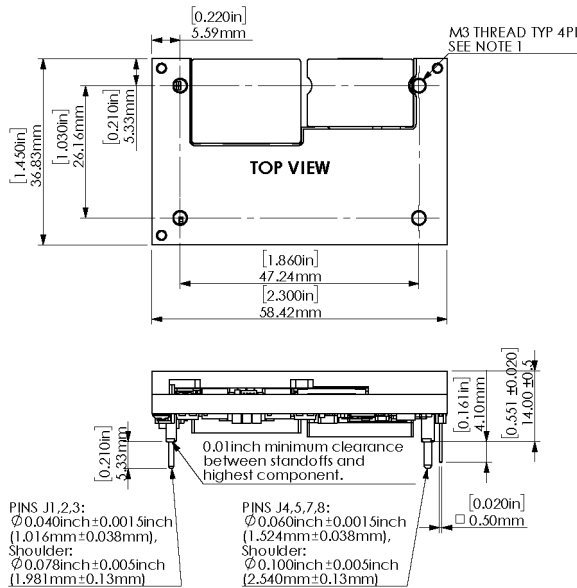
Pin #	Notes	Diameter (inches)	Length (inches)	Name	Function
J1	1,2	0.040	0.210	Vin(+)	Positive input voltage
J2	1,2	0.040	0.210	RC	Turns Unit On (low) and Off (high or open)
J3	1,2	0.040	0.210	Vin(-)	Negative input voltage
J4	1,2	0.060	0.210	Vout(-)	Negative output voltage
J5	1,2	0.060	0.210	Vout(-)	Negative output voltage
J7	1,2	0.060	0.210	Vout(+)	Positive output voltage
J8	1,2	0.060	0.210	Vout(+)	Positive output voltage
J6-1		0.020	0.161	PG	Power Good
J6-2		0.020	0.161	AGND	
J6-3		0.020	0.161	DATA	
J6-4		0.020	0.161	ALERT	
J6-5		0.020	0.161	CLOCK	
J6-6		0.020	0.161	ADDR0	
J6-7		0.020	0.161	I_SHARE_BUS	

1 Tolerance on pin diameter is  $\pm 0.0015"$ , tolerance on pin length is  $\pm 0.010"$

2 Unit's footprint on Customer's PCB will have pin holes that are 40mils larger than unit pin diameter. Design of unit must prevent unit from mounting lower on customer's PCB than intended. If pin shoulders are used for this purpose, they must be a minimum (including tolerance) of 45mils larger than unit's nominal pin diameter. Shoulder design must allow out-gassing from pin holes during customer's manufacturing process.

**MECHANICAL INFORMATION**

**Through-Hole Mount, Baseplate Version**



**NOTES:**

UNLESS OTHERWISE SPECIFIED:

1. M3 SCREW USED TO BOLT UNIT'S BASEPLATE TO OTHER SURFACES MUST NOT EXCEED 0.110" (2.8mm) DEPTH BELOW THE SURFACE OF BASEPLATE.

APPLIED TORQUE PER SCREW SHOULD NOT EXCEED 5.3in-lb (0.6Nm)

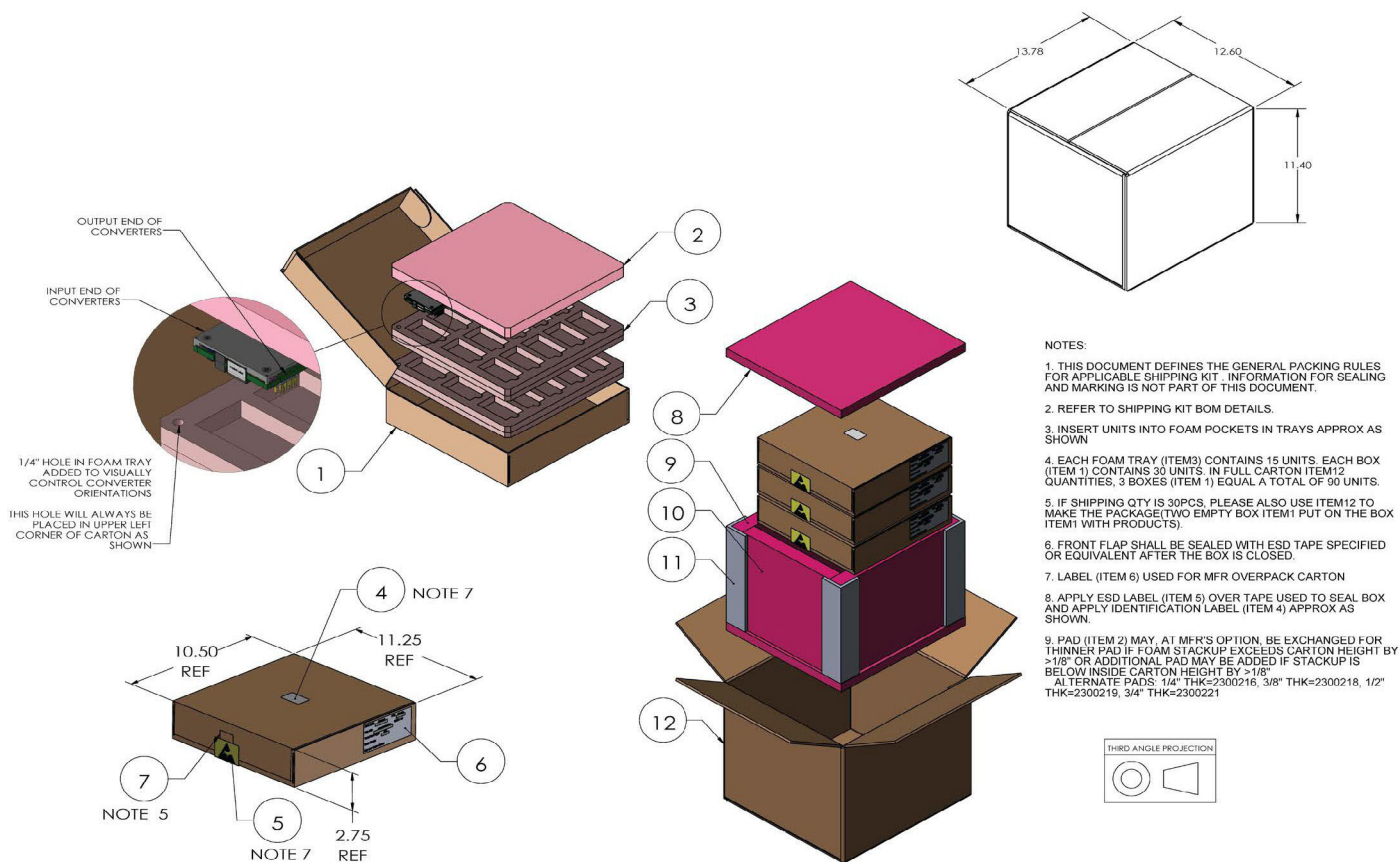
2. FOR COSMETIC SPECIFICATION AND PRODUCTION WORKMANSHIP STANDARD, PLS FOLLOW THE FILE NO. 60887.

3. ALL DIMENSIONS ARE IN INCHES (MILLIMETER).

4. ALL TOLERANCES: x.xx,  $\pm 0.02\text{in}$  (x.xmm,  $\pm 0.5\text{mm}$ ), x.xxx,  $\pm 0.01\text{in}$  (x.xmm,  $\pm 0.25\text{mm}$ ).

Pin	Designation
J1	Vin+
J2	RC
J3	Vin-
J4	Vout-
J5	Vout-
J7	Vout+
J8	Vout+
J6-1	PG
J6-2	AGND
J6-3	DATA
J6-4	ALERT
J6-5	CLOCK
J6-6	ADDR0
J6-7	I_SHARE_BUS

## PACKAGING INFORMATION


$$\text{MPQ} = 90$$

(15 units per tray, 2 trays per box, 3 boxes/cartons)

Shipping Box Dimensions = 10.0 inches x 10.0 inches x 2.5 inches

## TECHNICAL NOTES

### Through-Hole Soldering Guidelines

Murata Power Solutions recommends the specifications below when installing these converters. These specifications vary depending on the solder type. Exceeding these specifications can cause damage to the product. Your production environment can differ; therefore, 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

### Input Fusing

Certain applications and/or safety agencies might 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 currently limited. For greatest safety, Murata recommends a fast blow fuse installed in the ungrounded input supply line with a value which is approximately twice the maximum line current, calculated at the lowest input voltage. The installer must observe all relevant safety standards and regulations. For safety agency approvals, install the converter in compliance with the end-user safety standard.

### Input Under-Voltage Shutdown and Start-Up Threshold

Under normal start-up conditions, converters do not begin to regulate properly until the rising input voltage exceeds and remains at the Start-Up Threshold Voltage (see Specifications). Once operating, converters do not turn off until the input voltage drops below the Under-Voltage Shutdown Limit. Subsequent restart does 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. Be aware of input sources near the Under-Voltage Shutdown whose voltage decays as input current is consumed (such as capacitor inputs), the converter shuts off and then restarts as the external capacitor recharges. To prevent this issue, ensure the operating input voltage is above the UV shutdown voltage at all times.

### Start-Up Delay

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 regulated output voltage enters and remains within its specified regulation 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 the PWM controller at power up, thereby limiting the input inrush current. The On/Off Remote Control interval from inception to Vout regulated 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 regulation band. The specification assumes that the output is fully loaded at maximum rated current.

### Input Source Impedance

To ensure peak performance and stability of this module in all applications, the input source impedance and load conditions must be understood. The input source and load conditions will affect the performance of the module in the application. The input source must have a low impedance and to ensure this, a minimum input capacitor of 270uF is recommended, mounted as close as possible to the input pins of the module. The type of capacitor should also be considered, an electrolytic capacitor will degrade at lower temperatures therefore, the chosen capacitor should allow for temperature variations during operation of the module and maintain 270uF. If the input source is inductive, additional low ESR ceramic capacitors in the range of 22-100pF will be required across the Vin terminals to ensure stable operation. The output load also influences the minimum input capacitor requirements. Higher power, dynamic loading conditions might require higher input capacitance to ensure stable operation.

### I/O Filtering, 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. External input capacitors (Cin in the figure) serve primarily as energy storage elements, minimizing line voltage variations caused by transient IR drops in the input conductors. Users should select input capacitors for bulk capacitance (at appropriate frequencies), low ESR and high RMS ripple current ratings. In the figure below, the Cbus and Lbus components simulate a typical DC voltage bus. Your specific system configuration might require additional considerations. Note that the values of Cin, Lbus and Cbus will vary according to the specific converter model.

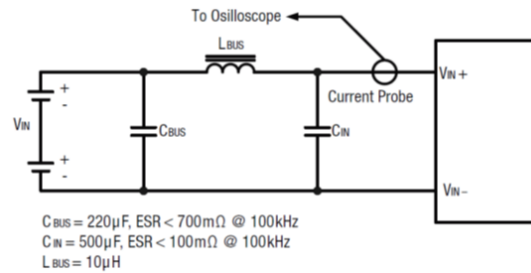


Figure 2. Measuring Input Ripple Current

In critical applications, output ripple and noise (also referred to as periodic and random deviations (PARD) can be reduced by adding filter elements such as multiple external capacitors. Be sure to calculate component temperature rise from reflected AC current dissipated inside the capacitor ESR.

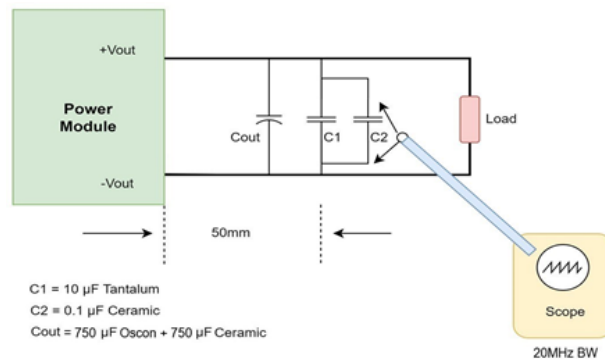


Figure 3. Measuring Output Ripple and Noise (PARD)

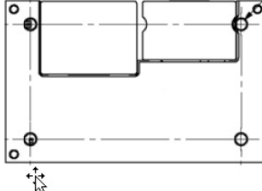
## Minimum Output Loading Requirements

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

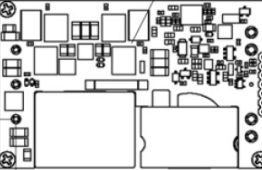
## Product Operating Temperature

Product operating temperature is used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at position. Temperature at these positions (Tref\_point) should not exceed the maximum temperature in the table below. The number of measurement points can vary with different thermal design and topology. Temperatures above maximum Tref\_point, measured at the reference point are not allowed and can cause permanent damage.

Position	Description	Maximum Temperature
Reference point	PCB Pin side	Tref_point = 125°C



Top View  
(baseplate)



Hot spot  
Bottom View  
(pin side)



### Thermal Shutdown

To protect against thermal overstress, these converters include thermal shutdown circuitry. If environmental conditions cause the temperature of the DC/DC's to rise above their 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, the converter will automatically restart. There is a small amount of hysteresis to prevent rapid on/off cycling. The temperature sensor is typically located adjacent to the switching controller, approximately in the center of the unit. See the Performance and Functional Specifications.

**CAUTION:** If you operate too close to the thermal limits, the converter might shut down suddenly without warning. Be sure to thoroughly test your application to the fan flowrate specifications.

### Temperature Derating Curves

The graphs in this datasheet illustrate a 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 accepts 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 very low flow rates (below about 25 LFM) are similar to "natural convection," that is, not using fan-forced airflow.

Murata Power Solutions performs characterization measurements in a closed cycle wind tunnel with calibrated airflow. Both thermocouples and an infrared camera system are used 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 might 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 Current Limiting

As soon as the output current increases to approximately 125% to 150% of its maximum rated value, the DC/DC converter shall enter current limiting mode. The output voltage shall decrease proportionally with increase in output current, thereby maintaining a somewhat constant power output. This is also commonly referred to as power limiting.

Current limiting inception is defined as the point at which full power falls below the rated tolerance. See the Performance/Functional Specifications. Note particularly that the output current might briefly rise above its rated value in normal operation as long as the average power is not exceeded. This enhances reliability and continued operation of your application. If the output current is too high the converter shall enter short circuit protection.

### Output Short Circuit Protection

When a converter is in current-limit mode, the output voltage will drop as the output current demand increases. If the output voltage drops too low (approximately 98% of nominal output voltage for most models), the magnetically coupled voltage used to develop the PWM bias voltage will also drop, thereby shutting down the PWM controller.

Following a time-out period, the PWM will restart, causing the output voltage to begin rising to its appropriate value. If the short-circuit condition persists, another shutdown cycle will initiate. This rapid on/off cycling is called "hiccup mode." The hiccup cycling reduces the average output current, thereby preventing excessive internal temperatures and/or component damage.

The "hiccup" system differs from older latching short circuit systems because you do not have to power down the converter to make it restart. The system will automatically restore operation as soon as the short circuit condition is removed.

### Remote On/Off Control

On the input side, a remote On/Off Control can be used with negative logic.

**Negative:** Models with negative logic are on (enabled) when the On/Off is grounded or brought to within a low voltage (see Specifications) with respect to  $-V_{in}$ . The device is off (disabled) when the On/Off is left open or is pulled high to approximately +15V with respect to  $-V_{in}$ .

Dynamic control of the On/Off function should be able to sink the specified signal current when brought low and withstand appropriate voltage when brought high. Be aware that there is a finite time in milliseconds (see Specifications) between the time of On/Off Control activation and a stable, regulated output. This time varies slightly with output load type and current and input conditions.

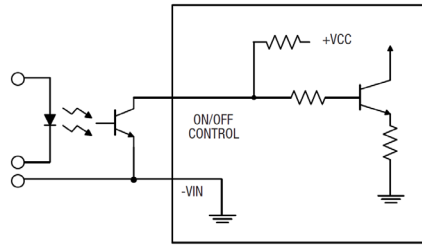


Figure 4. Driving the On/Off Control Pin (suggested circuit)

## 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 step loads. Install only enough capacitance to achieve noise objectives. Excess external capacitance may cause regulation problems, slower transient response and possible instability. Proper wiring of the Sense inputs will improve these factors under capacitive load.

The maximum rated output capacitance and ESR specification is given for a capacitor installed immediately adjacent to the converter. Any extended output wiring or smaller wire gauge or less ground plane can tolerate somewhat higher capacitance. Also, capacitors with higher ESR might use a larger capacitance.

## Load Sharing

Load sharing occurs when two or more MPQs are connected in parallel, at both the input and output terminals, to supply greater output current than one unit alone or to offer system redundancy for moderate loads. If one converter fails, the other converter(s) carry the load until the system is repaired.

The MPQs design allows load sharing using the active current share method. Compared to using traditional droop load sharing (DLS), it enables better thermal balance between load and sharing units. This is due to the higher accuracy achieved by active current sharing, and the fact that each unit can deliver higher output power in parallel mode. At light loads, the converter exhibits slightly higher output voltage and carries more of the output current. Since the MPQ's synchronous rectifier design does not accept appreciable reverse output current, starting at zero load, the MPQ with the higher output voltage carries more of the full load until the voltage at the output drops to that of the lower MPQ's.

## Load Sharing Guidelines

If you want to operate two or more MPQ's in load sharing, use the following guidelines:

[1] Operate both converters connected in parallel from the same 48V input power source. This simplifies the design and makes for more balanced power sharing. Using two different 48V input supplies must be carefully analyzed to avoid overloading one of the converters and is not recommended. Make sure the single 48V input source can supply the total current needed by all the parallel-connected MPQ's. (It is possible to rate the full system at more than the current capacity of a single MPQ. However, you lose the redundancy protection feature.)

[2] Use conservative loading. Do not assume for example that two parallel MPQ's can always supply "times two" amounts of output current. Allow for limits in input voltage and other factors. The maximum load of the paralleled modules equals to (max load of single module-6.25A) \* number of paralleled modules. The maximum load during ramp up is still limited to number of modules x maximum load of single module x 90% (modules x Ioutmax x 0.9).

If one MPQ overloads while in load share, it protects itself by entering overcurrent mode. If the whole system is running close to maximum output current, the remaining good MPQ soon enters overcurrent mode. These two events might not happen together, possibly leaving the system operating in degraded mode for a while. The solution is conservative design to avoid getting close to the load limits.

[3] Make the input wiring lengths and wire gauges identical on both inputs and outputs. If in doubt, make some precision measurements under full load. If you attempt to measure the current in one of the converters using a series shunt, the current meter might introduce enough finite resistance to affect the readings. (Note: Use a non-contacting "clamp-on" Hall effect DC current meter with zero IR loss.)

[4] If you add the optional input filters, use identical components with the same layout.

[5] Operate both converters in the same temperature and airflow environment. Under load sharing, small differences in cooling can amplify into load imbalances.

[6] Avoid operation near the low input voltage limit of the converter. Another subtle factor here is the external source impedance of the input supply. A source with higher impedance at full load might make the net input voltage seen by the converter close to its minimum input voltage. Be sure to account for the decrease in effective input voltage under load.

For battery sources, this means that the batteries should be freshly charged and that the AC trickle charger is in good working order. Note that older batteries increase their internal cell impedance even if their no-load output voltage appears acceptable. What counts is the voltage seen at the MPQ input connections with full current.

[7] As with any system design, thoroughly test the MPQ's connected in load sharing before committing the design to a real application.

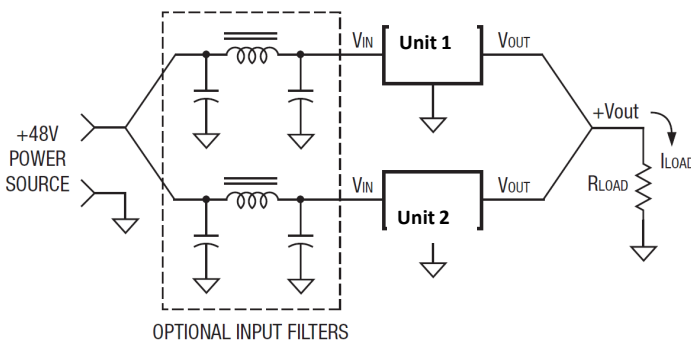
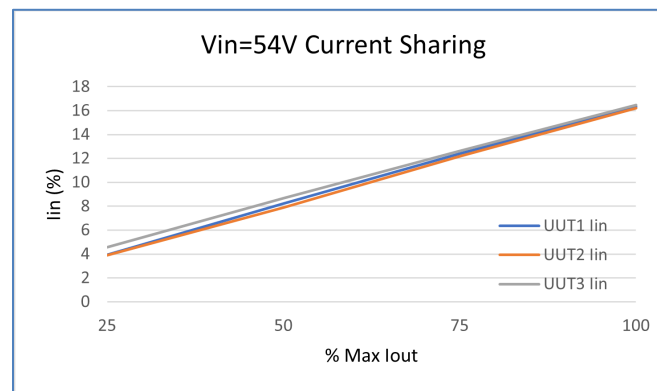


Figure 5. Load Sharing Block Diagram

The following table details the test results of units in parallel. Murata Power Solutions can meet 10% accuracy of current share. For 54Vin, the module operates in closed loop.

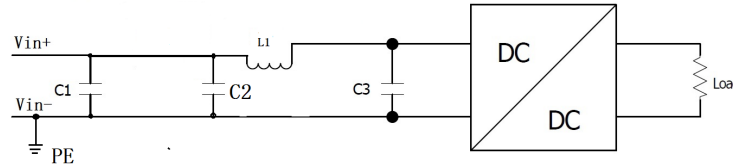
Current Share - Three Units in Parallel Test									
Vin	Io Load (A)	Io Load (%)	UUT1 Iin	UUT2 Iin	UUT3 Iin	Input Rating(A) (Po=860W)	I1 Load %	I2 Load %	I3 Load %
54	54	25	3.918	3.909	4.565	15.412	-1.37988	-1.43827	2.81815
54	108	50	8.227	7.879	8.669	15.412	-0.20330	-2.46129	2.66459
54	162	75	12.385	12.175	12.617	15.412	-0.04758	-1.41016	1.45774
54	213	100	16.332	16.192	16.480	15.412	-0.01730	-0.92569	0.94299



## Emissions Performance

Murata Power Solutions measures its products for conducted emissions against the EN 55032 and CISPR 32 standards. Passive resistance loads are employed and the output is set to the maximum voltage. If you set up your own emissions testing, ensure the output load is rated at continuous power while doing the tests.

The recommended external input and output capacitors (if required) are included. Refer to the fundamental switching frequency. This information is detailed in the product specifications. An external discrete filter is installed and the circuit diagram is shown below.



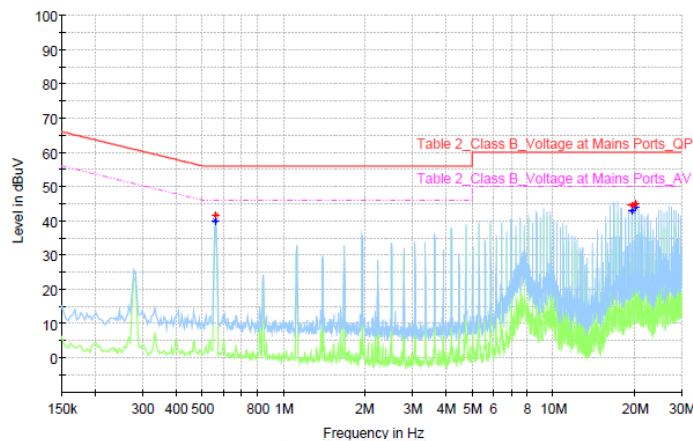
### [1] Conducted Emissions Parts List

Reference	Description
C1	270 $\mu$ F*2 (OS-CON Cap)
C2	10 $\mu$ F*4 (MLCC) + 4.7 $\mu$ F*2 (MLCC)
C3	4.7 $\mu$ F*2 (MLCC) + 1.2mF (OS-CON Cap)
L1	22 $\mu$ H

### [2] Conducted Emissions Test Equipment Used

- Hewlett Packard HP8594L Spectrum Analyzer (s/n: 3827A00153)
- 2Line V-networks LS1-15V 50 $\Omega$ /50U Line Impedance Stabilization Network

### [3] Conducted Emissions Test Results – Negative Line



Conducted Emissions Test Results, Positive Line  
CISPR 32, 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 depends on the user's PC board layout, the chassis shielding environment, and choice of external components. Since many factors affect both the amplitude and spectra of emissions, Murata Power Solutions recommends using an engineer who is experienced with emissions suppression.

### 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.

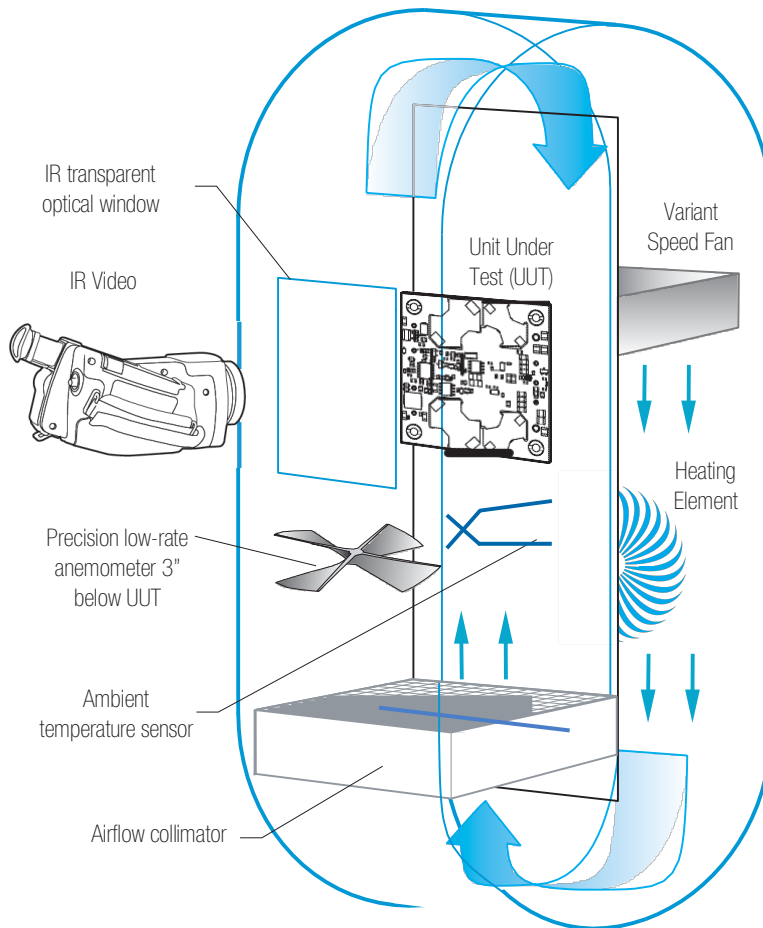
The IR camera monitors the thermal performance of the Unit Under Test (UUT) under static steady-state conditions. A special optical port is used which is transparent to infrared wavelengths.

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. 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.



**Figure 6. Vertical Wind**

